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December 1–6 | McCormick Place, Chicago

SSA01

Breast Imaging (Artificial Intelligence in Screening)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S406A

AI BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Shandong Wu, PhD, MSc, Philadelphia, PA (*Moderator*) Nothing to Disclose
John M. Lewin, MD, Denver, CO (*Moderator*) Nothing to Disclose

Sub-Events

SSA01-01 Using Deep Learning to Improve Efficiency of Breast Cancer Tomosynthesis Screening

Sunday, Dec. 1 10:45AM - 10:55AM Room: S406A

Participants
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PURPOSE

Digital breast tomosynthesis (DBT) has higher diagnostic accuracy than 2D digital mammography (MG) and is becoming widely available. However, DBT interpretation time, with 200-400 slices per exam, is significantly longer than MG's. Over 90% of screening exams are normal, so automation is desirable. This study explores using deep learning to filter out a portion of the normal DBT studies, allowing radiologists to focus on the more complex cases and improve their efficiency.

METHOD AND MATERIALS

This study was IRB approved and HIPPA compliant. It comprises 5,000 women who presented for screening DBT between 2013 and 2017. The de-identified data set includes prior exams, reaching 12,500 tomosynthesis screening exams accompanied by clinical information. For ground truth, we gathered 2899 screening exams with biopsy performed within 180 days of the screening exam (1064 malignant, 1835 benign) and normal exams that had 2 years follow up. In addition to breast-level labels indicating benign or malignant findings, we labeled the slice number in which the lesion is seen best, the range of slices that the lesion is seen in and graphical annotation overlaid on the 'best' slice. We developed a binary classifier of normal vs. undecided. We used a deep learning network, RetinaNet, utilizing a Feature Pyramid Network backbone, a proven architecture for detecting objects on different scales. We trained this network using the findings annotations, while customizing several aspects of the architecture to handle DBT inputs.

RESULTS

The target was to filter out a portion of the normal exams (i.e. exams without malignant or benign biopsy) keeping a false negative rate that is equivalent to radiologists. Our network succeeds to filter 37% of the normal exams (i.e. 37% specificity) with 97% sensitivity. The area under the ROC curve was 0.84 for this task.

CONCLUSION

By using one of the largest reported tomosynthesis dataset with biopsy-proven results, our study demonstrates the potential of A.I to reduce interpretation workload.

CLINICAL RELEVANCE/APPLICATION

One important practical issue related to DBT implementation is the longer interpretation time. Reducing the workload of reading normal exams can improve radiologist's efficiency.

SSA01-02 A Fully Representative Breast Cancer Screening Population for Validation of AI Algorithms

Sunday, Dec. 1 10:55AM - 11:05AM Room: S406A

Participants
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PURPOSE

AI algorithms are being developed for mammographic breast cancer detection and risk estimation. Algorithms should be validated in independent well-curated datasets. There has been a lack of fully representative datasets until now. Our aim was to provide an accessible infrastructure with a dataset representative of a true geographical screening population.

METHOD AND MATERIALS

From a geographically defined screening cohort of women 40 to 74 years old between 2008 and 2016, we included all first incident cancer cases and a random selection of 10,000 healthy controls. Information was linked between the screening register, the cancer register and the PACS. All screening examinations, with two views of each breast, were included. After data curation all information was anonymized and transferred to local storage. Tumors were annotated at pixel-level. Access to the final dataset has currently been offered to one external research group working on AI CAD for tumor detection. Their algorithm provided one prediction score for each examination.

RESULTS

Our case-control dataset included 1,303 cancer cases (10,732 mammograms) and 10,000 healthy controls (116,048 mammograms). The histological origin of cancer was 70% ductal, 10% lobular and 20% mixed or other. There were 36% invasive-only, 11% in situ-only and 53% mixed cancers. Pixel-level annotations were produced for 898 women (1,891 images). The first validated external algorithm was processed in less than 3 days. It showed an AUC of 0.958 (95%CI: 0.954 to 0.962) using the ground truth of pathologically confirmed diagnosis within 12 months of examination. The level of performance was similar for both invasive and in situ cases.

CONCLUSION

Our comprehensive case-control dataset representative of a true breast cancer screening population was used to validate the first external AI CAD algorithm showing very good accuracy. The dataset will remain available for validation of algorithms from further external research groups.

CLINICAL RELEVANCE/APPLICATION

Having access to a comprehensive dataset representative of a true screening population will improve the ability to train and test AI tools that are clinically reliable.

SSA01-03 Increase of Cancer Detection Rate and Reduction of False-Positive Recall in Screening Mammography Using Artificial Intelligence: A Multi-Center Reader Study

Sunday, Dec. 1 11:05AM - 11:15AM Room: S406A

Participants
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PURPOSE

To assess feasibility of artificial intelligence (AI) based diagnostic-support software whether it can be used to improve radiologists' diagnostic performance in terms of cancer detection and false-positive recall in breast cancer screening.

METHOD AND MATERIALS

A total of 400 exams of screening mammograms were retrospectively collected from two institutions. For each institution, 100 cancer, 40 benign, and 60 normal exams were collected. All cancer exams were proven by biopsy. Half of the benign exams were proven by biopsy (i.e. recalled benign) while the remainder were proven by at least 2 years of follow-up imaging. 80% of the exams were randomly selected respectively from each category and each institution (e.g., 16 recalled benign for each institution). All exams were 4-view paired. A blinded multi-reader multi-case study was performed with a group of 14 radiologists for the selected 320 exams. Each radiologist reads each case without and then with aid of Lunit INSIGHT for Mammography (Lunit Inc., South Korea), a deep learning-based software which shows per-breast malignancy scores as well as region-of-interests (ROIs) for suspicious malignant lesions (Fig.1). The difference of readers' decision without and with AI in terms of likelihood-of-malignancy (LOM; DMIST 7-pt score) and recall-ness (recall or not) was analyzed.

RESULTS

Significant improvement of diagnostic performance was shown for all 14 radiologists; average LOM-based ROC AUC was 0.810 and 0.881 without and with AI, respectively (p-value=0.0000047, C.I.=95%). Based on readers' binary decision whether each exam should be recalled or not, average cancer detection rate was increased from 75.3% to 84.8% while false-positive recalls (i.e. non-cancer recalls) were decreased from 28.0% to 25.4% where 20% of non-cancer exams were recalled benign cases.

CONCLUSION

This reader study showed a statistically significant improvement of diagnostic performance (0.071 increase in ROC AUC). Cancer detection rate was increased by 12.6% and false-positive recall rate was decreased by 9.6% with assistance of AI-based diagnostic-support software.

CLINICAL RELEVANCE/APPLICATION

With increase of cancer detection rate and decrease of false-positive recall rate, AI-based diagnostic-support software can be practically used in routine breast cancer screening.

SSA01-04 Can Artificial Intelligence Be Used as a Standalone Technique for Very Low Probability for Malignancy Mammograms?

Sunday, Dec. 1 11:15AM - 11:25AM Room: S406A

Participants
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PURPOSE

The purpose of this study was to determine if an Artificial Intelligence (AI) trained algorithm can be potentially used for standalone interpretation of very low probability for malignancy mammograms. It has been shown that the accuracy of AI based algorithms for 2D mammography can match or exceed the accuracy of the average radiologist. This study was performed to evaluate the accuracy of an AI based software (cmTriage, CureMetrix, Inc.) on a large data set of screening mammograms when set to a 99% sensitivity threshold (95% CI = [0.98, 1.0].

METHOD AND MATERIALS

A case based AI base algorithm was used to analyze 1255 screening mammograms obtained from 3 different imaging facilities. The exams were comprised of a blend of cases that had biopsy-confirmed malignant lesions as well as at least two year followup on the non-biopsied cases as validation of benignity. The thresshold of the software was set to 99% sensitivity. The number of cases that were assigned to very low probability of malignancy was calculated and then compared to the final classification of those cases

RESULTS

Out of the pool of screening cases, 40% of the cases were categorized as not suspicious by the algorithm. Comparison with the biopsy and/or long term followup showed that there were no cancers detected in the cases that were categorized as not suspicious by the triage software. In addition, 99% of the biopsy proven cancers were sorted into the suspicious category by the algorithm.

CONCLUSION

The AI based triage software was shown to be accurate in pre-analyzing mammograms and correctly sorted 99% of the malignant cases into the suspicious category and 40% of the non-malignant cases into the non-suspicious category. This suggests that the high sensitivity threshold setting of the AI-based algorithm could potentially be used to eliminate some very low probability of malignancy mammograms from the radiologist worklist

CLINICAL RELEVANCE/APPLICATION

Pre-analysis of mammograms using AI based triage software can potentially enhance radiologist workflow, productivity, and accuracy. Using high sensitivity thresshold, it is possible that AI based software could potentially be used as a standalone to eliminate very low probability for malignancy cases from the radiologist worklist.

SSA01-05 Data-Driven Imaging Biomarker for Breast Cancer Screening in Digital Breast Tomosynthesis: Multi-Domain Learning with Mammography

Sunday, Dec. 1 11:25AM - 11:35AM Room: S406A

Participants
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PURPOSE

To assess feasibility whether mammography data is helpful for developing data-driven imaging biomarker in digital breast tomosynthesis (DIB-DBT; an imaging biomarker for detection of breast cancer, which is derived from DBT data based on deep learning technology).

METHOD AND MATERIALS

A total of 1,517 exams of 4-view digital breast tomosynthesis (DBT) and 49,577 exams of 4-view digital mammograms (MMG) were retrospectively collected from an institution. We divided 1,517 exams of DBT into 1,187 (970 cancer, 52 benign, 165 normal) and 330 (244 cancer, 34 benign, 52 normal) exams for training and validation, and 49,577 exams of MMG into 47,719 (5,599 cancer, 17,971 benign, 24,149 normal) and 1,858 (619 cancer, 620 benign, 619 normal) exams for training and validation, respectively. For external validation, we also collected 448 exams (148 cancer, 150 benign, and 150 normal) of 4-view DBT from another institution. Previously, we demonstrated that using DBT and MMG concurrently is effective for developing DIB-DBT, where it was first trained with (large-scale) MMG then fine-tuned with (small-scale) DBT. We further aimed to enhance the utilization of MMG by multi-domain learning to boost the performance of DIB-DBT. Two-stage training was adopted - 1) pre-training with MMG, followed by 2) multi-domain fine-tuning with both of DBT and MMG. A total of four different approaches was compared in order to find the best way to exploit MMG for developing DIB-DBT - (a) training only with DBT, (b-d) training with MMG and then fine-tuning with (b) DBT (previous work), (c) DBT and MMG, (d) DBT and MMG by multi-domain learning.

RESULTS

Per-exam AUC of DIB-DBT on the internal validation dataset was 0.890, 0.899, 0.901, 0.910 for each method of (a-d) respectively, while per-exam AUC on the external validation dataset was 0.871, 0.880, 0.899, 0.901 for (a-d) respectively. Fig. 1 shows an

example of DIB-DBT (i.e. (d)).

CONCLUSION

This study demonstrated that multi-domain learning with large-scale MMG is an effective way for developing DIB-DBT especially with small-scale DBT. Further clinical validation is needed to utilize DIB-DBT as a reliable diagnostic-support tool for breast cancer detection.

CLINICAL RELEVANCE/APPLICATION

With further clinical validation, DIB-DBT could be practically used as an effective diagnostic-support tool for breast cancer screening in digital breast tomosynthesis

SSA01-06 Data-Driven Imaging Biomarker for Breast Cancer Screening in Mammography: Early Detection of Breast Cancer

Sunday, Dec. 1 11:35AM - 11:45AM Room: S406A

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PURPOSE

To assess feasibility of data-driven imaging biomarker in mammography (DIB-MMG; an imaging biomarker derived from large-scale mammography data based on deep learning technology) whether it can be used for early detection of breast cancer.

METHOD AND MATERIALS

A total of 105,592 exams of 4-view digital mammograms were retrospectively collected from multiple institutions for developing DIB-MMG, where 22,456 were cancer (confirmed by biopsy), 36,821 were benign (confirmed by biopsy or at least 1 year of follow-up imaging), and 46,315 were normal exams. Based on external validation in a separate institution with 3,696 exams of mammograms (1,073 were cancer; one for each patient), DIB-MMG showed 0.963, 94.1%, 80.2% of AUC, sensitivity, specificity, respectively. Among the 1,073 cancer patients, 85 patients had 116 exams of prior mammograms which were diagnosed as non-cancer at that time. A breast radiologist retrospectively reviewed the 116 exams and re-classified into three categories - 1) Missed (46 exams; 47 cancer / 45 non-cancer breasts): retrospectively seen in previous mammogram (mmg-p) and also seen in mammogram at diagnosis (mmg-d), 2) Interval (55; 61/49): retrospectively not seen in mmg-p but seen in mmg-d, and 3) Occult (15; 17/13): not seen both in mmg-p and mmg-d. DIB-MMG was analyzed for the Missed, Interval, and Occult cancers, respectively.

RESULTS

Per-breast AUC, sensitivity, specificity were used since all the data is positive in exam-level. Per-breast AUC was 0.841, 0.676, 0.620 for the Missed, Interval, Occult, respectively. Sensitivity (w/ specificity) at different operating points 0.05, 0.10 were 68.1% (88.9%), 55.3% (91.1%) for Missed, 49.2% (83.7%), 37.7% (91.8%) for Interval, and 41.2% (69.2%), 17.7% (84.6%) for Occult, respectively. Original operating point of DIB-MMG for routine screening was 0.10. Fig.1 shows examples of the Missed and Interval cancers.

CONCLUSION

This retrospective study showed feasibility of DIB-MMG for early detection of breast cancer on mammography, where 32 out of 47 missed cancers, 30 out of 61 interval cancers, 7 out of 17 occult cancers were detected by DIB-MMG. Overall AUC was 0.738. Further clinical validation with observer performance study is needed.

CLINICAL RELEVANCE/APPLICATION

With further clinical validation, DIB-MMG can be used as an effective diagnostic-support tool for early detection of breast cancer in screening mammography.

SSA01-07 Improved Breast Cancer Detection and Reading Time with Concurrent Use of Deep Learning-Based Artificial Intelligence for Digital Breast Tomosynthesis When Interpreted with Digital Mammography versus Synthetic Mammography

Sunday, Dec. 1 11:45AM - 11:55AM Room: S406A

Participants
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PURPOSE

To evaluate improvements in accuracy and reading time associated with concurrent use of Artificial Intelligence (AI) with Digital Breast Tomosynthesis (DBT) based on 2D image type combined with DBT.

METHOD AND MATERIALS

Twenty-four (24) radiologists participated in a retrospective reader study with 260 DBT exams, interpreting with Digital Mammography (DM/DBT) in 195 cases, including 43 cancer and 152 non-cancer cases and with Synthetic Mammography (SM/DBT) in 65 cases, including 22 cancer and 43 non-cancer cases. A crossover design was used to read all exams with and without AI with a 4-week washout period. Suspicious soft tissue and calcific lesions were detected in DBT slices by an AI system based on deep convolutional neural networks. Readers were provided detection outlines and 0-100% AI certainty of finding scores. Endpoints included Area Under the ROC Curve (AUC) requiring localization of malignant lesions, sensitivity, specificity and reading time, and were evaluated with AI versus without AI separately for DM/DBT and SM/DBT.

RESULTS

AUC improved for both 2D formats with AI versus without AI: 0.067 increase for DM/DBT (95% CI: 0.026, 0.108) from 0.781 without AI to 0.848 with AI; 0.034 increase for SM/DBT (95% CI: -0.001, 0.070) from 0.812 without AI to 0.846 with AI.Case-level sensitivity improved for both 2D formats with AI versus without AI: 0.092 increase for DM/DBT (95% CI: 0.017, 0.166) from 0.735 without AI to 0.827 with AI; 0.057 increase for SM/DBT (95% CI: 0.011, 0.103) from 0.839 without AI to 0.896 with AI.Specificity improved for both 2D formats with AI versus without AI: 0.080 increase for DM/DBT (95% CI: 0.039, 0.120) from 0.657 without AI to 0.737 with AI; 0.031 increase for SM/DBT (95% CI: -0.028, 0.090) from 0.522 without AI to 0.553 with AI.Reading time was shorter for both 2D formats with AI versus without AI: 29.2 sec with AI and 65.1 sec without AI for DM/DBT; 34.0 sec with AI and 61.2 sec without AI for SM/DBT. Reading time improved 55.1% with use of AI (95% CI: 44.5%, 63.7%) for DM/DBT and 44.4% (95% CI: 31.7%, 54.7%) for SM/DBT.

CONCLUSION

The use of AI with DBT improved AUC, sensitivity, specificity and reading time when reading DBT with digital or with synthetic 2D.

CLINICAL RELEVANCE/APPLICATION

Radiologist's breast cancer detection performance and efficiency improve with concurrent use of AI for DBT with digital or synthetic 2D.

SSA01-08 Artificial Intelligence Detecting Breast Cancer in a Screening Population: Accuracy, Earlier Detection on Prior Mammograms, and Relation with Cancer Grade

Sunday, Dec. 1 11:55AM - 12:05PM Room: S406A

Participants
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PURPOSE

To analyze the breast cancer detection accuracy of a deep learning-based artificial intelligence (AI) system in screening mammograms of screen-detected cancers, in their prior exams, and study possible dependencies with cancer grade.

METHOD AND MATERIALS

A total of 2,683 screening mammograms with biopsy-proven screen-detected cancers from the OPTIMAM database were retrospectively collected (1,212 had a prior mammogram available). OPTIMAM contains screening mammograms performed in the UK, where women are invited triennially, and each mammogram is independently read by two radiologists with an approximate recall rate of 4%. Regarding the available histology of the screen-detected cases, 1969 presented invasive cancers and 670 contained DCIS only; 1001 presented high-grade (G3) cancers, 1186 intermediate-grade (G2) cancers, and 314 low-grade (G1) cancers. Each mammogram was analyzed by an AI system (Transpara™, ScreenPoint Medical). The AI system produced a recall decision at different recall rates: 50%, 10%, 4%. Recall rate calibration was established for a typical screening population with another set of independent data. The mammograms in this study were never used to train, validate or test the AI system before. The distributions of recalled mammograms were statistically compared using Pearson's chi-squared test at 95% significance level.

RESULTS

The AI system had a sensitivity for screen-detected cancers of 99.3%, 87.7% and 76.1% at recall rates of 50%, 10%, and 4% respectively. When analyzing prior screening mammograms of screen-detected cancers, 16.8% would have been recalled by the AI system at a recall rate of 4%. There were significative differences when stratifying by cancer grade: at a recall rate of 4%, a greater proportion of the high-grade than low-grade cancers were recalled by the AI (80.7% G3 versus 68.2% G1, $P<0.001$).

CONCLUSION

The AI system achieves a high sensitivity at a recall rate of 50%, meaning that it could discriminate 50% of the screening population as being almost certainly normal, it has potential to detect cancers earlier, while sensitivity is higher for high-grade cancers than for low-grade.

CLINICAL RELEVANCE/APPLICATION

AI systems have great potential to assist radiologists in breast cancer screening by improving efficiency (reduced workload) and/or performance (earlier detection).

SSA01-09 The Effect of Chemoprevention Agents on Convolutional Neural Network-Based Breast Cancer Risk Model Using a Mammographic Dataset

Sunday, Dec. 1 12:05PM - 12:15PM Room: S406A

Participants
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PURPOSE

We have previously developed and published a novel convolutional neural network (CNN) derived pixel-wise breast cancer risk model using a mammographic dataset. Purpose of this study is to evaluate whether this risk model is modifiable with known chemoprevention regimen (tomoxifen and aromatase inhibitor therapy).

METHOD AND MATERIALS

An IRB approved study identified 558 high risk patients defined as history of atypia or DCIS diagnosed on core needle biopsy. Of 558 patients, 194 patients (group 1) underwent breast cancer risk reducing chemoprevention regimen (tamoxifen or aromatase inhibitor therapy) for a median of 3 years (range 1 - 5 years). 354 patients (group 2) did not undergo chemoprevention regimen. For each group mammographic dataset was composed of two time points (baseline and follow-up). Mammographic dataset was used for CNN based breast cancer risk prediction based on our previously published study. Briefly, each mammogram was normalized as a map of z-scores and resized to an input image size of 256x256. Then a contracting and expanding fully convolutional CNN architecture was composed entirely of 3x3 convolutions, a total of four strided convolutions instead of pooling layers, and symmetric residual connections. L2 regularization and augmentation methods were implemented to limit over-fitting. Statistical analysis was performed comparing group 1's risk reduction following chemoprevention regimen predicted by our CNN risk model compared to group 2 which did not undergo chemoprevention regimen.

RESULTS

Using our CNN based breast cancer risk model, the 194 patients in the treatment group (group 1) showed 20.5% in absolute risk reduction and 32.5% in relative risk reduction. 364 patients in the non-treatment group (group 2) showed 3.5% in absolute risk reduction and 6.5% in relative risk reduction. The absolute risk reduction and relative risk reduction between group 1 and group 2 were statistically significant (p=0.01 and p=0.001).

CONCLUSION

Our CNN based algorithm can predict breast cancer risk, and is modifiable with known chemoprevention regimen.

CLINICAL RELEVANCE/APPLICATION

Potential effectiveness of breast cancer chemoprevention agents may be assessed utilizing our CNN based risk prediction model based on mammographic images.

Printed on: 10/29/20

SSA02

Breast Imaging (MRI Diagnostics)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S402AB

BR MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Mami Iima, MD, PhD, Kyoto, Japan (*Moderator*) Nothing to Disclose
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Sub-Events

SSA02-01 High-Risk Lesions Detected by MRI-Guided Core Biopsy: Upgrade Rates at Surgical Excision and Implications for Management

Sunday, Dec. 1 10:45AM - 10:55AM Room: S402AB

Participants
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PURPOSE

To assess clinical and imaging characteristics of high-risk lesions detected by MRI-guided core biopsy and to evaluate upgrade rates to carcinoma at surgical excision

METHOD AND MATERIALS

A retrospective review was performed for all women presenting to an academic breast radiology center for MRI-guided biopsy from January 2015 - November 2018. Histopathological results from each biopsy were extracted, and high-risk lesions [atypical ductal hyperplasia (ADH), lobular carcinoma in situ (LCIS), atypical lobular hyperplasia (ALH), radial scar, papilloma, flat epithelial atypia (FEA), and benign vascular lesion] were included for analysis. Clinical history, imaging characteristics, surgical outcome following excision, and follow-up data were also recorded. If the lesion was excised in a mastectomy specimen or a lumpectomy specimen with a known cancer, then upgrade status was deemed indeterminate and not included in the upgrade rate calculation. Rigorous radiologic pathologic correlation was performed of upgraded lesions to determine whether biopsy results were concordant and the lesion was adequately sampled.

RESULTS

Of 810 MRI-guided biopsies, 189 biopsies (23.3%) met inclusion criteria as high-risk lesions. Excluded were 151 (18.6%) malignant and 470 (58.0%) benign lesions. Mean patient age of the included patients was 58.4 years (range 30-83). Upgrade rate was indeterminate in 41 (21.7%) of high-risk lesions. Surgical upgrade rates were high for ADH 32.4% (12/37) and FEA 100.0% (2/2); moderate for LCIS 7.0% (3/43); and low for ALH 0.0% (0/10), radial scar 0.0% (0/24), papilloma 0.0% (0/29), and benign vascular lesions 0.0% (0/3). Of the upgraded lesions, 82.4% (14/17) had concurrent breast carcinoma (7 contralateral and 7 ipsilateral), and 76.5% (13/17) were upgraded to DCIS or well-differentiated carcinoma. ADH was significantly more likely to be upgraded than non-ADH lesions ($p<0.0001$).

CONCLUSION

ADH obtained on MRI-guided core biopsy warrants surgical excision. Other high-risk lesions, however, may be candidates for imaging follow-up rather than surgical excision, especially in the setting of no concurrent breast carcinoma, and after meticulous radiologic-pathologic correlation.

CLINICAL RELEVANCE/APPLICATION

Identifying subsets of high-risk lesions biopsied under MRI-guidance that are rarely upgraded to carcinoma at surgical excision can safely prevent many women from undergoing surgery.

SSA02-02 Tumor Necrosis at Baseline Dynamic Contrast Enhanced (DCE) MRI for Prediction of Neoadjuvant Chemotherapy Treatment (NACT) Response in Triple Negative Breast Cancer (TNBC) Patients

Sunday, Dec. 1 10:55AM - 11:05AM Room: S402AB

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PURPOSE

To determine the predictive value of tumor necrosis at baseline DCE-MRI on treatment response to NACT in TNBC patients.

METHOD AND MATERIALS

This IRB-approved study includes 85 patients with stage I-III TNBC, who had baseline MRI, underwent NACT followed by definitive surgery. Tumors were segmented on the early phase subtraction of DCE-MRI. Necrosis was identified as non-enhancing intra-tumoral tissue on DCE with high T2 signal and shine through on the Apparent Diffusion Coefficient (ADC). Necrotic tumors were segmented with and without inclusion of necrotic regions. The longest dimension of the tumors, volume and percent of necrosis were calculated from contours. Metrics of necrosis were compared with pathologic complete response (pCR) or non-pCR in tissue evaluated after surgical resection, T stage of the tumor, and regional lymph node (LN) involvement at staging and at surgery (positive vs negative). Receiver operating characteristic (ROC) curves, Wilcoxon rank sum tests, and odds ratios (OR) were used for analysis.

RESULTS

Necrosis was seen in 31 pts (36.5 %), median volume was 4.8 cm3 (range 0.7-945 cm3), median percent was 22.8 % (range 4.6-86 %). pCR occurred in 37 pts (43.5%). There was no significant association between pCR and presence of necrosis (OR = 1.4, 95% CI (0.6, 3.3), P=0.49). The volume and percent of necrosis were not significantly different between pts with pCR and non-pCR [AUROCC = 0.52, 95% CI (0.40, 0.65); p=0.69; AUROCC = 0.54, 95% CI (0.41, 0.66) p = 0.52, respectively]. No significant association between T stage of the TNBC and presence of necrosis [OR = 2.3, 95% CI (0.6, 8.8) p = 0.23] was found. Necrotic lesions were seen in 21% (3/14) T1 lesions, 39% (17/44) T2 and 37% (10/27) T3-T4 lesions. There was no significant association between baseline necrosis and LN involvement at staging or at surgery [OR = 0.9, 95% CI = (0.4, 2.1), p= 0.73; OR = 0.5, 95% CI = (0.1, 1.4), p=0.16 respectively]. Tumor necrosis was seen in 38% (15/39) LN+ and in 35% (16/46) LN- pts at staging; 41% (26/64) LN+ and 24% (5/21) LN- pts at surgery.

CONCLUSION

Tumor necrosis at baseline in TNBC patients was not associated with pCR or nodal involvement and was not a predictor of response to NACT.

CLINICAL RELEVANCE/APPLICATION

Our study found that tumor necrosis at baseline imaging in TNBC patients had no association with their treatment response and therefore should not affect their treatment planning.

SSA02-03 Feasibility of Supine MRI-Navigated Ultrasound in Breast Cancer Patients

Sunday, Dec. 1 11:05AM - 11:15AM Room: S402AB

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PURPOSE

To evaluate the feasibility of image fusion between ultrasound (US) and supine magnetic resonance (MR) in breast cancer patients and to evaluate the differences in tumor location between prone and supine positions.

METHOD AND MATERIALS

This prospective study was approved by our institutional review board, and informed consent was obtained. Between May 2016 and December 2017, 88 patients who were undergoing additional supine MR (MRsup) following routine prone MR (MRpro) for breast cancer were included. Clockwise location of the tumor and discrepancies in the distances from nipple to lesion (NLD), skin to lesion (SLD), and lesion to chest wall (CLD) were evaluated between MRpro and MRsup (MRpro-sup), MRpro and MRsup navigated US (MRpro-USnav) and MRsup and USnav (MRsup-USnav). Associations between breast thickness and measurement discrepancies were analyzed using Pearson's correlation.

RESULTS

Total 91 index lesions were evaluated in 88 patients. The intraclass correlation coefficients (ICCs) for the clockwise location of MRpro and MRsup compared with USnav were 0.994 (range: 0.990-0.996) and 0.998 (range: 0.996-0.998), respectively. The mean MRpro-sup and MRpro-USnav measurement discrepancies were greater than those of MRsup-USnav. NLD showed the smallest mean MRsup-USnav measurement discrepancy. Most outer locations showed greater mean measurement discrepancies than inner locations, and each NLD, SLD, and CLD mean measurement discrepancy showed different tendencies according to location and lesion depth. High breast thickness showed significantly greater mean measurement discrepancies than low breast thickness (cutoff: median thickness of 74 mm). Breast thickness showed moderate and strong correlations with MRpro-sup ($r=0.583$, $p<0.001$) and MRpro-USnav ($r=0.634$, $p<0.001$) CLD discrepancies, and weak correlations with MRpro-sup ($r=0.347$, $p=0.001$) and MRpro-USnav ($r=0.343$, $p=0.001$) NLD discrepancies.

CONCLUSION

Image fusion between US and supine MR is feasible in breast cancer patients, although there is a considerable difference in tumor location measurements between prone and supine positions, especially with thicker breasts.

CLINICAL RELEVANCE/APPLICATION

Supine MRI-navigated US is feasible, and the error range between supine and prone position is predictable and may be helpful for estimating breast cancer location and surgical planning.

SSA02-04 Usefulness of MRI Projection Mapping System for Conserving Surgery of Breast Cancer: Comparison with Conventional Method and Pathohistological Findings

Sunday, Dec. 1 11:15AM - 11:25AM Room: S402AB

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PURPOSE

Conserving surgery of breast cancer is conventionally performed by referring MRI acquired in the prone position owing to its accurate detection of the tumor extent. However, the shapes of breast and cancer during MRI scan differ from those under surgery, because the surgery is performed in the supine position. The aim of this study was to evaluate usefulness of MRI projection mapping system (PMS), which we have developed as a prototype, for determining the tumor extent and surgical line in patients who underwent conserving surgery of breast cancer.

METHOD AND MATERIALS

Eleven patients with invasive breast cancer were enrolled. Contrast-enhanced breast MRI in the prone and supine positions was performed separately using a 1.5 T. Conserving surgery of breast cancer was performed based on the conventional method: its extent was determined by palpation, ultrasonography (US) and prone MRI. Immediately before the surgery, maximum intensity projection (MIP) image generated from supine MRI was projected onto the breast surface using structured light method by the MRI-PMS, which consisted of projector-camera system and personal computer. We compared the tumor location and associated intraductal component between the conventional method, MRI-PMS and pathohistological findings.

RESULTS

MRI projection mapping was successfully completed in 9 of the 11 patients; an operational failure occurred in 2 patients. The discrepancy of tumor location ranged from 3 to 9 mm (mean, 4.5 mm) between the conventional method and MRI-PMS. The 5 patients had intraductal component.. The intraductal component was visualized more clearly and perceived more easily by MRI-PMS than by the conventional method in the 4 of them. The total tumor extent defined by MRI -PMS corresponded to that by pathohistological findings in these patients.

CONCLUSION

MRI-PMS visualizes the breast cancer, especially that with intraductal component. Thus, MRI-PMS can be recommended for

conserving surgery of breast cancer.

CLINICAL RELEVANCE/APPLICATION

MRI projection mapping system is useful for conserving surgery of breast cancer because it visualizes the breast cancer well, especially that with intraductal component.

SSA02-05 Accelerating Acquisition of RESOLVE-DWI with Simultaneous Multi-slice (SMS) Technique in Diagnosing Breast Lesions

Sunday, Dec. 1 11:25AM - 11:35AM Room: S402AB

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PURPOSE

To investigate the feasibility and effectiveness of diffusion weighted imaging (DWI) using Simultaneous Multi-slice readout-segmented echo planar imaging (rs-EPI) to diagnose breast lesions.

METHOD AND MATERIALS

The IRB approved study was performed on a 3T scanner with a dedicated 16-channel phased-array breast coil (MAGNETOM Skyra, Siemens Healthcare, Erlangen, Germany). 46 female patients (average age of 42.3 years; range of 26-57 years) with 48 lesions (41 malignant and 7 benign) were enrolled in this study. Patients underwent bilateral breast MRI using a prototypical SMS rs-EPI sequence and a conventional rs-EPI sequence. T1-weighted MRI, T2-weighted MRI, and dynamic contrast-enhanced (DCE-MRI) were also conducted as references. The details of imaging parameters of both DWI sequences were listed in Figure 1. ADC, MK, MD values were quantitatively calculated for each lesion on both sequences. In addition, all images were qualitatively analyzed by a blinded read using a 5-point scale (1 = poor, 5 = excellent). The difference and correlation of both quantitative and qualitative parameters between conventional rs-EPI and SMS rs-EPI data were statistically analyzed.

RESULTS

Compared to conventional rs-EPI, The acquisition time of SMS rs-EPI was markedly reduced (2:17 vs4:27 minutes). The Pearson's correlation showed a excellent linear relationship for each parameter between SMS rs-EPI and conventional rs-EPI ($r = 0.935$, 0.914 and 0.965 for MK, MD and ADC respectively; $P<0.01$ for all, Fig.2). Furthermore, the ROC analysis demonstrated SMS rs-EPI had better diagnostic performance than conventional rs-EPI, however the values didn't differ significantly (Fig.3). In blinded read, SMS rs-EPI showed comparable imaging quality with conventional rs-EPI (Fig.4&5), with moderate to good inter-rater reliability (ICC = 0.63-0.83).

CONCLUSION

Compared to conventional rs-EPI technique, SMS rs-EPI can markedly reduce the acquisition time and yield similar diagnostic accuracy and comparable image quality, which may be useful to expand the scope of its clinical application in breast imaging, and increase the patient throughout.

CLINICAL RELEVANCE/APPLICATION

SMS RESOLVE allows for rapid realization of breast MR imaging, which may serve as a superior alternative for the diagnosis of breast lesions.

SSA02-06 Quantitative Tumor Volumes by Fast Dynamic Contrast Enhanced (DCE) MRI Predict Pathologic Complete Response (pCR) to Neoadjuvant Chemotherapy (NACT) in Triple Negative Breast Cancer (TNBC)

Sunday, Dec. 1 11:35AM - 11:45AM Room: S402AB

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PURPOSE

In TNBC, non-pCR has high risk of recurrence. We evaluated the dependence of the quantitative tumor volumes for predicting pCR status in TNBC on the temporal resolution of DCE MRI.

METHOD AND MATERIALS

In the ARTEMIS trial (NCT02276443), TNBC pts receive 4 cycles of Adriamycin-based chemo (C4AC) followed by taxane-based NACT. 35 pts underwent fast DCE-MRI with range of temporal resolution 8-49 s at baseline (BL) and after C4AC. A retrospective cohort (RC) of 50 TNBC pts who had NACT and BL standard DCE-MRI (temporal resolution 90-120 s) was compared. For all pts pCR was assessed at surgery. 3-dimensional tumor measurements were obtained and tumor volume was contoured by a breast radiologist on the early subtraction phase. Clinical tumor volume (CTV) was calculated using 3 tumor dimensions. Enhanced tumor volume (ETV) was extracted as volume of the contoured voxels, and functional tumor volume (FTV) was extracted as the subset of ETV with voxels below preset signal enhancement ratio (SER). CTV, ETV, FTV, and their changes between BL and C4AC scans were compared between pCR and non-pCR using Receiver Operator Characteristic (ROC) curve and Wilcoxon rank sum test.

RESULTS

An optimal SER of 0.45 was found to maximize AUC of pCR vs non-pCR in ARTEMIS group. In ARTEMIS pts, CTV, ETV, and FTV at BL were able to discriminate pCR and non-pCR, with the pCR pts having significantly smaller tumor volumes (AUC = 0.75, 0.74, 0.74 and p=0.0096, 0.022, 0.022, respectively). CTV, ETV, and FTV at C4AC were significantly different between pCR and non-pCR (AUC = 0.71, 0.74, 0.75 and p=0.041, 0.017, 0.019, respectively). The changes in CTV, ETV, and FTV from BL to C4 were significantly different between pCR and non-pCR (AUC = 0.70, 0.73, 0.71 and p=0.044, 0.026, 0.038). In contrast, CTV, ETV, and FTV in the RC at BL were not significantly different between pCR and non-pCR pts (AUC=0.62, 0.54, 0.53 and p=0.16, 0.66, 0.74 respectively). Tumor volumes measured in ARTEMIS pts were smaller than in the RC (p=0.061).

CONCLUSION

Quantitative tumor volumes measured by fast DCE may serve as an early predictor of treatment response in TNBC. Standard DCE MRI with lower temporal resolution may overestimate the tumor volumes.

CLINICAL RELEVANCE/APPLICATION

Tumor volumes measured with fast DCE MRI improve prediction of treatment response to NACT in TNBC in comparison with standard DCE MRI and may be useful imaging biomarkers of treatment response.

SSA02-07 Efficacy of 3-D Diffusion Weighted Imaging with Background Suppression (DWIBS) in Detection of Breast Carcinoma Compare to Dynamic Contrast Enhanced MRI

Sunday, Dec. 1 11:45AM - 11:55AM Room: S402AB

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PURPOSE

Aim is to evaluate the efficacy 3-D Diffusion weighted imaging with background suppression in detection of breast carcinoma. To evaluate efficacy of DWIBS in differentiation of malignant and benign breast lesions and it's comparison with CEMR.To evaluate ADC values of benign and malignant breast lesions.

METHOD AND MATERIALS

Study IRB and IEC approved.Study included 103 breast lesions which were detected on mammography and breast ultrasound. All the cases underwent breast MRI on 1.5 Tesla machine using dedicated breast coil. Multiplaner localizer applied with 3mm slice thickness. T1WI, T2WI and STIR in axial, STIR coronal, & sagittal plane. Axial DWI was done with b value 1500 sec/mm2. Pre contrast fat-suppressed T1W gradient echo images were obtained followed by intravenous contrast injection. Post processing was done by digitally subtracting the pre-contrast.ADC calculations obtained.All the cases were correlated histopathologically.

RESULTS

Study included 103 lesions.Lesions which showed diffusion restriction considered positive whereas lesions did not show restriction were considered as benign lesions. DWI with increase b value demonstrates lesions better with background suppression. Total 52(50.5%) lesions were benign and 51(49.5%) were malignant on Histopathology. Sensitivity of DWI was 90.2% (95% CI= 84.5,95.9), specificity was 94.2% (95% CI =89.7,98.7), PPV 93.9% 95% CI =89.3,98.5) and NPV 90.7% (95% CI =85.1,96.3). Mean ADCs of malignant lesions was 0.933 ± 0.21× 10 3 mm 2/s. and benign lesions was 1.847 ± 0.51 × 10 3 mm2/s. Area under curve was 0.97. with P value <0.001(significant).Cut off ADC value was 1.08 × 10 3 mm2. Sensitivity for the CEMR was 94.3 %(95% CI= 88.7-99.8),specificity 96.9% (95% CI= 92.7-100.0) PPV 97.1 95% CI =93,100) and NPV 93.9 95% CI =82.2,99.6).

CONCLUSION

DWIBS is an excellent non contrast investigation which can detect breast carcinoma and differentiate benign and malignant breast lesions and the result was comparable to CEMR technique.It can diagnose skin changes and nipple areolar changes as well.

CLINICAL RELEVANCE/APPLICATION

DWIBS can be use as non invasive, non radiation, non contrast method for differentiation in benign and malignant pathology and number of biopsy can be reduced in the clear benign pathologies . This method can be use in the screening of the high risk and dense breast parenchyma,younger population.

SSA02-08 Power of Time-dependent Diffusion MRI as a Prognostic Biomarker in the Breast

Sunday, Dec. 1 11:55AM - 12:05PM Room: S402AB

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PURPOSE

To investigate the utility of ADC values obtained with the different diffusion times (including short diffusion time recently available on clinical scanners) for differentiation of benign and malignant breast tumors as well as their prognostic biomarkers.

METHOD AND MATERIALS

200 cases were prospectively enrolled to this IRB-approved study and 149 breast lesions (86 malignant, 63 benign) were analyzed. DWI scans with prototype sequences using different diffusion times (effective diffusion time Deff = 5.1 ms and 96.6 ms) were performed, with b-values of 0 and 700 s/mm2 and acquisition time of 2.5 min for each on a 3T MRI. ADC change was calculated; (ADCshort - ADClong) / ADCshort x 100 (%), where ADC short and ADC long are ADC values with Deff = 5.1 ms and 96.6 ms. ADC values and ADC changes were compared between malignant and benign breast tumors, as well as between positivity and negativity in expression of their prognostic biomarkers.

RESULTS

Significantly smaller ADCshort and ADClong values were found in malignant compared than benign lesions ($P < 0.0001$ and < 0.0001). ADClong had significantly lower values than ADCshort, both in malignant and benign lesions ($P < 0.0001$ and < 0.0001, respectively). ADC changes were significantly larger in malignant compared with benign lesions ($P < 0.0001$). PgR-positive breast cancers had significantly lower ADCshort and ADClong values than PgR negative ($P < 0.01$ and < 0.05). Both ADCshort and ADClong values were significantly lower in ER-positive than ER-negative breast cancers ($P < 0.05$ and < 0.05). Significantly larger ADC change was observed in Ki-67 positive compared to Ki-67 negative cancers ($P < 0.01$). ADC decrease with diffusion times was remarkable in the peripheral region of typical invasive ductal carcinoma, while center had almost no ADC change, suggesting of central necrosis.

CONCLUSION

ADC values significantly changed depending on tumor types or prognostic factors of breast cancers. Time-dependent diffusion MRI might be a useful prognostic and predictive biomarker, allowing more accurate diagnosis and a safe promising approach to personalized therapy of breast cancer. Our results also underline the importance of checking diffusion times in the interpretation of breast DWI.

CLINICAL RELEVANCE/APPLICATION

The diffusion time dependence of ADC values can be a prognostic marker, potentially allowing to tailor treatment plans of breast cancers without the need of contrast agents

SSA02-09 Feasibility Study of Applying Simultaneous Multi-slice Technique in Diffusion-weighted Imaging of Breast Lesions

Sunday, Dec. 1 12:05PM - 12:15PM Room: S402AB

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PURPOSE

To evaluate the feasibility of applying simultaneous multi-slice (SMS) single-shot echo planar imaging (EPI) to accelerate MR diffusion imaging for breast lesions.

METHOD AND MATERIALS

60 patients (30 breast carcinoma,17 fibroadenoma of breast and 13 normal breast) who underwent breast MRI (3T,MAGNETOM Skyra,Siemens Healthcare) were collected.The following three different diffusion weighted imaging (DWI) scan protocols were applied.The first sequence(A) is the conventional single-shot echo planar DWI (EPI-DWI):TR/TE 5200ms/72ms,FOV 360mm×227.4mm,Slice thickness 5mm,Distance factor 1mm,Slices 30,Bandwidth 1644Hz/pix,Voxel size 0.9×0.9×5mm3,GRAPPA factor 2,b-values(averages) 50s/mm2(2) and 800s/mm2(6) with 3-scan trace mode,Scan time 2:31min.For the second(B) and the third(C) DWI protocols,a SMS factor of two and three were applied, respectively.In order to compare the image quality with those acquired by sequence A,all the sequence parameters were kept the as described above, except for changing the TR of sequence B to 2600ms(scan time 75s) and the TR of sequence C to 1800ms(scan time 55s).For all sequences,image quality is evaluated by two radiologists blinded to the acquisition schemes on a five-point scale.The quantitative analysis for the three sequences included image signal-to-noise ratio (SNR),ADC values of normal breast parenchyma and breast lesions.Paired t-test was used to compare the differences of SNR and ADC values between A and B,A and C.Inter-reader reliability was analyzed by calculating the intra-class correlation coefficient (ICC).

RESULTS

Compared with protocol A, the image quality of protocol C was significant reduced (ICC=0.4), while that of protocol B was stable (ICC= 0.9). The image SNR of A, B and C scan protocols were 21.2±3.0, 19.8±3.3 and 15.3±3.7, respectively. There was no significant difference between protocol B and A (p=0.162) of the image SNR. The SNR of protocol C were significant lower than those of protocol A(p<0.001). The ADC values (×10-3mm2/s) of normal breast parenchyma, breast carcinoma lesions and fibroadenoma of breast were 2.01±0.35, 0.98±0.25, 1.78±0.36, respectively. With SMS factor of 2, the ADC values of those three parts were 1.98±0.39,1.02±0.21,1.82±0.33. The ADC value of 3×SMS were 1.83±0.27,0.87±0.31, 1.87±0.27,respectively.There was no significant difference in ADC values between protocol B and A,C and A in normal breast parenchyma and lesions (all p > 0.05).

CONCLUSION

By applying SMS technique with a factor of 2,the acquisition time of breast DWI can be significantly reduced without sacrificing the image quality.However, if the SMS factor increases to 3,the image SNR decreases which affects clinical diagnosis.

CLINICAL RELEVANCE/APPLICATION

Comparing with conventional EPI-DWI,the SMS markedly Reduces the diffusion scan time and the image SNR still shows a good quality.Thus,SMS technique is recommended for DWI of the MR breast study.

Printed on: 10/29/20

SSA03

Science Session with Keynote: Cardiac (Coronary Artery Disease - Practice and Prognosis)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S105AB

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Prachi P. Agarwal, MD, Canton, MI (*Moderator*) Nothing to Disclose
Hildo J. Lamb, MD,PhD, Leiden, Netherlands (*Moderator*) Nothing to Disclose
Cristina Fuss, MD, Portland, OR (*Moderator*) Spouse, Officer, ViewRay, Inc

Sub-Events

SSA03-01 Cardiac Keynote Speaker: Prognostic Role of Coronary CT Angiography

Sunday, Dec. 1 10:45AM - 11:05AM Room: S105AB

Participants
Prachi P. Agarwal, MD, Canton, MI (*Presenter*) Nothing to Disclose

SSA03-03 Small Whole-heart Volume Predicts Major Adverse Cardiac Events in Non-obstructive Coronary Artery Disease: Insights from the PROMISE Trial

Sunday, Dec. 1 11:05AM - 11:15AM Room: S105AB

Participants
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Hugo Aerts, PhD, Boston, MA (*Abstract Co-Author*) Stockholder, Sphera Inc
Pamela Douglas, Durham, NC (*Abstract Co-Author*) Nothing to Disclose
Michael T. Lu, MD, Boston, MA (*Abstract Co-Author*) Grant, NVIDIA Corporation; Institutional Research Grant, Kowa Company, Ltd ; Institutional Research Grant, AstraZeneca PLC
Udo Hoffmann, MD, Boston, MA (*Abstract Co-Author*) Research Grant, Kowa Company, Ltd ; Research Grant, Abbott Laboratories; Research Grant, HeartFlow, Inc; Research Grant, AstraZeneca PLC;

PURPOSE

To investigate the predictive value of 3D whole heart volume (WHV) for major adverse cardiovascular events (MACE) in patients with stable chest pain and nonobstructive coronary artery disease (CAD).

METHOD AND MATERIALS

Among participants of the Prospective Multicenter Imaging Study for Evaluation of Chest Pain (PROMISE), we included those with nonobstructive CAD on cardiac computed tomography (CT). WHV was defined as pericardial sac volume excluding the epicardial fat, measured on non-contrast cardiac CT, and indexed to body surface area (iWHV) (Figure A). We determined the association of iWHV with traditional cardiovascular risk factors, coronary artery calcium (CAC), and MACE (all-cause death, myocardial infarction, unstable angina) over a median follow-up of 26 months. In a subgroup, we correlated the iWHV with measures of left-ventricular (LV) function and morphology and systemic inflammation (IL-6).

RESULTS

In 1,134 patients (63±9 years; 43% women), the mean iWHV was 294.3±65.6 cm3/m2. Remarkably, smaller iWHV was associated with female sex and individual CV risk factors (P<0.05 for all) but not with CAC score (Figure B). Similarly, smaller iWHV was associated with MACE, an association that persisted after adjustment for cardiovascular risk and CAC (HR (per decrease of one standard deviation) = 6.7; 95%CI:2.1-19.9; P=0.001) (Figure C). In the subgroup analysis of mechanistic determinants, iWHV correlated moderately with end-diastolic volume (EDV) (r=0.52), stroke volume (SV) (r=0.36), LV-mass (r=0.51) and weakly with LV-ejection fraction (EF) (r=-0.14), LV-mass/volume ratio (r=-0.07) and inflammation (IL-6; r=-0.21) (all correlations P<0.05). Notably, those with the smallest iWHV (i.e., first quintile) had preserved LV-EF (mean: 56.6±7.3%), no LV hypertrophy (mean iLV-

mass: 51.1±8.9 g/m2) or LV dilation (mean EDV: 57.2±12.0 ml/m2).

CONCLUSION

In patients with nonobstructive CAD and without clinical signs of heart failure, smaller iWHV was associated with MACE independent of traditional risk factors and CAC and correlated with smaller LV volumes, higher LV-mass/volume ratio, and increased inflammation.

CLINICAL RELEVANCE/APPLICATION

Given prior evidence linking nonobstructive CAD to coronary microvascular dysfunction and heart failure with preserved EF (HFpEF), we generate the hypothesis that iWHV may represent an early marker of HFpEF.

SSA03-04 Coronary Atherosclerosis in Apparently Healthy Master Athletes Discovered During pre-PARTECIPATION Screening: Role of Coronary CT-Angiography (CCTA)

Sunday, Dec. 1 11:15AM - 11:25AM Room: S105AB

Participants
Riccardo Marano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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Giancarlo Savino, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To assess the role of Coronary CT-Angiography (CCTA) and non-invasive detection of coronary atherosclerosis (cATS) in the assessment and clinical management of master athletes (MA) during the pre-participation screening (PPS). To assess the role of Coronary CT-Angiography (CCTA) and non-invasive detection of coronary atherosclerosis (cATS) in the assessment and clinical management of master athletes (MA) during the pre-participation screening (PPS).

METHOD AND MATERIALS

We retrospectively examined 167 MA who underwent CCTA in our hospital since 2006, analyzing symptoms, stress-test ECG, cardiovascular risk profiles (SCORE) and CCTA findings.

RESULTS

Among the whole enrolled population, 153 (91.6%) MA underwent CCTA for equivocal/positive stress-test ECG with/without symptoms, 13 (7.8%) just for clinical symptoms, 1 (0.6%) for the family history. The CCTA showed the presence of cATS in 69 MA (41.3%), congenital coronary anomalies (anomalous origin or deep myocardial bridge) in 8 (4.8%), both in 7 (4.2%). A negative CCTA was observed in 83 MA (49.7%). The risk-SCORE (age, hypertension, hypercholesterolemia, smoking) was a good indicator for the presence of moderate/severe cATS on CCTA. However, mild/moderate cATS was present in 17.8% of MA clinically stratified at a low risk-SCORE.

CONCLUSION

CCTA may be helpful in the PPS of MA with an abnormal stress test ECG and/or clinical symptoms engaged in competitive sports with a high cardiovascular involvement, while the invasive coronary angiography is more indicated in athletes with positive stress-test ECG and high clinical risk. Age, gender, presence of symptoms and clinical risk-SCORE assessment may help sports-physicians/cardiologists to decide whether to request a CCTA or not.

CLINICAL RELEVANCE/APPLICATION

CCTA may be helpful in the PPS of MA with an abnormal stress test ECG and/or clinical symptoms engaged in competitive sports with a high cardiovascular involvement.

SSA03-05 Impact of Diabetes on Coronary Artery Disease Progression in Selective Percutaneous Coronary Intervention-treated patients: Using Serial CCTAs

Sunday, Dec. 1 11:25AM - 11:35AM Room: S105AB

Participants
Rui Shi, Chengdu, China (*Presenter*) Nothing to Disclose
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Ke Shi, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Diabetes mellitus (DM) patients have been known to be susceptible to coronary artery disease (CAD). However, the impact of diabetes on plaque progression in CAD patients treated with selective percutaneous coronary intervention (PCI) has been rarely reported. Hence, the present study aimed to evaluate the impact of DM on CAD progression in selective PCI treated patients using serial coronary computed tomography angiography (CCTA), compared against non-diabetic patients.

METHOD AND MATERIALS

A total of 98 patients (age: 69.9 ± 11.0, 83.7% male) referred for selective PCI performed underwent serial CCTAs, which were arranged within one month before PCI and at least 6 month after PCI in our hospital were consecutively analyzed. All the subjects were categorized into diabetes group (36) and non-diabetes group (62). For all the CCTA scans, quantitative measures including segment involvement score(SIS), segment stenosis score(SSS) at baseline and follow-up CCTA, and CCTA-verified plaque progression were evaluated blindly to clinical data and compared between the two groups.

RESULTS

No statistical differences were found in baseline SSS (DM:6(IQR:3.25-8) vs. Non-DM:4(IQR:2-10), P=0.195) or SIS(DM:3(IQR:2-4) vs. Non-DM:2(IQR:1-4), P=0.298). During the median 1.5 year inter-scan period, significant difference was observed in ΔSIS (DM: 0(IQR:0-1) Vs. non-DM: 0 (IQR:0-0.25), P=0.029), ΔSSS (DM:2(IQR:0-3) vs. Non-DM: 0 (IQR:0-2);P<0.001) and Annulaised ΔSSS (0.64(IQR:0-1.83) vs. non-DM:0 (IQR:0-0.75),P=0.004) between the two groups.At per-segment level, compared to non-diabetes, proximal segments(P=0.003), noncalcific plaques(P=0.014) and original normal segments(P=0.005) of diabetic patients were more susceptible to plaque progression(PP). Multivariate logistic regression showed that DM (OR:5.52; 95%CI:1.67-16.48, P=0.005) and chest pain at baseline (OR:5.24; 95%CI:1.67-16.48, P=0.008) were independently associated with CAD progression after adjusting for confounding factors.

CONCLUSION

In the present study, more CCTA-verified progressive plaques were found in diabetes patients after PCI. DM, combined with baseline chest symptom, can further enhance the ability to identify patients who require a therapeutic strategy to halt disease progression.

CLINICAL RELEVANCE/APPLICATION

The present study provides an important opportunity to advance the understanding of the relationship between diabetes and CAD progression in stented patients.

SSA03-06 Artificial Intelligence-Based Coronary CT Fractional Flow Reserve Applied to Triple-Rule-Out CT Angiography in Acute Chest Pain

Sunday, Dec. 1 11:35AM - 11:45AM Room: S105AB

Participants
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Richard Bayer, Charleston, SC (*Abstract Co-Author*) Institutional Research support, Bayer AG; Institutional Research support, HeartFlow, Inc; Institutional Research support, Siemens AG
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Simon S. Martin, MD, Charleston, SC (*Abstract Co-Author*) Institutional Research support, Siemens AG
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PURPOSE

In this study, we evaluated the additional value of noninvasive artificial intelligence (AI)-based CT-FFR, derived from triple-rule-out coronary computed tomography angiography (TRO-CTA) for acute chest pain (ACP) in the emergency department (ED) setting.

METHOD AND MATERIALS

This retrospective, HIPAA-compliant, single-center study was approved by the university's institutional review board. AI-based, deep-learning CT-FFR (Siemens Healthineers) from TRO-CTA datasets was obtained in 159 of 271 (59%) eligible patients (89 men; mean age 57.0±9.7 years) presenting to the ED with ACP. The agreement between CT-FFR (<=0.80) and stenosis on TRO-CTA (>=50%), as well as downstream cardiac diagnostic testing was investigated. Furthermore, the predictive value of CT-FFR for coronary revascularization and major adverse cardiac events (MACE) was assessed over a one-year follow-up period.

RESULTS

CT-FFR and TRO-CTA demonstrated agreement in severity of CAD in 70% (111/159) of all cases. CT-FFR <=0.80 served as a better predictor for coronary revascularization and MACE than >=50% stenosis on TRO-CTA (hazard ratio [HR] 4.1; 95% confidence interval [CI] 1.5-11.4 vs. HR 2.3; 95% CI 0.9-6.0) (p<0.01). Additional diagnostic cardiac testing was performed in 59% (94/159) of patients and included single-photon emission computed tomography (SPECT) (n=62), stress echocardiography (n=31), and stress magnetic resonance imaging (MRI) (n=1). In this subgroup there was higher agreement as to the presence/absence of significant disease with CT-FFR (55%; 52/94) than with coronary TRO-CTA (47%; 44/94) (p<0.01). Reserving downstream testing for patients with CT-FFR <=0.80 would have reduced the number of additional downstream cardiac examinations by 47%.

CONCLUSION

CT-FFR derived from TRO-CTA was a better predictor for coronary revascularization and MACE and showed better agreement with additional diagnostic testing than TRO-CTA. Therefore, CT-FFR may improve the specificity in identifying ACP patients with significant CAD in the ED setting and reduce unnecessary downstream testing.

CLINICAL RELEVANCE/APPLICATION

AI-based CT-FFR derived from TRO-CTA datasets provides additional diagnostic and prognostic value in the evaluation of patients presenting to the ED with chest pain may reduce subsequent downstream testing.

SSA03-07 Combined Assessment of Myocardial Volume and Myocardial Blood Flow for Diagnosis of Obstructive Coronary Artery Disease in Cardiac Computed Tomography

Sunday, Dec. 1 11:45AM - 11:55AM Room: S105AB

Participants
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Naoto Kawaguchi, MD, Toon, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purpose of this study was to evaluate the diagnostic performance of combined assessment of myocardial volume and myocardial blood flow (MBF) for detecting obstructive coronary artery disease (CAD) by cardiac computed tomography (CT).

METHOD AND MATERIALS

A total of 36 patients, who underwent coronary CT angiography (CTA), dynamic stress myocardial CT perfusion (CTP), and invasive coronary angiography (ICA) with invasive fractional flow reserve (FFR) measurement, were enrolled. 256-slice CT (Philips Healthcare, Cleveland, USA) was used in this study. Severe stenosis (stenosis >=70%) and moderate stenosis (50-69%) with FFR <=0.8 on ICA were defined as obstructive CAD. All CTP and CTA data were analyzed by a commercially available workstation (Synapse Vincent ver.5, Fujifilm Medical Systems, Japan). CT-MBF was calculated by deconvolution analysis from dynamic stress CTP images, and coronary artery-related left ventricular myocardial volume (LVMV) on CT was automatically segmented using Voronoi algorithm-based myocardial segmentation. Then, the stenosis-related CT-MBF and LVMV (stenosis >=50% on CTA) were quantified using the image fusion of CT-MBF and the coronary artery territory mapping. Diagnostic performance of the combined assessment of the stenosis-related CT-MBF and LVMV was assessed, and compared with that of stenosis-related CT-MBF alone using the area under receiver operating characteristic curve (AUC).

RESULTS

Of 108 vessels in 36 patients, 65 vessels were suspected of significant stenosis in CTA. Sensitivity and specificity for identifying obstructive CAD were 87% and 60% for stenosis-related CT-MBF, and 87% and 77% for combined assessment of the stenosis-related CT-MBF and LVMV, respectively. The AUCs were 0.79 for the stenosis-related CT-MBF, and 0.89 for combined assessment of stenosis-related CT-MBF and LVMV. The AUC of combined assessment of stenosis-related CT-MBF and LVMV was significantly higher than that of stenosis-related CT-MBF alone ($p < 0.05$).

CONCLUSION

Stenosis-related LVMV could improve the diagnostic performance of CT-MBF for detecting obstructive CAD.

CLINICAL RELEVANCE/APPLICATION

The stenosis-related LVMV has influence on the severity of CAD as well as CT-MBF, and provides the incremental value for detecting obstructive CAD to the stenosis-related CT-MBF.

SSA03-08 Myocardial Blood Flow Analysis of Stress Dynamic Myocardial CT Perfusion for Hemodynamically Significant Coronary Artery Disease Diagnosis: The Clinical Value of Relative Parameter Optimization

Sunday, Dec. 1 11:55AM - 12:05PM Room: S105AB

Participants
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PURPOSE

To investigate the optimal relative parameter of quantitative myocardial blood flow (MBF) on dynamic myocardial CT perfusion (CTP) for the detection of hemodynamically significant coronary artery disease (CAD).

METHOD AND MATERIALS

A total of 86 patients who were prospectively recruited underwent adenosine triphosphate-stress dynamic myocardial CTP. The MBF value was measured by a manually drawn volume of interest (VOIs) on the MBF color-coded polar maps with perfusion defects of vessel-based territory. The relative MBF perfusion parameters were then calculated as Ratio1, Ratio2 and Ratio3 according to the three types of reference MBF values, respectively: 1) average segmental MBF value, 2) 75th percentile of the average segmental MBF value, and 3) highest segmental MBF value. All the data were derived from both the endocardial and transmural

layers of the myocardium. Invasive coronary angiography and fractional flow reserve (ICA/FFR) were used as the reference standards for myocardial ischemia evaluation.

RESULTS

151 vessels of 60 patients (43 men and 17 women; 61.38±8.01 years) were enrolled in the analysis. The performance of endocardial layer was superior to that of the transmural layer (all P <0.05). The Ratio3 of endocardial myocardium (AUC=0.906, 95% CI: 0.857-0.954), for which the highest segmental value was selected as the reference MBF, was superior to both Ratio1 and Ratio2 for ischemia detection (AUC, 0.906 vs. 0.879, P <0.05; 0.906 vs. 0.891, P =0.18), and the sensitivity, specificity, PPV, NPV and diagnostic accuracy were 74.1%, 93.6%, 87.8%, 85.3% and 86.1%, respectively. The cutoff value of Ratio3 was 0.675.

CONCLUSION

The relative MBF parameter of the endocardial myocardium using the highest segmental MBF value as a reference provided optimal diagnostic accuracy for the detection of hemodynamically significant CAD.

CLINICAL RELEVANCE/APPLICATION

The relative MBF perfusion parameters are promising assessment in stress dynamic myocardial CT perfusion (CTP) for myocardial ischemia evaluation, the investigation of optimal relative MBF analysis method not only helps in improving the CTP diagnostic accuracy, but also can further promoting the standardization of CTP technology.

SSA03-09 A Radiomics Approach to Predict Myocardial Fibrosis on Coronary Computed Tomography Angiography in Hypertrophic Cardiomyopathy

Sunday, Dec. 1 12:05PM - 12:15PM Room: S105AB

Participants
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PURPOSE

To evaluate the usefulness of surrogate biomarkers as predictors of myocardial fibrosis in hypertrophic cardiomyopathy using radiomics data from coronary computed tomography angiography (CCTA).

METHOD AND MATERIALS

Between January 2018 and March 2019, consecutive 50 inpatients with hypertrophic cardiomyopathy (HCM) who simultaneously underwent CCTA (Somatom Force, Siemens Healthineers) and cardiac magnetic resonance (CMR) (Ingenia 3.0T, Philips) within 5 days were retrospectively enrolled. Late gadolinium enhanced (LGE) of magnetic resonance imaging (MRI) was used as reference standard for differentiation of non-fibrosis and fibrosis segment. All segments were drawn automatically using a prototype (Cardiac function, Frontier, Siemens) in three dimensions according to AHA 17-segment model and were randomly assigned into a training cohort (n=583, 70%) and a testing cohort (n=267, 30%). 1226 features were generated using a Radiomics prototype (Frontier, VB10, Siemens), and minimum redundancy maximum relevance (mRMR) feature ranking were applied to select useful features in the training cohort. A radiomics signature model was then built by multivariate logistic regression analysis to differentiate between fibrosis and non-fibrosis segment using a prototype (Radiomics, Frontier, Siemens). The area under curve (AUC) value was calculated from a ten-fold validation for evaluation. The prediction performance was tested on the testing cohort.

RESULTS

A total of 850 segments were analyzed, among which 312 (36.7%) segments were diagnosed of fibrosis according to MRI. 10 radiomics features were selected by mRMR, showing significant association with myocardial fibrosis (p<0.05). Based on the multivariate logistic model, our radiomics signature incorporating 9 features (squareroot_ngtdm_Busyness , exponential_glrlm_RunEntropy , wavelet-HHL_gldm_DependenceVariance, etc.) showed good discrimination in the training cohort (AUC 0.82) and test cohort (AUC 0.75 , sensitivity 0.61 , specificity 0.82).

CONCLUSION

Our radiomics model provided a robust complementary tool for the diagnosis of myocardial fibrosis on CCTA, that may facilitate clinical decision-making for patients who are diagnosed of HCM.

CLINICAL RELEVANCE/APPLICATION

Coronary CTA provided a robust complementary tool to CMR in detecting myocardial fibrosis in hypertrophic cardiomyopathy and is recommended in the evaluation of patients who are contraindicated for MRI.

SSA04

Cardiac (Myocardial Ischemia and Viability (MRI))

Sunday, Dec. 1 10:45AM - 12:15PM Room: S102CD

CA MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Susan K. Hobbs, MD,PhD, Pittsford, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSA04-01 Intracoronary Compared with Intravenous Bolus tirofiban on No-Reflow Phenomenon in Patients with ST-Segment Elevation Myocardial Infarction Undergoing Primary Percutaneous Coronary Intervention: A Cardiac Magnetic Resonance Study

Sunday, Dec. 1 10:45AM - 10:55AM Room: S102CD

Participants
Quanmei Ma, Shenyang, China (*Presenter*) Nothing to Disclose
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PURPOSE

The aim of the study was to investigate potential effect of intracoronary administration of glycoprotein IIb/IIIa inhibitor tirofiban on no-reflow phenomenon (NR) assessed by CMR compared to intravenous routine in patients with ST-segment elevated myocardial infarction undergoing primary percutaneous coronary intervention (PCI).

METHOD AND MATERIALS

120 patients were randomized into 2 groups (Tirofiban i.c. Versus i.v.). CMR was completed within 3-7 days after ST-segment elevation myocardial infarction. CMR was also performed in 3 to 6 months follow up after discharge. Left ventricular function, volumes, infarct size, microvascular obstruction, hemorrhage, myocardial salvage, myocardial perfusion index and tissue tracking strain were performed on CMR analysis.

RESULTS

The microvascular obstruction (32/52 versus 24/68, $p < 0.05$) showed significantly difference between the intravenous and the intracoronary tirofiban groups. The area at risk (34.4% [interquartile range: 9.0% to 62.4%] versus 33.5% [interquartile range: 8.9% to 50.5%], $p > 0.05$) and infarct size (17.8% [interquartile range: 9.3% to 25.5%] versus 16.8% [interquartile range: 8.8% to 24.3%], $p > 0.52$) did not differ significantly between the two groups. The myocardial salvage index was similar (22.4% [interquartile range: 8% to 43%] versus 21.6% [interquartile range: 7% to 42%], $p > 0.05$). No significantly difference was found in myocardial perfusion index, myocardial strain between the two groups. The intracoronary tirofiban group was associated with higher %ΔLVEDV compared with intravenous group (-9.41% [interquartile range: -13.5% to -2.41%] versus -0.09% [interquartile range: -7.7% to 7.37%], $p<0.01$).

CONCLUSION

This CMR study in ST-segment elevation myocardial infarction patients showed benefit of decreasing MVO for intracoronary tirofiban administration compared to intravenous in patients undergoing PICC. Intracoronary tirofiban administration showed improvement in left ventricular remodeling. No benefit was found with respect to infarct size, myocardial perfusion index and myocardial strain 3-6 months after infarction.

CLINICAL RELEVANCE/APPLICATION

Intracoronary tirofiban administration could be potentially applied to reduce MVO incidence compared to intravenous in STEMI patients undergoing PICC.

SSA04-02 Assessment of Early Left Ventricle Myocardial Strain with Cardiovascular Magnetic Resonance Feature Tracking: A Prospective Study in Patient of Acute ST-elevated Myocardial Infarction

Sunday, Dec. 1 10:55AM - 11:05AM Room: S102CD

Participants
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PURPOSE

To investigate the diagnostic performances of early left ventricular (LV) strain, using a cardiovascular magnetic resonance feature tracking (CMR-FT) technology, in patients with acute ST-elevation myocardial infarction (STEMI) after primary percutaneous coronary intervention (PPCI).

METHOD AND MATERIALS

Seventy-eight patients of acute STEMI underwent CMR imaging at 2-6 days after successful PPCI. The imaging protocol included conventional cine imaging, for assessing LV regional radial (RS), circumferential (CS), longitudinal (LS) strains as well as function, and late gadolinium enhancement for assessing LV infarct size, transmurality and microvascular obstruction (MVO). LV strain were analyzed in a 16-segment model.

RESULTS

Hyperenhancement was detected in 495 (40%) of 1248 segments, including 423 (85%) transmural hyperenhancement, and was accompanied by MVO in 173 (35%) of hyperenhancement segments. Regional radial (RS) and circumferential strain (CS) were significantly diminished in segments with hyperenhancement and decreased even further if MVO was also present ($p<0.001$). CS surpassed RS in its ability to differentiate between transmural and non-transmural infarct ($p<0.001$ and $p=0.002$, respectively). Furthermore, CS was superior to RS in discriminating infarcted segments with MVO from infarcted segments without MVO (all $p<0.001$).

CONCLUSION

Regional strain analysis performs ability in differentiating between non-infarcted myocardium, infarcted myocardium with and without MVO, transmural and non-transmural infarcted myocardium. Peak circumferential strain is the most accurate marker of regional function.

CLINICAL RELEVANCE/APPLICATION

Strain shows great potential in noninvasive diagnosis of early LV regional infarct, transmurality, and MVO in patient of acute STEMI. CMR-FT may provide a useful tool in early assessment of myocardial strain.

SSA04-03 Impact of Ischemia Time on Cardiac Functional and Structural Parameters: CMR Assessment and Histological Correlation in a Porcine Model of Myocardial Infarction

Sunday, Dec. 1 11:05AM - 11:15AM Room: S102CD

Awards
Trainee Research Prize - Fellow

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PURPOSE

The pig model of myocardial infarction (MI) is considered the gold standard for the analysis of cardioprotective/regenerative strategies before moving towards the clinical setting. However, there is no systematic study investigating cardiac structural and functional outcomes in relation to the duration of the ischemic insult. We have evaluated the impact of time of ischemia in cardiac damage and performance over time by CMR.

METHOD AND MATERIALS

Pigs (N=32) underwent MI by closed chest balloon occlusion of the mid-left anterior descending (LAD) coronary artery. Animals were randomized into four groups differing in the duration of ischemia (30, 60, 90, and 120min) and then reperfused. A sham-operated group was performed (N=8). The impact of ischemia was assessed by serial CMR at days 3 and 42 post-MI. The following parameters were determined: global and regional function, wall edema, necrosis, and microvascular obstruction. Molecular markers of fibrosis and myocyte hypertrophy were determined in the ischemic myocardium.

RESULTS

At day3, CMR revealed that cardiac damage and function was similar in sham and pigs subjected to 30min ischemia. In contrast, edema and necrosis significantly increased from 60min onwards with a progressive trend over time. Microvascular obstruction was most extensively seen in animals with >=90min of ischemia. These structural alterations associated to a significant and comparable drop in systolic function in pigs subjected to >=60min ischemia (p=60min of ischemia (p=60min of ischemia (p=60min ischemia (P<0.05 vs 30min). At day42 scar size followed the same pattern and systolic and diastolic volumes significantly increased in animals subjected to 60min ischemia, with the worst performance in animals having 120min of ischemia ($p<0.05$ vs. day 3 and 30min ischemia). Gene and protein levels of fibrosis-related markers (collagens and vimentin) were significantly and similarly enhanced in

the infarcted myocardium of pigs subjected to 60min or longer ischemia (P<0.05 vs 30min). The same was true for myocyte surface and volume extension.

CONCLUSION

Mid-LAD coronary occlusion for 60min suffices to induce cardiac structural and functional alterations amenable to therapeutic interventions.

CLINICAL RELEVANCE/APPLICATION

There is a need to standardize methodological approaches of MI-induction in human-like animal models to successfully translate preclinical benefits into the clinical arena.

SSA04-04 Early Detection of Myocardial Fibrosis by CMR Quantitation Extracellular Volume Fraction in a Hypertensive Swine Model

Sunday, Dec. 1 11:15AM - 11:25AM Room: S102CD

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PURPOSE

Our study aims to determine whether ECV and Native T1 quantified by cardiac magnetic resonance (CMR) can demonstrate left ventricle (LV) extracellular interstitial fibrosis in a hypertensive (HTN) swine model and quantitatively evaluate the dynamic change over time.

METHOD AND MATERIALS

Twenty-five adult male Chinese miniature pigs aged 6-12 months underwent cardiac MR imaging at three time points: pre- and 1 month-, 3 months- post induction of hypertension. Native T1 value and ECV fraction was prospectively performed at all imaging time points. The left ventricle (LV) systolic function was calculated using the cine images. Individual and segmental native T1 value and ECV fraction were compared to the late gadolinium enhancement (LGE) images. Animals were euthanized after the last examination of MRI. Histopathologic examinations of heart were performed later.

RESULTS

The systolic/diastolic pressure was gradually increased. There was no obvious abnormal performance in the triphenyl tetrazolium chloride (TTC) stain and no obvious increased signal intensity in the LGE in all stages of hypertension. However, the ECV fraction and Native T1 value increased with modelling time ($p < 0.001$). The results were demonstrated by pathological results where fibrous tissues were observed increasing gradually in the HE, Masson and Picrosirius stain.

CONCLUSION

T1 and ECV derived from CMR may be a non-invasive method in the early detection of myocardial interstitial fibrosis in hypertensive heart disease prior LGE detectable by conventional CMR. T1 and ECV can also reflect the severity of myocardial involvement in the progress of hypertension. For detection of myocardial fibrosis, combined both advantages of native T1(higher sensitivity) and ECV(higher specificity) can make a more accurate evaluation of myocardial fibrosis.

CLINICAL RELEVANCE/APPLICATION

The presence of diffuse fibrosis may be a potential mechanism for increasing cardiovascular risk in HTN patients. Early detection and taking methods to reduce diffuse fibrosis can reduce the incidence of such risk.

SSA04-05 The Relationship between Systolic and Diastolic Strains Measured from Tissue Tracking Cardiovascular Magnetic Resonance and Adverse Remodeling in Post-STEMI Patients

Sunday, Dec. 1 11:25AM - 11:35AM Room: S102CD

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PURPOSE

Adverse left ventricle (LV) remodeling was supposed to be the main culprits of ST-segment elevation myocardial infarction (STEMI) patients' poor life quality. This study aimed to determine associations between the diastolic strains rate and adverse LV remodeling in post-STEMI patients.

METHOD AND MATERIALS

A number of 52 (M/F: 46/6, age: 54.27 yrs) STEMI patients who underwent coronary intervention three months ago were prospectively recruited from 2016 to 2017. Follow-up was done until 2018. The primary end points were the symptoms of heart failure (NYHA II-IV). Consent was acquired from each patient and 3.0 T MRI was arranged. Adverse LV remodeling defined by a 12%

increase in LV end diastolic volume (LVEDV). The early (EDSR) and late (LDSR) peak diastolic strain rates were derived from the two peak points on the corresponding curve of time-to-SR curve in the diastole (Figure 1). t-test was performed when comparing between groups. Logistic regression test was done for statistical analysis and $P < 0.05$ was considered as significant.

RESULTS

Myocardial infarction size, all the peak strains, systolic peak strain rates and the early diastolic strain rates were significantly correlated with Adverse LV remodeling. None of the parameters was independent determinant. 23/52 (44.2%) patients complained of heart failure symptoms at the one-year follow-up. Multivariate Logistic regression test showed that only the ratio between the EDSR and LDSR in the radial direction on the short axis (DSRR-SR) was the independent predictor of the heart failure symptoms (6.59; range, 6.71-3.68; P=0.026).

CONCLUSION

Both systolic and diastolic strains were correlated with Adverse LV remodeling at short-time follow-up for STEMI patients, while only the DSRR-SR could independently predict heart failure at the long-time follow-up. The quantitative measurement of diastolic function through myocardium strains might help with better clinical management for STEMI patients.

CLINICAL RELEVANCE/APPLICATION

This study gave clues that myocardium deformation was associated with adverse LV remodeling at the early stage for post-STEMI patients. Furthermore, the diastolic strain rates could potentially provide unique prognostic information for STEMI patients to predict heart failure.

SSA04-06 Ectopic Fat Deposition in Obese Patients with Type 2 Diabetes: Correlation with Left Ventricle Function and Microcirculation

Sunday, Dec. 1 11:35AM - 11:45AM Room: S102CD

Participants
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PURPOSE

To investigate the relationship between microvascular dysfunction and ectopic fat deposition in type 2 diabetes mellitus (T2DM) patients with preserved ejection fraction.

METHOD AND MATERIALS

Forty-eight T2DM patients (23 males, age 56.23±10.65) and fifteen healthy volunteers were prospectively enrolled. All of them were underwent CMR (3.0-T, Siemens Medical Solutions, Erlangen, Germany). Patients with LVEF< 55% were excluded, and all the patients were divided into obesity group (BMI>=24) and non-obesity group(BMI<24). All CMR parameters were measured using the cine sequence and perfusion imaging. Single-voxel H-magnetic resonance spectroscopy was performed to detect the triglyceride content of myocardial (Interventricular septum), liver(segment VII) and muscle(The erector spinae of the same level as the liver), which was calculated as a percentage relative to the signal of myocardial water by the post-processing software (jMRUI, version 6.0).

RESULTS

All patients remained normal LV function and LV global stress compared with normal controls(P>0.05). Myocardial triglyceride content was significantly higher in T2DM patients compared with healthy volunteers (1.41±0.65% vs. 0.61±0.22%, P<0.001). Compared with non-obesity group, triglyceride content of heart and liver were increased in obese group (all P<0.05). Myocardial triglyceride content was correlated with left ventricle mass (r=0.52), Upslope (r=-0.53) and TimeMax (r=0.49), and liver triglyceride content was correlated with Upslope (r=-0.33) and TimeMax (r=0.43). ROC analysis revealed that sensitivity and specificity were obtained for predicting the occurrence of TimeMax with the Myocardial triglyceride content (AUC=0.83) and myocardial triglyceride content (AUC=0.63).

CONCLUSION

T2DM with obesity are more prone to fatty ectopic deposits. Although the patient's myocardial function and global strain did not show be damaged, ectopic fat may cause myocardial microcirculation disturbance. At the same time, we found in addition to myocardium, excessive deposition of liver fat may also lead to myocardial microcirculation.

CLINICAL RELEVANCE/APPLICATION

Although the patient's myocardial function and global strain did not show be damaged, ectopic fat may cause myocardial microcirculation disturbance.

SSA04-07 Relationship between Myocardial Microvascular Dysfunction and Myocardial Triglyceride Content in Preserved Ejection Fraction Type 2 Diabetes Mellitus: Assessment with 1H-Magnetic Resonance Spectroscopy

Sunday, Dec. 1 11:45AM - 11:55AM Room: S102CD

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PURPOSE

Cardiac lipid over-storage and lipotoxic injury to cardiomyocytes have been considered as one of the important mechanisms of cardiac dysfunction coursed by metabolic abnormalities. For patients with early diabetic cardiomyopathy, the presence of myocardial microvascular dysfunction requires greater attention. The purpose of this study was to assess the effects of myocardial triglyceride content on left ventricle myocardial microvascular dysfunction in type 2 diabetes mellitus with Preserved left ventricle ejection fraction (LVEF).

METHOD AND MATERIALS

forty-eight type 2 diabetes patients (23 males, age 56.23±10.65) and fifteen healthy volunteers were prospectively enrolled. All of them were underwent CMR (3.0-T, Siemens Medical Solutions, Erlangen, Germany). We excluded patients with LVEF <55%. All cardiac function parameters were measured using the cine sequence. Myocardial perfusion parameters included upslope, time to maximum signal intensity (TTM) and max signal intensity (MaxSI), which were calculated by the signal-time curve of the first-pass myocardial perfusion imaging. Single-voxel 1H-magnetic resonance spectroscopy was performed to detect the myocardial triglyceride content, which was calculated as a percentage relative to the signal of myocardial water by the post-processing software (jMRUI, version 6.0).

RESULTS

Myocardial triglyceride content was significantly higher in T2DM patients compared with healthy volunteers (1.46±0.705% vs. 0.61±0.22%, p< 0.001). Systolic and diastolic function did not significantly differ between patients and healthy. The Pearson analysis showed the myocardial triglyceride content was associated with LVEDV (r=0.32, p<0.05), LVESV (r=0.31, p<0.05), upslope (r=-0.34, p<0.05) and TTM (r=0.37, p<0.05). Multivariable analysis indicated that myocardial triglyceride content was associated with TTM (ß=0.51,p<0.05, 95%CI:2.24-20.74), independently of diabetic duration, age, sex, BMI, blood pressure and LV functional parameters.

CONCLUSION

Myocardial triglyceride content is increased in preserved ejection fraction T2DM and is associated with myocardial microvascular dysfunction, independently of diabetic duration and Individual basic characteristics.

CLINICAL RELEVANCE/APPLICATION

For diabetic with preserved ejection fraction,myocardial triglyceride content is increased than normal, and is associated with myocardial microvascular dysfunction

SSA04-08 Novel Short Inversion Time 3D LGE Imaging in Ischaemic Scars

Sunday, Dec. 1 11:55AM - 12:05PM Room: S102CD

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PURPOSE

Late gadolinium enhancement (LGE) visualizes myocardial scar and fibrosis. After myocardial infarction (MI), subendocardial infarcts can be missed due to poor contrast between the blood pool and the subendocardium. The aim of this study was to evaluate the benefit of 3D LGE imaging using a single breath-hold inversion recovery sequence with a fixed, short inversion time (TI =100 ms) (short3D LGE) in comparison to standard 3D LGE imaging with an adjusted TI (3D LGE).

METHOD AND MATERIALS

3D LGE and short3D LGE (both sequences with the same spatial resolution of 1.2 x 1.2 mm² and slice-thickness of 8 mm; field of view, 350 x 350 mm², single breath-hold) were acquired in 40 patients with MI (12 female, mean age 61.1 ± 14 years) at 1.5T (Achieva, Philips, Best, Netherlands). Two independent, blinded readers evaluated 680 segments (AHA 17-segment model) using a 5-point Likert scale in terms of scar visibility. Contrast-to-noise ratio (CNR) between scar and blood pool and between normal myocardium and blood pool was calculated in both datasets.

RESULTS

3D LGE showed 131 infarcted segments out of 680 (19.2%), short3D LGE revealed 141 segments (20.7%). Short3D LGE demonstrated better scar visibility (4.3 vs 2.9, $p < 0.01$) and excellent CNR between scar and blood pool (824.3 ± 249 vs. 221 ± 156, $p < 0.01$), but weak CNR between remote myocardium and blood pool (247.5 ± 241 vs. 1246.6 ± 363, $p < 0.01$) compared to 3D LGE. Agreement between the readers was moderate for 3D LGE and substantial for short3D LGE (weighted $\kappa = 0.55$ vs. 0.76).

CONCLUSION

Short3D LGE provided very good scar visualization and revealed even more infarcted segments in comparison to standard 3D LGE. Although not suitable to replace standard 3D LGE imaging due to insufficient contrast between remote myocardium and blood pool, this novel single breath-hold sequence could be used additionally to standard 3D LGE imaging, especially in patients with subendocardial scars and suboptimal nulling of the myocardium.

CLINICAL RELEVANCE/APPLICATION

Short3D LGE with fixed inversion time makes scar detection easier especially in subtle subendocardial infarcts and when myocardial nulling is difficult.

SSA04-09 The Relationship between Circulating miR-1 Change and Ischemia-Reperfusion Injury in Patients with ST-Segment-Elevation Myocardial Infarction: A Cardiovascular Magnetic Resonance Study

Sunday, Dec. 1 12:05PM - 12:15PM Room: S102CD

Participants
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PURPOSE

This study aimed to evaluate the relationship between circulating microRNAs (miRNAs) and ischemia-reperfusion injury using cardiovascular magnetic resonance (CMR).

METHOD AND MATERIALS

Sixty patients with a first STEMI treated with primary percutaneous coronary intervention(PCI) who underwent CMR imaging at 1 week and 3-6 months after STEMI were evaluated. miR-1 was measured using PCR-based technologies in plasma samples collected at admission and 3 days after PCI. The difference of miR-1 (ΔmiR-1) was calculated. The relationship between ΔmiR-1 and Microvascular obstruction (MVO) was estimated. The association between ΔmiR-1 and the changes of LV diastolic volumes(%ΔLVEDV), and ejection fraction(%ΔLVEF) at follow up were estimated.

RESULTS

The miR-1 at admission showed no difference between MVO positive group and MVO negative group ($P > 0.05$). miR-1 at admission exhibited positive associated with %ΔLVEDV at 3-6 months ($r=0.378$, $P < 0.05$). No significant difference was found between miR-1 at admission and changes of LVEF during follow-up ($P = 0.43$). The expression different of miR-1 showed difference in the MVO positive group and MVO negative group, 5.46 ± 15.32 vs. -5.45 ± 12.37, respectively,$p<0.01$. The area under the curve of receiver operator curve analysis for ΔmiR-1 was 0.81,and when the cut off valve of ΔmiR-1 was 1.54,the sensitivity and specificity were 0.64,0.91, respectively. No significant difference was found between ΔmiR-1 at admission and %ΔLVEDV, and %ΔLVEF.

CONCLUSION

Plasma ΔmiRNA-1 was associated with ischemia-reperfusion injury in STEMI patients undergoing PCI. miRNA-1 at admission was a predictor of LV remodeling at 3-6 months after STEMI.

CLINICAL RELEVANCE/APPLICATION

Plasma ΔmiRNA-1 could potentially be applied to estimate ischemia-reperfusion injury extent in STEMI patients undergoing PCI.

SSA05

Chest (ILD/COPD/Airways)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E350

CH CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSA05-01 Pulmonary Surface Irregularity as a Quantitative CT Biomarker for Idiopathic Pulmonary Fibrosis

Sunday, Dec. 1 10:45AM - 10:55AM Room: E350

Awards
Trainee Research Prize - Fellow

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PURPOSE

Idiopathic pulmonary fibrosis (IPF) causes peripheral fibrotic changes that lead to pulmonary surface irregularity (PSI). The purpose of this study was to assess the accuracy of a quantitative PSI score on high-resolution chest CT for predicting transplant-free survival in patients with IPF.

METHOD AND MATERIALS

For this IRB-approved HIPAA-compliant retrospective single-center observational pilot study, adult patients diagnosed with IPF (N=50; 25F/25M) were age and sex matched with a control group with no known lung disease (N=50; 25F/25M). While blinded to clinical data, three readers independently measured PSI on ten high-resolution axial CT images using custom semi-automated software (Liver Nodularity LLC, Hoover, AL). Patients' age, gender, and pulmonary function test (PFT) results were used to calculate the GAP index, a method for predicting mortality in IPF. A t-test was used to compare the PSI scores between cohorts. Multivariate cox regression analysis was used to associate PSI score and GAP index with transplant-free survival in the IPF cohort. Inter-observer agreement assessed by intraclass correlation coefficient (ICC).

RESULTS

There were zero (0/100) technical failures for measuring the PSI score. Median time to measure the PSI score was 4.7 min. A mean PSI score of 5.38 for the IPF cohort was significantly higher than 3.14 for the control cohort ($p<0.001$). The median (range) PSI score in the IPF cohort was 5.21 (3.05-9.33). The PSI score was independent of the FVC, DLCO and the GAP index ($r=0.07$, $p=0.6$), ($r=-0.07$, $p=0.6$), and ($r=0.16$, $p=0.2$), respectively. The median transplant-free survival for the IPF cohort was 3.6 years. In univariate analysis, patients with IPF and a high PSI score (>median) were 5 times more likely to die than patients with IPF and a low PSI score (HR:5.03; 95%CI:1.86-13.6). In multivariate analysis, only the PSI score was associated with transplant-free survival (HR:1.36 per unit increase; 95%CI:1.01-1.84). Inter-observer agreement for the PSI score among 3 readers was good (ICC:0.75; 95%CI:0.63-0.84).

CONCLUSION

Quantitative measurement of pulmonary surface irregularity on high-resolution chest CT images has good inter-observer agreement and is a strong independent predictor of transplant-free survival in patients with IPF.

CLINICAL RELEVANCE/APPLICATION

The pulmonary surface irregularity (PSI) score is a broadly applicable, quantitative CT biomarker that has high inter-observer agreement and is predictive of survival in patients with IPF and potentially many other forms of pulmonary fibrosis.

SSA05-02 Identification of Pathological UIP in Patients with an Alternative Diagnosis (to IPF) Pattern using Quantitative CT Analysis

Sunday, Dec. 1 10:55AM - 11:05AM Room: E350

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PURPOSE

New IPF guidelines support pursuing surgical lung biopsy in patients with an alternative diagnosis pattern on chest computed tomography (CT) scans. However, up to half of these patients will still have UIP on pathology. The purpose of this study was to determine if a commercially available quantitative imaging tool could be used to identify patients with an alternative diagnosis CT pattern who were highly likely to have a UIP histologically.

METHOD AND MATERIALS

Chest CT scans and lung biopsy specimens were available for review in 225 subjects who had undergone multidisciplinary diagnosis. In 92 of these subjects, their CT pattern was suggestive of an alternative diagnosis to IPF and these patients were included in the study. Non-contrast CT scans were analyzed using the Computer Aided Lung Informatics for Pathology Evaluation and Rating (CALIPER) program, which quantifies the amount of various abnormal CT patterns on chest CT. The resulting data was analyzed statistically using the student's t-test or Mann-Whitney U test as appropriate. Multivariable analysis using logistic regression was performed.

RESULTS

The volume of low attenuation regions, reticulation, ground-glass opacity, honeycombing, or total lung volume did not predict the presence of UIP pattern on pathologic specimens. However, the total vessel related structures (VRS) volume on chest CT was significantly higher in subjects with UIP on pathology as opposed to those without UIP on pathology (182.8±18.3 cm3 versus 140.2±24.3 cm3, respectively; P<0.001). On multivariable analysis, VRS (P=0.032) and race (P=0.041) were significantly associated with UIP pathology. A VRS cut-off of 173 cm3 or greater was associated with a UIP pathology in 84.2% (32/38) of cases. VRS value less than 173 cm3 was associated with a UIP pathology in only 44.4% (24/54) of cases (P<0.001).

CONCLUSION

In subjects with an alternative diagnosis pattern on CT, a higher VRS is associated with a significantly higher proportion of UIP on pathology. At a threshold value of 173 cm3, the predictive accuracy for UIP on lung biopsy specimens approaches that reported for the probable UIP pattern on CT. Application of this to clinical practice could potentially minimize the need for performing lung biopsies for patients in whom a confident diagnosis could not be achieved.

CLINICAL RELEVANCE/APPLICATION

VRS may be an adjunct to HRCT in predicting pathology in patients with diffuse lung disease.

SSA05-03 Preliminary Result of Respiratory Change Analysis For Peripheral Normal-Appearing Lung Field By Dynamic-Ventilation CT: Comparison Between Idiopathic Pulmonary Fibrosis and Connective Tissue Disease Associated Interstitial Lung Disease

Sunday, Dec. 1 11:05AM - 11:15AM Room: E350

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PURPOSE

To compare cross-correlation coefficients (CCC) as an index of concordance of normal appearing lung fields in sub-pleural regions with those located in the center in regional density-based parameters on dynamic-ventilation CT between idiopathic pulmonary fibrosis (IPF) and interstitial lung disease of connective tissue disease (CTD-ILD)

METHOD AND MATERIALS

Five IPF and 5 CTD-ILD patients underwent dynamic-ventilation CT by using 320-row scanner (Aquilion ONE, Canon Medical

Five IPF and 5 CTD-ILD patients underwent dynamic-ventilation CT by using 320-row scanner (Aquilion ONE, Canon Medical Systems, Otawara, Tochigi, Japan) with 16cm-coverage during 5.5m-sec single respiration for upper and lower lung fields in a single examination (4.8 mSv). Spherical volumes of interests (VOI) with 10mm-diameter were set on normal appearing lung area in central and sub-pleural regions at the level of aortic arch, tracheal bifurcation and orifice of right lower pulmonary vein in both lungs at peak-inspiration. Dedicated software automatically tracked VOI based on combined algorithm including non-rigid registration techniques in the remaining phase during a single respiration. CCC between central and sub-pleural regions for mean, kurtosis and skewness of CT density histogram and estimated air volume calculated based on mean CT density in VOI were obtained. Mann-Whitney U test was performed to compare the CCCs between IPF and CTD-ILD in total as well as ventral and dorsal lung fields.

RESULTS

In total, CCCs for kurtosis in IPF were significant lower than those in CVD-ILD (IPF median: 0.636 IQR: 0.256-0.978, CTD-ILD median: 0.974, IQR: 0.934-0985, p<0.0001). Similarly, CCCs for kurtosis in IPF were significant lower both in ventral and dorsal lung fields as compared with CTD-ILD (ventral area; median for IPF: 0.58, median for CTD-ILD: 0.976, p<0.021, dorsal area; median for IPF: 0.636, median for CTD-ILD: 0.972, p<0.0003). For mean, skewness of CT density histogram and estimated air volumes were almost similar between IPF and CTD-ILD.

CONCLUSION

Dynamic-ventilation CT demonstrated lower CCC for kurtosis in IPF indicative of temporal ventilation disproportion in sub-pleural normal appearing regions.

CLINICAL RELEVANCE/APPLICATION

Dynamic-ventilation CT could be useful for detection early-stage IPF in combination with regional analysis of density-based parameters for sub-pleural normal area.

SSA05-04 Radiomic Hyper-Curvature Features for Predicting Survival of Patients with Idiopathic Pulmonary Fibrosis

Sunday, Dec. 1 11:15AM - 11:25AM Room: E350

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PURPOSE

To evaluate the comparative performance of a radiomic hyper-curvature (RHC) model of lung CT images in the prediction of the overall survival of patients with idiopathic pulmonary fibrosis (IPF).

METHOD AND MATERIALS

We retrospectively collected clinical and lung CT data of 172 IPF patients with pulmonary function tests from the Lung Tissue Research Consortium. The lung regions were extracted from the CT images using our previously developed method, after which the bronchi and aerated lungs were separated using histogram thresholding, region growing and mathematical morphology. To characterize patients' lungs, we computed 363 RHC features that characterize the principal curvatures, curvedness, light/dark blobs, lines and sheets, and curvature scales of the bronchi and the aerated lungs. An elastic-net penalty method was used to select and combine these RHC features with a Cox proportional hazards model for predicting the survival of the patient. Evaluation was performed by use of bootstrapping with 1,000 replications, where concordance index (C-index) was used as a measure of prediction performance. The performances of the RHC model was compared with the clinical biomarkers of gender and age, and gender, age, and physiology (GAP) index by use of two-sided t-test.

RESULTS

Bootstrap evaluation yielded the following C-index values: (a) age and gender: C-index 52.1%, [95% confidence interval (CI): 44.8, 59.3]; (b) GAP index: C-index 58.9%, [CI: 50.8, 67.2], P<0.0001 in comparison with (a); (c) RHC: 71.2% [CI: 65.6, 76.9], P<0.0001 in comparison with (b). Kaplan-Meier survival curves of patients stratified to low- and high-risk groups based on the RHC model showed statistically significant (P < 0.0001) difference.

CONCLUSION

The RHC model yielded higher performance than that of GAP model in the prediction of overall survival. Thus, RHC can be an effective imaging biomarker for predicting overall survival of patients with IPF.

CLINICAL RELEVANCE/APPLICATION

Radiomic hyper-curvature features that are automatically calculated from lung CT images can provide an effective prognostic imaging biomarker for precise management of patients with IPF.

SSA05-05 Diagnosis of Idiopathic Pulmonary Fibrosis (IPF) Applying the New Diagnostic Criteria of 2018 ATS/ERS/JRS/ALAT Guidelines

Sunday, Dec. 1 11:25AM - 11:35AM Room: E350

Participants
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PURPOSE

In 2018, the new diagnostic criteria has been proposed for diagnosis of idiopathic pulmonary fibrosis (IPF) from ATS/ERS/JRS/ALAT. This study was to evaluate the evolution of diagnosis of IPF by comparison of the new criteria to the previous 2011 guideline.

METHOD AND MATERIALS

This retrospective study included 535 patients with pathologically proven fibrosing interstitial pneumonia including usual interstitial pneumonia (UIP, n=339), nonspecific interstitial pneumonia (NSIP, n=97) and chronic hypersensitivity pneumonitis (HP, n=98). Three experienced chest radiologists who were blinded to the pathologic diagnosis classified the HRCT pattern of disease based on 2011 criteria (UIP, Possible UIP and Inconsistent with UIP) and 2018 criteria (UIP, Probable UIP, Indeterminate for UIP and Alternative diagnosis) for the diagnosis of UIP. Classification based on 2011 and 2018 criteria were compared and interobserver agreement was evaluated. In each classification, overall survival of patients was also evaluated.

RESULTS

Of the 535 cases, 177 (33.1%) had HRCT findings of UIP, 148 (27.7%) had probable UIP, 39 (7.3%) had indeterminate for UIP and 171 (32.0%) had alternative diagnosis. Of 184 cases with possible UIP based on 2011 criteria, 148 (80.4%) cases were categorized to probable UIP and 36 (19.6%) cases categorized to indeterminate UIP. Among those with probable UIP, 104 (70.3%) had pathologically UIP (concordant group), 33 (22.3%) had NSIP and 11 (7.4 %) had HP. 39 of those with indeterminate for UIP on HRCT had pathologically UIP in 28 cases (71.8%). Of the 339 patients with pathologically UIP, subjects with indeterminate for UIP showed significantly better survival compared to other groups based on 2018 criteria (log-rank test, P=0.001). Between 2011 and 2018 criteria, interobserver agreement did not showed significant difference (2018, $\kappa = 0.512$ for; 2011, $\kappa = 0.546$).

CONCLUSION

Applying the new diagnostic criteria for diagnosis of IPF, group of possible UIP based on 2011 criteria can be reclassified to two different categories, probable UIP and indeterminate for UIP based on 2018 criteria. The patients with indeterminate for UIP on HRCT showed better prognosis compared to the other groups based on new criteria.

CLINICAL RELEVANCE/APPLICATION

In the new CT criteria for diagnosis of IPF, group of possible UIP based on 2011 criteria can be reclassified to probable UIP and indeterminate for UIP, which seems to have different prognosis.

SSA05-06 Deep Learning Enables Automatic Classification of Emphysema Pattern on Computed Tomography

Sunday, Dec. 1 11:35AM - 11:45AM Room: E350

Participants
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PURPOSE

Visual pattern of emphysema on chest CT, using the Fleischner Society classification scale, is associated with physiologic impairment and risk of death. We sought to determine whether subject-level emphysema pattern, classified using a deep learning (DL) method, could predict impairment and mortality.

METHOD AND MATERIALS

9652 subjects in the COPDGene study, with available baseline CT and visual emphysema scores, were partitioned into two non-overlapping sets (2507 for training and 7143 for testing). A DL algorithm was trained to classify pattern of parenchymal emphysema according to Fleischner criteria. We compared visual and DL emphysema scores with clinical parameters including pulmonary function tests (PFT). The Cox proportional hazard model was used to evaluate relationships between emphysema scores and survival. For independent verification the DL algorithm was also tested using 1962 subjects enrolled in the ECLIPSE study.

RESULTS

Emphysema classification by the DL method was associated with impairment on PFTs, six-minute walk distance and St. George's Respiratory Questionnaire ($p < 0.0001$ in each case). DL emphysema classification improved fit of linear mixed models in the prediction of these clinical parameters compared to visual scoring ($p < 0.0001$). Compared to subjects without emphysema, mortality was greater in subjects classified as having emphysema grade beyond trace (adjusted hazard ratios were 1.47, 1.64, 2.94, 5.27, and 9.67, respectively, for mild, moderate, confluent and advanced destructive, $p<0.01$). Testing in the ECLIPSE cohort showed comparable results.

CONCLUSION

Pattern of emphysema, scored automatically using DL, is associated with functional impairment and risk of mortality. Compared with visual scoring, DL provides additional information that can be used to predict diminished function and mortality risk.

CLINICAL RELEVANCE/APPLICATION

Standardized, objective assessment of radiologic images using DL could facilitate subject selection for clinical trials, and risk stratification in clinical practice or in lung cancer screening.

SSA05-07 Structural Image-based Computational Model to Assess Pulmonary Ventilation in COPD Patients: A Comparison with Xenon-enhanced Dual-energy CT Imaging Data

Sunday, Dec. 1 11:45AM - 11:55AM Room: E350

Participants
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PURPOSE

Thoracic computed tomography (CT) is an established technique routinely used to detect structural pulmonary abnormalities. The aim of this study was to demonstrate the CT-based full-scale airway network (FAN) flow model and to compare the modelled pulmonary ventilation with xenon-enhanced dual-energy computed tomography (Xe-DECT) derived pulmonary ventilation in chronic obstructive pulmonary disease (COPD) patients.

METHOD AND MATERIALS

A total of 9 COPD patients underwent Xe-DECT scanning. The virtual non-contrast (VNC) images and ventilation maps were coregistered without the influence of lung volume and evaluated using in-house software. The geometries of lobes and large airways were segmented from VNC images for the FAN flow modelling. Small airways were generated utilising the branch growing algorithm. To enhance the patient-specificity on the FAN model, pulmonary tissue density map extracted from CT images and the lung function tests were applied for the initial and boundary conditions of the model. The FAN model computed the dynamic characteristics of airway flow. In addition to the air flow, the model solved dynamic scalar transfer to simulate gas ventilation. Ventilation maps projected on a coronal plane and line profiles of ventilation were used for comparison of the FAN model and Xe-DECT images. The visual analysis with models and images was performed by experienced radiologists. Pearson correlation coefficients were calculated to assess their correlation.

RESULTS

The pulmonary ventilation calculated from the FAN model was visibly similar to the Xe-DECT images, and the Pearson correlations of the ventilation profiles on the projected plane between the model and images were statistically significant ($r = 0.83 \pm 0.13$, $P<0.001$).

CONCLUSION

The CT-based FAN model showed visual and statistical significance when correlated with the Xe-DECT imaging data. The FAN model utilising structural data may provide additional ventilation information.

CLINICAL RELEVANCE/APPLICATION

The FAN model utilising structural CT data may be used to derive pulmonary ventilation maps and quantitative ventilation data.

SSA05-09 Gender Differences in Airway Dimensions: A Study Based on Quantitative Computed Tomography

Sunday, Dec. 1 12:05PM - 12:15PM Room: E350

Participants
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PURPOSE

The fairly high prevalence of more chronic obstructive pulmonary disease (COPD) in individuals who had never smoked and the increased risk in women raise important questions about the role of gender differences in the airway dimensions. However, there are limited data on non-smokers. Therefore, we investigated how quantitative high-resolution computed tomography (HRCT) measures of wall area percentage (WA%) vary with sex of non smokers.

METHOD AND MATERIALS

We included 94 cases including 49 males and 45 females who underwent chest CT. All included subjects were non-smokers; without current or ex-chronic pulmonary disease (such as chronic obstructive pulmonary disease, asthma, bronchiectasia, lung cancer, chronic inflammation) and all underwent HRCT examination. The HRCT images were quantitatively assessed, providing airway dimensions. We compared the differences of inner diameter, wall area percentage (WA %) for each airway between males and females.

RESULTS

The median age was 64 in males and 68 in females. Internal diameter were smaller for women than men in all measured airway (3.51 ± 0.90 VS 4.23 ± 1.17 mm for segmental; and 2.64 ± 0.43 vs 2.97 ± 0.46 mm for subsegmental bronchi respectively, $p < 0.001$).

However, women had greater WA% in segmental and subsegmental bronchi (62.59±0.07 VS 56.27 ±11.42 for segmental; and 67.36±0.09 VS 57.97±0.16 for subsegmental bronchi, P<0.001.

CONCLUSION

We found significant differences in quantitative HRCT measures of WA% and internal diameter between varying sex of non smokers. Although gender and smoking are strong contributors to COPD, the differences found in this study may explain, in part, variations in disease prevalence-other factors also seem to be important.

CLINICAL RELEVANCE/APPLICATION

Quantitative high-resolution computed tomography (HRCT) measures of wall area percentage (WA%) vary with sex of non smokers.

SSA06

Science Session with Keynote: Emergency Radiology (Practice Management)

Sunday, Dec. 1 10:45AM - 12:15PM Room: N227B

ER SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Karen S. Lee, MD, Boston, MA (*Moderator*) Nothing to Disclose
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Sub-Events

SSA06-01 Emergency Radiology Keynote Speaker: Optimizing Efficiency and Quality

Sunday, Dec. 1 10:45AM - 11:05AM Room: N227B

Participants
Scott D. Steenburg, MD, Zionsville, IN (*Presenter*) Institutional research collaboration, IBM Corporation

SSA06-03 Imaging Workflow Acceleration at a Level 1 Trauma Centre after 24/7 In-house Radiologist Staff Coverage Implementation

Sunday, Dec. 1 11:05AM - 11:15AM Room: N227B

Participants
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PURPOSE

This study aims to evaluate the effect of 24/7 staff radiologist shifts at a Level 1 Trauma Centre on study turnaround time and final report release times as measured by relevant time frames and categorized by CTAS score, radiology shift and day of the week.

METHOD AND MATERIALS

A retrospective chart analysis was conducted on all patients over 18 years old with scans performed at the emergency department (ED). A total of 68,846 exams from pre-24/7 period were taken (Oct 1, 2012 to Sept 30, 2013) and a total of 71,255 from post-24/7 period (Oct 1, 2013 to Sept 30, 2014). The Canadian Triage and Acuity Score (CTAS) was recorded for each patient, categorizing them from most to least acute: CTAS 1 (Resuscitation), 2 (Emergent), 3 (Urgent), 4 (Less Urgent) and 5 (Non-Urgent). The time between imaging request and end of imaging (Time A) and between end of imaging and final report (Time B) were calculated. The Student's t-test and Mann-Whitney test were used to determine statistical significance between pre- and post-24/7 staff radiologist time lengths, where $p<0.05$ was considered statistically significant.

RESULTS

Time A significantly decreased between pre and post-24/7 by 87 min on average for patients with CTAS 3, 71 min for patients with CTAS 4 and 29 min for patients with CTAS 2. Time B was significantly shortened by 332 min on average for patients with CTAS 2, 316 min for patients with CTAS 1 and 3 and 259 min for patients with CTAS 4. The largest decrease in Time B was observed for patients with CTAS 2, with reductions over the shifts that were newly covered by 24/7 Radiology staff, by an average of 626.6 mins during overnight shifts and weekends.

CONCLUSION

The implementation of around-the-clock attending radiologist coverage at our Level 1 Trauma Centre significantly decreased time between image request and imaging completion for patients with CTAS 2 to 4, and between imaging completion and final report release for patients with CTAS 1 to 4. Patients with CTAS 2 benefitted from the largest decrease in time for this time frame.

CLINICAL RELEVANCE/APPLICATION

The presence of 24/7 staff radiologists can significantly reduce imaging time and report finalization times for CTAS 2 and 3 patients, respectively, which in turn may contribute to faster disposition of ED patients and therefore facilitate faster care for incoming critically ill patients.

SSA06-04 Improving ED Efficiency and Patient Safety: Impact of Overnight In-house Radiology Staff Coverage on Imaging-related ED Recalls

Sunday, Dec. 1 11:15AM - 11:25AM Room: N227B

Participants
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PURPOSE

In-house overnight staff radiologist coverage significantly reduces the overall turnaround time (TAT) for imaging studies. Although TAT is a useful metric for performance, the impact of overnight staff coverage on the quality of acute patient care is still questioned, largely due to published low discrepancy rates between radiology residents and staff. One of the more significant managemant changes related to discrepancies is the call back of patients after discharge from ED, caused by ED physicians acting on preliminary resident reports. This study analyzes how the number of ED patients being called back due to discrepant prelim and final imaging reports changed after implementing an overnight staff coverage model at a major Level 1 trauma center with over 675 acute care beds.

METHOD AND MATERIALS

Using ED visit information of two years prior (2016 and 2017) and one year after (2018) rollout of overnight radiology staff coverage, all patients were identified who had overnight imaging performed during their ED visit and who returned to the ED within 48 hours. Visit notes were assessed by two independent scores who determined if the patient's return was due to an imaging report related recall or not. Descrepant scorers' opinions were assessed by a senior third scorer performing chart review. Logistic regression was used to determine if the new coverage model had a significant impact on the number of ED recalls related to imaging report discrepancies.

RESULTS

ED patient visits with overnight imaging were 9,412 in 2016; 9,736 in 2017; and 10,254 in 2018. Number of imaging related recalls were 51, 57 and 7 (in 2016, 2017, and 2018 respectively). Coverage model was a statistically significant predictor of recalls ($b = 2.11$, $z = 5.42$, $p < 0.001$), before the new overnight staff coverage patients were 8.30 95%CI[4.16, 19.68] times more likely to get a recall related to discrepancy in prelim and final read. Despite an increase of ED visits with overnight imaging of almost 9% in 3 years, imaging related absolute number of recalls dropped by 90%.

CONCLUSION

Despite increasing ED visits, overnight attending coverage has significantly reduced ED recalls related to imaging, improving ED patient safety and ED efficiency.

CLINICAL RELEVANCE/APPLICATION

Overnight final imaging interpretation by in-house staff radiology coverage significantly reduces callback rate in ED patients requiring acute care, improving ED efficiency and patient safety.

SSA06-05 Imaging Information Overload: Quantifying the Burden of Interpretive and Non-Interpretive Tasks for CT Angiography for Aortic Pathologies in the ED

Sunday, Dec. 1 11:25AM - 11:35AM Room: N227B

Participants
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PURPOSE

Advances in CT imaging has allowed for improved resolution and the ability to create high quality reformations. The unintended consequences is an increase in the volume of images that theradiologist must interpret. With improved imaging, more incidental findings are found, leading to recommendations for follow-up imaging. CT angiography of the chest (CTA) is the study of choice to evaluate aortic pathologies, but over-utilization in the emergency department (ED) can increase the cognitive burden on the radiologist. The purpose is to quantify the complexity of CTA chest exams performed in the ED over a 10 year period.

METHOD AND MATERIALS

This is a retrospective analysis of adults patients (>= 18 years) presenting to the ED at a single Level 1 tertiary care hospital for

the evaluation of acute aortic pathology with CTA Chest from Jan 1, 2005 to Dec 31, 2015. The number of images and reformats per study were obtained from PACS. Aortic findings, including aortic dissection, aneurysm, and post-operative aortic repair, were determined from the radiology report. Imaging recommendations and verbal communication were evaluated. Descriptive statistics and partial correlation analysis were performed with correlation coefficients (CC) calculated.

RESULTS

A total of 4368 studies were performed over 10 years. The mean age was 64 years, with 56.8% male patients. Studies per year increased 163% over the study period. The number of images and reformats per scan increased from 487 to 2918 images and 6.4 to 13.7 reformats (CC = 0.93 and 0.96, respectively, both $p<0.0001$). The proportions of exams requiring verbal communication increased from 9.3% to 24.7% (CC=0.77, p=0.008) and recommendations from 1.8% to 28.9% (CC=0.66, p=0.03). Overall proportion of cases with aortic findings was 27.3%. However, the proportion of exams with aortic findings did not significantly change over the study period (CC= 0.12, p=0.73).

CONCLUSION

This study demonstrates the increasing complexity of CTA exams as seen by the increase in the number of images and reformats per study. Non-interpretive tasks also increased accordingly. Although the number of CTA exams increased over time, the proportion of studies with aortic pathology remained constant.

CLINICAL RELEVANCE/APPLICATION

More compliant adherence to appropriateness criteria and careful thought in determining necessary reformats in CTA protocols should be considered in order to prevent radiologist burn out.

SSA06-06 Value of a 24-hour Teleradiology Service for Cruise Ships in Detecting Previously Missed Pathologies

Sunday, Dec. 1 11:35AM - 11:45AM Room: N227B

Participants
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PURPOSE

The introduction of a round the clock teleradiology service for a cruise ship as a novel concept in maritime telemedicine. Using a VPN tunnel we implemented a workflow with a routine high standard interpretation of x-rays that were imaged on board and read by experienced radiologists in a tertiary hospital.

METHOD AND MATERIALS

This study was conducted between February 2017 and September 2018 and four cruise ships were involved in total. The ships were equipped with a mobile digital x-ray unit using digital storage imaging plates (SIEMENS Polymobil). The digital x-ray images were transmitted in a standardized fashion from the cruise ships to the hospital via satellite internet. Using VPN secured data transfer of images was managed together with patient data and integrated to the PACS (GE Healthcare, Centricity Universal Viewer). In the tertiary hospital images were analyzed by the radiologist on-call and reports were immediately sent back via VPN.

RESULTS

Overall 410 x-rays of 355 patients were acquired on board and successfully transmitted via satellite from the cruise ships to the tertiary hospital. The vast majority were skeletal x-rays (n=349) with fracture after a trauma being the most frequent query (n=259). The remaining cases were chest x-rays (n=52) with pneumonia (n=36) being the most frequent query and abdominal x-rays (n=9). In 246 cases no pathologies were seen. Common pathologies were as follows: fracture or dislocation (n=77), osteoligamental injury (n=11), arthrosis (n=16) and others (n=49). In 86% of cases the initial report by the physician on board matched the report in the tertiary hospital. However, in 14% of the cases the radiologist in the tertiary hospital detected pathologies, which were previously missed by the physician on board.

CONCLUSION

Using a VPN tunnel we were able to demonstrate a robust and well-functioning workflow allowing a routine high standard interpretation of x-rays that were imaged on board by experienced radiologists in a tertiary hospital. The radiologists in the tertiary hospital detected pathologies in 14% of the cases, which were previously overlooked and potentially would not have been treated.

CLINICAL RELEVANCE/APPLICATION

A 24-hour teleradiology service for cruise ships has the potential to improve immediate patient care in emergencies on board of cruise ships by making use of the expertise of a radiologist.

SSA06-07 Urgency Emergency Radiology: Imaging at Urgent Care Centers

Sunday, Dec. 1 11:45AM - 11:55AM Room: N227B

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PURPOSE

Urgent care centers are facilities that provide ambulatory care outside of the emergency department. The incorporation of radiography capabilities within these practices make imaging accessible and can serve as screening tests for various conditions. The purpose of this study is to examine the image utilization patterns and to quantify positive cases. In addition, the frequency of radiologist recommendations and documented verbal communication will be examined.

METHOD AND MATERIALS

This retrospective study evaluated radiographs performed for both pediatric and adult patients visiting one of 10 urgent care centers within a large metropolitan city from January 1, 2019 to March 31, 2019. All imaging was interpreted by emergency radiologists at an academic Level 1 trauma center. The number of exams were evaluated by body systems. The number of positive findings, radiologist recommendations, and documented verbal communication were quantified.

RESULTS

A total of 3289 patients were identified over the 3 month period. The average age was 38.4 years (range between 1 to 103) with 61% of patients female. Chest radiographs were the most commonly ordered study accounting for 37.4% of all exams with a positive findings rate of 16.3%. Lower extremity exams comprised of 30.0% of exams with a positivity rate of 27.6%. Upper extremity radiographs accounted for 23.6% of exams with a positivity rate of 33.0%. Imaging of the spine and ribs accounted for 7.2% of exams with 16.4% cases being positive. Abdominal and facial bone radiographs were not commonly ordered, accounting for 0.8% and 1% of all exams respectively, with 7.4% and 27.3% of cases having positive findings. Accounting for all studies, the positivity rate was 23.7%, in which 5.4% had radiologists making recommendations for further imaging or follow-up. Only 1.4% of exams required verbal communication of findings.

CONCLUSION

This study demonstrates the utilization of onsite radiography at a network of urgent care centers within a large metropolitan city, with studies interpreted by emergency radiologists at an academic teaching hospital. Chest and extremity radiographs were commonly ordered exams. Almost a quarter of studies had positive findings, although the rate of recommendations and verbal communication was low.

CLINICAL RELEVANCE/APPLICATION

This study provides insight into the workflow of incorporating ambulatory care imaging within the context of an ED radiology practice.

SSA06-08 Does Intravenous Contrast Utilization Affect CT Scan Operation in Emergency Department? A Large Urban Tertiary Academic Center Experience

Sunday, Dec. 1 11:55AM - 12:05PM Room: N227B

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PURPOSE

Rapid turnaround times in computed tomography (CT) department is essential for efficient management of high patient volumes in a busy urban emergency department. There have been a number of published studies showing prolonged emergency department (ED) stays secondary to use of oral contrast media in CT. However, there is a paucity of quantitative data on the effect of intravenous contrast media on CT workflow in ED. We analyzed the potential effect of intravenous contrast administration in CT studies on the ED workflow.

METHOD AND MATERIALS

In this retrospective study, database of CT acquisitions from April 2018 to April 2019 were retrospectively reviewed at a tertiary-level academic hospital. The non-contrast and contrast enhanced CT studies ordered by emergency department were extracted and compared. CT studies ordered for evaluation of stroke, high-energy trauma and aortic emergencies were excluded. Time intervals between order time and start of the scans were compared. For statistical analysis Mann- Whitney- U test was used. Significance was set at 0.05.

RESULTS

18951 CT scans were evaluated (13872 non-contrast CT vs 5079 contrast enhanced CT). The overall average time intervals for non-contrast CT and contrast enhanced CT were 48 minutes 38 seconds and 1 hour 17 minutes 10 seconds, respectively ($p<0.001$). Similar pattern was observed regardless of the type of CT study performed.

CONCLUSION

The use of intravenous iodinated contrast media can cause about a half-hour delay in emergency department workflow at a large

academic institution.

CLINICAL RELEVANCE/APPLICATION

At large institutions, the use of iodinated intravenous contrast media may prolong order to image acquisition time significantly. Physicians and radiologists must take the time interval difference into consideration when planning for improved operational efficiency and CT turnaround time reductions.

SSA06-09 Increasing Timely Access to Emergency CTs via Discrete Event Simulation

Sunday, Dec. 1 12:05PM - 12:15PM Room: N227B

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PURPOSE

This study aims to investigate ways of reducing turnaround times (TAT) for urgent computed tomography (CT) studies completed at the emergency department (ED) of a major urban Academic Level 1 Trauma Center.

METHOD AND MATERIALS

To model the complex dynamics of the workflow for urgent ED patient CTs, a discrete event simulation model (DES) was developed using the software Simul8 version 24.0. The model was built using a year worth of historical data, and the base model results were validated against current performance metrics. The model was then used to explore the effects of several scenarios on emergency CT TAT, including: 1) decreasing the need for protocols assigned by radiologists, 2) increasing the number of CT technologists as well as reallocating some of their existing shifts, 3) reducing appointment booking delays, and 4) increasing overall demand for emergency CTs.

RESULTS

Scenario results were as follows: 1) reducing the number of protocols will have mild impacts on TAT (e.g. reducing the number of protocols by 30% will reduce TAT by 6.3%). 2) Reallocating one of the technologists shifts from day-time to night-time can reduce TAT by as much as 12.8%, and adding new shifts so that two CT technologists are available at all times can produce a TAT reduction of 18%. 3) Reducing booking delays by 50% will reduce TAT by 15.2%, and investing in an automated booking system for emergency cases would reduce it by 25.9%. Finally, 4) increasing demand by 5% next year and 10% the following year, will produce an increase in TAT by 3% and 11%, respectively.

CONCLUSION

This study highlights the benefits of predictive modeling the uncertainties and the dynamic behavior of complex systems such as the imaging workflow for ED patients. DES is a powerful tool that can be used to test different scenarios before committing any resources to implement process changes. The use of DES has provided insightful information of what process changes will have the most impact on TAT, and so it allows hospital leadership to focus on implementing the changes that will provide the best return.

CLINICAL RELEVANCE/APPLICATION

Modeling ED imaging workflow helps to improve operational efficiency because it provides the quantitative evidence necessary to guide decisions that aim to maximize resource investments.

SSA07

Gastrointestinal (LIRADS)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S103AB

GI MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSA07-01 Accuracy of Liver Imaging Reporting and Data System Category 4 or 5 for Diagnosing Hepatocellular Carcinoma: A Systematic Review and Meta-Analysis

Sunday, Dec. 1 10:45AM - 10:55AM Room: S103AB

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PURPOSE

We aimed to systematically determine the accuracy of Liver Imaging Reporting and Data System (LI-RADS) for magnetic resonance imaging (MRI) diagnosis of hepatocellular carcinoma (HCC) and to determine the sources of heterogeneity between reported results.

METHOD AND MATERIALS

Original studies that reported the diagnostic accuracy of LI-RADS for HCC using MRI were identified in MEDLINE and EMBASE up to October 25, 2018. Study quality was assessed using QUADAS-2. We categorized studies into two groups, LR-5, and LR-4 or LR-5, criteria, and obtained the meta-analytic summary sensitivity and specificity of both criteria with a bivariate random-effects model. Subgroup analyses and meta-regression analysis were performed to further explore study heterogeneity.

RESULTS

Among the 157 articles screened, 18 studies covered LR-5 (3651 lesions), and 16 studies covered LR-4 or LR-5 (3182 lesions). For the LR-5 criterion, the meta-analytic summary sensitivity and specificity were 62.1% (95% CI [confidence interval], 53.9-69.7%; $I2$=91.6%) and 92.8% (95% CI, 89.9-94.9%; $I2$=66.8%), respectively (Fig. 1A). For the LR-4 or LR-5 criterion, the meta-analytic summary sensitivity and specificity were 88.4% (95% CI, 82.7-92.5%; $I2$=89.2%) and 81.7% (95% CI, 73.5-87.8%; $I2$=88.3%), respectively (Fig. 1B). For the LR-5 criterion, the three factors of subject enrollment, MRI scanner field strength, and type of reference standard were significantly associated with study heterogeneity (P <= 0.04). For the LR-4 or LR-5 category criterion, the three factors of subject enrollment, MRI contrast agent, and type of reference standard were significantly associated with study heterogeneity (P <= 0.03).

CONCLUSION

The LR-5 criterion was highly specific, but showed suboptimal sensitivity for diagnosing HCC in patients at risk of HCC. In comparison with the LR-5 criterion, the sensitivity of the LR-4 or LR-5 criterion increased, but the specificity decreased. Substantial study heterogeneity was noted, and four significant factors were identified: subject enrollment, the type of reference standard, MRI scanner field strength, and contrast agent type.

CLINICAL RELEVANCE/APPLICATION

The LR-5 criterion was highly specific, but had suboptimal sensitivity for diagnosing HCC. Substantial study heterogeneity was noted, and further randomized controlled studies are needed to validate the diagnostic performance of LI-RADS.

SSA07-02 Using Ancillary Features to Update Liver Imaging Reporting and Data System version 2018 on Gadobenate Dimeglumine-Enhanced MRI

Sunday, Dec. 1 10:55AM - 11:05AM Room: S103AB

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PURPOSE

To evaluate whether ancillary features on gadobenate dimeglumine-enhanced MRI can be used to upgrade LI-RADS categories from LR-4 to LR-5.

METHOD AND MATERIALS

260 patients with chronic liver disease at high risk for HCC were retrospectively included. Hepatobiliary phase (HBP) was obtained 2 hours after gadobenate dimeglumine injection at 3.0T scanner, and all HBP images can be used to evaluate liver observations according to LI-RADS criteria. Blinded to the clinical and pathological data, two abdominal radiologists evaluated LI-RADS v2018 major and ancillary features for the largest observation in each patient on MR images in consensus. Observations were categorized according to LI-RADS version 2018 as well as various modifications to LI-RADS, in which LR-4 could be upgraded to LR-5 by the presence of ancillary features as listed in Table 1. Diagnostic sensitivity, specificity, accuracy, false negative rate (FNR), false positive rate (FPR), positive predictive value (PPV), negative predictive value (NPV) of category LR- 5 were calculated for LI-RADS v2018 and for each modified LI-RADS. Receiver operating characteristic (ROC) curves were generated and areas under the ROC curve (AUC) were computed.

RESULTS

Final diagnoses for the 260 observations included 216 HCCs, 5 intrahepatic cholangiocarcinomas, 5 combined hepatocellular-cholangiocarcinomas, 2 metastatic tumors, 2 focal nodular hyperplasias, 7 arterio-portal shunts, 20 hemangiomas, 1 abscess, 1 cyst, and 1 dysplastic nodule. Overall, 0% LR-1(0/2) and LR-2 (0/28), 90% (10/11) LR-3, 86% LR-4 (19/22), and 99% LR-5 (174/175) were HCCs according to LI-RADS v2018. The final LI-RADS categories, as well as the sensitivity, specificity, accuracy, FNR, FPR, PPV, NPV and AUC of LR-5 using v2018 and each modified LI-RADS are listed in table 1. Modified LI-RADS I (in which HBP hypointensity can be used to upgrade LR-4 to LR-5) showed higher sensitivity (94.4 vs 80.6%) and accuracy (93.5 vs 83.5%) than LI-RADS v2018 without significantly reducing specificity (88.6 vs 97.7%), PPV (97.6 vs 99.4%), or AUC (0.915 vs 0.891).

CONCLUSION

Modified LI-RADS I may improve sensitivity and accuracy for diagnosing HCC without impairing specificity or positive predictive value.

CLINICAL RELEVANCE/APPLICATION

HBP hypointensity may be used to upgrade LR-4 to LR-5 without impairing specificity or positive predictive value for a diagnosis of HCC on gadobenate dimeglumine-enhanced MRI in Chinese patients.

SSA07-03 Effect of Upgrading LR-4 Lesions to LR-5 Using HCC Favoring Ancillary Features on Diagnostic Performance of HCC

Sunday, Dec. 1 11:05AM - 11:15AM Room: S103AB

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PURPOSE

To determine whether upgrading LR-4 lesion to LR-5 using ancillary features (AF) favoring HCC in LI-RADS version 2018 increases the diagnostic performance of HCC.

METHOD AND MATERIALS

112 patients with chronic B-, C- viral hepatitis or cirrhosis and surgically proven primary hepatic malignancy (98 HCC, 11 cHCC-CCC, 2 IHCC, 1 dysplastic nodule) were evaluated with gadoxetate-enhanced MRI in 2013. Two board-certified radiologists retrospectively assessed the presence of major features of HCC, imaging features of LR-M criteria, and HCC favoring ancillary features according to LI-RADS v2018 and assigned an LI-RADS category for each nodule in consensus. The diagnostic accuracy of

each LI-RADS category was described by sensitivity, specificity and positive and negative predictive values with 95% confidence interval. LR-4 lesions were then upgraded to LR-5 if (1) at least one HCC favoring AF was present and (2) lesion was not previously upgrade from LR-3 to LR-4. Diagnostic accuracy of this upgraded LR-5 was compared to initial LR-5 using McNemar X2-test. 5-year overall survival (OS) was evaluated via Kaplan-Meier method, log rank test and Cox proportional hazard model.

RESULTS

All three out of three LR-3 lesions, 18 (85%) out of 21 LR-4 lesions, 70 (98%) out of 71 LR-5 lesions and 7 (41%) out of 17 LR-M lesions were HCCs. As for non-HCC malignancy, except for 3 (27%) out of 11 cHCC-CCCs and 1 dysplastic nodule, all non-HCC malignancy were assigned as LR-M. 9 (42%) out of 21 initial LR-4 lesions were upgraded to LR-5 due to more than one HCC favoring AF. For HCC, initial LR-5 showed sensitivity and specificity of 71.4% and 92.8%, while HCC favoring AF-upgraded LR-5 showed sensitivity and specificity of 79.6% and 85.7%. Accuracy of upgraded LR-5 was 80.4% compared to 74.1% of initial LR-5. In McNemar X2-test, specificity of initial LR-5 was not significantly different from specificity of upgraded LR5 (P=0.317).

CONCLUSION

Upgrading LR-4 lesions to LR-5 increases accuracy without significantly decreasing HCC specificity; thus HCC favoring AF can be used to upgrade LR-4 to LR-5.

CLINICAL RELEVANCE/APPLICATION

Contrary to LI-RADS v2018, HCC favoring ancillary features should be used to upgrade LR-4 lesions to LR-5 because it increases accuracy of HCC without significantly decreasing HCC specificity.

SSA07-04 Assessing Accuracy of the LI-RADS v2017 Treatment Response Algorithm in Evaluating Ablated Hepatocellular Carcinoma

Sunday, Dec. 1 11:15AM - 11:25AM Room: S103AB

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PURPOSE

To assess the performance of the LI-RADS v2017 Treatment Response Algorithm (TRA) in identifying viability of ablated hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

This was an Institutional Review Board approved and HIPAA compliant retrospective study. Patients who underwent ablation of HCC prior to liver transplantation between January 1, 2011, and December 31, 2015, at a single tertiary care center were identified. All patients underwent pretreatment abdominal MRI within 90 days of treatment and post-treatment MRI within 90 days of transplant. Based on transplant histopathology colocalized with imaging, lesions were categorized as completely (100%) or incompletely (<=99%) necrotic. Three radiologists classified each nodule into an LR-TR category (Viable/Non-Viable) according to imaging features. Final LR-TR categories were compared with histopathology and the correlation was calculated. Inter-reader agreement was assessed using Fleiss' Kappa.

RESULTS

36 patients with 53 lesions were included. 58% (31/53) of lesions were ablated using microwave ablation, and the remaining 42% (22/53) with radiofrequency ablation. TRA accuracy for predicting complete tumor necrosis at the time of transplant ranged from 0.75-0.78, with a negative predictive value ranging from 0.77-0.80. Accuracy for predicting incomplete tumor necrosis at the time of transplant ranged from 0.61-0.78, with a positive predictive value ranging from 0.68-0.89. 11% (6/53) of treated lesions were LR-TR Equivocal by consensus, with most (5/6) incompletely necrotic on histopathology. Inter-reader agreement for pre-treatment LI-RADS category was k=0.44 (95% CI 0.16-0.62), lower than agreement for TRA category, k=0.68 (95% CI 0.57-0.78).

CONCLUSION

The TRA is accurate in predicting viable or non-viable HCC after ablation. Of the ablated lesions rated as LR-TR Equivocal, many were incompletely necrotic nodules.

CLINICAL RELEVANCE/APPLICATION

The LI-RADS TRA's performance for predicting histopathological necrosis in HCC lesions following locoregional therapy has not been extensively assessed, and in this work is shown to be accurate.

SSA07-05 Ancillary Features in LI-RADS Version 2018: A Strategy to Improve Diagnostic Performance for HCC on Gadoxetate Disodium-enhanced MRI

Sunday, Dec. 1 11:25AM - 11:35AM Room: S103AB

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PURPOSE

To determine the frequency of occurrence and strength of association with hepatocellular carcinoma (HCC) of each ancillary feature (AF) in the Liver Imaging Reporting and Data System (LI-RADS) version 2018, and to develop an appropriate strategy for applying the AFs to improve diagnostic performance on gadoxetate disodium-enhanced MRI.

METHOD AND MATERIALS

A total of 385 nodules (283 HCCs, 18 non-HCC malignancies, 84 benign nodules) of 3.0 cm or smaller in 266 patients at risk for HCC who underwent gadoxetate disodium-enhanced MRI in 2016 were retrospectively evaluated. Two radiologists independently assigned a LI-RADS category to each nodule. The frequency and diagnostic odds ratio of each AF were assessed. To improve the diagnostic performance for HCC, various criteria were developed based on the number of AFs detected favoring malignancy in general or HCC in particular. Generalized estimating equation models were used to compare the diagnostic performance of each criterion with that of the major features (MFs) only.

RESULTS

The AFs showing a significantly different frequency between HCC and non-HCC lesions were restricted diffusion, mild-moderate T2 hyperintensity, transitional-phase hypointensity, hepatobiliary-phase hypointensity, and hepatobiliary-phase isointensity. Of these AFs, hepatobiliary-phase hypointensity had the highest frequency and strongest association with HCC. When we applied AFs in addition to MFs, the new criterion (with a number of AFs >=4) had significantly higher sensitivity (80.6% vs. 70.0%; *P*<.001) than MFs only, without a significant lowering of specificity (85.3% vs. 90.2%; *P*=.060).

CONCLUSION

The AFs varied in the frequencies of occurrence and strengths of association with HCC. To improve the diagnostic performance for HCC, a new criterion of four or more AFs in addition to the MFs might be the best option.

CLINICAL RELEVANCE/APPLICATION

A criterion of four or more AFs in addition to MFs may be the best strategy to improve the diagnostic performance for HCC on gadoxetate disodium-enhanced MRI using LI-RADS, and is recommended in the evaluation of suspected HCC in patients at risk.

SSA07-06 LI-RADS v2018: Value of Quantitative Assessment of Arterial Phase Hyperenhancement and Washout with Extracellular MRI Contrast Agent

Sunday, Dec. 1 11:35AM - 11:45AM Room: S103AB

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PURPOSE

To assess the influence of quantitative arterial phase hyperenhancement (APHE) and washout (WO) of contrast enhanced MRI on LI-RADS v2018 categorization and compare the quantitative LI-RADS score with conventional qualitative reading.

METHOD AND MATERIALS

60 patients (19 female; mean age 56y) at risk for HCC with 71 liver lesions (28 hepatocellular carcinoma (HCC), 43 benign lesions) who underwent MRI with extracellular contrast agent were included in this HIPPA-compliant retrospective study. Four blinded radiologists independently reviewed all MRI and assigned a LI-RADS score per lesion. Two other radiologists drew regions of interests within the lesion and the adjacent liver parenchyma on pre- and post-contrast MR images. The percentage of arterial enhancement and the liver-to-lesion contrast ratio were calculated for quantification of APHE and WO. The presence or absence of APHE, WO or both was recorded according to the quantitative measurements. Using these quantitative parameters, a quantitative LI-RADS score was assigned in lesions classified as LR-3-5. The diagnostic accuracy was assessed with receiver-operating-characteristics (ROC) analysis and the DeLong test to compare for significant differences between the area under the curve (AUC).

RESULTS

The ROC analysis for the qualitative LI-RADS score showed an AUC of 0.869, 0.946, 0.940 and 0.919 for reader 1, 2, 3, and 4, respectively. The quantitative LI-RADS score where only APHE/WO/or both were replaced showed an AUC of 0.875/0.849/0.874, 0.942/0.924/0.914, 0.933/0.917/0.878 and 0.902/0.852/0.843 for readers 1, 2, 3 and 4, respectively. The AUC of the quantitative LI-RADS score was significantly lower than of the qualitative score only for reader 4 when quantitative WO (p=0.012) and both, quantitative APHE and WO (p=0.047) were used.

CONCLUSION

The qualitative LI-RADS score showed similar or higher diagnostic accuracy compared to the quantitative LI-RADS score. Therefore, qualitative visual assessment appears to be the better approach to scoring liver lesions according to LI-RADS v2018.

CLINICAL RELEVANCE/APPLICATION

A quantitative approach for LI-RADS scoring does not increase diagnostic accuracy; hence, visual assessment should be maintained to score liver lesions according to LI-RADS v2018.

SSA07-07 Hepatocellular Carcinoma Detection by Abbreviated-Protocol Dynamic Contrast-enhanced MRI in Patients with Cirrhosis Using LI-RADS v2018

Sunday, Dec. 1 11:45AM - 11:55AM Room: S103AB

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PURPOSE

Determine the accuracy of abbreviated-protocol dynamic contrast enhanced MRI and complete-protocol MRI for detection of hepatocellular carcinoma (HCC) in cirrhosis patients

METHOD AND MATERIALS

In this IRB-approved HIPAA-compliant retrospective cohort study, 100 consecutive cirrhosis patients underwent standard complete-protocol MRI (cMRI) at 1.5T or 3T for workup for suspected HCC, using extracellular gadolinium contrast. Images of abbreviated-protocol MRI (aMRI; coronal T2-weighted and axial dynamic contrast-enhanced T1-weighted sequences) were extracted from cMRI (aMRI sequences + unenhanced axial T2-, T1-, and diffusion-weighted sequences). Both aMRI and cMRI images were independently read by 4 blinded fellowship-trained abdominal radiologists using Liver Imaging and Reporting Data System (LI-RADS) v2018. Each review (aMRI, cMRI) was scored as positive if any liver observation of LR-4, 5, or M was present, or negative otherwise. Each patient was followed from the time of index cMRI until final HCC status was determined using a composite reference standard of histopathlogy <=6 months, consensus expert panel review of index cMRI or followup-CT/MRI <=6 months (by two different senior abdominal radiologists), and clinic followup at >12 months (in those with negative index cMRI only). Patient-level HCC detection sensitivity and specificity were calculated for aMRI and cMRI with 95% confidence intervals, and compared by McNemar's test at a=0.05.

RESULTS

Mean age of the study cohort was 57.7 years (range 23-77). 14 patients were excluded due to non-diagnostic exam (5), prior HCC treatment (1), use of hepatobiliary contrast agent (1), loss to followup (3), and unable to determine final HCC diagnosis (4). Per-reader detection accuracy of aMRI and cMRI in remaining 86 cirrhosis patients are shown in Figure. No statistically significant differences were found by McNemar's test (p>0.05) between aMRI and cMRI, in sensitivity or specificity.

CONCLUSION

Abbreviated-protocol dynamic contrast enhanced MRI has sensitivity 89.3-96.4% and specificity 84.5-89.7% for HCC detection; no statistically significant difference was found compared to complete-protocol MRI. Further validation is needed in an asymptomatic cirrhosis population to support its use as a screening test.

CLINICAL RELEVANCE/APPLICATION

Abbreviated-protocol dynamic contrast enhanced MRI (a 15-min exam) offers high sensitivity and specificity for hepatocellular carcinoma (HCC) detection and has a potential as a screening test in cirrhosis patients at risk for HCC.

SSA07-08 Inter-reader Reproducibility and Overall Survival Predictability of LI-RADS Tumor Response Algorithm after Drug-eluting-Beads Transarterial Chemoembolization as an Initial Treatment Hepatocellular Carcinoma

Sunday, Dec. 1 11:55AM - 12:05PM Room: S103AB

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PURPOSE

LI-RADS (Liver Imaging and Reporting Data System) Tumor Response (LR-TR) algorithm standardizes the assessment of tumor

response to locoregional therapy in hepatocellular carcinoma (HCC). This study evaluated the inter-reader reproducibility of LR-TR categories (nonviable, equivocal, viable), and whether LR-TR categories predict survival in patients with HCC after first-time drug-eluting-beads transarterial chemoembolization (DEB-TACE).

METHOD AND MATERIALS

All DEB-TACE procedures from 2011 to 2015 at two hospitals affiliated with a liver transplant center were reviewed. Key exclusion criteria were prior HCC-related treatment and lack of pre- and post-treatment multiphasic abdominal MRI or CT within 3 months of DEB-TACE. Four readers (2 radiology residents and 2 fellowship-trained abdominal radiologists) independently reviewed the pre-and post-treatment exams, assigned LR-TR categories to up to two treated tumors per patient, and measured the size of the pre-treatment and the enhancing component of the treated tumor. Inter-reader agreement for LR-TR categories and tumor size were respectively assessed by Fleiss' kappa and intra-class correlation coefficient (ICC). Kaplan-Meier/Cox survival analysis for patient-level LR-TR category (the mode of all lesion LR-TR categories by all readers in a patient) was performed, before and after adjusting for Barcelona Clinic for Liver Cancer stage (BCLC A vs. >=B) and Child-Pugh-Turcott class (CPT A vs. >=B).

RESULTS

75 patients were included, yielding 108 lesions. Inter-reader agreement was moderate for the three LR-TR categories (κ=0.56 [0.55,0.58]). Inter-reader reproducibility for tumor size was excellent for untreated tumors (ICC=0.94 [0.92,0.95]) and good for treated tumors (ICC=0.83 [0.78,0.87]). No significant difference was detected in overall survival between LR-TR nonviable and viable groups (Fig. 1) before or after adjustment for BCLC stage/CPT class, respectively p=0.96 and 0.78.

CONCLUSION

LI-RADS tumor response algorithm for HCC after first-time DEB-TACE has moderate inter-reader reproducibility but may not predict overall survival. Further reader education/training is needed to improve reproducibility. Further research is needed to better translate LR-TR assessment to predict patient survival/guide therapy.

CLINICAL RELEVANCE/APPLICATION

LI-RADS tumor response algorithm for HCC requires reader education and may not predict survival in patients undergoing first-time DEB-TACE.

SSA07-09 Clinical Validation of CEUS LI-RADS in Prospective Multi-Center Study: Preliminary Results

Sunday, Dec. 1 12:05PM - 12:15PM Room: S103AB

Participants
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PURPOSE

The American College of Radiology Contrast-Enhanced Ultrasound Liver Imaging Reporting and Data System (CEUS LI-RADS) is developed to classify focal liver observations in patients at risk of HCC. The aim of this prospective multicenter study is to validate the CEUS LI-RADS.

METHOD AND MATERIALS

A total of 273 nodules from 255 patients at risk of HCC are included in this ongoing study conducted at 8 centers (6 in the USA, 1 in Canada and 1 in Italy). Focal liver observations are classified as LR-5, (definitely HCC) if greater than 1 cm with arterial phase hyperenhancement, and late, mild washout. Rim enhancement and/or early washout and/or marked washout qualify as LR-M (malignant, but not specific for HCC). Other observations are classified as definitely benign (LR-1); probably benign (LR-2), intermediate malignancy probability (LR-3); probably HCC (LR-4). Tumor-in-Vein is characterized as LR-TIV. Definite HCC diagnosis on MRI, imaging follow-up or histology for MRI-indeterminate observations were used as reference standard.

RESULTS

The median focal liver observation size is 2.4cm. Of 273 nodules, 162 (59%) have confirmed diagnosis while 111 (41%) nodules remain indeterminate, currently undergoing imaging surveillance or awaiting histological confirmation. Of 162 confirmed nodules, 136 are HCC (82%), 6 (4%) other malignancies (2 ICC, 1 combined hepatocellular-cholangiocarcinoma, 3 metastasis) and 22 (14%) are benign. A total of 84 confirmed observations are characterized as LR-5 and 100% of them are HCC. The sensitivity of LR-5 for HCC is 63%. All 14 LR-1 and LR-2 observations are benign. All 11 LR-M observations are malignant (5 HCC, 4 metastasis, 2 ICC). 67% (14/21) of LR-3 observations and 92% (24/26) of LR-4 observations are HCC. 5% of nodules are not characterized on CEUS (LR-NC)

CONCLUSION

The CEUS LR-5 classification is 100% specific for HCC, confirming high clinical value of CEUS for noninvasive HCC diagnosis.

CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced ultrasound is a reliable method of focal liver observations classification in patients at risk for HCC

Printed on: 10/29/20

SSA08

Gastrointestinal (Radiomics)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S104A

AI CT GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSA08-01 MRI Radiomics Features Predict Immuno-oncological Characteristics and Recurrence of Hepatocellular Carcinoma

Sunday, Dec. 1 10:45AM - 10:55AM Room: S104A

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PURPOSE

To assess the value of qualitative and quantitative radiomics features measured with MRI for noninvasive prediction of histopathologic and genomics characteristics, as well as outcomes of hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

This retrospective study was IRB-approved and the requirement of informed consent was waived. Forty-eight patients with HCC (M/F 35/13, mean age 60y) who underwent hepatic resection or transplant within 4 months of abdominal MRI were included. Qualitative imaging traits, quantitative non-texture related and texture features were assessed in index lesions on contrast-enhanced T1-weighted and diffusion-weighted images. Advanced histopathological analysis was performed using multiplex immunohistochemistry. Gene expression analysis was performed on paraffin-embedded tissue blocks of the index HCC lesions. The association of imaging features with histopathologic and genomics features was assessed using binary logistic regression and correlation analyses. Binary logistic regression analysis was also employed to analyze the association of radiomics, histopathologic and genomics features with radiological recurrence of HCC at 12 months.

RESULTS

Qualitative (correlation coefficient r=-0.41-0.40, P<0.042) and quantitative (r=-0.52-0.45, P<0.049) radiomics features correlated with immunohistochemical cell type markers for T-cells (CD3), macrophages (CD68), and endothelial cells (CD31). MRI radiomics features also correlated with expression of immunotherapy targets PD-L1 at protein level (r=0.41-0.47, P<0.029) as well as PD1 and CTLA4 at mRNA expression level (r=-0.48-0.47, P<0.037). Follow-up imaging data up to at least 1 year after surgery was available for 43 patients, of whom 10 patients showed HCC recurrence within 1 year after surgery. Several radiomics features showed significant association with HCC recurrence (highest AUC =0.80, odds ratio=5.51, P<0.028), while histopathologic and genomics features did not (P>0.098).

CONCLUSION

We observed significant associations of MRI radiomics features with HCC histopathological and genomics characteristics and recurrence. We are currently validating these results in a prospective study.

CLINICAL RELEVANCE/APPLICATION

Our results suggest that MRI radiomics features may serve as noninvasive predictors of HCC biological properties and recurrence, providing potentially valuable information for treatment planning.

SSA08-02 Multi-Institutional Study using Radiomics and Machine Learning Model to Differentiate Benign and Malignant Focal Hepatic Lesions on Dual-Energy CT

Sunday, Dec. 1 10:55AM - 11:05AM Room: S104A

Participants
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PURPOSE

To assess the application of a machine learning (ML) model-based approach for differentiating benign and malignant focal hepatic lesions on post-contrast dual energy CT (DECT) using tumor analysis and radiomics prototypes (eXamine, Siemens Healthineers).

METHOD AND MATERIALS

Our included 174 adults from the US (Site-A: 103, 65 ± 15 years, 53M:50F) and India (Site-B=71, 48 ± 17 years, 46M:25F) with benign (Site-A=60;Site-B=35) or malignant (Site-A=43;SiteB=36) focal hepatic lesions on post-contrast dual source, DECT (Site-A: Siemens Force or Flash; Site-B: Siemens Flash). Most malignant lesions had histology; benign lesions had characteristic imaging features or were stable on follow-up CT. Low and high kV images in arterial phase (2-3mm) were de-identified, exported, and processed with the TA prototype to derive iodine concentrations and uptakes as well as 585 radiomic features within each lesion's volume and rim. ML model based statistical evaluation (Site-A: Training; Site-B: Test) was performed with the radiomics prototype. Random Forest Classifier was used to calculate the accuracy (AUC) for differentiating benign and malignant hepatic lesions.

RESULTS

Multivariate logistic regression demonstrated that 31 radiomic features enabled distinction between benign and malignant lesions (AUC 0.7-0.8; p=0.0002-0.03; gldm, glszm, glrlm, glszm, first order-kurtosis). With ML model based random forest classifier 12 inner rim radiomic features enabled lesion characterization (AUC=0.82, p<0.0001) with high specificity (97%) and positive predictive value (94%). Only 1/35 benign (flash-filling hemangioma) lesions was classified as malignant lesion (false positive). Compared to radiomics, accuracy was lower for normalized and total iodine uptake (AUC= 0.7; p-0.003; outer lesion rim).

CONCLUSION

With a ML model, the DECT based tumor analysis and radiomics prototypes enable accurate differentiation of benign and malignant hepatic lesions.

CLINICAL RELEVANCE/APPLICATION

Trained ML based predictive models can be generated and integrated with clinical workflow to characterize and classify focal hepatic lesions seen on dual-energy CT.

SSA08-03 Application of Radiomic MRI Features in Differentiation of Combined Hepatocellular Cholangiocarcinoma, Cholangiocarcinoma, and Hepatocellular Carcinoma Using Machine Learning

Sunday, Dec. 1 11:05AM - 11:15AM Room: S104A

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PURPOSE

Definitive morphological imaging features of combined hepatocellular-cholangiocarcinoma (cHCC-CC) have not been established. We aim to use radiomic features to predict diagnosis of cHCC-CC, cholangiocarcinoma (CC) and hepatocellular carcinoma (HCC) with machine learning.

METHOD AND MATERIALS

We conducted a retrospective review of pre-treatment gadolinium or gadoxetate disodium enhanced liver MRI performed between

2004 and 2018 in our institute for 86 patients with pathology proven cHCC-CC (n=38), CC (n=24) and HCC (n=24). Precontrast, arterial, portal venous, hepatic venous and 5 minutes delayed phases were included. Regions of interest (ROIs) were drawn around the largest diameter of the tumors, avoiding nearby normal tissues. 1370 radiomic features were extracted by standard library (PyRadiomics 2.1.2). Using Principle Component Analysis, they were fused to 20 first principle components that explain the majority of variance. These components were used in a 4-fold cross-validation by a Support Vector Machine (SVM) classifier to evaluate the performance of the predictive model for each MRI sequence using pathology diagnosis as endpoints.

RESULTS

We tested two endpoints predictions: 1. cHCC-CC vs. non cHCC-CC with the expectation of differentiating cHCC-CC from HCC and CC, given its unique pathology; 2. HCC vs. non HCC, due to the difference in management. For differentiation of cHCC-CC from HCC and CC, fused radiomic features from hepatic venous and precontrast phases demonstrated higher prediction value than other sequences, with AUC of 0.77 and 0.64 respectively. For the differentiation of HCC from cHCC-CC and CC, arterial, 5 min delayed, portal venous, and hepatic venous phases demonstrated highest prediction values, with AUC of 0.81, 0.80, 0.79, and 0.79 respectively.

CONCLUSION

cHCC-CC is a unique histological entity with treatment implications including liver transplantation due to poorer prognosis than either HCC or CC. Our results demonstrated fused MRI radiomic features in hepatic venous and precontrast phases are promising in differentiating cHCC-CC from HCC and CC. MRI of arterial and 5 min delayed phases have good predictive value to differentiate cHCC-CC and CC from HCC.

CLINICAL RELEVANCE/APPLICATION

The promising predicative value of radiomic MRI features in the differentiation of cHCC-CC, HCC and CC will help with improved preoperative imaging diagnosis and treatment planning including liver transplantation.

SSA08-04 A Radiomics Model Based on Preoperative Gadoxetic Acid-Enhanced MR Imaging for Predicting Liver Failure after Major Hepatectomy

Sunday, Dec. 1 11:15AM - 11:25AM Room: S104A

Participants
Wangshu Zhu, Guangzhou, China (*Presenter*) Nothing to Disclose
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PURPOSE

The clinical indexes are not sufficiently accurate in predicting the outcome of remnant liver function after surgery. The purpose of this study was to determine a radiomics model based on preoperative gadoxetic acid-enhanced MR imaging for predicting liver failure (LF) after major hepatectomy in cirrhotic patients with hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

For this retrospective study, a radiomics-based model was developed based on 101 patients with HCC, with major liver resection between June 2012 and June 2018. Radiomic features were obtained from hepatobiliary phase of gadoxetic acid-enhanced MR images. The radiomics signature was built by using the least absolute shrinkage and selection operator method and multivariable logistic regression model was adopted to establish a radiomics nomogram. Nomogram performance for predicting liver failure was determined using its receiver operating characteristics curve, calibration curve and decision curve.

RESULTS

The radiomics signature, with radiomics score calculated consisting of 5 radiomics features, achieved favorable performance for predicting LF. The radiomics nomogram, which incorporated the radiomics signature and indocyanine green clearance rate at 15 minutes (ICG-R15), showed the highest performance for predicting liver failure (area under the curve [AUC],0.894; 95% confidence intervals [CI], 0.823-0.964). The integrated discrimination improvement (IDI) analysis showed a significant improvement in the accuracy of LF prediction, especially when radiomics signature was added to the clinical prediction model (IDI = 0.117, P = 0.002).

CONCLUSION

A radiomics-based model of preoperative gadoxetic acid-enhanced MR images can be used for liver failure in cirrhotic patients with HCC after major liver resection.

CLINICAL RELEVANCE/APPLICATION

A radiomics-based model in predicting liver failure after major hepatectomy

SSA08-05 Radiomic Analysis for Preoperative T-Staging in Patients with Rectal Cancer

Sunday, Dec. 1 11:25AM - 11:35AM Room: S104A

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PURPOSE

The accurate preoperative assessment of tumor stage is critical for treatment and prognosis of rectal cancer. This study was aimed at constructing a radiomic prediction model to preoperatively assess the primary tumor (T) stage accurately in patients with rectal cancer.

METHOD AND MATERIALS

The magnetic resonance imaging (MRI) data of 349 patients with rectal cancer were collected from February 2011 to October 2017 in this study (T1, n=49; T2, n=79; T3, n=157; T4, n=64). The patients were divided randomly into training cohort (n=240) and validation cohort (n=109). The radiomic features were extracted from high-resolution T2-weighted imaging (HR-T2WI) and diffusion-weighted imaging (DWI) data, then selected to compose radiomic signatures. Incorporating the radiomic signatures and clinical independent risk factors, we constructed a radiomic assessment model by artificial neural network (ANN). The calibration, discrimination, and clinical utility of the radiomic models were assessed by independent validation.

RESULTS

The radiomic signature was significantly related to T stage of rectal cancer ($p<0.01$), and showed good preoperatively T-staging performance. The area under the curve (AUC) was 0.822, 0.733 and 0.779 in discriminating between early stages (T1 and T2 stage, T1/2) and advanced stages (T3 and T4 stage, T3/4), between T1 and T2 stages, and between T3 and T4 stages, respectively. Moreover, with combination of the raidomic signature and clinical independent risk factors, the raidiomic assessment models showed improved performance. The AUC was 0.858, 0.801 and 0.815 discriminating between T1/2 and T3/4 stages, between T1 and T2 stages, and between T3 and T4 stages, respectively. And the performance was confirmed in an independent validation cohort (AUC, 0.842, 0.773 and 0.730).

CONCLUSION

The radiomic model has an excellent performance in preoperative assessment of T stage of rectal cancer. It can improve the accuracy of T staging in patients with rectal cancer.

CLINICAL RELEVANCE/APPLICATION

The radiomic prediction model can improve the accuracy of T-staging assessment in patients with rectal cancer.

SSA08-06 Radiomics Signature on Multiparametric MRI: Association with Disease-free Survival in Patients with Locally Advanced Rectal Cancer

Sunday, Dec. 1 11:35AM - 11:45AM Room: S104A

Participants
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PURPOSE

To develop a radiomics signature based on pre-treatment multiparameter MRI features to estimate disease-free survival (DFS) in patients with locally advanced rectal cancer (LARC) after receiving neoadjuvant chemoradiotherapy (CRT) and to establish a radiomics nomogram incorporating the radiomics signature and clinicopathological findings.

METHOD AND MATERIALS

142 consecutive patients with LARC (training: validation cohorts = 71:71) were enrolled in our retrospective study. 1188 imaging features were extracted from pre-CRT T2WI, contrast enhanced T1WI, and ADC images for each patient. Least absolute shrinkage and selection operator (LASSO) Cox regression was performed to select key features and build a radiomics signature in the training set, and the cutoff point of the radiomics signature to divide the patients into high- and low-risk groups was determined using ROC curve analysis. Kaplan-Meier analysis was used to determine the association of the radiomics signature and DFS. Combining clinicopathological factors, a radiomics nomogram was constructed to validate the radiomic signatures for individualized DFS estimation. Nomogram discrimination and calibration were evaluated.

RESULTS

Higher Rad-scores were significantly associated with worse DFS in both the training and validation cohorts (both $P< 0.05$). The radiomics nomogram, incorporating the radiomics signature and ypN, tumor differentiation, and MRF, estimated DFS (C-index, 0.715; 95% confidence interval [CI], 0.67-0.79) better than the clinicopathological or Rad-score-only nomograms.

CONCLUSION

This study demonstrated that the radiomics signature is an independent biomarker for the estimation of DFS in patients with LARC. Combining the radiomics nomogram improved individualized DFS estimation.

CLINICAL RELEVANCE/APPLICATION

radiomics signature is an independent biomarker for the estimation of DFS in patients with LARC

SSA08-07 Reproducibility of Radiomics Features Using Single-Energy Dual-Source CT: Influence of Radiation Dose and CT Reconstruction Settings Within the Same Patient

Sunday, Dec. 1 11:45AM - 11:55AM Room: S104A

Participants

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PURPOSE

To investigate the impact of radiation dose and reconstruction CT settings on the reproducibility of radiomic features within the same patient, as well as to identify correction factors for mitigating these sources of variability.

METHOD AND MATERIALS

This is a retrospective study of 78 patients (33 women [mean age, 61 years; age range, 28-74 years] and 55 men [mean age, 60 years; age range, 34-81 years] with 151 metastatic liver lesions who underwent a single-energy dual-source contrast-enhanced dose split staging CT. By using the imaging raw datasets technique parameters were altered, resulting in 28 different CT datasets per patient which included different dose level, section thickness, kernel and reconstruction algorithms settings. Using a training dataset, reproducible intensity, shape and texture RFs (r2>0.95) were selected and correction factors were calculated by using a linear model to convert each RF to its estimated value under the reference technique. Using a test dataset, reproducibility of hierarchical clustering based on RFs measured under different CT techniques was assessed.

RESULTS

The percentage of RFs deemed reproducible for any variation of the different technical parameters was 11% (12/106). RFs in the shape category were the least likely to be affected by variability due to changes in technical parameters (87.5% [14/16]). Of all technical parameters, reconstructed section thickness had the largest impact on the reproducibility of RFs (12.3% [13/106]). The results of the hierarchical cluster analysis, showed improved clustering reproducibility when reproducible RFs without and with dedicated correction factors (Prob=0.62-1.0) where used.

CONCLUSION

Our patient study confirmed that many RFs are highly affected by CT acquisition and reconstruction settings to the point of being non-reproducible. By selecting reproducible RFs along with dedicated correction factors a significant improvement in the clustering reproducibility of RFs could be achieved.

CLINICAL RELEVANCE/APPLICATION

Radiomic features of databases with heterogenous CT radiation dose and reconstruction settings are largely non-reproduceable and thus, may be limited in their use for prognostic clinical studies.

SSA08-08 Prediction and Measurement of Treatment Response in Metastatic Liver Disease with Machine Learning Radiomics

Sunday, Dec. 1 11:55AM - 12:05PM Room: S104A

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PURPOSE

To assess if machine learning (ML) based-radiomics can predict and measure treatment response in patients with metastatic liver disease in patients with breast cancer.

METHOD AND MATERIALS

Our IRB approved study included 98 adult women (mean age 54±11 years) with metastatic liver disease from breast cancer. All patients underwent contrast abdomen-pelvis CT in portal venous phase at two timepoints - baseline (BL: pre-treatment) and follow-up (FU: between 3-12 months following treatment). Patients were subcategorized into three subgroups based on RECIST 1.1. criteria (Response Evaluation Criteria in Solid Tumors version 1.1): 32 with stable disease (SD), 32 with partial response (PR) and 34 with progressive disease (PD) on follow up CT. CT images from BL and FU were deidentified and exported to radiomics prototype (eXamine, Siemens Healthineers). The prototype enabled semiautomatic segmentation of the target liver lesions for extraction of first and high order radiomics. Statistical analyses with logistic regression and random forest classifiers was performed with the prototype to assess how well BL radiomics predicts treatment response, and whether radiomics can differentiate SD from

PD and PR on the two timepoints.

RESULTS

BL radiomics differentiated SD from PR (AUC 0.718) and also SD from PD (AUC 0.797). There was no significant difference between the radiomics on BL and FU CT images of patients with SD (P= 0.998). Busyness (an NGTDM feature) and surface volume ratio (a shape feature) were the most powerful predictors of PD between the BL and FU exams (AUC 0.892). BL and FU radiomics were strong measures of PR (AUC 0.938; p= 0.026 with multivariate logistic regression) and random forest classification (AUC 0.78).

CONCLUSION

Radiomics can predict and measure treatment response in patients with metastatic liver disease.

CLINICAL RELEVANCE/APPLICATION

Machine-learning based radiomics has promise to help predict and differentiate stable metastatic liver disease from progressive disease and partial response to treatment.

SSA08-09 Preoperative Prediction of Early Recurrence in Advanced Gastric Cancer: A Radiomic Model Using Computed Tomography

Sunday, Dec. 1 12:05PM - 12:15PM Room: S104A

Participants
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PURPOSE

In the clinical management of advanced gastric cancer (AGC), preoperative identification of early recurrence after curative resection is essential. Thus, we aimed to create a Radiomic Model Using Computed Tomography to predict early recurrence in AGC patients preoperatively.

METHOD AND MATERIALS

Ethical approval was obtained for this retrospective analysis, and the informed consent requirement was waived. This study enrolled 521 consecutive patients (302 in the training set and 219 in the test set) with clinicopathologically confirmed AGC from our center. Radiomic features were extracted from preoperative diagnostic CT images. Machine learning methods were applied to shrink feature size and build a predictive radiomic signature. We incorporated the radiomic signature and clinical risk factors into a nomogram using multivariable logistic regression analysis. The area under the curve (AUC) of operating characteristics (ROC) and accuracy were assessed to evaluate the nomogram's performance in discriminating early recurrence.

RESULTS

A radiomic signature, including two hand crafted features and one deep learning feature, was significantly associated with early recurrence (p-value<0.0001 for both sets). The radiomic signature showed a good performance for discriminating early recurrence with AUCs of 0.820 (95% CI, 0.772-0.869) in the training set and 0.799 (95% CI, 0.741-0.857) in the test set. In addition, clinical N stage, clinical T stage, and carcinoembryonic antigen levels were considered independent predictors for early recurrence. The nomogram, combining all these predictors, showed powerful prognostic ability in both the training and test sets with AUCs of 0.851 (95% CI, 0.807-0.895) and 0.842 (95% CI, 0.791-0.894), respectively. The predicted risk yielded good agreement with the observed recurrence probability.

CONCLUSION

By incorporating a radiomic signature and clinical risk factors, we created a radiomic nomogram to predict early recurrence in patients with AGC, preoperatively, which may serve as a potential tool to guide personalized treatment.

CLINICAL RELEVANCE/APPLICATION

radiomic nomogram may improve risk stratification and serve as a potential biomarker for guiding individual care in patients with AGC.

SSA09

Gastrointestinal (Rectal Cancer)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S103CD

GI MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
David D. Bates, MD, Hastings On Hudson, NY (*Moderator*) Research support, General Electric Company
Viktoriya Paroder, MD,PhD, Bronx, NY (*Moderator*) Nothing to Disclose
Andrea Laghi, MD, Rome, Italy (*Moderator*) Speaker, General Electric Company; Speaker, Guerbet SA; Speaker, Bayer AG; Speaker, Bracco Group; Speaker, Merck & Co, Inc
Myles T. Taffel, MD, New York City, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSA09-02 Radiomic Shape Descriptors of Rectal Wall and Lumen on MRI are Associated with Low and High Pathologic Tumor Stages After Chemoradiation for Rectal Cancer

Sunday, Dec. 1 10:55AM - 11:05AM Room: S103CD

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PURPOSE

The relatively poor expert restaging accuracy of MRI in rectal cancer after chemoradiation (sensitivity ~53%) may be due to difficulties in visual assessment of residual tumor. However, both the rectal wall and lumen may distort in shape due to tumor impact. While previous studies have examined radiomic appearance (texture) of rectal tumors on MRI, we evaluated whether radiomic shape features of the entire rectal wall and the lumen are associated with pathologic tumor stage after chemoradiation therapy (CRT).

METHOD AND MATERIALS

60 patients were retrospectively identified across 2 sites, from whom an axial 3T T2W MRI was available after standard-of-care chemoradiation but prior to excision surgery. The entire rectal wall (ERW) and the lumen were annotated by an expert radiologist on all MRIs. 96 shape descriptors (2D and 3D) were extracted from each of lumen and ERW separately, for each patient. Top 2 ranked radiomic shape features associated with pathologic tumor stage (evaluated on excised specimens) were identified via cross-validation on a training subset from Site 1 (n=33). These were evaluated using discriminant analysis on a hold-out validation set of 27 patients (n=13 from Site 1, n=14 from Site 2).

RESULTS

Top-ranked radiomic shape descriptors for distinguishing low (ypT0-2) and high (ypT3-4) stages after CRT were 2D shape change in ERW across rectal volume (p=0.0004) and 3D volumetric roundness of the lumen (p=0.0014). These features resulted in an AUC of 0.82 in the training set (n=33), and an AUC of 0.82 on hold-out validation (n=27, 2 sites). By contrast, ERW volume (p=0.0357) and lumen volume (p=0.8431) were not significantly different or discriminatory between pathologic stages in either cohort.

CONCLUSION

Radiomic shape features of the entire rectal wall and lumen are highly relevant for discriminating patients with low and high tumor stage after chemoradiation, likely capturing implicit effects of residual tumor expanding or contracting the rectum.

CLINICAL RELEVANCE/APPLICATION

First study of radiomic shape features of rectal structures on post-chemoradiation MRI reveal physiologically intuitive differences in low and high pathologic tumor stages, and could enable better evaluation of rectal cancer response to neoadjuvant CRT.

SSA09-03 Diagnostic Accuracy of Magnetic Resonance Tumor Regression Grade for Pathological Complete Response in Rectal Cancer Treated with Neoadjuvant Chemoradiotherapy: A Systematic Review and Meta-Analysis

Sunday, Dec. 1 11:05AM - 11:15AM Room: S103CD

Participants
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PURPOSE

We aimed to systematically evaluate and determine the diagnostic accuracy of the magnetic resonance tumor regression grade (mrTRG) for diagnosing pathological complete response (pCR) and pathological T1 or lower than T1 stage (<=ypT1) in rectal cancer patients treated with neoadjuvant chemoradiotherapy (CRT), with a focus on the selection of candidates for less aggressive treatments such as local excision or watch and wait approaches.

METHOD AND MATERIALS

Original studies that investigated the correlation of mrTRG with pathological tumor regression grade and pathological T stage were identified in MEDLINE and EMBASE up until August 31, 2018 according to PRISMA guidelines. The search terms included colorectal cancer, chemoradiation therapy, magnetic resonance imaging, and response or regression. A bivariate random effects model was used to for statistical analysis.

RESULTS

Six studies with 916 patients were included. The meta-analytic summary sensitivity and specificity of mrTRG 1 for pCR were 32.3% (95% CI, 18.2-50.6%) and 93.5% (95% CI, 91.5-95.1%) (Fig. 1A), while for <=ypT1 they were 31.8% (95% CI, 16.2-53.0%) and 94.7% (95% CI, 91.9-96.5%) (Fig.1B). On the contrary, sensitivity and specificity of mrTRG 1 or 2 for pCR were 69.9% (95% CI, 60.2-78.1%) and 62.2% (95% CI, 56.2-67.8%), while those for <=ypT1 were 71.4% (95% CI, 61.6-79.6%) and 67.7% (95% CI, 59.8-74.7%).

CONCLUSION

mrTRG 1 showed high specificity for pCR and <=ypT1, but suboptimal sensitivity. mrTRG 1 or 2 showed higher sensitivity for pCR and <=ypT1, but lower specificity. Because of the suboptimal sensitivity of mrTRG 1, it might be limited as a criterion for organ preservation after CRT.

CLINICAL RELEVANCE/APPLICATION

Good response of mrTRGs may be a limited criterion for diagnosing pCR or selecting patients for local excision or watch and wait approaches.

SSA09-04 Locally Advanced Rectal Cancer: The Value of Intravoxel Incoherent Motion Imaging and Diffusion Kurtosis Imaging in Evaluating Pathological Complete Response to Neoadjuvant Chemoradiotherapy

Sunday, Dec. 1 11:15AM - 11:25AM Room: S103CD

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PURPOSE

To investigate the role of intravoxel incoherent motion diffusion-weighted imaging (IVIM) and diffusion kurtosis imaging (DKI) in evaluating pathological complete response (pCR) to neoadjuvant chemoradiotherapy (CRT) in locally advanced rectal cancer (LARC).

METHOD AND MATERIALS

42 LARC patients (cT3/4 or N+) were consecutively enrolled in this prospective study, and underwent pre- and post-CRT rectal MRI on a 3.0 T MRI scanner, including IVIM and DKI sequences with 12 b values. They all received neoadjuvant CRT and subsequent surgery. Pathological tumor regression grade (TRG) of the surgical specimen served as the reference standard. Patients were divided into pCR (TRG0) and non-pCR group (TRG1-3). Slow diffusion coefficient (D) (.10-3 mm2/s), fast diffusion coefficient (D*) (.10-3 mm2/s), perfusion-related diffusion fraction (f), mean kurtosis (MK), mean diffusion (MD) (.10-3 mm2/s) and monoexponential ADC value (.10-3 mm2/s) were calculated by manually drawing ROIs on three representative slices of primary and residual tumor on pre- and post-CRT b=800 s/mm2 images. ROIs were then copied to images of IVIM and DKI parameters. Independent t test, Mann-Whitney U test, and ROC curves were used for statistical analyses.

RESULTS

The pCR group (n=7) had a significant higher post-CRT f (P=0.012), D*(P=0.027), MD (P=0.005) and ADC value (P=0.016) than non-pCR group (n=35). Also the percentage changes of f (P=0.034), MD (P=0.043) and ADC value (P=0.030) after CRT were significant higher in the pCR group. ROC curves showed that post-CRT f, D*, MD and ADC value presented AUCs of 0.739, 0.722, 0.788, and 0.767 in selecting pCR, and the post-CRT MD had a higher sensitivity (82.9% vs. 77.1%) and similar specificity (both 85.7%) than ADC value. Besides, percentage changes of f, MD, and ADC value after treatment presented AUCs of 0.755, 0.747, and 0.735 in identifying pCR, and the percentage f had a higher specificity (85.7% vs. 71.4%) and lower sensitivity(71.4% vs. 80%) than ADC value.

CONCLUSION

IVIM and DKI parameters, especially MD and f could help to differentiate pCR from non-pCR after nCRT in LARC.

CLINICAL RELEVANCE/APPLICATION

IVIM and DKI could help to more reliably select pCR in patients with LARC after CRT, thus could help individualized treatment in clinical. Complere responders may receive non-operative treatment instead of radical resection with reduced surgery related morbidities and improved life quality.

SSA09-05 The Additional Value of Post-nCRT MRI Characteristics for Predicting Locally Advanced Rectal Cancer Patients 3-year DFS

Sunday, Dec. 1 11:25AM - 11:35AM Room: S103CD

Participants
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PURPOSE

The aim of this study was to investigate the additional value of post-nCRT MRI characteristics for predicting locally advanced rectal cancer patients 3-year DFS.

METHOD AND MATERIALS

In this retrospective study, pre- and post-neoadjuvant chemoradiotherapy (nCRT) MRI morphologic (e.g. pre-nCRT MRI-detected extramural venous invasion) and clinicopathologic variabilities (e.g. pathological complete response) were evaluated in all patients. 3-year DFS was estimated using Kaplan-Meier product-limit method, and Cox proportional hazards models were used to determine associations between morphologic or clinicopathologic variabilities and survival outcomes.

RESULTS

A total of 171 patients (median age of 55 years; age range, 27-82 years) were included in the study. 137 (80.1%) patients performed both pre- and post-nCRT MRI examination, while 34 (19.9%) patients did not perform post-nCRT MRI. Pathological type of tumor was an independent predictor for 3-year survival on pathologic variables. In univariate and multivariate analysis, non-adenocarcinoma was a significant factor for worse long-term survival outcomes with the DFS of 38.0 months (95% CI 25.1-51.0 months, P=0.022) in univariate and with the HR of 3.155 (95% CI 1.160-8.586) in multivariate analysis (P=0.024). Other pathologic characteristics subgroup (vascular tumor thrombus, dentate line involvement, CRM involvement and KRAS gene mutation) showed worse DFS compared to reference subgroup in Kaplan-Meier univariate analysis, but the difference were not significant in COX analysis.The 3-year DFS of patients with positive mrEMVI were 52.6 months in univariate analysis, while the negative patients were 65.1 months (P=0.003). Multivariate analysis result was not significantly different (P=0.563), but the HR in mrEMVI positivity patients was 1.270 .In univariate analysis, mrTRG was the independent predictor for 3-year survival on post-nCRT MRI variables (P=0.011) . Partial response patients showed worse DFS compared to those with complete response (HR=2.809, 95% CI 0.451-17.496), but the difference was not significant (P=0.268).

CONCLUSION

Pathological type was the independent risk factor for long-term outcomes in LARC patients; while the other morphologic and clinicopathologic characteristics were not significantly related to survival.

CLINICAL RELEVANCE/APPLICATION

Pre- and post-nCRT MRI characteristics provide more individualieze predicting information for LARC patients outcomes.

SSA09-06 MRI in Restaging Locally Advanced Rectal Cancer: Detailed Reasons of Discrepancy when Taking Pathology as Standard of Reference

Sunday, Dec. 1 11:35AM - 11:45AM Room: S103CD

Participants
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PURPOSE

To analyze the detailed reasons of discrepancy between restaging MRI and pathology in comprehensive morphologic indicators of tumor response

METHOD AND MATERIALS

The MRI and pathological data of 57 consecutive patients who received neoadjuvant treatment and curative surgery from August 2015 to July 2018 were prospectively collected and retrospectively analyzed. The sensitivity and specificity of restaging MRI in detecting tumor regression grade (TRG), T, N stage, circumferential resection margin (CRM), extramural vascular invasion (EMVI) were calculated when taking pathology as reference. One-by-one comparison between restaging MRI and pathology was conducted to analyze the detailed reasons of discrepancy.

RESULTS

The sensitivity of restaging MRI in detecting TRG3-5, T3-4, N+, CRM involvement and EMVI was 77.1%, 100.0%, 75.0%, 87.5% and 91.7%, respectively. Whereas the specificity was 72.7%, 62.5%, 70.7%, 85.7% and 64.4%, respectively. Perirectal irregular spiculation of fibrosis caused overstaging of T2 disease. Extramural infiltration depth of residual tumor in fibrotic area was not accurately identified, therefore accurate T3 staging was not obtained. Massive fibrosis mixed with tumor-like signal could stretch mesorectal fasica or adjacent organs, and be evaluated as persistent CRM involvement or T4b disease. Fibrosis could manifest as similar shape and signal intensity to invaded vessels shrinked after treatment, resulted in the overstaging of EMVI. Inflammatory cell infiltration in fibrotic area could demonstrate as high signal intensity on DWI, which was similar to residual tumor and resulted in the omission of pCR. Acellular mucin scattered in massive fibrosis could manifest as residual tumor. Edematous mucosa and submucosa, and muscularis propria could also be mistaken as residual tumor for the intermediate signal intensity on T2 weighted images.

CONCLUSION

MRI was prone to overstage the residual tumor. The discrepancy between MRI and pathology was mostly caused by the misinterpretation of fibrosis. Inflammation cell infiltration, acellular mucin, edematous mucosa and submucosa, and muscularis propria could also be mistaken as residual tumor.

CLINICAL RELEVANCE/APPLICATION

Preoperative prediction of tumor response is essential for treatment decision. Identification of what MRI features lead to misinterpretation could help improve selection of good responders.

SSA09-07 CT-derived Radiogenomic Signatures Predicting BRAF/KRAS Mutations and Overall Survival in Primary Colorectal Carcinoma Patients

Sunday, Dec. 1 11:45AM - 11:55AM Room: S103CD

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PURPOSE

To determine the ability of CT-derived radiogenomic signatures/models to predict between key mutation (BRAF/KRAS/other wild-type {WT}) of primary colorectal carcinoma (CRC) patients and their overall survival (OS).

METHOD AND MATERIALS

In this retrospective study, we evaluated 134 histopathological proven CRC patients with known genomic data, and available treatment naïve contrast-enhanced CT scans. Using 3D slicer, the entire primary tumor was semi-automatically segmented on the porto-venous phase, and the volume of interest (VOI) was extracted; subsequently, the VOI was imported into our in-house pipeline radiomic analysis to obtain 610 radiomic features per volume. For feature selection, classification model and validation, the least absolute shrinkage selection operator regression (LASSO), Xgboost, and leave-one-out-cross-validation were used, respectively.

RESULTS

Of 134 patients (male, 66; female, 68; average age, 57.9 years) with BRAF (N=47), KRAS (N=46), and WT (N=41); for mutation status, top 55 LASSO features were able to stratify the CRC patients, with an accuracy (99.3%), area under the curve (99.88%-100%), and *P*-value (2.2e-16). For overall survival 40 LASSO features were able to predict good versus poor OS (30 months), with sensitivity, specificity, and *P*-value of 100%, 97%, and 2e-16 respectively. Additional subgroup analysis revealed the ability of only 10 LASSO features to predict OS for BRAF, KRAS and WT with *P*-value of 3.049e-9, 9.19e-11, and 2.87e-7.

CONCLUSION

Our radiogenomic signatures were able robustly to stratify the CRC patients based on their molecular data, and to predict their OS status using pre-treatment CT scans.

CLINICAL RELEVANCE/APPLICATION

Radiogenomics is an emerging field that lends a non-invasive tool for quick CRC patients stratification based on their genomic/molecular profiles.

SSA09-08 Building of Comprehensive Prognostic Scoring System for Recurrence After Rectal Cancer Surgery: Based on Radiologic and Clinicopathologic Evaluation

Sunday, Dec. 1 11:55AM - 12:05PM Room: S103CD

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PURPOSE

To evaluate risk factors of rectal cancer and develop prognostic scoring system for individual recurrence risk assessment.

METHOD AND MATERIALS

Total 489 rectal cancer patients who underwent surgery from 2009 to 2013 were included in the study. Univariate and multivariate Cox proportional hazard model were used to determinate significant prognostic factors among clinical (age, sex, clinical stage, CEA level, anastomotic leak), radiological (anal verge, tumor length, peritoneal reflection, T-, N-stage, lateral LN involvement, threatened circumferential resection margin (CRM), T3 subclassification, extramural venous invasion (EMVI), mean apparent diffusion coefficient (ADC), diffusion volumetry), and pathologic variables (pCRM, lymphatic/venous/perineural invasion, pathologic subtype, immunohistochemistry markers, T-, N-stage). Individual prognostic scores were calculated from selected significant prognostic factors. Patients were divided into low, moderate, and high risk groups according to the prognostic scores. Recurrence rates of each risk groups were obtained. Recurrence free survivals were analyzed by Kaplan-Meier method with the log-rank test.

RESULTS

Distance from anal verge, presence of EMVI on MRI; perineural invasion, N stage on pathology were selected as significant prognostic factors in multivariate analysis. Pathologic T-stage was added to these factors to build prognostic scoring system. Risk coefficient of each 5 factor was assigned as 2, 3, 3, 3, 1, respectively, according to the beta coefficient (ß = 0.52, 0.65, 0.8, 0.31, 0.89). Total 489 patients were classified as low (score 0-1, n=172), intermediate (score 2-3, n=123), and high (score 4-11, n=194) risk groups, according to individual prognostic scores (0-11). Recurrence rates of low, intermediate, and high risk groups were 7.6%, 15.5%, 36.6%, respectively ($p<0.001$). The Kaplan-Meier curve for recurrence free survival showed the prognostic differences between the 3 risk groups.

CONCLUSION

Multifactorial prognostic scoring system based on radiologic and clinicopathologic variables correlated well with recurrence rate after rectal cancer surgery and could be a comprehensive approach to evaluate the prognosis of individuals.

CLINICAL RELEVANCE/APPLICATION

New prognostic scoring system, based on radiologic, and clinicopathologic factors, is useful for comprehensive assessment of individual recurrence risk in the post-operative rectal cancer patients.

SSA09-09 Scan Time Reduction in Rectal Diffusion-Weighted Imaging: Evaluation of the Simultaneous Multislice Acceleration Technique

Sunday, Dec. 1 12:05PM - 12:15PM Room: S103CD

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PURPOSE

To assess the feasibility of simultaneous multislice-accelerated diffusion-weighted imaging (SMS-DWI) of the rectum compared to conventional DWI (C-DWI) for rectal cancer patients.

METHOD AND MATERIALS

DWI of the rectum was performed for 65 patients with initially diagnosed rectal cancer. All patients underwent C-DWI and SMS-DWI with acceleration factors of 2 and 3 (SMS2-DWI and SMS3-DWI, respectively) using a 3 T machine. Acquisition times of three DWI sequences were measured. Image quality among the three DWI sequences was reviewed by two independent radiologists using a 4-point Likert scale and subsequently compared using the Friedman test. Apparent diffusion coefficient (ADC) values for rectal cancer and normal rectal wall were compared among the three sequences using repeated measures analysis of variance.

RESULTS

Acquisition times using SMS2-DWI and SMS3-DWI were 38.2% and 55.5%, respectively, shorter than those with C-DWI. For all image quality ratings other than distortion (image sharpness, artifact, lesion conspicuity, and overall image quality), C-DWI and SMS2-DWI produced better image qualities than did SMS3-DWI ($P < 0.001$), with no significant differences observed between C-DWI and SMS2-DWI ($P >= 0.054$). ADC values of rectal cancer ($P = 0.943$) and normal rectal wall ($P = 0.360$) were not significantly different among C-DWI, SMS2-DWI, and SMS3-DWI.

CONCLUSION

SMS-DWI using an acceleration factor of 2 is feasible for rectal MRI, resulting in substantial reductions in acquisition time while maintaining diagnostic image quality and ADC values similar to those with C-DWI.

CLINICAL RELEVANCE/APPLICATION

SMS-DWI using an acceleration factor of 2 can be incorporated into routine rectal MRI protocol, with shorter scan time and similar image quality compared to conventional DWI.

Printed on: 10/29/20

SSA10

Science Session with Keynote: Genitourinary (Benign Gynecologic Disease)

Sunday, Dec. 1 10:45AM - 12:15PM Room: N228

GU MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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David D. Childs, MD, Clemmons, NC (*Moderator*) Nothing to Disclose
Elaine M. Caoili, MD, MS, Ann Arbor, MI (*Moderator*) Nothing to Disclose

Sub-Events

SSA10-01 Genitourinary Keynote Speaker: New Frontier in Imaging the Benign Female Pelvis

Sunday, Dec. 1 10:45AM - 10:55AM Room: N228

Participants
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SSA10-02 The Additional Value of Expertise and Structured Reporting in Pelvic MRI Assessment of Endometriosis: A Comparison of Three Review Methods for Diagnosis and Staging

Sunday, Dec. 1 10:55AM - 11:05AM Room: N228

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PURPOSE

To compare the diagnostic characteristics of Routine-Read, Structured-Reported read, and Structured Expert-Read pelvic MRI for the diagnosis and staging of pelvic endometriosis in a tertiary care academic medical center.

METHOD AND MATERIALS

530 patients with pathological confirmation of endometriosis were found from 2013-2018; 59/530 (11.1%) had surgical staging and adequate preoperative pelvic MRIs for review. Reports on file were considered routine-read (RR); MRI studies were independently reassessed with a structured-reporting template (SR) and by an structured expert reader (SER). Involvement was recorded by compartment [anterior (AC), middle (MC), posterior (PC), adnexal (AX), and other compartments (OC)]. Using surgical-pathologic staging as the gold standard, diagnostic discrepancy between the RR, SR and SER was assessed with the McNemar's test for paired nominal data. Agreement between SR and SER was assessed using Cohen's unweighted kappa.

RESULTS

295 compartments were assessed in 59 women (mean age= 38.8 y; range= 20-69) and 147/295 (49.8%) were involved surgically/pathologically. Diagnostic comparison results: (1) sensitivity: RR=42.9%; SR=86.4%; SER=74.2%. SR's increased sensitivity was significant for the PC, MC, AC (all, $p=0.001$) and AX ($p=0.038$) but not OC ($p>0.05$). Higher sensitivity by SER was significant for the PC and AC ($p<0.001$), and MC ($p=0.004$), but not AX or OC ($p>0.05$); (2) overall specificity: RR=95.3%; SR=45.9%; SER=81.8%. Neither SR nor SER found different results for specificity in OC ($p>0.5$) when compared to RR. RR sensitivity relied heavily on detection of AX involvement whereas SR and SER showed additional sites of disease (mainly in the PC, MC and AC), while maintaining a comparable specificity for SER. Agreement between SR and SER was fair at $k=0.342$ (95% CI: 0.25, 0.44).

CONCLUSION

Even at a tertiary care academic center, SER outperforms both SR and RR in the assessment of pelvic endometriosis. Although lack of expertise may reduce specificity, the use of a structured reporting template can significantly increase sensitivity the detection and staging of endometriosis; especially in the posterior, middle and anterior compartments.

CLINICAL RELEVANCE/APPLICATION

Structured reporting in conjunction with expertise can assist in surgical planning and counseling of patients living with endometriosis. MRI can play a vital role in surgical candidacy determination and surgeon selection.

SSA10-03 Vaginal and Rectal Gel Filling Improves the Diagnostic Performance of Endometriosis MRI in Detecting

Deep Infiltrating Peritoneal and Rectal Endometriosis

Sunday, Dec. 1 11:05AM - 11:15AM Room: N228

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PURPOSE

No consensus exists in the literature on the value of vaginal and rectal filling in the pre-operative MRI diagnostics of DIE. The aim of our study was to investigate this.

METHOD AND MATERIALS

103 patients, operated 2015-2017 with preoperative 1,5 T and 3 T pelvic MRI with or without vaginal and rectal gel opacification blinded to intraoperative findings were analyzed retrospectively by a specialized gynecologic radiologist and then compared to intraoperative findings by looking at the operation report, postoperative diagnosis and intraoperative images and videos. All lesions were histopathological proven (except bowel lesions not being resected). Statistical analysis was performed with SPSS (Vers 25.0) with ANOVA and Excel (Crosstabs, confusion matrix, correlation coefficient, T-test).

RESULTS

103 patients were analyzed, 45% with, 55% without gel filling. Mean age was 33,2 years (18-46), mean BMI 23.0 (16.1-36.8) and the women had a mean of 1,4 previous surgery. The prevalence of endometriosis in the study population was 0.80. 32.6% of the patients had a rASF °I and° II endometriosis, 55.9% °III and °IV. The detection accuracy of DIE improved significantly when proceeding MRI with vaginal and rectal gel filling (filling / non-filling group: Sens. 0.92/0.82, Spec. 0.56/0.41, PPV 0.89/0.84, NPV 0.63/0.38, Acc. 0.85/0.74). 22% of the patients underwent a bowel resection. The overall detection of rectal endometriosis (serosal, musc. propria, mucosal) was higher in the filling group (Correl. 0.68 vs. 0.46) and clearly superior in the detection of deeper rectal endometriosis (musc. propria and mucosal layers) : filling-group: Sens. 100%, NPP 100% / non-filling-group: Sens. 13%, NPP 53%. Sigma endometriosis was observed in 17/103 patients (17%), 9 of them underwent bowel resection.

CONCLUSION

Adapted MRI protocols with vaginal and rectal gel opacification lead to better preoperative diagnostic in peritoneal deep infiltrating endometriosis and in evaluation the depth of the intra-intestinal endometriosis. The feasibility of this so called 'MRI-jelly method' was high.

CLINICAL RELEVANCE/APPLICATION

For planning surgery and weighing the indication to bowel resection accurate pre-operative diagnostic of DIE is crucial. Adapted MRI protocol with vaginal and rectal gel application is recommendable non-invasive method.

SSA10-04 Uterine Junctional Zone Thickness in Patients with Intrauterine Device (IUD): Is There a Difference from the General Female Population?

Sunday, Dec. 1 11:15AM - 11:25AM Room: N228

Participants
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PURPOSE

Our purpose is to evaluate the thickness of the uterine junctional zone in patients with IUD and compare with literature values for the general female population.

METHOD AND MATERIALS

This is an observational retrospective IRB approved study. From the period of January 2016 until March 2018, 292 pelvic MRI of women of reproductive age (between 17 and 50 years old) and with IUD were evaluated. Exclusion criteria were direct signs of adenomyosis (periendometric cysts, adenomyomas and asymmetric thickening of the junctional zone). The thickness of the junctional zone was measured in the sagittal T2-weighted TSE sequences without fat suppression. In addition, the relationship between the thickness of the junctional zone and the thickness of the entire myometrium was measured at the same location.

RESULTS

The mean thickness of the junctional zone was 8 mm (range: 2 to 27 mm). The mean ratio of junctional zone thickness to myometrium thickness was 0.47 (range: 0 to 1.55). The junctional zone of 135 patients (46.2%) showed normal value thickness (< 7 mm). Moderate thickening (between 7 and 12 mm) of the junctional zone was seen in 136 women (46.6%). Exuberant thickening (> 12 mm) was seen in 21 patients (7.2%), with no other findings of adenomyosis. The relation between junctional zone thickness

and myometrium were 0.4 or less in 106 patients (36.3%) - within normal range based on the literature - and greater than 0.4 in 186 women (63.7%). When we compared our findings with normal values of the literature (normal up to 7 mm), the results showed to be statistically significant (p<0.001), suggesting that junctional zone of --patients with IUD is thicker).

CONCLUSION

IUD is associated with thickening of the uterine junctional zone beyond normal values, a finding that should not be mistaken for adenomyosis.

CLINICAL RELEVANCE/APPLICATION

The knowledge of new values --considered normal for the uterine junction zone thickness in patients with IUD helps to avoid the misdiagnosis of adenomyosis based on this indirect sign alone.

SSA10-05 Multi-parametric MR Relaxometry of Adenomyosis: Assessment of Symptom and Prediction of Response to Gonadotropin Releasing Hormone Analogue

Sunday, Dec. 1 11:25AM - 11:35AM Room: N228

Participants
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PURPOSE

To investigate whether MR relaxometry can evaluate symptoms of adenomyosis including dysmenorrhea and abnormal uterine bleeding, and to explore whether MR relaxometry can further predict the therapeutic response to gonadotropin releasing hormone analogue (GnRHa) in patients with adenomyosis.

METHOD AND MATERIALS

Between Nov 2017 and Aug 2018, 52 patients clinically diagnosed as adenomyosis underwent multi-parameter uterine MR examinations including T1, T2 and T2* relaxometry on a 3T MR scanner (Ingenia CX, Philips Healthcare, the Netherlands) during peri-ovulatory period. Visual analogue scale (VAS) of dysmenorrhea and blood hemoglobin level were collected before GnRHa injections and 6 months after. T1, T2, and T2* relaxation times of lesions were measured blindly by two radiologists via Intellispace Portal (version 10.1.0.64190, Philips Healthcare, the Netherlands) on slices showing maximum lesion area, as well as maximum diameters of lesions on sagittal T2W images. Spearman rank correlation coefficients were calculated to determine the relationship between relaxation times and VAS. Student t tests were performed to compare the difference of lesions' features between patients with different therapeutic responses. A p value <0.05 was considered statistically significant.

RESULTS

A moderate, negative correlation was found between T2* relaxation time of lesions and VAS (r=-0.4808, p=0.0004). Twenty-three patients received GnRHa injection, and 14 of them achieved complete response (CR, VAS=0 and normal Hgb) after 6 months, while 9 patients with partial response (PR, VAS>0 or anemia). T2* relaxation times of lesions were shorter in patients with CR than those with PR (43.73±2.019 ms vs. 55.43±5.465 ms, p=0.0295). Differences were found regarding T2 relaxation times and lesion maximum diameters but they were not statistically significant (63.12±1.913 ms vs. 71.07±3.685ms, p=0.0501, and 61.46±6.899 mm vs. 41.69±5.721 mm, respectively).

CONCLUSION

T2* relaxation time of lesions can quantitatively assess dysmenorrhea severity in patients with adenomyosis. Furthemore, T2* relaxometry showed potential as a quantitative imaging marker to predict GnRHa therapeutic response in patients with adenomyosis.

CLINICAL RELEVANCE/APPLICATION

T2* relaxometry can make both assessment and prediction as a non-invasive method, and guide different patients to GnRHa or other therapeutic plans based on different findings.

SSA10-06 Uterine Fibroid Embolization: MRI Texture Analysis as a Predictor of Radiological Outcome

Sunday, Dec. 1 11:35AM - 11:45AM Room: N228

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PURPOSE

To assess the association of morphologic and texture features on pre-embolization contrast-enhanced MRI with the radiological

response of uterine artery embolization (UAE) for uterine fibroids

METHOD AND MATERIALS

This retrospective study analysed the pre-embolization pelvic MRI studies of 80 patients that underwent UAE in our tertiary care centre. Cases were chosen to have good representation of two types of post MRI embolization response: 1) good - > 70% fibroid necrosis (48 cases) and 2) poor < 70% fibroid necrosis (32 cases). Quantitative differences of multiple texture parameters between the two groups were assessed on the venous phase of the pre-embolization MRI. The dominant fibroid on the venous phase was delineated in 3D with semi-automatic in-house software. Volume and six histogram-derived texture features (mean, variance, skewness, kurtosis, entropy, uniformity) were computed for each region of interest. Univariate t-tests were computed to test for statistical difference between the two outcome-based groups. Accounting for Bonferroni correction for multiple comparisons, features with $p<(0.05/7)=0.0071$ were selected and univariate diagnostic models were built separately for each selected feature. 95% confidence intervals were estimated using 1000 bootstrap iterations.

RESULTS

Three features with $p<0.0071$ were found, with the following diagnostic performance (95% confidence interval shown in parentheses): The AUC, Sensitivity and Specificity for Volume 0.86 (0.71,0.92) 0.88 (0.74,1.0) 0.79 (0.48,0.86) Mean 0.75 (0.63,0.85) 0.78 (0.53,0.94) 0.70 (0.29,0.78) Skewness 0.73 (0.59, 0.82) 0.44 (0.27,0.55) 0.76 (0.73,1.0) respectively.

CONCLUSION

Among the three selected features, volume appears to be the single best feature and outperformed other histogram-based texture features. In future work, we will collect an independent testing dataset, at which time machine learning techniques will be used to optimize a predictive model.

CLINICAL RELEVANCE/APPLICATION

Volume and regional texture features (mean, skewness) can help predict radiological outcomes of UAE and such studies may eventually allow better patient selection for UAE

SSA10-07 A Retrospective Study of the Ultrasound Characteristics of Surgically-proven Ovarian Torsion

Sunday, Dec. 1 11:45AM - 11:55AM Room: N228

Participants
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PURPOSE

Ovarian torsion can be a challenging diagnosis to confirm or exclude with ultrasound. In this 5-year retrospective study, we aimed to evaluate the ultrasound characteristics of the ovaries in women who underwent surgery for the presumed diagnosis of ovarian torsion.

METHOD AND MATERIALS

We queried our institution's electronic medical record system for all women who were admitted or discharged from two hospitals in our healthcare system between November 2012 and November 2017 and had an ICD-9 or ICD-10 code diagnosis of ovarian torsion. All patients who underwent surgery for the treatment of ovarian torsion were included in the study. The pre-surgical ultrasound studies were then reviewed by an attending radiologist and two radiology residents to determine ovarian volumes, ovarian parenchymal echotexture, ovarian color and spectral flow patterns, ovary location, ascites, presence of an adnexal mass, and presence of the whirlpool sign. We then reviewed the operative notes and corresponding pathology reports to determine which patients had confirmed ovarian torsion. Statistical analysis was performed using SAS.

RESULTS

A total of 64 patients were admitted or discharged with a diagnosis of ovarian torsion. Of these, 55 patients underwent surgery and were included in the analysis. The average patient age was 30 years old. At surgery, 39 patients had confirmed ovarian torsion (71%) and 16 did not (29%). The average volume of torsed ovaries was 202 ml (CI 125 - 279 ml) and for non-torsed ovaries 135 ml (CI 58 - 212 ml). The distribution of ovarian volumes was positively skewed, and no significant difference was found between the torsed ovaries and non-torsed ovaries ($P = 0.12$). The positive predictive values (PPV) were 86% for absent flow on color doppler, 79% for absent arterial flow on spectral doppler, and 75% for absent venous flow. PPV for the presence of heterogenous stroma was 74%, peripheral follicles 88%, presence of a mass 73%, moderate or large volume of ascites 80%, and for the whirlpool sign was 90%.

CONCLUSION

False positive rates remain high (29%), and no single sonographic finding is specific to ovarian torsion. Positive predictive values for common findings ranged from 75% for absent venous flow to 90% for whirlpool sign, which was only seen in 10 patients.

CLINICAL RELEVANCE/APPLICATION

Our results suggest evaluation of the vascular pedicle for whirlpool sign may be of utility when looking for ovarian torsion.

SSA10-08 Differentiation Between Ovarian Ischemia and Hemorrhagic Infarction by MRI in Cases of Adnexal Torsion

Sunday, Dec. 1 11:55AM - 12:05PM Room: N228

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PURPOSE

To demonstrate the role of magnetic resonance (MR) imaging findings, in differentiating between ovarian infarction and ischaemia and consequently the rate of ovarian salvage in cases of adnexal torsion.

METHOD AND MATERIALS

25 patients with surgically proven ovarian torsion were evaluated by two radiologists regarding the following MR findings: Ovarian enlargement, ovarian parenchymal hypointensity on T2-weighted images (WI), Hyperintensity on T1 (WI) with fat saturation, Recognition of twisted pedicle, Diffusion restriction and Ovarian parenchymal enhancement.. Also Pelvic fluid collection,and Uterine deviation These MR findings were statistically correlated with the operative findings and histopathological results (for cases of ovarian infarction).

RESULTS

Pathologically, ovarian haemorrhagic infarction was confirmed in 6 out of 25 cases. Ovarian hyposignal on T2 WI was seen in all cases with infarction 6/6. Ovarian hyperintensity (compared to the contralateral sides) was observed in 4/6 and 5/6 cases with infarction on T1WI and DWI, respectively Ovarian enlargement, fluid collections, uterine deviation and twisted pedicle were detected in most cases with or without haemorrhagic infarction. Poor parenchymal contrast enhancement was observed in all cases without or with necrosis

CONCLUSION

Detection of ovarian infarction is of prognostic importance in cases of torsion to assess salvageability, and thus may affect the surgical decision. Swollen hypointense ovarian parenchyma on T2 WI with lack of contrast uptake are the most reliable MRI signs, followed by hypersignal on T1 WI fat sat and DWI.

CLINICAL RELEVANCE/APPLICATION

MRI is not commonly employed as a first-line imaging study in suspected torsion, but can be very helpful in pregnant patients with an inconclusive US or as a problem solver in equivocal cases. It is important to assess salvageablity of the torsed ovary preoperatively.

SSA10-09 Prevalence of Pathologies in Infertile Women Identified by MR Virtual Hysterosalpingography

Sunday, Dec. 1 12:05PM - 12:15PM Room: N228

Participants
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PURPOSE

CT Virtual Hysterosalpingography (CT-VHSG) emerged as a good non-invasive modality to evaluate the gynecologist system using very low radiation dose. Recently MR-Virtual Hysterosalpingography (MR-VHSG) appears with the advantage of lacking of ionizing radiation. The objective of this paper is to evaluate the usefulness of MR-VHSG in infertility versus CT-VHSG, and determine the prevalence of disease in each anatomic region of the gynecologist system.

METHOD AND MATERIALS

Patients were studied by CT-VHSG and MR-VHSG. CT studies were performed in a 128-slice CT scanner (Discovery CT750 HD, GE Healthcare) and MR studies in a high filed 3T scanner (Discovery HXT, GE Healthcare). Findings in each modality were reported by two different radiologists in a blinded fashion according to different anatomic regions: cervix, uterine wall, uterine cavity and fallopian tubes. Sensitivity (S), Specificity (SP), Positive Predictive Value (PPV) and Negative predictive Value (NPV) were determined by the exact binomial method for each region. Disease prevalence was reported in each region.

RESULTS

Fifty two infertile women were studied. In the cervix, 21 patients presented pathological findings: 6 polyps, 6 C-section scars, 3 stenosis,1 sinequiae, 7 hypertrophic folds, 5 glandular dilatation. Prevalence of disease: 9,77 %. Per patient S, Sp, PPV and NPV were: 96%, 95%,96% and 95%. Per lesion S, Sp, PPV and NPV were 89%, 95%, 92%, 98%. In the uterine wall, 6 patients presented anomalies (1 septate, 3 unicorn, 2 arcuate uterus). S, Sp, PPV and NPV 100%. In uterine cavity, 13 patients presented pathology (6 polyps,1 submucosal myoma, 5 sinequiae,1 hyperplasic folds). Disease prevalence 5.24 %. Per patient S, Sp, PPV and NPV were 100%, 94%, 85%, 100%. Per lesion S, Sp, PPV and NPV were 92%, 98%, 80%, 99%. In the fallopian tubes 8 patients presented pathology: tubal occlusion, dilatation, hidrosalpinx and negative Cotte. Per patient, S, Sp, PPV and NPV were 82%, 92%,72%, 97%. Disease prevalence 17,65%. Per lesion S, Sp, PPV and NPV were 88%, 99%, 88%, 99%.

CONCLUSION

MR-VHSG showed very good results in the evaluation of the gynecological system. These promising results should be validated in a larger number of patients so as to determine its the role in clinical work.

CLINICAL RELEVANCE/APPLICATION

MR-VHSG is a promising, ionizing radiation-free examination for the evaluation of the infertile woman.

Printed on: 10/29/20

SSA11

Genitourinary (Renal Neoplasia)

Sunday, Dec. 1 10:45AM - 12:15PM Room: N230B

CT GU

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSA11-01 Diagnostic Accuracy of the Clear Cell Likelihood Score (ccLS) in Clinical Practice: Impact of Tumor Stage

Sunday, Dec. 1 10:45AM - 10:55AM Room: N230B

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PURPOSE

The paradoxical lack of decreased mortality from renal cell carcinoma despite the increased incidental detection of renal masses demonstrates a need for risk stratification prior to intervention. As the most common and aggressive histologic subtype, identification of clear cell renal cell carcinoma (ccRCC) during radiologic evaluation would be valuable. Previous work has shown the predictive value of a clear cell likelihood score (ccLS) derived from multiparametric magnetic resonance imaging (mpMRI). Here we assess the prospective performance of ccLS for renal masses across all stages in clinical practice.

METHOD AND MATERIALS

We conducted a retrospective, multi-institution analysis of prospectively generated clinical data. The ccLS was incorporated into the clinical report of mpMRI at 2 different institutions in 06/2016. Prospectively assigned ccLS of renal masses evaluated between 06/2016 and 10/2018 were reviewed. ccLS were correlated with histologic diagnosis when available. Diagnostic performance for diagnosing ccRCC and post-test probabilities of ccLS were quantified by contingency table analysis.

RESULTS

634 mpMRIs were obtained for renal mass evaluation and prospectively assigned ccLS by 1 of 16 fellowship-trained radiologists. Of these, 255 renal masses (244 patients) had pathologic tissue diagnosis after the mpMRI via renal biopsy (34) or surgical excision (221) and represent the study cohort. Overall, 24% were ccLS 1-2, 12% ccLS 3, and 64% ccLS 4-5. 45.1% of the masses were clinical stage T1a, 24.7% T1b, 3.5% T2, 24.3% T3, 2.4% T4. The figure shows the distribution of histologic diagnosis across ccLS. The sensitivity and specificity of ccLS >=4 in diagnosing ccRCC are 87.8% and 80.2%, respectively. The sensitivity and specificity of ccLS >=3 in diagnosing ccRCC are 98.2% and 64.8%, respectively. Diagnostic accuracy improved in higher stage tumors (Cochran-Armitage trend test, p = 0.0025).

CONCLUSION

A non-invasive diagnosis of ccRCC in patients with renal masses using mpMRI can be achieved with reasonable clinical performance in a busy clinical practice with a large number of interpreting radiologists. ccLS performance improved in larger tumors.

CLINICAL RELEVANCE/APPLICATION

Implementation of ccLS in clinical practice can help reduce the number of renal biopsies prior to surgical resection (95.1% of ccLS 4-5 were malignant). Histologic prediction with mpMRI is improved in larger tumors.

SSA11-02 Infiltrative Renal Masses: Are We Reporting What's There? Impact on Patient Outcome

Sunday, Dec. 1 10:55AM - 11:05AM Room: N230B

Participants
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PURPOSE

To determine the prospective reporting rate of infiltrative features in radiologically identified renal masses and to evaluate the impact on patient outcomes.

METHOD AND MATERIALS

522 patients with renal tumors managed with partial or radical nephrectomy (2012-2014) with locally-advanced and/or aggressive histology were analyzed. Preoperative CT/MRI were retrospectively, independently reviewed by 2 radiologists. Infiltrative renal masses (IRM) were defined as having poorly-defined interface with parenchyma and non-elliptical shape in one or more distinct and unequivocal areas and features were identified as extensive or focal. Cancer-specific mortality (CSM) was estimated using Kaplan-Meier. Significant, independent predictors of CSM were evaluated using Cox-proportional-hazards analysis.

RESULTS

Image-review confirmed 133 IRMs (25%), including 103 RCCs, 59 with sarcomatoid or poorly-differentiated features on pathology. IRMs were larger and more often symptomatic compared to non-IRMs, and disseminated-disease was also more common (all $p<0.001$). Overall, 109 IRMs were imaged at our center; 42 were documented as IRM in preoperative radiology reports, while infiltrative features were not documented in 67 (61%). Only 4 (6%) of these 67 were documented as infiltrative by the surgical team. 2-year CSM was 29% and 6% for IRM and non-IRM patients, respectively ($p<0.001$, Figure A). CSM difference was found documented versus undocumented IRMs ($p=0.04$, Figure B) and both showed significantly increased CSM compared to non-IRMs (both $p<0.001$). Among IRMs, extensive infiltrative-features and disseminated-disease were associated with CSM, while documentation-status failed to associate. Among IRMs, extensive infiltrative-features and disseminated-disease were associated with CSM, while documentation-status failed to associate.

CONCLUSION

Twenty-five percent of locally-advanced and/or histologically-aggressive renal tumors exhibited infiltrative features, although many were not documented prospectively. Even within this high-risk population, infiltrative-features were independent predictors of CSM, whether documented or not.

CLINICAL RELEVANCE/APPLICATION

Infiltrative features in renal tumors have a strong impact on patient prognosis and should be routinely assessed and documented during radiologic evaluation of renal masses.

SSA11-03 Evaluating Distribution of Renal Tumor Growth Rate in Hereditary Cancers: A Single Center Study

Sunday, Dec. 1 11:05AM - 11:15AM Room: N230B

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PURPOSE

To investigate the distribution of growth rate across different subtypes and sizes of renal tumors associated with hereditary renal cancers, using serial volumetric imaging.

METHOD AND MATERIALS

A registry of patients with hereditary renal cancers was retrospectively reviewed for patients with a minimum of two preoperative cross-sectional imaging. Longest diameter of the tumor was measured for all time points using less than 3 mm slice thickness CT in corticomedullary phase of high-resolution T2-WI MRI. Tumor growth rate between every two consecutive instances of imaging was calculated using the same modality (CT/MRI), and was used as a data point for statistical evaluation. Association between tumor size at each instance and its subsequent growth rate was analyzed using repeated-measures statistical models, which were also used to compare growth rates across renal tumor subtypes.

RESULTS

Images included 1142 CT scans and 734 MRI. Tumors included pathologically confirmed cases of Clear Cell renal cell carcinoma

(ccRCC, n=197), Papillary type 1 (n=47), and Oncocytoma (n=12) from patients with Von Hippel-Lindau syndrome (n=75), Hereditary Papillary Renal Carcinoma (n=13), and Birt-Hogg-Dube syndrome (n=7). The number of pairs of consecutive of measurements, their median growth rate (in mm per 365 days), and interquartile range were: n=777, median=2.35, IQR=(0.00, 6.67) for ccRCC; n=134, median=1.00, IQR=(0.00, 4.66) for Papillary Type I; and n=27, median=1.44, IQR=(0.00, 4.89) for Oncocytoma. The data did not show any evidence of an association between tumor size at presentation and its subsequent growth rate, for any of the 3 subtypes. There was no evidence of average tumor growth rates being different between tumor subtypes in hereditary renal tumors. Based on all 3 subtypes combined (n=938), the median growth rate was 1.97 mm per 365 days, with an interquartile range of (0.00, 6.27).

CONCLUSION

The data analyzed showed no evidence of an association between renal tumor growth rate and tumor size in ccRCC, Papillary, and oncocytoma associated with hereditary renal syndromes, and showed no evidence of a difference in average growth rate among the 3 subtypes.

CLINICAL RELEVANCE/APPLICATION

Tumor size at presentation measured on serial images does not seem to be a reliable measure to estimate future growth, hence it is not suggested as a marker to schedule surveillance frequency of renal masses associated with hereditary renal cancers.

SSA11-04 The Arrowhead Sign (AS) a Novel, Reproducible Radiographic Indicator of Intramuscular Venous Branch Invasion (pT3a) in Patients with Renal Cell Carcinoma

Sunday, Dec. 1 11:15AM - 11:25AM Room: N230B

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PURPOSE

Accurate preoperative prediction of T3a disease in renal cell carcinoma (RCC) is a clinical challenge. Knowledge of renal intramuscular venous invasion can influence clinical decision-making regarding the suitability of nephron-sparing surgery. We report and validate the observation that tumors that exhibit invasion into the muscular branches of the venous vasculature form a 'beak-shaped' irregularity as they grow towards the renal sinus fat and resembles an 'arrowhead'. We sought to determine if the 'Arrowhead Sign (AS)' CT finding could be used as a preoperative predictor of proximal venous invasion on final histopathologic evaluation

METHOD AND MATERIALS

We queried our IRB-approved, kidney cancer database and identified 174 patients with localized renal tumors who underwent surgical resection between 2009 and 2018 and had a pre-operative contrast imaging within 90 days of surgery. Two fellowship-trained junior abdominal radiologists and a senior radiologist with 25 years of experience blindly and independently reviewed the imaging. To evaluate for likelihood of tumor venous invasion on final histopathology, images were assessed for the following radiographic predictors of cT3a disease: sinus fat infiltration, perinephric invasion, and AS.Indicators were scored on a 1- 4 scale according to reader's degree of confidence in the finding, with a score of 1 - definitely present,to 4 - definitely absent. Statistical analyses were performed.

RESULTS

Final pathologic staging revealed pT1=116 (66.6%), pT2=9 (5.1%), pT3=48 (27.5%) and pT4=1 (0.006%). The sensitivity and specificity of AS for predicting muscular venous invasion were 92% and 73%, respectively. Perinephric invasion had 62% sensitivity and 85% specificity, while sinus fat infiltration was 89% sensitive and 73% specific. Inter-reader agreement for AS was moderate (x = 0.64).

CONCLUSION

The arrowhead sign is a novel and potentially clinically actionable predictor of muscular venous invasion in patients with RCC. Of the three indicators, it had the highest sensitivity and moderate intra-reader agreement. These initial findings justify further investigation.

CLINICAL RELEVANCE/APPLICATION

The ability to stage pT3a (RCC) with imaging can influence surgical management and eligibility for clinical trials. Of the three commonly reported imaging features the,' arrowhead sign,' had the highest sensitivity and larger validation studies are warranted.

SSA11-05 Renal Mass Characterization with Dual-energy CT: Validation of a Dual-layer Spectral CT Platform in an Anthropomorphic Renal Phantom Model

Sunday, Dec. 1 11:25AM - 11:35AM Room: N230B

Participants
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PURPOSE

To validate the application of a dual-layer spectral CT platform for renal mass characterization using dual-energy CT (DECT).

METHOD AND MATERIALS

A custom renal phantom model consisting of three cylinders simulating unenhanced state (A) (0 mgI/mL), nephrographic (B) (7 mgI/mL) and excretory phases (C) of the kidneys (5 mgI/ml) was used. In addition, six rods were fabricated to mimic simple and hyperdense cysts (0 mgI/mL), unenhanced (0 mgI/mL) and contrast-enhanced minimally- (0.5 mgI/mL), moderately- (1 mgI/mL), and avidly-enhancing (3 mgI/mL) solid renal masses (labelled 1-6 respectively). Simulated kidneys with varying renal masses were inserted into an anthropomorphic human phantom (ATOM 701, CIRS Inc.) in three body sizes (small, medium, large) and scanned with 120 kV single-energy and dual-energy CT using a dual-layer spectral CT (IQon Spectral CT; Philips Healthcare). For each scan, full radiation dose and 40% radiation dose-reduced acquisitions were obtained. Single-energy, dual-energy 70 keV monochromatic and iodine maps were reconstructed and computed. The effect of body habitus and radiation exposure on renal mass characterization was also assessed.

RESULTS

Consistent and statistically significant attenuation differences were observed between the unenhanced, minimally-, moderately-, and avidly- enhancing lesions ($p<0.05$ for all comparisons) without variation between the small and medium body sizes. No statistically significant attenuation difference was found among the renal lesions when standard radiation dose was compared to 40% reduced dose with the exception of the moderately enhancing renal lesion in nephrographic phase in a small body size. Iodine quantification was variable with statistical significance between phase of contrast, body size and radiation dose.

CONCLUSION

Attenuation changes calculated from dual energy CT data using a dual-layer platform can be used to differentiate among different renal lesion types, without significant variation with different radiation dose levels. However, the iodine quantification technique shows significant variation as a function of study phase, body size and radiation dose.

CLINICAL RELEVANCE/APPLICATION

Radiation dose reduced acquisition can be implemented for renal mass characterization with DECT on a dual-layer platform. However, circumspection should be paid when using the iodine quantification with different study phases, body size and radiation dose levels.

SSA11-06 Cost-Effectiveness of Dual-Energy CT Versus MRI for Characterization of Small Incidental Indeterminate Renal Lesions

Sunday, Dec. 1 11:35AM - 11:45AM Room: N230B

Participants
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PURPOSE

To develop a Markov Monte Carlo decision-analytic model to evaluate the cost effectiveness of dual-energy (DE) CT versus multiphasic single-energy (SE) CT and MRI for characterizing small incidentally detected indeterminate renal lesions.

METHOD AND MATERIALS

A decision analytic Markov model was constructed to estimate life expectancy and lifetime costs for otherwise healthy 64-year-old patients with small (<= 4 cm) incidentally detected, indeterminate renal lesions on routine imaging (e.g. ultrasound or single-phase CT). Three strategies for evaluating renal lesions for enhancement were compared: multiphase SECT (e.g. true unenhanced and nephrographic phase), multiphasic MRI, and single-phase DECT (nephrographic phase only in dual-energy mode). Model incorporated modality specific diagnostic performance, incidence and prevalence of incidental renal cell carcinomas (RCCs), effectiveness, costs, and outcomes. An incremental cost-effectiveness analysis was performed to identify strategy preference at a willingness-to-pay (WTP) thresholds of $50,000 and $100,000 per quality-adjusted life-year (QALY) gained. Deterministic and probabilistic sensitivity analysis were performed by using Monte Carlo simulations (100,000 runs).

RESULTS

Under the base-case assumptions, DECT was the dominant strategy as it was most cost-effective with a higher effectiveness (mean 0.95) and lower cost ($2108) compared to MRI (mean of 0.93 and $3105) and multiphasic SECT (0.93 and $2851). Results were robust to changes in model parameters based on sensitivity analysis. The probability that the single-phase DECT imaging strategy was cost-effective was 76% at a willingness to pay of $50,000/QALY.

CONCLUSION

Dual-energy CT is more cost-effective than multiphasic single-energy CT and MRI for characterizing small incidentally detected indeterminate renal lesions.

CLINICAL RELEVANCE/APPLICATION

Incidental indeterminate renal lesions are commonly encountered and often warrant additional imaging workup. DECT is a more cost-effective than MRI and SECT to determine whether there is renal lesion enhancement and should be considered the preferred workup strategy.

SSA11-07 Apparent Diffusion Coefficient Predicts Malignancy in T1-Hyperintense Small Renal Masses

Sunday, Dec. 1 11:45AM - 11:55AM Room: N230B

Participants
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PURPOSE

Small renal masses (<4 cm) can be difficult to accurately classify as benign or malignant, particularly if they are T1 hyperintense on MRI. This intrinsic signal, potentially related to intralesional hemorrhage, may limit evaluation of contrast enhancement and signal intensity on other sequences. The purpose of this study was to test whether apparent diffusion coefficient (ADC) measurements may predict malignancy.

METHOD AND MATERIALS

This IRB-approved single-center retrospective study identified patients with a T1-hyperintense renal mass less than 4 cm on MRI. Malignant lesions were pathologically proven; a benign mass was established by a predefined hierarchy of pathologic proof, follow-up ultrasound, or follow-up imaging (MR/CT) showing more than 5 years of stability. T1 hyperintensity, defined as a signal intensity equivalent to or greater than the adjacent cortex, was confirmed by an abdominal radiologist with over 20 years of abdominal imaging experience. Two additional abdominal radiologists independently measured ADC values by drawing the largest region of interest within the lesion. This was normalized to the ADC of the ipsilateral background kidney (i.e. ADClesion / ADCipsilateral) and represented as ADCratio. (Figure). Inter-reader reliability was assessed using intra-class correlation coefficient (ICC). Multivariate binary logistic regression was used to control for lesion size.

RESULTS

There were 58 benign and 37 malignant renal lesions in 95 patients (51 [54%] males; age 61 ± 13 years; size 1.9 ± 0.9 cm). Inter-reader agreement for lesion and ipsilateral kidney was excellent (ICC of 0.94 [CI: 0.91, 0.96] and 0.84 [CI: 0.76, 0.89] respectively). ADCratio was significantly lower in malignant compared to benign lesions (0.65 ± 0.29 vs. 1.03 ± 0.32, $p<0.001$ [Figure]). Malignant lesions were significantly larger than benign lesions (2.7 ± 0.9 vs. 1.5 ± 0.6 cm, $p<0.001$). After controlling for lesion size, ADCratio remained a significant predictor of malignancy; each 0.1 unit decrease in ADCratio conferred a 1.49 times higher odds of malignancy (95% CI: 1.20, 1.84; $p<0.001$).

CONCLUSION

ADCratio is a significant predictor of malignancy in small T1-hyperintense renal lesions.

CLINICAL RELEVANCE/APPLICATION

Small renal masses with intrinsic T1 hyperintensity on MRI can be difficult to classify as benign versus malignant. ADCratio may serve as a useful differentiating feature.

SSA11-08 Accuracy of Contrast-enhanced Ultrasound for Characterization of Complex Cystic Renal Masses and Its Agreement with CT for the Bosniak Classification

Sunday, Dec. 1 11:55AM - 12:05PM Room: N230B

Participants
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PURPOSE

To evaluate the diagnostic accuracy of contrast-enhanced ultrasound (CEUS) for characterization of complex cystic renal masses according to Bosniak classification system and its agreement with CT.

METHOD AND MATERIALS

This prospective study approved by the Institutional Review Board comprised of 50 patients with complex cystic renal masses, detected on gray-scale ultrasound. All patients were evaluated by both CEUS and CT, after obtaining informed consent. CEUS was performed on a single ultrasound machine with a 1-6 MHz curvilinear using second generation contrast agent. Contrast CT was performed on the same 128-slice scanner in all patients. All patients were classified according to the Bosniak classification using both modalities. Imaging follow up was performed for Bosniak II and IIF lesions and histopathological diagnosis was obtained for Bosniak III and IV lesions. Mc Nemar test was used to compare sensitivity and specificity of the two methods. p value < 0.05 was considered statistically significant. Inter rater kappa agreement was used to find out agreement between CEUS and CT.

RESULTS

Out of 50 patients, 12 were female and 38 were male with ages ranging from 18 to 78 years. On CEUS, complex cysts were characterized as follows: 18 as Bosniak II, 18 as Bosniak IIF, 10 as Bosniak III and 4 as Bosniak IV. On CT, these complex cysts were characterized as follows: 20 as Bosniak II, 16 as Bosniak IIF, 12 as Bosniak III and 2 as Bosniak IV. CEUS upgraded two Bosniak II cysts into Bosniak IIF and two Bosniak III cysts into Bosniak IV. Mean septal thickness and mean number of septae was significantly higher on CEUS as compared to CT (p value < 0.05). Strength of agreement was excellent (k value of 0.818) between the two modalities for all categories of Bosniak classification.

CONCLUSION

CEUS has similar diagnostic accuracy to CT in characterization complex cystic renal masses for all categories of Bosniak classification.

CLINICAL RELEVANCE/APPLICATION

In patients with complex renal cysts, CEUS can be used as safer alternative to CT to prevent radiation exposure and for those with chronic kidney disease, where iodinated contrast is contraindicated.

SSA11-09 Morphometric Image Analysis Predicts Surgical Outcomes During Level II-IV Level Inferior Vena Cava Tumor Thrombectomy

Sunday, Dec. 1 12:05PM - 12:15PM Room: N230B

Participants
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PURPOSE

To assess if the scored morphometric analysis of renal vein and Inferior Vena Cava (IVC) tumor thrombus diameters and renal cell carcinoma (RCC) volume extracted from preoperative CECT and MRI can predict surgical outcomes and complications of level II-IV IVC tumor thrombectomy.

METHOD AND MATERIALS

In this IRB approved, HIPAA compliant retrospective study, we queried CECT and MRI imaging studies of 83 patients performed over a 10-year window (Nov 2007 - Dec 2017). Manual segmentation of the venous thrombus was performed by an experienced radiologist in Synapse 3D. The 3D regions of interest (ROIs) included IVC, renal vein, thrombus and renal mass. Segmental volumetric-analysis was performed separately on the suprarenal and infrarenal IVC, the caval thrombus volume included both tumor as well as bland thrombus. In all cases, maximum diameter of the IVC and renal vein, as well maximal bowing of the IVC and renal vein ostium diameter were measured. The radiological variables were compared to a measure of complications captured by Clavien-Dindo (CD) score. Random forest was used as the machine learning tool to build the composite prediction models with all candidate predictors. Leave-one-out procedure was used to assess the robust prediction accuracy. Area under the curve was used to assess the prediction accuracy for binary surgical outcome and R2 was used for continuous outcome.

RESULTS

Five composite prediction models were built using random forest. The leave-one-out validation showed that the composite prediction models using imaging-based morphometric predictors alone can achieve a robust and statistically significant AUC=0.7 95% CI (0.58 0.81) in predicting CD. We also found that the models can robustly explain significant amount of total variance of natural log-transformed (ln) ln(Estimated Blood loss): 15% (p<0.01); ln(Number of units transfused): 7% (p=0.01); ln (Operation time): 6% (p=0.02) and ln(Trans): 5% (p=0.06).

CONCLUSION

Imaging-based morphometric models can be accurately used to predict surgical outcomes and complications. This can be used to assist with surgical planning and patient counseling.

CLINICAL RELEVANCE/APPLICATION

Radiologic morphometric analysis in patients with RCC with level II-IV IVC thrombus can help predict surgical outcomes and complications.

SSA12

Science Session with Keynote: Informatics (Artificial Intelligence: Cutting Edge Artificial Intelligence)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E450A

AI IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSA12-01 Informatics Keynote Speaker: The French Radiology AI Data Hub

Sunday, Dec. 1 10:45AM - 10:55AM Room: E450A

Participants
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SSA12-02 FalcoNet-GMC: A 3D Convolutional Neural Network Module for Instance Segmentation and Quantification of Distant Recurrence from Gynecological Cancers

Sunday, Dec. 1 10:55AM - 11:05AM Room: E450A

Participants
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CONCLUSION

A multifunctional web-based auxiliary system for distant recurrence from gynecologic cancer will enhance the early detection for salvage treatment, with better segmentation by compartment weight maps.

Background

Early detection of distant recurrence in the lung and thoracic lymph nodes is critical for successful salvage treatment for gynecological cancers. We introduce a novel web-based auxiliary system for ovarian and cervical cancer spread to chest, featuring: (1) A novel 3D convolutional neural network (CNN) named CompartNets for delineation of lung/lymph node metastases; (2) A 3D CNN for segmentation of lung, trachea, esophagus, heart, aorta, and spinal cord; (3) A 3D-based radiomic quantification module, VQM (Volumetric Quantification Master).

Evaluation

Contrast-enhanced CT of 40 ovarian cancers and 60 cervical cancers with distant recurrence were recruited as training dataset. Two board-certified radiologists manually delineated the lesion contours as ground truth. A 3D ESPNet model was trained for organ segmentation to generate compartment weight maps. Second, two 3D RetinaESPNets were pretrained on The Cancer Imaging Archive (TCIA). Transfer learning was conducted to detect distant recurrence. Independent testing was carried out in randomly selected 8 ovarian cancer and 12 cervical cancer patients. The segmentation of CompartNet was compared with pure 3D RetinaESPNet without compartment maps and pure 3D ESPNet without detection. The recall/precision reached 97%/93% for pulmonary recurrence and 91%/87% for nodal recurrence, respectively. For segmentation of lung/lymph node recurrence, the intersection over union (IoU) score of CompartNets reached 0.93/0.93, compared with 0.89/0.88 of pure RetinaESPNets and 0.77/0.77 of pure ESPNet. The mean IoU of organ segmentation was 0.93.

Discussion

The IoUs of CompartNets are improved compared with pure RetinaESPNets, owing to loss weighting of normal compartments, which are indecipherable within tumor bounding box. With organ segmentation and lesion-based VQM, our system can differentiate locations of metastases between mediastinum, lung, and chest wall.

SSA12-03 Automated Detection of Vertebral Fractures in CT Using 3D Convolutional Neural Networks

Sunday, Dec. 1 11:05AM - 11:15AM Room: E450A

Participants

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CONCLUSION

Our method achieves an AUC of 0.95±0.02 outperforming Valentinitsch et al. We also illustrate that our method achieves higher recall (0.905) on the operating point reported by Bar et al. The results of our 5-fold cross-validation experiment demonstrate that our 3D data-driven method compares favourably to state-of-the-art using 2.5D learned features and 3D engineered features. The small sample size and use of cross-validation are limitations of this proof-of-concept. This will be adressed in a larger follow up study, currently ongoing.

Background

We present a data-driven approach to automatically detect vertebral fractures in spine-containing CT images. Inspired by radiology practice, existing methods are based on 2D and 2.5D features but we present, to the best of our knowledge, the first method learning 3D features for detecting vertebral fractures.

Evaluation

For this study, we build a training database of 90 de-identified CT image series. These images were acquired on three different scanners (Siemens, Philips and General Electric; 120 kVp tube voltage; maximum in-plane spacing and slice thickness are respectively 0.92mm x 0.92mm and 1.5mm) and contain 90 patients scanned for various indications (average age: 81 years, range: 70 - 101 years, 64% female patients, 12% negative cases). We present a two-staged vertebra fracture detection method that first predicts a class probability for every voxel using a 3D CNN and secondly aggregates this information to a patient-level fracture prediction.

Discussion

We performed a stratified 5-fold cross-validation to estimate the expected performance of our 3D method. For each run, we selected 15% of the images in the training folds as validation samples to determine when to stop training based on validation performance. We report the ROC curve because this metric describes model performance independently of the class distribution and is well suited to compare results from different test sets. Since our method involves two hyperparameters that can be chosen to deliver distinct classifiers, we build the ROC curve using the convex hull representing the optimal classifiers from a group of potential classifiers.

SSA12-04 Universal High Performance Pelvic/Hip Fracture Detection on Pelvic Radiographs of Trauma Patients Using Cascaded Deep Networks

Sunday, Dec. 1 11:15AM - 11:25AM Room: E450A

Participants
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PURPOSE

Detecting fracture from pelvic radiographs is an important yet challenging task because of the high variety of possible fracture types in hip and pelvis. Existing detection methods only detect hip fracture and do not address the more complex pelvic fracture. We propose a universal fracture detector via two-stage cascaded deep neural network that is capable of handling both pelvic and hip fractures.

METHOD AND MATERIALS

Our method is developed using 4,410 pelvic radiographs (1,975 hip fractures, 801 pelvic fractures and 1,630 images without fractures) with only image level fracture labels. The first stage deep network mines the potential fracture regions of interest (ROIs) from the whole image globally, which are then examined locally by the second network to classify the fracture and type (i.e., pelvic/hip fracture) per local ROI. A fracture probability heatmap is produced to indicate potential fracture sites. We recruit 17 primary physicians (emergency physician and surgeon) and 6 consulting physicians (orthopedic specialist and radiologist) to review an independent test dataset of 150 pelvic radiographs (50 hip fractures, 50 pelvic fractures, and 50 without fractures), and compare the detection results from the physicians with the proposed model.

RESULTS

Our two-stage 'global-to-local' cascaded deep neural network achieves an accuracy of 0.907 in the independent testing dataset, which is comparable with the primary physicians (0.882, IQR[0.863-0.923]), but slightly lower than consulting physicians. The model

sensitivity and specificity are 0.962 and 0.938 for the hip fracture, 0.842 and 0.953 for the pelvic fracture. For all physicians, the model may avoid 2.17% missed hip fracture, and 7.74% missed pelvic fracture. For the primary physicians, the model may avoid 2.82% missed hip fracture, and 9.18% missed pelvic fracture. The fracture heatmaps consistently show correct fracture sites for true positive detection cases.

CONCLUSION

We propose an algorithm to detect pelvic and hip fractures from pelvic radiographs. It consistently and significantly outperforms previous automated methods and is a promising tool to avoid misdiagnosis by physicians.

CLINICAL RELEVANCE/APPLICATION

Our method provides accurate diagnosis of both hip and pelvic fractures in pelvic radiographies. It also produces fracture location heatmap to assist physicians to identify potential fracture sites.

SSA12-05 Defacing Neuroimages

Sunday, Dec. 1 11:25AM - 11:35AM Room: E450A

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CONCLUSION

The present model was trained to deface brain CTs and also worked well for FLAIR images. The image binarization preprocessing step shows a promising approach of "train one, earn many", that could potentially be extended to all MRI sequences, not only FLAIR. This work demonstrates the use of AI to protect patient privacy, allowing the use of head CTs in open databases for worldwide collaboration in machine learning projects.

Background

The Health Insurance Portability and Accountability Act (HIPAA) defines 18 identifiers as protected health information that need to be removed from healthcare exams, including 'full face photographic images and any comparable images'. This raises the concern about the possibility of patient identification by 3D rendering of head CTs or brain MRIs. There is a need for sharing imaging data for open collaboration while ensuring the patient's privacy. In this context, image de-identification has become a necessity. We propose a two-step deep learning model to automatically deface head CTs and brain MRIs.

Evaluation

This study was approved by our institutional review board, and written informed consent was waived. A total of 1123 axial brain CT studies were anonymized. Manual segmentation of the face was done using bounding boxes in each slice using md.ai (md.ai, New York). Masks were generated from the bounding boxes and the CTs werebinarized. The first model consists of a binary classification (NASNet mobile) that predicts if that slice contains a face or not. The second step is a Unet trained to segment the face only in the slices that had faces. The final performance was evaluated with AUC, Dice Similarity Coefficient and visual inspection. The same model trained on binarized CTs was tested on FLAIR (630 studies) and in an external batch of CTs (500 studies).

Discussion

Step one resulted in a model with an AUC of 0.999 in the test set. Step two resulted in a Dice Coefficient score of 0.97/0.93/0.91 in the train/validation/test sets, respectively. Visual inspection of the head CTs from the test set and the external batch showed 100% defacing and on FLAIR resulted in 99.5% defacing.

SSA12-06 Automated Detection and Delineation of Hepatocellular Carcinoma on Multiphasic Contrast-Enhanced MRI Using Deep Learning

Sunday, Dec. 1 11:35AM - 11:45AM Room: E450A

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PURPOSE

The Liver Imaging Reporting and Data System (LI-RADS) uses multiphasic contrast-enhanced (CE) imaging for diagnosis of hepatocellular carcinoma (HCC). In order to make the workflow more efficient and to provide a first benchmark for this modality, a deep learning algorithm was trained to segment the liver and HCC based on CE-MRI.

METHOD AND MATERIALS

A single deep convolutional neural network (DCNN) for liver segmentation and HCC delineation was trained on late arterial (25-30s), portal venous (60-70s) and delayed phase (3 min) CE-MRI. The U-Net was chosen as the DCNN's architecture and recent optimizations (residual blocks, Leaky ReLUs, instance normalization) were adopted. The network was presented with stacks of adjacent axial slices across the three phases. The U-Net was trained (70%), validated (15%) and tested (15%) on a dataset consisting of 174 patients with 231 lesions. Manual 3D segmentations of the liver and HCC made by a board-certified radiologist served as ground truth. The dice similarity coefficient (DSC) was measured between the manual and automated methods. In addition to the U-Net, a random forests classifier employing radiomic features (RF) and thresholding (TR) the mean activation of a segmentation were used to reduce the false positive rate (FPR).

RESULTS

The algorithm detected 73% and 75% of HCC on validation and test sets, respectively, using a DSC criterion between the individual lesion and corresponding segmentation of >0.2. The FPR on the validation set were 2.81, 0.77, and 0.85 for the U-Net, U-Net+RF, and U-Net+TR, respectively. A combination of all methods (U-Net+RF+TR) further improved the FPR to 0.62 and on the test set, it was 0.75. Mean DSC/case was 0.49 and 0.48 on validation/test. Mean DSC between detected lesions and corresponding segmentation was 0.64/0.68. Liver segmentations had a mean DSC of 0.91/0.91.

CONCLUSION

Our results are comparable to studies using monophasic CT by Vorontsov et al., and Chlebus et al. They achieved a higher DSC per case (0.66/0.58) whereas our model was more sensitive (0.66/0.57) and could be used to identify regions of interest which an experienced radiologist could either discard or flag for further inspection.

CLINICAL RELEVANCE/APPLICATION

DCNNs are capable of supporting radiologists by segmenting the liver and identifying potential HCCs automatically. This could enable a more workflow efficient and clinically realistic implementation of LI-RADS.

SSA12-07 Constructing a Platform Based on Deep Learning Model to Mimic the Self-Organization Process of CT Images Order for Automatically Recognizing Human Anatomy

Sunday, Dec. 1 11:45AM - 11:55AM Room: E450A

Participants
Feng-Mao Lin, New Taipei , Taiwan (*Presenter*) Nothing to Disclose
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PURPOSE

To demonstrate the ability of a deep learning application to automatically identify computed tomography (CT) slice regions by major Human anatomy. This application will be deployed in National Health Insurance of Taiwan (NHI) to classify the around 458 million CT images in 2018.

METHOD AND MATERIALS

954 and 4095 CT series were selected for training and testing correspondingly from NHI and TCIA. The voxel spacing must > 0.6 mm, and series must > 40 slices. Each image was standardized to 128^2 pixels. The AlexNet and ResNet was trained with grey scale images and the 3 color images (bone, liquid and air), correspondingly. The loss function is identical to Ke Yan, and et al. in 2018 and guides slice scores increased by slice order. Linear regression was used to adjust slice score of a series which the r-square < 0.8. The series was split into 4 parts and new slice score was estimated from two of the best parts. Manually annotated lung boundary was used to find the cutoff for measuring sensitivity and specificity.

RESULTS

The AlexNet and ResNet was trained for 2 days. The r-square of linear regression was to measure the linearity between slice score and its order. The amount of series with r-square < 0.8 was reduced from 4.1% to 1.7% in AlexNet and 6.8% to 2.2% in ResNet by using our error correction approach. Fig. 1 depicted the images with similar slice score having similar body part. Based on lung boundary, the score variant of lower boundary was larger than upper boundary. The cutoff was selected based on the highest value of specificity*sensitivity. ResNet had the best prediction performance in training data and validation data (Spec. > 0.94, Sens. > 0.9). AlexNet provided the best prediction performance in NHI validation data (Spec. > 0.91 and Sens. > 0.94). The error correction slightly improved the sensitivity and specificity. The specificity and sensitivity were both larger than 0.9 in NHI validation data by using AlexNet and ResNet.

CONCLUSION

First, the preprocessing process could accelerate training process and reach lower loss by using ResNet and AlexNet is efficient in during the prediction. Fig 2. showed our error correction process sucessfully adjusting slice score to corresponding body part. Since the organ boundary was varied from person to person, this approach is good for large part Identification. Although we found ResNet and error correction could provide good prediction quality with small training data, the model proposed by Ke Yan, and et al. in 2018 trained with large training data is one of the state of art methods.

CLINICAL RELEVANCE/APPLICATION

NHI collected around 458 million medical CT images in 2018. Our application will deploy in one of the largest medical databases in the world. Precisely retrieve the certain images of Human Anatomy could accelerate related application development and reduce the storage usage.

SSA12-08 An Ensemble of Models with a Multi-Threshold Approach to Improve Chest X-Ray Predictions

Sunday, Dec. 1 11:55AM - 12:05PM Room: E450A

Participants
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PURPOSE

Our main goal is to assess if deep learning can decrease the list of exams that radiologists need to read, with minimal loss of critical cases. We propose an ensemble with a multi-threshold approach, focusing on the detection of general opacities.

METHOD AND MATERIALS

We use four public datasets: JSTR, OpenI, Shenzen, and Chest-Xray14. After removing some lateral and low quality images, the total amount of images were 117,094 images. We cut the images surrounding the lung mask predicted with a trained U-net, applied a Limited Adaptive Histogram Equalization (CLAHE), resized to 384x384 and normalized based on the mean and standard deviation of images in the ImageNet. Then we developed three models: M1: a binary classifier to detect if an image has some finding or if it is normal M2: a multilabel trained with all images to predict five classes: mass/nodule, edema, atelectasis, alveolar opacity, and non-opacity. M3: a multilabel to predict the same five classes, but without the normal images in the training set. All of them use Inception V4. The ensemble was created using a weighted average in the form: (4*ym1 + 3*ym2 + 3*ym3)/10. We calculate the AUC of ROC Curve and choose two best cut-points using Youden's index.

RESULTS

The mean F1 Score of our model is 0.478 among all classes with an AUC of 0.90 for mass/nodule, 0.86 for edema, 0.85 for atelectasis, 0.86 for alveolar opacity and 0.93 for nonopacity. Analyzing the predictions, we saw that normal images had lower values, the target classes had high values, and in the middle values were images of other pathologies. This justifies the use of two thresholds. With the two thresholds, the general quality of our model is improved. We correctly classified more than 70% of all normal images with just 5% of False Negative Rate (FNR) and the average True Positive Rate (TPR) is 44% in the target classes.

CONCLUSION

The image preprocessing along with the use of ensemble and multi thresholds techniques produced a model with greater certainty and better results.

CLINICAL RELEVANCE/APPLICATION

We can accelerate the radiologist's work by detecting 70% of normal images, decreasing the number of images analyzed and suggesting the pathology according to what was predicted.

SSA12-09 CT Organ Segmentation: Use of Variational Autoencoders to Detect Incorrect Segmentations in a Large Dataset (> 12,000 CT Scans)

Sunday, Dec. 1 12:05PM - 12:15PM Room: E450A

Participants
Veit Sandfort, MD, Bethesda, MD (*Presenter*) Nothing to Disclose
Ke Yan, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose
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Ronald M. Summers, MD,PhD, Bethesda, MD (*Abstract Co-Author*) Royalties, iCAD, Inc; Royalties, Koninklijke Philips NV; Royalties, ScanMed, LLC; Royalties, Ping An Insurance Company of China, Ltd; Research support, Ping An Insurance Company of China, Ltd; Research support, NVIDIA Corporation; ; ; ;

PURPOSE

Organ segmentation on CT using neural networks is highly effective but training labels are expensive and insufficient training data impairs performance. Typically, organ segmentation datasets have <400 CTs. Many pathologies and variations are not captured in such small training data. This may explain the gap between theoretical and real-world performance. Images which differ from training data can cause surprisingly severe failures of the algorithms.We hypothesize that failed segmentations can be detected using variationalautoencoders (VAE) without supervision.

METHOD AND MATERIALS

The Segmentation Decathlon data and internal data were used for training (n of 131,41 and 56 for liver, spleen and kidney). CT colonography scans from a large cohort (n=12495) were used for training and testing the autoencoder. A modified 3DUnet was trained on the labeled data. Organ segmentations were performed on 12495 CTs. For each organ a 3D variational autoencoder was trained on all segmentations in an unsupervised fashion. Then, the organ segmentations were passed through the variational autoencoder and the reconstruction error (Dice score) was measured. Organ segmentations (n=2510x3) were visually assessed for significant error by a physician. ROC curves and AUC for detection of failed segmentations were calculated.

RESULTS

The reconstruction errors of the autoencoder were 0.87, 0.76 and 0.81, for liver, spleen and kidney, respectively. Of the reviewed segmentations, 1.6-4.9% showed significant errors. The variational autoencoder reconstruction error was highly effective in detecting problematic segmentations, evidenced by AUCs of 0.94, 0.87 and 0.9 for liver, spleen and kidney (for ROC curve and an example see figure, note that the erroneous area [arrow] is not present in the autoencoder output).

CONCLUSION

The use of deep learning based segmentation in medical imaging has been increasing rapidly. These algorithms are powerful but not very robust in regard to cases with unexpected characteristics and this may cause catastrophic failure of the algorithm.We show that our method can detect failed segmentations effectively (AUCs 0.87-0.94).This is useful for continuous quality monitoring and for active learning.

CLINICAL RELEVANCE/APPLICATION

Deep learning methods are vulnerable to failure when confronted with unexpected cases. This is a critical issue for clinical uses. Our method has the potential to detect such failure without supervision.

Printed on: 10/29/20

SSA13

Science Session with Keynote: Molecular Imaging (Neuroimaging)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S503AB

MR MI NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Peter Herscovitch, MD, Bethesda, MD (*Moderator*) Nothing to Disclose
Karina Mosci, MD, Brasilia, Brazil (*Moderator*) Nothing to Disclose

Sub-Events

SSA13-01 Molecular Imaging Keynote Speaker: Artificial Intelligence in Neuroimaging

Sunday, Dec. 1 10:45AM - 11:05AM Room: S503AB

Participants
Satoshi Minoshima, MD, PhD, Salt Lake City, UT (*Presenter*) Consultant, Hamamatsu Photonics KK; Research Grant, Hitachi, Ltd; Research Grant, Nihon Medi-Physics Co, Ltd;

SSA13-03 Clinical-Radiological Features of Methotrexate Induced Sub-Acute Leukoencephalopathy in Patients with Acute Lymphoblastic Leukemia: "Panda Eye Sign" on DW-MR Imaging

Sunday, Dec. 1 11:05AM - 11:15AM Room: S503AB

Participants
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Tanvi Vaidya, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Subacute leukoencephalopathy in ALL is a rare complication after high dose methotrexate (HDMTX) administration and recognizing this self-remitting entity has important therapeutic implications. We did a retrospective study to evaluate the role of MR imaging in diagnosing this entity and asses the incremental value of Qualitative and Quantitative diffusion weighted MR (DW-MRI).

METHOD AND MATERIALS

A retrospective review of database was performed for adolescent and adult ALL (Aged>14 years) patients who were treated at our center with the modified Berlin-Frankfurt-Münster (BFM)-90 protocol (BFM-90 protocol). 438 patients were screened from year 2014-2015, of which 239 patients were eligible for the BFM-90 protocol. All patients were treated with high dose methotrexate (>1g/m2) and presented with new onset of neurological disturbances were identified. Eleven patients of ALL aged >14 years who developed acute onset of neurological symptoms within two weeks (14 days) after administration of high dose methotrexate and underwent CT and MR imaging with diffusion weighted MR imaging (with 48 hours of presentation) were analyzed. The mean mADC values (10-3 cm2/sec) were calculated on a voxel-by-voxel basis using ADW 4.4 software provided with the MR imaging unit.

RESULTS

Eleven patients were identified from a cohort of 239 patients (~5%). They presented with focal neurological deficits within ~14 days after HDMTX that resolved completely with conservative measures. The CT scans were normal in all these patients. A consistent finding seen in all these cases was the occurrence of restricted diffusion in the region of the centrum semiovale on DW-MRI. On diffusion maps, symmetrical areas of hyperintensity resembled 'Panda eyes' and mADC cut-off of our series was 0.000453 x 10-3 +/- 0.000120 cm2/sec.

CONCLUSION

CT brain and Conventional MR imaging have no significant role to play in diagnosing this entity however restricted in the centrum semiovale is a consistent imaging finding and the "panda eye sign" as seen on DW imaging can be considered diagnostic for methotrexate induced subacute leukoencephalopathy and this sign can help in timely establishment of the diagnosis and appropriate management.

CLINICAL RELEVANCE/APPLICATION

The literature is limited on incremental of colored diffusion maps and mean apparent diffusion co-efficient (mADC) values and their role in diagnosing MIN.

SSA13-04 Biotin-Conjugated Upconversion Nanoparticles for Metabolic MR Imaging of Invasive Margin of Glioma

Sunday, Dec. 1 11:15AM - 11:25AM Room: S503AB

Participants
Hua Zhang, Shanghai, China (*Presenter*) Nothing to Disclose

PURPOSE

To prepare one stable biotinylated/polyethylene glycolylated upconversion nanoprobes (biotin/PEG-UCNPs) to study the expression level of biotin receptor in GL261 glioma and its feasibility for detection invasive margin of glioma

METHOD AND MATERIALS

Hydrophobic multifunctional upconversion nanoparticles (UCNPs) were synthesized by solvothermal method. TEM, XRD ,fluorolog-3 modular fluorescence spectrometer and other instruments were used to analyze the surface features such as uniformity and dispersion of nanoprobes. Cell counting kit-8 (CCK-8) analyzed the effect of bion-UCNPs on the activity of RAW264.7 and BCECs. CLSM was used to observe the endocytosis efficiency of GL261 glioma cells for biotinylated and non-biotinylated nanoprobes, then the distribution of nanoprobes in glioma tissues compared with pathology. GE Discovery 3.0T MR analyzed the relaxation rate of biotinylated nanoprobes and the relative signal intensity (rSI) of biotinylated nanoprobes in gliomas at different time points. HE staining of cortical, striatum, hippocampal and hematological parameters of normal C57BL/6 mice were evaluated the potential toxicity of biotinylated nanoprobes to living organisms.

RESULTS

Biotinylated nanoprobes with similar particle size (particle size of about 25 nm) possessed good dispersibility, low toxicity and single-band UCL spectrum centered at 660 nm. The relaxation rate reached 6.124 mM-1S-1. Under CLSM, the glioma cells significantly endocytosed biotinylated nanoprobes rather than the non-biotinylated nanoprobes. After biotin receptor presaturation, the glioma cell endocytosis was significantly reduced. T1 signal generated by the biotinylated nanoprobes in the glioma region could still be observed in 24 hours, and the tumor developing area was expanding. The body boundary of biotinylated nanoprobes well corresponded to the HE-stained glioma border, but the tumor cells were scattered around the boundary. No obvious adverse reactions were observed in the cortical, striatum, hippocampal.

CONCLUSION

GL261 gliomas highly express biotin receptors. Biotinylated UCNPs are able to efficiently target glioma via biotin receptors, and show a significant contrast effect on the edge of glioma invasion.

CLINICAL RELEVANCE/APPLICATION

(dealing with invasive margin of glioma) Biotin-UCNPs can explicitly demonstrate the glioma cells scattered around the boundary via biotin receptor

SSA13-05 Dynamic Contrast-Enhanced Magnetic Resonance Imaging for Monitoring the Anti-angiogenesis Efficacy in a C6 Glioma Rat Model

Sunday, Dec. 1 11:25AM - 11:35AM Room: S503AB

Participants
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PURPOSE

To observe the changes of dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) parameters in monitoring the early effects of antiangiogenic therapy in a C6 glioma rat model.

METHOD AND MATERIALS

Twenty-six rats were used to establish a C6 glioma model and were randomly divided into a treated group (n = 13) and a control group (n = 13). Rats in the treated group were administered with bevacizumab (Bev) for 7 days, while rats in the control group were administered with vehicle at the same dose. Conventional MRI and DCE-MRI scans were obtained, respectively, on days 0, 1, 3, 5, and 7 after treatment; tumor volume and MRI parameters were dynamically observed. Hematoxylin and eosin (HE) and immunohistochemical (IHC) examination including MVD and proliferating cell nuclear antigen (PCNA) were performed on day 7. One-way ANOVA was used to compare intra-group differences in each group and t-test was used to compare inter-group differences of MRI parameters between the two groups. Correlations between MRI quantitative parameters and IHC scores were analyzed.

RESULTS

The tumor volume and relative change of tumor volume in the treated group were significantly lower than that of control group on day 7 after treatment with Bev. Ktrans and Kep decreased in the treated group while they increased in the control group; Ve increased in the treated group while it decreased in the control group. A significant difference in MRI parameters between the two groups was observed on days 5 and 7 after treatment. Ktrans and Kep showed positive correlations with MVD, while Ve showed negative correlation with PCNA.

CONCLUSION

DCE-MRI dynamically and accurately assessed the early effects of anti-angiogenic therapy against tumors and may be used as a

therapeutic strategy.

CLINICAL RELEVANCE/APPLICATION

DCE-MRI can assessed effects of anti-angiogenic therapy of glioma.

SSA13-06 The Correlation Analysis of MR Diffusion Tensor Imaging: MR Perfusion Weighted Imaging and Fluorine-18-deoxyglucose Positron Emission Tomography in Patients with Malignant Brain Tumors

Sunday, Dec. 1 11:35AM - 11:45AM Room: S503AB

Participants
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PURPOSE

MR diffusion tensor imaging (DTI), MR dynamic susceptibility contrast perfusion weighted imaging (DSC-PWI), and fluorine-18-deoxyglucose (FDG) positron emission tomography (PET) are major clinical advanced imaging techniques for malignant brain tumors. The purpose of this study is to evaluate the correlation between MR DTI and PWI parameters and FDG-PET changes in patients with malignant brain tumors.

METHOD AND MATERIALS

75 paired MR DTI, DSC-PWI and FDG-PET examinations in 62 patients with malignant brain tumors, including high grade gliomas, brain metastases and cerebral lymphomas, were enrolled in this study. The interval between MR (DTI and DSC-PWI) and FDG-PET examinations ranged from 0 to 13 days in 66 paired MR DSC-PWI and FDG-PET examinations, another 6 paired stable post-surgical scans were acquired within 28 days. The ADC, FA and rCBV maximal rCBV ratio without and with contrast leakage correction were measured using FDA-approved GE BrainStat and NordicICE programs. The tumor versus normal tissue count ratio (TNR) in the "hot" ROIs were calculated for comparison. The correlations between minimal ADC, maximal FA and maximal rCBV ratio of rCBV without and with contrast leakage correction and TNR were evaluated with Spearman Rank correlation analysis.

RESULTS

There was no significant correlation between ADC and FA and TNR derived from FDG-PET ($p>0.05$). The mean maximal rCBV ratio of rCBV with contrast leakage correction (1.88±1.41) were higher than rCBV without contrast leakage correction (1.19 ± 0.77, $p<0.05$). The rCBV with contrast leakage correction has better correlation with FDG-PET-TNR than rCBV without contrast leakage correction, $p<0.001$. Figure 1.

CONCLUSION

The rCBV with contrast leakage correction shows better correlation with FDG-PET-TNR. Combination of MR DTI, MR-DSC-PWI and FDG-PET parameters could provide comprehensive information of tumor microstructure, hemodynamic and metabolic abnormality.

CLINICAL RELEVANCE/APPLICATION

Combination of MR DTI, MR-DSC-PWI and FDG-PET parameters could provide comprehensive information of tumor microstructure, hemodynamic and metabolic abnormality.

SSA13-07 Radiomic Classification of Tumors Based on Tumor-Associated Macrophage Burden

Sunday, Dec. 1 11:45AM - 11:55AM Room: S503AB

Participants
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PURPOSE

A high burden of tumor-associated macrophages (TAMs) has been correlated with an aggressive disease phenotype and poor prognosis in several cancer types. Non-invasive imaging techniques for stratifying tumors based on TAM burden could help in treatment planning and monitoring response to immune-directed therapies. In this pre-clinical study, we investigated a radiomics approach for the stratification of solid tumors based on TAM burden.

METHOD AND MATERIALS

Studies were performed in transgenic mouse models of neuroblastoma (NB) with low and high TAM burden. The SV40-induced NB mouse model, which develops spontaneous adrenal tumors (NB-Tag), was used as a model of low TAM burden (n=5). Knock-out NB-Tag mouse models lacking Ja18 (*Ja18-/-*) (n=6) or CD1d (*CD1d-/-*) (n=4) were used as models of high TAM burden. The high TAM burden in knock-out models was confirmed by flow cytometry. Contrast-enhanced CT (CECT) imaging was performed four days after administration of a liposomal-iodine (Lip-I) nanoparticle contrast agent. Tumors were segmented in CT images and quantitative radiomic analysis was performed using an open-source software (PyRadiomics). A Wilcoxon statistical test was used for

selection of radiomic features.

RESULTS

Average tumor CT signal did not differ significantly between tumors in low and high TAM burden groups. However, radiomic analysis identified 49 features that differentiated ($p<0.05$) low TAM tumors from high TAM *CD1d-/-* tumors, and 31 features that differentiated ($p<0.05$) low TAM tumors from high TAM *Ja18-/-* tumors. Subsequently, tumors in two high TAM burden groups (*CD1d-/-* and *Ja18-/-*) were pooled together and compared against tumors in low TAM NB-Tag group to determine if radiomic analysis differentiated tumors based on TAM burden but independent of knock out model. Analysis yielded 26 features that separated ($p<0.05$) low TAM tumors from high TAM tumors. Radiomic features based on first order statistics and gray level size zone matrix represented the dominant set of features that enabled separation of tumors based on TAM burden, suggesting markedly different tumor texture in CECT images in low and high TAM burden tumors.

CONCLUSION

Radiomic analysis identified texture-based features that stratified tumors based on macrophage burden.

CLINICAL RELEVANCE/APPLICATION

Radiomics may enable surveillance of immune cell burden in solid tumors.

SSA13-08 Long-Duration MRI Imaging of Single-Cell In-Vivo and In-Vitro via Magnetic Vortex Nanorings

Sunday, Dec. 1 11:55AM - 12:05PM Room: S503AB

Participants
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PURPOSE

To develop an ultra-high sensitive MRI contrast agent for long-term in vivo and in vitro single-cell tracking, which can escape early lysosomes into cytoplasm, especially under the disturbance of alternating magnetic field.

METHOD AND MATERIALS

Bone marrow mesenchymal stem cells (BMSCs) of SD rats were labeled with 50 μg/ml Fe ferrimagnetism vortex magnetic nanorings (FVIOs). In vitro MRI was performed on three groups with number of 1, 5 and 10 labeled BMSCS. For in vivo imaging, 10, 100 and 1000 labeled BMSCs were injected into SD rats' brain via stereotaxis technology and scanned at 7T SWI (susceptibility weighted imaging). After 1h of co-culture of BMSCs and nanorings, alternating magnetic field (AMF) were added for minutes of continuous interference. Another 23h co-culture was performed, then BMSCs were stained and lysosomal escape effect was detected under confocal microscope. GFP-transfected BMSCs were co-cultured with FVIOs by the same method and transplanted into the striatum of SD rats according to the number of cells for long-term magnetic resonance detection.

RESULTS

From the in vitro 7T MRI images, the signals of single FVIOs labeled BMSCs could be clearly detected compared with contract groups. And the in vivo results shows that at least 10 transplanted BMSCs in SD rats' brain could be detected by strong MRI signal. Confocal results also shows that AFM disturbance could successfully facilitate FVIOs to escape from lysosomes into cytoplasm in 10 minutes at early period of co-culture of BMSCs and FVIOs . The same FVIOs labeled GFP-MSCs were transplanted into rats' brain and also could be detected for more than 8 weeks at 7T MRI. Immunofluorescence histochemical analysis showed that some transplanted cells were still alive and corresponding to the signal position detected by MRI.

CONCLUSION

The FVIOs we reported had ultra-high MRI sensitivity to accurately track single cell both in vitro and in vivo, as well as succeed in escaping the lysosome under the interference of alternating magnetic field.

CLINICAL RELEVANCE/APPLICATION

Ferrimagnetism vortex magnetic nanorings has a broad prospect of clinical application because of its low toxicity, low dose and high sensitivity. Its high safety and efficiency surpasses the contrast agents currently used in clinic. In addition, it provides a robust tracer technology support in the further treatment of stem cells and promote stem cell treatment to the clinic faster and better.

SSA13-09 Quantification of Blood Spinal Cord Barrier Opening After Application of Magnetic Resonance Guided Focused Ultrasound

Sunday, Dec. 1 12:05PM - 12:15PM Room: S503AB

Awards
Trainee Research Prize - Medical Student

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PURPOSE

To develop observer-independent MRI quantification of blood spinal cord barrier (BSCB) permeability after magnetic resonance guided focused ultrasound (MRgFUS) in spinal cord injury (SCI).

METHOD AND MATERIALS

Rats (n=21) underwent T8-T10 laminectomy and extradural compression of the spinal cord (23g weighted aneurysm-type clip, 1 min). High-resolution T1w MR images (3T Siemens, 3D VIBE, FOV=162 mm162 mm×45 mm, res=0.4 mm×0.4mm×0.8 mm interpolated to 0.2 mm×0.2 mm×0.4 mm, TR/TE=6.21/2.94 ms, FA=10°) were obtained pre-MRgFUS without contrast, pre-MRgFUS half-dose contrast, and post-MRgFUS full-dose contrast (Gadoteridol, 0.25 mL/kg, 0.1 mL saline). Rats (n=11) were placed on a MRgFUS system (256-element phased-array transducer, f=940 kHz, focal depth=10cm, intensity FWHM=1.8×2.5×10.9 mm3), injected Optison microbubbles (0.2 mL/kg, 0.1 mL saline) and received 3 doses in 4 locations, 2 mm apart (25 ms bursts, 1 Hz pulses for 3 min, 1.0-2.1 MPa peak pressure). Shams (n=10) received equivalent procedures with no sonications. Spinal cords were segmented manually or semi-automatically using the Spinal Cord Toolbox. SCI rats post-MRgFUS average ROI intensity were normalized to pre-MRgFUS half-contrast. Non-injured rats (n=3) were administered Evans Blue post-MRgFUS and spinals cords were sectioned into 5 mm x 7 samples. Absorbance was measured by spectrophotometry at 655 nm per mg tissue and correlated to post-MRgFUS ROIs normalized to pre-MRgFUS.

RESULTS

Semi-automatic segmentation reduced time by 95% and showed no difference to the manual method (Pearson = 0.92, p=.00001, n=71 regions). Evans Blue absorbance correlated to image intensity in MRgFUS and control ROI (Pearson = 0.82, p=.02, n=6). Increase in signal intensity in MRgFUS ROI relative to control was seen in all SCI MRgFUS rats (10.65±12.4%, range: 0.96-43.9%, n=11). SCI sham MRgFUS revealed no change (0.63±0.52%, range: 0.15-1.63%, n=10). This result was significant between both groups (p=.003).

CONCLUSION

Semi-automatic segmentation of the rat spinal cord was successful. Evans Blue absorbance was correlated to image intensity values in non-injured rats. Quantitative methods are sensitive for detection of BSCB opening induced by MRgFUS in the SCI animal model.

CLINICAL RELEVANCE/APPLICATION

Most potential therapeutics for SCI require invasive (surgery) or semi-invasive (intrathecal) delivery. The use of MRgFUS to open the BSCB and deliver therapeutics will facilitate recovery from SCI.

Printed on: 10/29/20

SSA14

Musculoskeletal (Bone Marrow and Neoplasms)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E450B

CT MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Ali Guermazi, MD,PhD, West Roxbury, MA (*Moderator*) Shareholder, Boston Imaging Core Lab, LLC; Research Consultant, Merck KGaA; Research Consultant, Roche, Inc; Research Consultant, TissueGene, Inc; Research Consultant, Galapagos, Inc; Research Consultant, AstraZeneca PLC; Research Consultant, Pfizer Inc

Sub-Events

SSA14-01 Diagnostic Accuracy of Dual-Layer Detector CT Using Calcium-Suppressed Images for the Detection of Bone Marrow Edema in Wrist

Sunday, Dec. 1 10:45AM - 10:55AM Room: E450B

Participants
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PURPOSE

To evaluate the performance of calcium suppressed images (CaSupp) obtained by dual-layer detector computed tomography (DLCT) for the detection of bone marrow edema (BME) in patients with wrist pain.

METHOD AND MATERIALS

We retrospectively analyzed 49 patients with wrist pain (44 distal radius fractures, 2 carpal bone fractures, 2 scaphoid nonunion advance collapses, 1 Kienböck disease), who underwent both DLCT and MRI. Two blinded and independent readers evaluated CaSupp images for evaluating BME by using color-coded maps. Using MRI images as the reference standard, the sensitivity and specificity of CaSupp images were analyzed for detecting BME of radius, ulna, and carpal bones.

RESULTS

On MRI, 44 distal radius and 30 distal ulna fractures were found. In detecting BME of radius and ulna, two readers showed 100% of agreement. When CaSupp images were compared with MRI images, sensitivity and specificity for detecting BME were both 100% for radius, and 88% and 87.5% for ulna, respectively. For carpal bone, BME was found in 8 of 44 radius fractures and 5 of patients with only carpal bone abnormalities on MRI. Those carpal bone BMEs were detected on CaSupp images with following diagnostic accuracy: sensitivity, 92.8% for reader 1 and 64.2% for reader 2; specificity, 88.5% in both readers. For detection of carpal bone BME, two readers showed moderate agreement (agreement 75.5%, kappa value 0.43).

CONCLUSION

CaSupp images reconstructed from DLCT enabled detection of BME in fractured distal radius and ulna with substantially high diagnostic accuracy when compared to MRI images. However, CaSupp demonstrated limited performance in visualization of BME of carpal bone pathologies.

CLINICAL RELEVANCE/APPLICATION

CaSupp images showed similar performance in visualization and detection of BME in wrist, including incomplete fracture compared with MRI. CaSupp images is expected to be a promising technique to demonstrate BME in wrist.

SSA14-02 3D UTE Bicomponent T2* Analysis of Cortical Bone using a Novel Soft-Hard Composite Excitation Pulse

Sunday, Dec. 1 10:55AM - 11:05AM Room: E450B

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PURPOSE

To evaluate 3D UTE bi-component T2* analysis of cortical bone ex vivo and in vivo using a novel soft-hard composite excitation pulse on a 3T scanner.

METHOD AND MATERIALS

UTE bi-component T2* analysis has been used to quantify T2*s and relative fractions of bound water (BW) and pore water (PW) in cortical bone. However, chemical shift artifact and fat-water oscillation may significantly affect the quantification accuracy. Here a 3D UTE Cones sequence with a soft-hard composite pulse was developed on a 3T GE MR750 scanner, and compared with Cones imaging with a short rectangular pulse excitation and a conventional FatSat module, respectively. The sequences were applied to bovine bone samples (n?=?2) and tibial midshafts of volunteers (n?=?6). Bi-component T2* analyses were performed and results including T2* and fractions were compared.

RESULTS

Comparable fat suppression was achieved with the soft-hard composite pulse and the FatSat module. More robust bi-component T2* fitting was achieved with 3D UTE Cones imaging with the soft-hard composite pulse, which outperformed the short rectangular pulse with greatly reduced fat water oscillation and chemical shift artifacts especially for cortical bone imaging, as shown in Figure 1. The conventional FatSat module suppressed fat signal and related fat-water oscillation, however, the BW fraction was greatly reduced due to direct saturation. For bovine bone samples the mean BW fraction was 75.73±1.58% for the composite pulse and 52.9±27.8% for the hard pulse. For human tibial midshafts the BW fraction was 71.3±3.0% for the composite pulse and 34.7±1157.1% for the hard pulse. The short T2 signals of cortical bone in the UTE-Cones images with the soft-hard pulse excitation were much better preserved than those in the FatSat UTE-Cones images. Meanwhile, fat signals were greatly suppressed by the soft-hard composite pulse, leading to much improved T2* bi-component analysis of bound and pore water fractions.

CONCLUSION

The 3D UTE Cones sequence with a soft-hard composite pulse allows more robust volumetric mapping of bound and pore water T2*s and relative fractions in cortical bone.

CLINICAL RELEVANCE/APPLICATION

The 3D UTE Cones sequence with a soft-hard composite pulse allows more robust volumetric mapping of bound and pore water T2*s and relative fractions in cortical bone.

SSA14-03 Differentiation of Myelodysplastic Syndrome from Aplastic Anemia Using Conventional Multiparametric MRI and Machine Learning

Sunday, Dec. 1 11:05AM - 11:15AM Room: E450B

Participants
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PURPOSE

Distinguishing myelodysplastic syndromes (MDS) from aplastic anemia (AA) can be challenging because patients with these diseases share many clinical features, such as hypocellular bone marrow (BM). This research aimed to build an MRI-based predictive model to differentiate between these entities using a machine learning algorithm.

METHOD AND MATERIALS

Patients with histologically confirmed MDS (n=24) or AA (n=29) were retrospectively investigated. First, we used three machine-learning approaches including a logistic regression model for the classification task to differentiate the entities. We included mean ADC, indices calculated from the ADC histogram, perfusion indices, and fat fraction from ROIs within the BM of L1-L3, and whole blood test data, including the reticulocyte percentage, as inputs in the model. We used 10-fold cross-validation to prevent overfitting. Next, we compiled datasets of the lumbar MR images of T1WI. We fine-tuned a convolutional neural network (CNN) on our training dataset. The CNN with standard cross-entropy loss function and the Adam optimizer with an initial learning rate of 0.001 provided automated prediction of the diagnosis. Third, the diagnostic performances of a radiology fellow, experienced musculoskeletal radiologist, and senior hematologist with specific expertise in pancytopenia were calculated.

RESULTS

Of the 53 MRIs tested, the algorithm by conventional multiparametric MRI predicted diagnosis correctly by the logistic regression model with the highest accuracies of 77.4% for MDS and 77.4% for AA with a combination of features of age, fat fraction, and platelet count. The accuracy achieved by the CNN on random sampling with 90% of training set size and 50 iterations was 84.0% (Figure). In general, the misclassified results were caused by signal intensity and heterogeneity within the BM. The AUC (95%CI) for the CNN was 0.810. The fellow, radiologist, and hematologist showed 60%, 66%, and 66% accuracy, respectively.

CONCLUSION

The CNN provided better differentiation of MDS from AA than conventional multiparametric MRI or visual inspection by human observers. Age, fat fraction of lumbar BM, and platelet count in whole blood proved useful for differentiation of these two entities.

CLINICAL RELEVANCE/APPLICATION

A machine learning algorithm proved effective for differentiating MDS from AA. Machine learning may help to improve prognosis through early and appropriate treatment.

SSA14-04 Quantitative Assessment of Bone Marrow Adipose Tissue after Roux-en-Y Gastric Bypass Surgery in Postmenopausal Women

Sunday, Dec. 1 11:15AM - 11:25AM Room: E450B

Participants
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Peter Bisschop, Amsterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To determine the effect of laparoscopic Roux-en-Y gastric bypass surgery (RYGB) on quantitative assessment of bone marrow adipose tissue (BMAT) and volumetric bone mineral density (vBMD), in postmenopausal women. Bariatric surgery rates are rising as a consequence of the increase in obesity and its associated diseases. RYGB effectively reduces body weight and improves metabolic health, but is also associated with increased fracture risk. BMAT could be a possible mediator of the increased fracture risk following bariatric surgery, since high BMAT is associated with increased fracture risk.

METHOD AND MATERIALS

The study was approved by the local medical ethics committee. We included 17 postmenopausal, non-diabetic obese women, scheduled for laparoscopic RYGB. We determined bone marrow fat signal fraction (BMAT) of L3-L5, measured by SE-Dixon Quantitative Chemical Shift Imaging and vBMD of L3-4, measured by QCT, before surgery and 3 and 12 months after surgery. Data were analyzed by linear mixed model.

RESULTS

BMAT was negatively associated with vBMD at baseline (R2=0.41 p=0.005). Body weight decreased after surgery from 106±15 [baseline] to 91±13 [3 months] and 74±10 kg [12 months, p<0.001]. BMAT decreased after surgery from 52±8% [baseline] to 50±8% [3 months] and 46±7% [12 months, p<0.001]. vBMD decreased after surgery from 104±27 [baseline] to 95±21 [3 months, p=0.001] and 98±26 mg/cm3 [12 months, p=0.080]. Calcium and vitamin D did not change after surgery.

CONCLUSION

We show a decrease in BMAT 12 months after RYGB and a decrease in vBMD 3 months after RYGB. As high BMAT is associated with increased risk of fractures, independently of BMD in some studies, quantitative assessment of BMAT could potentially be interesting as a new imaging biomarker for assessment for bone quality following RYGB.

CLINICAL RELEVANCE/APPLICATION

Quantitative assessment of bone marrow adipose tissue by quantitative chemical shift imaging has potential as an imaging biomarker for bone quality after RYGB surgery.

SSA14-05 Improved Detection of Benign and Malignant Rib Lesions in the Routine CT Work-Up of Oncological Patients Using Automated Unfolded Rib Image Post-Processing

Sunday, Dec. 1 11:25AM - 11:35AM Room: E450B

Participants
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PURPOSE

To evaluate the performance of automated CT post-processing software generating unfolded rib images for improved detection of both benign and malignant rib lesions during routine diagnostic work-up of oncological patients.

METHOD AND MATERIALS

1008 in- and outpatients (63.66 ±14.25 years; range 18.67 to 95.67 years; 405 females and 603 males) undergoing chest-CT between 07/2018-1/2019 at our own institution were retrospectively evaluated. Patients underwent chest-CT alone or as part of a whole-body CT staging/restaging. The CT-protocol consisted of 120kV, 100 mAs, matrix 512x512, collimation 0.6mm, reconstructed section thickness 3mm and 1mm using a soft tissue spatial resolution kernel (I30f) and a sharp kernel (B70f). Both transversal image data sets were used for "conventional" diagnosis including coronal reformates with 3mm slice thickness. 1mm slice thickness image data sets of all patients were additionally directed from the scanner to a computational server where they were automated post-processed to 3D unfolded ribs. The "unfolding" of the rib using the centreline as an axis allows a synchronous display and rotation of all ribs from 0 to 360°. The standard of reference was 18F-FDG-PET, Ga68-DOMITATE-PET/CT, bone scan or imaging follow-up (>6mo).

RESULTS

From a total of 1008 evaluated patients 763 (73.02%) were hematooncologic patients. A total of 104 rib lesions were found by

transversal CT-image reading whereas the unfolded rib image reading detected 305 lesions. 89 were classified malignant and 202 were classified benign. Detection of malignant rib lesions proved significant both for <1cm diameter (p<0.02) and >1cm diameter (p<0.007). The sensitivity, specificity, PPV and NPV for detection of malignant rib lesions was 97.7%/98.5%/96.6%/99% for unfolding ribs and 76.4%/100/92.7%/90.5% for conventional (transversal) image reading. Detection of sclerotic rib lesions and lesions >1cm in diameter was significantly better (p<0.01) for the unfolding rib algorithm.

CONCLUSION

The 'unfolded rib' reformates are significantly superior for rib lesion detection compared to conventional transversal CT-scan reading and should be therefore used in all patients in particular in those with oncologic background.

CLINICAL RELEVANCE/APPLICATION

The 'unfolded rib' reformates are significantly superior for rib lesion detection and should be therefore used in all patients in particular in those with oncologic background.

SSA14-06 Convolutional Neural Networks versus Expert Radiologist Accuracy in Differentiating Benign and Malignant Soft Tissue Neoplasms

Sunday, Dec. 1 11:35AM - 11:45AM Room: E450B

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PURPOSE

To evaluate the accuracy of convolutional neural networks (CNNs) in differentiating pathologically-proven benign from malignant soft tissue musculoskeletal neoplasms as compared to that of experienced musculoskeletal radiologists.

METHOD AND MATERIALS

One hundred patients with histologically-confirmed soft tissue tumors were identified from the institutional medical record. T1W, fat-suppressed T2W (fsT2W), fat-suppressed T1W pre- (T1-Pre) and post-contrast (T1-Post) MR images were used to train four CNNs, each using data from one sequence. A fifth CNN was created using all imaging sequences in combination. For image pre-processing, volumetric regions of interest (ROIs) corresponding to tumor boundaries were segmented on Horos software. PyOsiriX was used to export images and ROI masks for later analyses. Patches of 201 x 201 pixels were generated in each tumor ROI. Five-hundred patches per MR sequence were selected from each of the 100 patients, with 60 patients chosen for testing, 10 for validation, and 30 (50% benign) for independent testing. The training and validation studies were used to optimize an Inception V4 CNN with 201 layers, constructed in Tensorflow. Tumors in the testing set were classified as benign or malignant using the CNN models. Two blinded MSK radiologists also classified the same testing cases as benign or malignant. Accuracy of the CNN models was compared to that of the radiologists. Statistical tests included Area Under the Curve (AUC) and Fisher's Exact Test.

RESULTS

Each radiologist attained an accuracy of 0.66. The five CNNs achieved the following accuracies and AUCs, respectively: 0.69, 0.70 (T1W); 0.74, 0.80 (T1-Pre) 0.78, 0.76 (T1-Post); 0.70, 0.70 (fsT2W); 0.80, 0.82 (combined CNN). No significant difference was found between the accuracy of the combined CNN model and either radiologist (p>0.05). False positive rate for malignancy was significantly higher in both radiologists as compared to the combined CNN (p<0.05).

CONCLUSION

CNNs differentiate benign versus malignant soft tissue neoplasms with moderate accuracy using individual MR sequences and good accuracy using the full conventional MR imaging protocol. Overall accuracy is similar to expert radiologist interpretation.

CLINICAL RELEVANCE/APPLICATION

Machine learning approaches could serve as a valuable adjunct to clinical practice for physicians and non-musculoskeletal fellowship trained radiologists.

SSA14-07 Qualitative Evaluation of MRI Features of Lipoma and Atypical Lipomatous Tumors: Results from a Multi-Center Study

Sunday, Dec. 1 11:45AM - 11:55AM Room: E450B

Participants
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PURPOSE

The purpose of this study was to: (a) evaluate MRI qualitative features that differentiate benign lipomas (BL) from atypical lipomatous tumors (ALT); (b) assess radiologic confidence in diagnosing BL versus ALT.

METHOD AND MATERIALS

This retrospective multicenter study recruited a total of 247 (136 females) subjects (median age:59 years; range:23-92). All subjects underwent presurgical contrast-enhanced MRI. MRI was centrally read by a board-certified radiologist for site, depth (superficial/deep), architectural complexity, level of fat suppression, enhancement and septa. Significant features in univariate analysis were further studied using a logistic regression model with 1000-samples bootstrapped 95% confidence interval (CI). The radiologist's impression was recorded as BL or ALT. A 4-point scale (1-4) reflecting the diagnostic confidence was also used, with 4 being the highest level of confidence. Histopathology (including MDM2) was used as the diagnostic reference standard.

RESULTS

71 ALTs were pathologically verified. Subjects with ALTs were significantly older (61±13 vs. 56±12yr) and presented with pain or discomfort. Multiple features were significantly associated with the pathologic diagnosis in univariate analysis, but in multivariate analysis only large tumor size (OR=1.08, 95%CI:1.01-1.16), deep location (OR=4.31, 95%CI:1.02-18.33), proximal lower limb location (OR=5.97, 95%CI:2.12-16.82), incomplete fat saturation (OR=3.28, 95%CI:1.14-9.49), and increased architectural complexity (OR=9.44, 95%CI:3.51-25.44) were independent predictors of ALT. Overall radiologist impression was 80% sensitive (95%CI:69-89%) and 79% specific (95%CI:72-85%). 8/97 cases with a confidence score of 4 and 9/64 cases with a confidence score of 3were misdiagnosed. Radiologist confidence score inversely correlated with the proportion of misdiagnosis ($p<0.05$).

CONCLUSION

The MRI features tumor size, depth, location, fat saturation and architectural complexity were independent predictors of ALT. Though these features may help in the differentiation of lipomatous lesions, several cases were misdiagnosed even when the radiologist expressed a high level of diagnostic confidence.

CLINICAL RELEVANCE/APPLICATION

MRI features can help differentiating lipomatous lesions, however, even when the radiologist's confidence level is high, several cases were misdiagnosed. Clinician should be aware of the limitations of MRI features.

SSA14-08 CT Radiomics in Alveolar Soft Part Sarcoma Response to Novel Immunotherapy Regimen

Sunday, Dec. 1 11:55AM - 12:05PM Room: E450B

Participants
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PURPOSE

Axitinib/pembrolizumab has recently shown superior efficacy compared to historical controls in the treatment of alveolar soft part sarcoma (ASPS). We aimed to evaluate CT texture analysis of ASPS lesions treated with this novel immunotherapy regimen.

METHOD AND MATERIALS

This IRB-approved study included 28 lesions in 10 subjects with ASPS enrolled in a prospective phase 2 clinical trial. Patients received axitinib and pembrolizumab combination therapy. Target lesions were chosen according to RECIST 1.1 guidelines. All target lesions were segmented on portal-venous phase CT using mint Lesion 3.4, and the following radiomics features were extracted: long axis, short axis, volume, entropy, kurtosis, skewness, mean of positive pixels (MPP), and uniformity of distribution of positive gray-level pixel values (UPP). Results were compared to maximum diameters at the lesional level.

RESULTS

The 28 lesions were followed for mean of 13 months (range 3 to 27 months); this yielded a total of 152 distinct lesional timepoint assessments. Baseline mean Dmax=2.6 cm, and volume=9.1 cc. Best individual lesion responses by Dmax were as follows: 5 lesions disappeared, 13 decreased by at least 30%, 3 remained stable, and 7 progressed by at least 20%. Decrease in Dmax at 3-month follow-up was highly associated with non-progressive disease (p=0.0004, Wilcoxon rank-sum), as were decreases in short axis and volume (p=0.003 and 0.0003, respectively). Of textural features, only decreases in kurtosis, entropy, and skewness were associated with lesion non-progression (p=0.04, 0.04, and 0.03, respectively).

CONCLUSION

Morphologic changes in ASPS lesions at 3-months are strong predictors of durable response; while in isolated cases early and

predictive changes in image textural parameters were observed, in general these parameters do not substantially improve response prediction over Dmax at the 3-month time-point.

CLINICAL RELEVANCE/APPLICATION

In ASPS treated with this immunotherapy-based regimen, one-dimensional assessments at 3 months are sufficient to predict durable lesion response.

SSA14-09 Organ Dose and Total Effective Dose of Whole-Body CT in Multiple Myeloma Patients

Sunday, Dec. 1 12:05PM - 12:15PM Room: E450B

Participants
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PURPOSE

Whole body low-dose CT (WBLDCT) plays an important role in the work-up of patients with plasma cell disorders and has recently been incorporated in the International Myeloma Working Group criteria for multiple myeloma (MM). However, data are lacking on the radiation exposure of such CTs. The purpose of this study was to evaluate organ dose and total effective dose of WBLDCT performed on different CT scanners in patients with MM and to compare it to the effective dose of a radiographic skeletal survey and typical diagnostic CTs. We hypothesized that the effective dose of WBLDCT would be lower than that of diagnostic CTs and higher than that of a skeletal survey.

METHOD AND MATERIALS

Our study was IRB approved and HIPAA compliant. We retrospectively analyzed data from 228 patients (47.4% females, mean age 67.9±10.4 years, mean weight 81.8±22.4 kg) who underwent WBLDCT for the work-up or surveillance of MM. Patients were scanned using one of our six multi-detector CT-scanners (Figure 1). Organ doses and total effective doses per scan were calculated using a commercially available dose management platform (Radimetrics, Bayer Healthcare, Leverkusen, Germany). The median effective dose was then compared to radiographic skeletal survey and representative diagnostic CTs performed in our institution.

RESULTS

The mean effective dose of our WBLDCT-protocol was 4.82 mSv. A significant higher effective dose was observed in females compared to males (4.95 mSv vs. 4.70 mSv, P=0.002). The mean organ dose ranged from 3.72 mSv (esophagus) to 13.09 mSv (skeleton). The mean effective dose varied amongst different CT-scanners (range 4.34-8.37 mSv) (Figure 1). The median effective dose of WBLDCT was more than twice the dose of a skeletal survey (4.82 vs 2.04 mSv), 23% higher than a diagnostic contrast-enhanced chest CT (3.9 mSv), 46% lower than a diagnostic contrast-enhanced abdomen/pelvis CT (9.0 mSv), and 45% lower than a lumbar spine CT (8.7 mSv).

CONCLUSION

WBLDCT in MM has a higher effective dose than a radiographic skeletal survey, but a lower effective dose than diagnostic CTs of the lumbar spine, abdomen and pelvis. This underlines the broad applicability of WBLDCT in the management of MM patients.

CLINICAL RELEVANCE/APPLICATION

The additional diagnostic value of low-dose whole-body CT in the management of MM patients outweighs the relatively limited additional radiation dose as compared to a radiographic skeletal survey.

SSA15

Science Session with Keynote: Musculoskeletal (Pelvis and Hip)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E451A

MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Darryl B. Sneag, MD, Plainview, NY (*Moderator*) Nothing to Disclose
Luca Maria Sconfienza, MD, PhD, Milano, Italy (*Moderator*) Travel support, Bracco Group; Travel support, Esaote SpA; Travel support, ABIOGEN PHARMA SpA; Speakers Bureau, Fidia Pharma Group SpA

Sub-Events

SSA15-01 The Effect of Deep Convolution Neural Networks on Radiologists' Performance in the Detection of Hip Fractures on Digital Pelvic Radiographs

Sunday, Dec. 1 10:45AM - 10:55AM Room: E451A

Participants
Yoshiko Hayashida, MD, Fukuoka, Japan (*Presenter*) Nothing to Disclose
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PURPOSE

In the case of radiographically occult hip fractures, patients undergo further imaging, including additional CT or MRI. The purpose of our study is to develop an automated deep learning system (Deep Convolutional Neural Network: DCNN) for detecting hip fractures using CT or MRI as a gold standard, and to evaluate the diagnostic performance of 7 readers with and without DCNN.

METHOD AND MATERIALS

The study population consisted of 327 patients who underwent pelvic CT or MRI and were diagnosed as femoral fractures. Radiography was performed in all cases. All radiographs were manually checked and annotated by radiologists referring to CT or MRI for selecting ROI. At first, a DCNN with architecture of GoogleNet model was trained by 302 cases. The remaining 25 cases and 25 control subjects were used for the observer performance study and for the testing of DCNN. Seven readers of radiologists with 9,13 and 24-year experience, an orthopedist with 22-year experience, a radiology trainee with 3-year experience, a general physician with 4-year experience and a senior resident took part in this study. A continuous rating scale was used to record each observer's confidence level.Subsequently, each observer read the radiographs with the DCNN outputs and rated again. The observer performance was evaluated by using receiver operating characteristic (ROC) analysis. The area under each ROC curve (AUC) was used to compare in detecting fractures with and without the DCNN output.

RESULTS

The AUCs of the 7 readers were 0.920,0.886, 0.842 0.839, 0.827, 0.810, and 0.698, respectively. The average AUC of the 7 observers was 0.832. The AUC of DCNN alone was 0.905. The AUCs of the 7 readers with DCNN outputs were 0.934,0.928, 0.896 0.866, 0.862, 0.841, and 0.800 respectively. The average AUC of the 7 readers with DCNN outputs was 0.876. The AUC of both experienced and less-experienced readers with DCNN output were higher than those without, respectively ($p<0.05$). The AUC of the 2 experienced readers with DCNN output exceeded the AUC of DCNN alone.

CONCLUSION

For detecting the hip fractures on radiographs, DCNN developed using CT or MRI as a gold standard by radiologists improved the diagnostic performance including the experienced readers.

CLINICAL RELEVANCE/APPLICATION

For detecting the hip fractures on Xp, DCNN developed using the higher-level reference standards increased the efficiency of diagnosis. This methodology provides more accurate data labeling.

SSA15-02 Hip Abductor Pathology in Ischiofemoral Impingement

Sunday, Dec. 1 10:55AM - 11:05AM Room: E451A

Participants
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PURPOSE

Ischiofemoral impingement (IFI) is associated with abnormalities of the quadratus femoris muscle and narrowing of the ischiofemoral (IF) and quadratus femoris (QF) spaces. The hip abductors play important roles in pelvic stability. We hypothesized that abductor insufficiency might be a contributing factor to the development of IFI. The purpose of our study was to assess hip abductor pathology in patients with IFI.

METHOD AND MATERIALS

The study was IRB approved and HIPAA compliant. The study group comprised 140 patients with IFI (mean age: 56±13 y, 130 f, 10 m) and 140 age and gender-matched controls without IFI. Two MSK radiologists performed measurements of IF and QF distances, assessed quadratus femoris muscle for edema and atrophy, and the integrity of the tensor fascia lata, gluteus medius and minimus tendons. IFI and control groups were compared with a two-tailed t-test or Fisher's exact test.

RESULTS

As expected, patients with IFI had decreased IF and QF distances ($p<0.0001$) compared to controls. All patients with IFI had abnormalities of the quadratus femoris muscle, whereas the QF muscle was normal in controls ($p<0.0001$). Patients with IFI had a higher prevalence of gluteal medius and minmus partial and full-thickness tears compared to controls ($p=0.007$). There were no tears of the tensor fascia lata in either group.

CONCLUSION

Abductor insufficiency might play a role in the pathophysiology of IFI in elderly patients. This emphasizes the need of abductor strengthening or repair in the treatment of IFI.

CLINICAL RELEVANCE/APPLICATION

Physical therapy focusing on abductor strengthening might become a first line non-invasive therapeutic approach to treat ischiofemoral impingement.

SSA15-03 Greater Trochanteric Pain Syndrome: An Association with the Iliac-trochanteric-shaft Angle

Sunday, Dec. 1 11:05AM - 11:15AM Room: E451A

Participants
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Aleksandr Rozenberg, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Vishal Desai, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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William B. Morrison, MD, Philadelphia, PA (*Abstract Co-Author*) Consultant, AprioMed AB Patent agreement, AprioMed AB Consultant, Zimmer Biomet Holdings, Inc Consultant, Samsung Electronics Co, Ltd Consultant, Medical Metrics, Inc

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PURPOSE

Greater trochanteric pain syndrome (GTPS) is a common cause of lateral hip pain. Repetitive friction between the greater trochanter (GT) and iliotibial band (ITB) is a proposed cause and thought to be related to altered ITB kinematics and gait patterns. The purpose of this study is to assess if the angle of the ITB as it passes from its iliac origin over the GT to its tibial insertion is associated with GTPS.

METHOD AND MATERIALS

Consecutive subjects with a clinical diagnosis of GTPS and MRI features consistent with GTPS (GT bursitis, gluteal tendinosis) were included. The angle subtended from the iliac origin of the ITB to the lateral femoral shaft with apex at the GT was recorded (iliac-trochanteric-shaft angle, ITS). The grade of GTB and gluteus minimus and medius tendinosis as well as the femoral neck-shaft angle (FNS), center edge angle (CEA) and patient demographics were recorded. Consecutive age and gender matched controls with hip MRI performed for indications other than GTPS and with an absence of radiological features of GTPS were identified and the ITS angle, FNS angle and CEA were recorded. Student's t-test was utilised to evaluate for differences between subjects and controls.

RESULTS

106 subject and 106 control exams were included (64% female, 36% male). Mean ages were similar (56.9 vs 55.3 yrs respectively, p 0.69). The mean and median ITS angles were 158.2/158° and 166.9/165° respectively (p 0.0001) with the difference significant for both males and females. No difference was observed in FNS angle (131.6 vs 131.8°, p 0.83) and CEA (34.7 vs 33.6°, p 0.21). In the subject cohort GTB was present in 84% (mild 58%, moderate 20%, severe 6%). Gluteus minimus tendinosis was present in 90% (mild 54%, moderate 32%, severe 4%) and gluteus medius tendinosis was present in 80% (mild 52%, moderate 24%, severe 4%) with an association between decreasing ITS angle and increasing grade of GTB and gluteal tendinosis.

CONCLUSION

Increasing acuity of the angle of the ITB from its origin as it crosses the GT represented by the ITS angle is associated with clinical and radiological GTPS likely as a result of altered kinematics and increased friction with the peritrochanteric structures associated with GTPS.

CLINICAL RELEVANCE/APPLICATION

ITS angle is a simple measurement which could potentially identify patients at risk of developing GTPS and may have implications for treatment and preventative strategies.

SSA15-04 AIIS and Subspinous Impingement: When Do Two Become One?

Sunday, Dec. 1 11:15AM - 11:25AM Room: E451A

Participants
Terence P. Farrell, MBBCh,FFR(RCSI), Philadelphia, PA (*Presenter*) Nothing to Disclose
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Johannes B. Roedl, MD, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The morphology of the anterior inferior iliac spine (AIIS) and subspinous region (SS) are increasingly identified as important components in the spectrum of extra-articular hip impingement (EA-HI). These regions are anatomically distinct and accurate classification of impinging morphology is critical in guiding management. SS morphology has been classified arthroscopically, however, no radiological classification exists. The purpose of this study is to classify the spectrum of morphology and imaging appearances of the AIIS and SS on MRI and CT and to evaluate for an association between their morphology and the presence of EA-HI. We will also discuss the validity of MRI in the evaluation of SS and AIIS morphology as well as appropriate imaging protocols in the assessment of EA-HI.

METHOD AND MATERIALS

Consecutive patients under 50 years old with clinical hip impingement and available MRI and/or CT of hip were included. Age matched controls with an absence of clinical hip impingement and labral tear on imaging were selected. Studies were reviewed by two MSK radiologists in consensus for AIIS and SS morphology as well as radiological features of hip impingement including rectus femoris origin pathology, pericapsular edema, femoroacetabular impingement (FAI) and acetabular labral tear. Exclusion criteria included fracture, osteoarthritis and active core injury.

RESULTS

60 subject and 40 control exams were included (62.5% male, 37.5% female). All patients had an MRI, 20% of patients also had a CT for review. Abnormal morphology of the AIIS (case vs controls: 55% vs 29.5%, p=0.04) and SS (55% vs 29.5%, p=0.05) was associated with EA-HI and labral tears. 42% had combined AIIS and SS impingement. AIIS or SS impingement coexisted with FAI in 32.5% of cases vs 12.5% of controls (p=0.02). There was a strong correlation between MRI and CT morphology classification (r=0.7).

CONCLUSION

AIIS and SS impingement are separate entities in close anatomic proximity which frequently coexist as causes of EA-HI. Distinct classification systems as well as a high index of suspicion and knowledge of normal AIIS and SS anatomy, variant morphology and pathology are crucial to accurately diagnose and treat EA-HI.

CLINICAL RELEVANCE/APPLICATION

AIIS and SS impingement are distinct causes of EA-HI. The approach to surgical management is different and a knowledge of normal and variant morphology is crucial to accurately guide intervention.

SSA15-05 Prevalence of Femoral Retroversion is High and Depends on the Measurement Method in Patients with Unilateral SCFE: A Controlled CT-Based Study

Sunday, Dec. 1 11:25AM - 11:35AM Room: E451A

Participants
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Mariana Ferrer, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Jennifer Kallini, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Patricia Miller, Bosoton , MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The optimal surgical treatment in patients with healed slipped capital femoral epiphysis (SCFE) and secondary hip impingement is controversial. Although commonly linked with femoral retroversion, prevalence of femoral retroversion in SCFE is unknown. We sought to: determine the prevalence of femoral retroversion in affected and unaffected hips using different measurement methods in patients with unilateral SCFE.

METHOD AND MATERIALS

A retrospective, controlled study on 79 symptomatic patients (mean age of 15 ± 4 years; 38 [48%] males) with unilateral SCFE and pelvic CT scans including the femoral condyles. Fifty-six (71%) patients had undergone previous in-situ fixation and presented with secondary impingement. Four common measurement methods for femoral version were used to compare SCFE hips and the contralateral, unaffected hips. Methods included the femoral head center and differed regarding the level of the landmarks for the proximal femoral reference axis. From proximal to distal: Lee et al.- (most proximal connection of the femoral neck and greater trochanter), Reikeras et al.- (femoral neck center where anterior and posterior cortices run parallel) -, Tomczak et al.- (center of the greater trochanter at the femoral neck base)- and Murphy et al.- (base of the femoral neck superior to the lesser trochanter) methods. Prevalence of femoral retroversion (<0°) and femoral version were compared.

RESULTS

In SCFE hips the more proximal methods according to Lee et al. (mean femoral version, -19°±16°), Reikeras et al. (-15° ± 14°) yielded a higher prevalence of retroversion with 91%, 84% versus 47%, 60% compared to the more distal methods of Tomczak et al. (0°±13°) and Murphy et al. (-4°±16°), (all p <0.001). By contrast prevalence of retroversion was lower in the unaffected hips for the respective measurement methods (all p <0.001): Lee et al. 42% (2°±12°), Reikeras et al. 32% (5°±11°), Tomczak et al. 5% (18°±11°), Murphy et al. 4% (19°±13°).

CONCLUSION

Prevalence of femoral retroversion is high in SCFE and depends on the measurement method. Thus, to avoid errors in treatment planning a consistent measurement method including respective reference intervals should be used.

CLINICAL RELEVANCE/APPLICATION

Routine measurement of femoral version in SCFE could help surgeons to identify hips in which an additional femoral osteotomy is needed to correct a retroverted femur or whether cam correction alone is sufficient.

SSA15-06 MRI Assessment of Subspine Impingement: Features Beyond Anterior Inferior Iliac Spine Morphology

Sunday, Dec. 1 11:35AM - 11:45AM Room: E451A

Participants
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Thomas Youm, New York, NY (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the MRI features associated with subspine impingement (SSI) including the osseous morphology of the anterior inferior iliac spine (AIIS) and femoral cam and associated soft tissue injuries.

METHOD AND MATERIALS

We performed a retrospective study of symptomatic patients who underwent arthroscopic treatment for femoroacetabular impingement (FAI) between December 2014 and March 2017. A subset of patients who had clinical and intraoperative findings of SSI were selected as the SSI group and the rest made the FAI group. Patients included had preoperative MRI within 6 months from surgery. Preoperative MRI was assessed by two radiologists independently and blinded to clinical information for AIIS morphology, presence of distal cam (we defined it as bump more distal to the head neck junction), signs of impingement on the distal femoral neck including sclerosis, edema, or cystic changes of the femoral neck and femoral neck synovial edema, edema of the superior capsule and rectus femoris tendon (RFT) at the AIIS level, and presence and location of chondrolabral lesions. The inter-reader agreement was also assessed.

RESULTS

Total of 62 patients with FAI met the inclusion criteria. 20 patients out of 62 (32%) were also diagnosed with SSI. The mean time difference between the MRI and arthroscopy was 4.1 ± 1.8 months. Distal cam was present in 80% of patients with SSI and in 19% of patients with FAI (p<0.001). We found no significant difference in AIIS morphology variants between the two groups. There was statistically significant difference in presence of signs of impingement on the distal femoral neck (77% vs 18%) between SSI and FAI groups respectively (p<0.001). Superior capsular edema was present in 80% in SSI and 29% in FAI group (p<0.05). No significant difference was between two groups regarding RFT edema and presence or location of chondrolabral lesions. There was substantial agreement between readers for detecting distal cam (kappa=0.80) and anterior chondral lesions (kappa=0.62), and moderate agreement for signs of distal femoral neck impingement, anterior labral and superior chondral lesions.

CONCLUSION

Our study showed that in addition to osseous morphology, there are associated soft tissue injuries which can be utilized to improve the accuracy of SSI diagnosis.

CLINICAL RELEVANCE/APPLICATION

Several osseous and soft tissue pathologies can be used to enhance the accuracy of detecting SSI in patient with FAI.

SSA15-07 Ultra-low Dose CT of the Pelvis: Applying Tin Prefiltration to Achieve a Radiation Dose Equivalent or Lower Than Radiographs

Sunday, Dec. 1 11:45AM - 11:55AM Room: E451A

Participants
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PURPOSE

The aim of this study was to develop an ultra-low dose pelvic CT protocol using tin prefiltration for spectral shaping of the x-ray beam to achieve a dose equivalent or lower than radiographs and to provide a virtual diagnostic radiograph.

METHOD AND MATERIALS

Three pelvic cadavers received standard pelvic radiographs and were repeatedly scanned on a 128-detector row CT scanner with identical pitch, slice thickness and iterative reconstruction strength: 1) conventional dose and reduced dose scan with tin prefiltration, both with automated tube voltage and current modulation; 2) successive tin prefiltered ultra-low dose scans with two dose equivalent protocols up to a maximum dose of a standard radiograph of the pelvis (0.44mSv) using a fixed tube voltage (Sn100kV and Sn140kV) and a fixed tube current (138-277mAs and 25-50mAs). Radiation dose was compared and virtual radiographs of CT data were computed using a customized cone-beam algorithm in Matlab (MathWorks). CT image quality was assessed quantitatively by signal- and contrast-to-noise ratio (SNR,CNR) and figure of merit (FOM) for CNR dose efficiency. On a 5-point scale CT images and virtual radiographs were rated qualitatively by two readers.

RESULTS

For each of the three cadavers no substantial difference was observed for SNR, CNR and FOM between ultra-low dose protocols. The ultra-low dose protocol with Sn140kV/50mAs that performed best in all 3 cadavers was chosen by consensus reading: overall image quality was rated good (mean 4.3 and 4.3, for reader 1 and 2 respectively), image noise weak to minimal (mean 4.0 and 4.7) and artifacts almost none (mean 4.7 and 4.7). Mean effective dose (0.36mSv) was substantially lower compared to conventional dose (mean 3.08mSv; -88% reduction) und reduced dose (1.88mSv; -81%) scans. Overall subjective image quality of the three virtual radiographs was rated excellent (mean 4.7 and 4.7).

CONCLUSION

We showed the feasibility of ultra-low dose pelvic CT scans of cadavers with tin prefiltration with a dose less than a conventional radiograph. The reconstructed virtual radiographs exhibited excellent image quality.

CLINICAL RELEVANCE/APPLICATION

Standard radiographs of the pelvis can be replaced by an ultra-low dose pelvic CT scan providing both cross-sectional information and a virtual radiograph with a dose below standard radiographs.

SSA15-08 Evaluation of Athletic Pubalgia in the Setting of Femoroacetabular Impingement

Sunday, Dec. 1 11:55AM - 12:05PM Room: E451A

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

To evaluate the incidence of athletic pubalgia in patients with femoroacetabular impingement (FAI) on MRI.

METHOD AND MATERIALS

An IRB approved retrospective search identified 134 patients (total 163 hips) with clinical or imaging diagnosis of femoroacetabular impingement (FAI) who had a hip MRI between January 2015 and July 2018. Patients who had prior hip surgery were excluded. Two fellowship trained musculoskeletal radiologists blindly reviewed all studies in consensus and evaluated for the presence of: acute/chronic osteitis pubis, adductor/abdominis rectus tendinosis and tear, and aponeurotic plate tear. Demographic data (age, sex, sports participation, and treatment) was obtained from the electronic medical record. Imaging data (femoral version, acetabular version, alpha angle, and lateral center edge angle) were obtained from reports or measured by a third blinded musculoskeletal radiologist. Statistics included t-test, chi-square test, and one-way ANOVA with significance set to $p < 0.05$.

RESULTS

Incidence of pubalgia findings: Aponeurotic tear (14%), adductor tendinosis (71%), adductor tendon tear (10%), abdominis rectus tendinosis (1%), abdominis rectus tendon tear (<1%), acute osteitis pubis (14%), chronic osteitis pubis (42%). Incidence of treated pubalgia findings: Aponeurotic tear 30% (7/23), adductor tendinosis 14% (16/115), adductor tear 71% (12/17), acute osteitis pubis 26% (5/19), and chronic osteitis pubis 7% (4/56). Demographic/imaging data compared with pubalgia findings: Male vs. Female: adductor tendon tears 14% (16/115) vs. 2% (1/48) ($p = 0.024$) and acute osteitis pubis 19% (17/90) vs. 5% (2/42) ($p = 0.025$). Sports participation vs. No history of sports: adductor tendon tears 20% (12/61) vs. 5% (5/102) ($p = 0.003$) and chronic osteitis pubis 56% (28/50) vs. 33% (28/84) ($p = 0.010$). Alpha angle > 60° vs. Alpha angle < 60°: Chronic osteitis pubis 50% (44/88) vs. 26% (12/46) ($p = 0.008$). All other differences in demographic and imaging data were not significant when assessed against the pubalgia findings.

CONCLUSION

There is a high incidence of athletic pubalgia in FAI patients with certain findings found more commonly in males, in those with prior sports participation, and in the presence of a cam lesion.

CLINICAL RELEVANCE/APPLICATION

Identification of co-existent pubalgia findings with FAI may alter patient management. Our results add to the growing theory that there is pathophysiologic interplay between the two processes.

SSA15-09 Musculoskeletal Keynote Speaker: Therapeutic Arthrogram of the Hip for Adhesive Capsulitis - An Innovative Treatment Procedure that Reduces Capsular Stiffness and Increases Muscle Activation

Sunday, Dec. 1 12:05PM - 12:15PM Room: E451A

Participants
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Printed on: 10/29/20

SSA16

Nuclear Medicine (Genitourinary Oncology Nuclear Medicine and PET)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S505AB

CT GU NM OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sonya Y. Park, MD, Seoul, Korea, Republic Of (*Moderator*) Nothing to Disclose

Sub-Events

SSA16-01 AI Pipeline System for Detection of Bone Metastases on PET-CT

Sunday, Dec. 1 10:45AM - 10:55AM Room: S505AB

Participants
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PURPOSE

To develop a machine learning system for the detection of bone metastases from the data of CT based on ground truth generated from 18F-fluorodeoxyglucose (FDG) PET.

METHOD AND MATERIALS

In this study, 198 whole body PET-CT examinations (105 men and 93 women; mean age, 63.8 years ± 12.9 [standard deviation]) with one or more bone metastases were retrospectively evaluated. At first, an automated annotation generation tool for bone metastases was created to extract lesions from PET. A binary bone mask was obtained from CT and multiplied with the rescaled PET volume. This resulted in a PET volume with FDG uptake in bones only. A convolutional neural network (CNN), ResNet-50, was then used to discard high FDG uptake regions which did not correspond to bone metastases, such as brain or bladder. Each candidate of bone metastasis was assigned a unique lesion number before it was converted into slice-wise bounding boxes. Secondly, one of the authors labeled each automatically extracted lesion with osteoblastic metastasis, osteolytic metastasis, intertrabecular metastasis and other. The 198 examinations were split in 173 examinations for training and 25 examinations for validation. A Mask R-CNN model was trained on the training set using labeled bounding boxes as ground truth. Finally, prediction accuracy was measured on the validation set.

RESULTS

In a total of 198 examinations, 1263 lesions were detected with the annotation tool and composed of 364 osteoblastic metastases, 365 osteolytic metastases, 24 intertrabecular metastases, and 510 others such as normal lesions, postoperative lesions, degenerative changes, and inflammation. The sensitivity was 77.8% for osteoblastic metastases, 54.2% for osteolytic metastases, and 100% for penetrating metastases with a false positive per image of 0.701 in the validation datasets.

CONCLUSION

We successfully developed an AI pipeline system to detect bone metastases from the data of CT and FDG-PET. This is the first report on an AI-based automatic annotation system for PET-CT. Some limitations such as the low sensitivity for osteolytic metastases and too many false positives should be improved.

CLINICAL RELEVANCE/APPLICATION

Since the sensitivity for osteoblastic metastases was higher than that in the previous paper on human detection, our AI system can reduce the oversight of radiologists to detect bone metastases on CT.

SSA16-02 Detection of Seminal Vesicle Involvement and Extra-Prostatic Extension of Primary Prostate Cancer by Fluciclovine PET-CT

Sunday, Dec. 1 10:55AM - 11:05AM Room: S505AB

Participants
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PURPOSE

To evaluate the diagnostic performance of fluciclovine PET-CT in determining the extent of primary prostate cancer specifically seminal vesicle involvement (SVI) and extra-prostatic extension (EPE).

METHOD AND MATERIALS

51 patients with high risk primary prostate cancer, without conventional imaging findings of systemic metastasis, deemed eligible for potential curative surgery were recruited and underwent fluciclovine PET-CT after obtaining informed consent. Image interpretation was performed by a board-certified nuclear medicine physician blinded to other clinical and imaging data. Abnormal or absent uptake indicating the presence or absence of SVI and EPE was recorded. Histologic findings of SVI and EPE were compared with preoperative imaging results. Measures of diagnostic performance of fluciclovine PET-CT were assessed. Equivocal interpretations were analyzed as negative.

RESULTS

44/51 patients with a mean ± SD PSA of 25.8 ± 31.1 ng/ ml underwent radical prostatectomy and extended lymph node dissection within 11.8 ± 9.9 days of imaging. The remaining 7 were excluded from the final analysis as they were either still awaiting surgery or considered unsuitable for curative surgery. 28/44 and 20/44 patients were interpreted as positive for SVI and ECE respectively on fluciclovine PET-CT. On histology, 20/44 and 36/44 were positive for SVI and ECE respectively. Consequently, sensitivity, specificity and positive predictive value (PPV) of fluciclovine PET-CT for determination of SVI were: 80%, 50% and 57.1% respectively. For assessment of EPE, sensitivity, specificity and PPV of fluciclovine PET-CT were: 50%, 75% and 90% respectively.

CONCLUSION

Fluciclovine PET/CT showed high sensitivity and moderate PPV in the detection of SVI in primary prostate cancer. It also demonstrated high positive predictive value and moderate specificity in the detection of EPE.

CLINICAL RELEVANCE/APPLICATION

Fluciclovine PET/CT may be of use in preoperative determination of tumor extent in primary prostate cancer and consequently choice of therapy. Further studies with PET/MR with better anatomic definition may therefore be beneficial.

SSA16-03 Combined Hybrid Axumin (18F- Fluciclovine) PET/MRI Interpretation Compared to the Individual Interpretation of Axumin PET and Dedicated Prostate MRI in Evaluating for Prostate Cancer Local Recurrence

Sunday, Dec. 1 11:05AM - 11:15AM Room: S505AB

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PURPOSE

To determine if evaluation for prostate cancer local recurrence with a combined reading of hybrid Axumin PET/MRI leads to more confident interpretation with fewer indeterminate results when compared to separate reading of Axumin PET and multiparametric prostate MRI (mpMRI).

METHOD AND MATERIALS

This is a retrospective study of 60 patients with biopsy-proven prostate cancer who have had definitive therapy with concern for recurrence, who underwent a hybrid Axumin PET/MRI. PET and MRI images were reviewed separately by a nuclear medicine and an abdominal imaging specialist, respectively, each blinded to the other. Lesions were assigned a likelihood of local recurrence score. Axumin PET/MRI images were then jointly interpreted and a consensus likelihood of local recurrence score was assigned. The scores were based on qualitative 5-point scales outlined by each reader prior to the study. Scores were compared between individual PET or MRI and combined PET/MRI interpretations using Chi-Square and linear-by-linear association tests.

RESULTS

We evaluated 60 Axumin PET-MRI exams with a total of 68 lesions. 39 (65%) patients had radical prostatectomy while 21 (35%)

had local therapy only. The average patient age was 69 years old (range 45-85). There is a significant difference in the interpretation scores between individual mpMRI and combined Axumin PET/MRI interpretation (p=0.006). Of the 24 lesions with scores of 2-4 on MRI, 9 (38%) lesions were downgraded to a score of 1 and 10 (42%) lesions were upgraded to a score of 5 on combined interpretation. There is a trend toward a significant difference between individual PET and combined PET/MRI, with a linear-by-linear association of 1.1 (p = 0.139). Of the 17 lesions assigned scores of 2-4 on PET, 5 (29%) lesions were upgraded to a score of 5 and 4 out of 43 lesions (9%) with a PET score of 1 were upgraded to a score of 5 on combined interpretation.

CONCLUSION

The combined interpretation of Axumin PET/MRI showed significantly more confidence in assessing for locally recurrent prostate cancer over interpretation of MRI alone and a trend toward significance in confidence over interpretation of PET alone.

CLINICAL RELEVANCE/APPLICATION

Combined reading of Axumin PET/MRI increases confidence in local recurrence detection, facilitating management in prostate cancer patients with clinical concern for recurrent disease after treatment.

SSA16-04 Tumor Foci Size but Not Lymph Node Size Affects 18F-fluciclovine PET/CT Detection of Metastatic Lymph Nodes in Primary Prostate Cancer

Sunday, Dec. 1 11:15AM - 11:25AM Room: S505AB

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PURPOSE

To determine the effect of sizes of lymph node (LN) and metastatic foci (MF) on the diagnostic performance of preoperative fluciclovine PET/CT for identifying LN metastasis (LNM) in patients with primary prostate cancer.

METHOD AND MATERIALS

51 patients with intermediate to high-risk prostate cancer underwent fluciclovine PET/CT (Dose: 366.3±22.2 MBq) prior to radical robotic prostatectomy (RP) with extended pelvic lymph node dissection (EPLND). LNs were excised according to 12 predefined templates and correlated to PET findings. Metastatic LNs and MF in LNs were measured bidimensionally by a board certified urologic pathologist. Sizes of metastatic LNs and MF in templates with positive and negative PET findings were compared using t-test. For every LN packet (LNP), the greatest long axis diameter of LN and MF were utilized as the most conservative surrogate for the LNP.

RESULTS

EPLND was performed in 45/51 patients with median PSA 18.0 ng/ml (range 0.58-147.03 ng/ml) and Gleason score (Grade group) 8 (4) within 7 days (range 1-41 days) after fluciclovine PET. Of these, 24/45 (53.3%) patients had histologically confirmed LNM. 508 LNPs (mean 11 packets per patient) were analyzed. LNM were detected in 82/508 (16.1%) LNPs on histology. Fluciclovine PET detected LNM in 36/82 (43.9%) LNPs (true positives) while 46/82 (56.1%) LNPs were either benign or not seen (false negatives) on fluciclovine PET. Of the remaining 426/508 LNPs, 3/426 (0.7%) were read as equivocal on PET but were benign on histology (false positives). There was no significant difference in the mean long axis diameters of true positives (15.1 mm [range 3.0-40.0 mm]) and false negatives (13.1 mm [range 3.0-52.0 mm]; p=0.13) LNPs. In contrast, the mean long axis diameters of MF within true positive LNPs (11.4 mm [range 1.0-40.0 mm]) were significantly higher than false negative LNPs (3.9 mm [range 0.4-14.0 mm]; p<0.01). 13/52 (25.0%) LNPs with MF <=7 mm were detected on fluciclovine PET while 23/30 (76.7%) LNPs with MF >7 mm were detected on fluciclovine PET.

CONCLUSION

Fluciclovine PET detection rate of LNM was influenced by the size of metastatic foci but not lymph node size. Metastatic foci >7 mm were more likely to be detected on fluciclovine PET than MF <=7 mm.

CLINICAL RELEVANCE/APPLICATION

The ability of preoperative fluciclovine PET/CT to detect lymph node metastasis in patients with primary prostate cancer is influenced by the size of the metastatic focus within the lymph node.

SSA16-05 Difference in the Spectrum of Metastatic Disease on 68Ga PSMA PET/CT after Radical Prostatectomy and after Radical Radiotherapy in Patients of Carcinoma Prostate with Biochemical Recurrence

Sunday, Dec. 1 11:25AM - 11:35AM Room: S505AB

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PURPOSE

To determine the pattern of metastatic disease with 68Ga PSMA PET/CT in patients with biochemical recurrence after definitive treatment

METHOD AND MATERIALS

A retrospective analysis of subjects with carcinoma prostate, who had undergone definitive treatment (Radical prostatectomy or Radiotherapy) and presented with biochemical recurrence, was done by 68Ga PSMA PET/CT. The data collected was analysed to establish temporal occurrence and patterns of regional and distant metastatic disease in both the groups and correlated with serum PSA levels.

RESULTS

The study included 200 subjects with history of adenocarcinoma prostate. In the post radical prostatectomy group (n=144), median serum PSA was 1.8 ng/ml, the overall metastatic detection rate was 39.3% for PSA 0.2 to < 0.5 ng/ml, 47.3% for PSA 0.5 to < 1 ng/ml, 68.4% for PSA 1 to < 2 ng/ml and 93.1% for PSA >=2 ng/ml. In this group local recurrence was identified in 28.73 % and lymph nodal metastases in 65.1%, with the pelvic lymph nodal metastases being the most common site of metastasis followed by bone metastases. The mean time for serum PSA recurrence in the radical prostatectomy group was 49.77±44.44 months (range 2-184 months). In the post radiotherapy group, median serum PSA was 5.2 ng/ml, the detection rate was 88.8 % for PSA 2 to < 4 ng/ml and 100 % for PSA >= 4 ng/ ml. Local recurrence after radiotherapy was present in 79.5 % of the group and 63.6 % had lymph nodal metastases. The mean time for serum PSA recurrence following radiotherapy was 49.15± 24.32 months, (range 12-111 months).

CONCLUSION

Radical prostatectomy and Radical radiotherapy are the two standard treatment options for localized carcinoma prostate. Although the extent and patterns of recurrence differed in the two groups, the temporal occurrence of metastatic disease remained comparable.

CLINICAL RELEVANCE/APPLICATION

68Ga-PSMA has been suggested as a novel tracer for detection of prostate cancer relapse and metastases with high specificity and sensitivity.

SSA16-06 Correlation of Findings on 18F-Fluciclovine PET/CT with Failure-Free Survival of Salvage Radiotherapy in Post-Prostatectomy Patients with Biochemical Recurrence

Sunday, Dec. 1 11:35AM - 11:45AM Room: S505AB

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PURPOSE

To examine the impact of fluciclovine PET on failure-free survival (FFS) of radiotherapy (RT) ± androgen deprivation therapy (ADT) in recurrent prostate cancer patients post-prostatectomy.

METHOD AND MATERIALS

69 post-prostatectomy patients with biochemical recurrence in the experimental arm of a randomized controlled study (NCT01666808/NIH R01CA169188) underwent fluciclovine PET prior to RT±ADT. RT was based on PET and clinical findings: no

uptake/prostate bed only uptake - RT to prostate bed only, pelvic nodal uptake - RT to prostate bed+pelvis, extrapelvic nodal uptake - no RT. RT (median 66.6 Gy in 1.8 Gy fractions) was initiated 17±10 days after PET scan. 21 patients received RT+short course ADT. 8 patients at 12 months and 3 additional patients at 18 months post-RT were censored due to lack of follow-up. Treatment failure was defined as either serum prostate-specific antigen (PSA) >=0.2 ng/ml+post-RT nadir followed by another higher value, a continued rise in the serum PSA despite RT, initiation of systemic therapy after completion of RT, or clinical progression. FFS based on fluciclovine PET findings were compared using Fisher's exact test.

RESULTS

53/69 (76.8%) patients had positive fluciclovine PET findings. 4/69 patients were ineligible for RT due to systemic disease, hence, FFS was assessed in 65 patients (median PSA 0.32 [range 0.02-9.79] ng/ml). FFS at 6, 12 and 18 months was 63/65 (96.9%), 52/57 (91.2%), and 43/54 (79.6%), respectively. In patients with no uptake, FFS was 16/16 (100%), 15/15 (100%), 12/13 (92.3%) at 6, 12, and 18 months, respectively. In patients with uptake in the prostate bed only, FFS was 27/27 (100%), 21/22 (95.5%), 18/21 (85.7%) at 6, 12, and 18 months, respectively. In patients with pelvic±prostate bed uptake, FFS was 20/22 (90.9%), 16/20 (80.0%), 13/20 (65.0%) at 6, 12, and 18 months, respectively. FFS trends did not reach statistical significance at any timepoint.

CONCLUSION

Findings on fluciclovine PET/CT correlate with failure-free survival, potentially reflecting metabolic tumor burden and may have prognostic value. Longer follow-up duration and comparison to a control group not undergoing PET, are required to fully evaluate the value of fluciclovine PET based radiotherapy.

CLINICAL RELEVANCE/APPLICATION

Findings on fluciclovine PET/CT correlate with failure-free survival of salvage radiotherapy and may have prognostic value in post-prostatectomy patients with biochemical recurrence.

SSA16-08 Significant Interval Decrease in Bone Mineral Density in Osteopenic Patients: A Notable Limitation of FRAX Analysis in Dual-energy X-ray Absorptiometry

Sunday, Dec. 1 11:55AM - 12:05PM Room: S505AB

Participants
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PURPOSE

Bone mineral density (BMD) evaluation, considered to be the standard measure for the diagnosis of osteoporosis and fracture risk assessment, is most commonly measured by dual-energy x-ray absorptiometry (DXA). For patients diagnosed with osteopenia, the Fracture Risk Assessment Tool (FRAX) was developed, which incorporates clinical factors to aid the clinician in patient management. If the FRAX score in an osteopenic patient predicts a 10-year fracture risk of 20% or greater for a major osteoporotic fracture or 3% or greater for a hip fracture, therapy is warranted. However, any significant decline in BMD when compared to a prior DXA is not reflected in the FRAX analysis. Our goal was to determine the frequency with which there is a significant decline in BMD in patients diagnosed with osteopenia by DXA, but whose FRAX score predicts a fracture risk of less than 20% for a major osteoporotic fracture or less than 3% for a hip fracture.

METHOD AND MATERIALS

Over a period of 12 months, the number of patients diagnosed with osteopenia by DXA were counted, who (1) had a significant decrease in BMD when compared to a prior DXA and (2) the FRAX scores were both less than 20% for a major osteoporotic fracture and less than 3% for a hip fracture.

RESULTS

A total of 278 patients with osteopenia by DXA had a significant decrease in spine and/or hip BMD when compared to a previous DXA, yet the FRAX scores were both less than 20% for a major osteoporotic fracture and less than 3% for a hip fracture.

CONCLUSION

Fracture risk assessed by FRAX analysis is often underestimated in osteopenic patients whose BMD has significantly declined from a prior DXA. Therefore, in this clinical setting, a low FRAX score should not influence the therapeutic decision.

CLINICAL RELEVANCE/APPLICATION

The following sentence should be added to the DXA scan report in the above clinical scenario: "It should be noted that a significant decrease in BMD from a prior DXA is not reflected in FRAX analysis."

SSA16-09 Effect of Tumor Histology on Detection of Pelvic and Para-Aortic Nodal Metastasis with FDG-PET in Stage IB Cervical Cancer

Sunday, Dec. 1 12:05PM - 12:15PM Room: S505AB

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PURPOSE

To determine if the detection of FDG-avid pelvic and para-aortic lymph nodes in early stage cervical cancer patients is dependent on tumor histology.

METHOD AND MATERIALS

Patients with IB1-2 cervical cancer who underwent pre-surgical FDG-PET between 1997-2018 were identified in a tertiary academic center database. All patients had radical hysterectomy with pelvic and para-aortic lymph node dissection. The detection of pelvic and para-aortic lymph nodes by FDG-PET vs. surgical dissection was compared. FDG-PET sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were determined and stratified by tumor histology. Freedom from relapse (FFR) was analyzed with Kaplan-Meier analysis and Cox proportional hazards models.

RESULTS

We identified 212 patients with early-stage cervical cancer (84% FIGO IB1, 16% IB2) who underwent pre-surgical FDG-PET; 137(65%) had squamous carcinoma and 75(35%) had adenocarcinoma. PET/CT was performed in 189(89%) patients and 23(11%) had PET only. Surgical dissection revealed positive pelvic and para-aortic lymph nodes in 25% and 3.3% of patients, respectively. For squamous carcinoma, the sensitivity, specificity, PPV and NPV of FDG-PET for pelvic nodal metastasis were 44%, 99%, 95% and 78%, respectively. For adenocarcinoma, the corresponding results for pelvic nodal metastasis were 25%, 99%, 67% and 92%, respectively. The overall sensitivity, specificity, PPV and NPV of FDG-PET for para-aortic nodal metastasis was 29%, 99%, 67%, and 98%, respectively. With a median follow up of 9.3 years, the 5-year FFR for squamous carcinoma and adenocarcinoma was 83% vs. 96% (p=0.008), respectively.

CONCLUSION

Pelvic nodal metastasis was less likely to be detected by FDG-PET in patients with early-stage adenocarcinoma than with squamous carcinoma. Patients with adenocarcinoma had a better prognosis than those with squamous carcinoma.

CLINICAL RELEVANCE/APPLICATION

FDG-PET was half as sensitive for detecting pelvic lymph nodes in adenocarcinoma vs. squamous carcinoma.

Printed on: 10/29/20

SSA17

Neuroradiology (Stroke 1)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S501ABC

AI CT ER NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSA17-01 A Deep Learning Algorithm for Detecting Challenging Cases of Acute Ischemic Stroke on Non-Contrast Brain CT

Sunday, Dec. 1 10:45AM - 10:55AM Room: S501ABC

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PURPOSE

Improving the diagnostic accuracy for acute ischemic stroke (AIS) has the potential to reduce erroneous administration of tissue plasminogen activator (tPA) to patients presenting with stroke-like symptoms. Non-contrast CT is obtained in the acute setting to rule out intracranial hemorrhage but has poor sensitivity and specificity for AIS. Thus, the most ambiguous cases are referred to Diffusion Weighted MRI (DW-MRI) after administration of tPA for diagnostic confirmation. The aim of this study is to produce stroke annotations on non-contrast CT images based on corresponding DW-MRIs in these challenging cases, and then automatically detect and segment AIS directly from non-contrast brain CT images.

METHOD AND MATERIALS

8879 CT slices from 199 patients CT scans were collected and split into training (75%), validation (15%), and test (10%) sets. Out of 199 patients, 99 patients were confirmed to have stroke based on DW-MRIs (positive samples), and 100 patients had no evidence of AIS based on clinical follow up (negative samples). Board-certified radiologists annotated the CT for AIS on positive samples by comparing to corresponding DW-MRIs. The training dataset was then passed through a Mask R-CNN model with a ResNet-50 backbone with L2 Regularization. The loss function was optimized by stochastic gradient descent with momentum. The model was initialized with weights pretrained on the Common Objects in Context dataset. The validation set was used to tune hyperparameters.

RESULTS

The model was assessed on the ability to identify a CT slice as containing a stroke and the ability to segment the regions of corresponding diffusion on MRI on the held-out test set. The model has a whole image classification specificity of 0.6849, sensitivity of 0.4792, F1 score of 0.1394, and accuracy of 0.6736. Additionally, the model demonstrated a promising ability to automatically segment AIS, achieving a mean average precision on true positive predictions of 0.3478 at an intersection-over-union of 10%.

CONCLUSION

Our Mask R-CNN model provides a promising means of detecting acute ischemic stroke on non-contrast CT.

CLINICAL RELEVANCE/APPLICATION

The algorithm can be used to improve the diagnostic accuracy for AIS on non-contrast CT in emergency settings to improve patient selection for intravenous thrombolysis and mechanical thrombectomy.

SSA17-02 Infarct Lesion Prediction Using Baseline MRI in Acute Ischemic Stroke Patients: A Comparison Study between Deep Learning Model and Clinical Thresholding Methods

Sunday, Dec. 1 10:55AM - 11:05AM Room: S501ABC

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PURPOSE

We aim to determine whether a deep learning model trained on acute stroke patients can predict the 3-7 day infarcted region from baseline DWI/PWI MRI and to compare its prediction with state-of-the-art clinical thresholding methods.

METHOD AND MATERIALS

Patients with baseline DWI/PWI and 3-7 day T2-FLAIR imaging were selected from two large acute ischemic stroke trials. Six image channels from baseline imaging were used as model inputs (DWI, ADC, and from PWI: Tmax, CBF, CBV, and MTT). Ground truth was manually segmented on 3-7 day T2-FLAIR. The network structure was an attention-gated deep convolutional U-net with a composite loss function. The model outputs a map where each voxel represents the probability of being part of the lesion. Patients were grouped into unknown, minimal, partial, major reperfusion status. Area-under-the-curve (AUC), Dice score coefficient (DSC), and predicted lesion volume difference were analyzed. In minimal and major reperfusion, the model was compared to a thresholding method (RAPID) using Tmax>6 sec and ADC<620 x 10-6 mm2/s by a paired sample Wilcoxon test, respectively.

RESULTS

182 patients were included (age 65±16 yrs, baseline NIHSS 15 [IQR 10-19]). For all patients, the model had a median AUC of 0.91 (IQR 0.87, 0.95); at 0.5 probability threshold, median DSC was 0.53 (IQR 0.31-0.68) and lesion volume differences were 9.1 ml (IQR -14.2-28.6) and 23.7 ml (IQR 11.4-50.1) (absolute difference). In minimal reperfusion patients, median AUC was 0.90 (IQR 0.85, 0.94) vs 0.78 (IQR 0.72, 0.82) for the Tmax model ($p<0.001$); in major reperfusion patients, median AUC was 0.93 (IQR 0.89, 0.96) vs 0.68 (IQR 0.62, 0.76) for the ADC model ($p<0.001$). In partial or unknown reperfusion patients, AUC was similar: 0.90 [IQR 0.86, 0.96] and 0.92 [IQR 0.86, 0.96], respectively.

CONCLUSION

A deep learning model trained without reperfusion status performs better at infarct lesion segmentation compared to commonly-used threshold-based methods in minimal and major reperfusion patients, while also achieving high performance in partial or unknown reperfusion patients.

CLINICAL RELEVANCE/APPLICATION

A deep learning model without reperfusion information trained on acute images can achieve good performance at predicting imaging outcome at 3-7 days.

SSA17-03 Quantitative Evaluation of Multiphase Versus Single Phase Computed Tomography Angiography for the Detection of Distal Ischemic Stroke

Sunday, Dec. 1 11:05AM - 11:15AM Room: S501ABC

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PURPOSE

The aim of this investigation was to quantitatively evaluate the effects of the addition of peak and delayed venous phase imaging to arterial phase CTA for the detection of distal ischemic strokes. Changes in sensitivity, specificity, time required to render a final decision, and subjective level of diagnostic confidence were quantified.

METHOD AND MATERIALS

Four attending radiologists contributed as readers to this IRB-approved, HIPAA-compliant study. For each reader, two sessions were conducted; in each session, the reader retrospectively interpreted the CTA studies of 104 patients (52 positive, 52 negative) who underwent imaging for suspicion of acute ischemic stroke, resulting in a total of 832 interpretations. During the first session for each reader, only arterial phase images were available; during the second session, peak and delayed venous phase images were additionally available. The patients' images were randomized and de-identified, and the two reading sessions for each radiologist

were separated by at least one month in order to minimize inter-session confounding. Data collected included presence or absence of arterial occlusion, time to render a final decision, and subjective level of diagnostic confidence.

RESULTS

The addition of venous phase images resulted in a significant 7.5% absolute increase in sensitivity (86.5% vs. 94.0%, p = .004) and an insignificant increase in specificity (98.2% vs. 99.0%, p = .387). No significant increase was observed in relative positive predictive value (97.2% vs. 98.1%, p = .511) but a small significant increase in relative negative predictive value was seen (87% vs. 91%, p = .001). A small but significant reduction in reading time was observed (66.7 seconds vs. 59.6 seconds, p = .001). A significant increase in diagnostic confidence was observed (2.26 vs. 2.58, p < .001). Inter-radiologist agreement (Kappa value) increased from 0.76 to 0.84.

CONCLUSION

The addition of peak and delayed venous phases to arterial phase CTA imaging for the detection of distal ischemic stroke significantly increases diagnostic sensitivity, reading speed, and reader confidence without incurring a corresponding reduction in specificity.

CLINICAL RELEVANCE/APPLICATION

By increasing sensitivity and reading speed at no cost to specificity, conducting multiphase imaging as a routine stroke protocol has the potential to improve diagnostic accuracy and patient outcomes.

SSA17-04 Deep Learning-Based Contrast Enhanced Time-Resolved Cone-Beam CT Angiography with IV Injection

Sunday, Dec. 1 11:15AM - 11:25AM Room: S501ABC

Participants
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PURPOSE

The purpose of this work was to develop a deep learning technique to generate time-resolved cone-beam CT angiography (TR-CBCTA) from cone-beam CT perfusion data sets.

METHOD AND MATERIALS

With IRB approval and written consent, 43 patients with acute ischemic stroke and a high NIH stroke scale scores (>5) were recruited in one-stop-shop C-arm cone beam CT stroke imaging clinical trial study. The recruited subjects received both diagnostic CT and C-arm cone-beam CT perfusion imaging. The C-arm cone beam CT perfusion data acquisitions consist of nine 5-seconds bidirectional rotational scans with 100 cc contrast medium injected intravenously followed by 50 cc saline flush. To generate TR-CBCTA, the acquired high quality diagnostic CT images were used to train our previously published deep learning angiography (DLA) neural network to extract vascular features from axial CT images. This trained deep neural network was transferred to learn TR-CBCTA from the acquired cone-beam CT perfusion data sets. To capture the spatiotemporal characteristics of TR-CBCTA, the trained DLA model was fine-tuned using images from the acquired cone-beam CT perfusion data sets. The trained model was then used to generate TR-CBCTA of other data sets from different patients. The generated TR-CBCTA images were subject to qualitative assessment of image quality of large arteries (i.e internal carotid artery - ICA, middle cerebral artery - MCA, anterior cerebral artery - ACA and the distal branches of the MCA and ACA) as well as the anatomy of the cerebral venous system. The presence/absence of residual bone and mis-registration artifacts was also evaluated.

RESULTS

All major arteries as well as venous drainage showed good to excellent image quality in time-resolved DLA images. No significant residual signal from osseous structures was observed.

CONCLUSION

A deep learning based method was developed to generate TR-CBCTA from cone-beam CT perfusion data sets with reduced mis-registration and residual bone artifacts induced by inter-sweep patient motion and known to be the major technical limitation.

CLINICAL RELEVANCE/APPLICATION

Time-resolved cone-beam CT angiography from cone-beam CT perfusion data sets may enable reliable use of c-arm based time-resolved CTA to directly visualize vascular occlusions and assess collaterals to ischemic stroke patients.

SSA17-05 Quantitative CT Perfusion: Do the CT Scanner Model and Variation in Vascular Flow Rate Affect Quantitative Measures of Parametric Maps?

Sunday, Dec. 1 11:25AM - 11:35AM Room: S501ABC

Participants
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PURPOSE

Using a CT perfusion phantom, we sought to determine whether quantitative measurements on CT perfusion maps differed between CT manufacturers and scanner models and to determine if differences in simulated blood flow rates affect these quantitative measurements.

METHOD AND MATERIALS

A unique CT perfusion phantom comprised of 4 movable rods was used in this study. The phantom contains 2 rods designed to simulate arterial and venous flow rates and 2 rods replicating identical normal perfused brain tissue. The simulated arterial and venous contrast rods are designed to move at 5 distinct speeds, allowing acquisition of datasets at 5 different simulated blood flow rates. Scanning was performed using standard clinical protocols on 3 different CT scanner models at each of the speeds. The CT phantom was scanned 5 times for one of the phantom speeds to confirm reproducibility. Datasets from each scan were post processed using commercial perfusion software to create time attenuation curves and parametric perfusion maps for cerebral blood volume (CBV), cerebral blood flow (CBF) and mean transit times (MTT). Region of interest (ROI) measurements in the simulated brain tissue rods were obtained for 3 centrally located scan slices.

RESULTS

Quantitative ROI measurements revealed that CBF values increased, MTT decreased, and CBV did not change with increased phantom speed, as expected, for all three CT scanner models. The absolute values of CBV and CBF were different across CT scan manufacturers, although closer in range between two models of a single CT manufacturer, for a given phantom speed. For example, at a simulated flow rate of 1.5 mm/sec measured at a central phantom slice position, CBF(ml/100g/min) was 17.7 for Scanner 1 (mfgr 1), 14.0 for Scanner 2 (mfgr 1), and 36.0 for Scanner 3 (mfgr 2); CBV(ml/100g) was 4.9 for Scanner 1, 4.2 for Scanner 2, and 7.8 for Scanner 3; MTT(sec) was 16.7 for Scanner 1, 18.0 for Scanner 2, and 16.2 for Scanner 3.

CONCLUSION

Scanner manufacturers and models yield substantially different quantitative ROI values; therefore, one must be cautious when using absolute values for interpreting CT perfusion images, particularly when attempting to devise threshold values for CBF and CBV.

CLINICAL RELEVANCE/APPLICATION

Since quantitative values are not consistent across CT scanners, one must be cautious when using them for interpreting CT perfusion, particularly if attempting to devise threshold values for CBF and CBV.

SSA17-06 Imaging Triage of Acute Stroke Patients for Endovascular Clot Retrieval (ECR): Audit of the Effects of Broadened Eligibility Criteria and Process Improvements on Utilisation of CT Perfusion at a Health Network Stroke Centre

Sunday, Dec. 1 11:35AM - 11:45AM Room: S501ABC

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PURPOSE

The DAWN and DEFUSE-3 trials published in 2017 showed improved outcomes for later-presenting acute stroke (AS) patients with large vessel occlusion treated with endovascular clot retrieval (ECR). At our institution we experienced a markedly increased volume of CT perfusion (CTP) studies for patients with potential AS during 2018. We aimed to determine if there were associations between: 1. liberalized temporal eligibility criteria and increased CTP utilization and 2. CTP utilization and number of patients having ECR who were discharged home.

METHOD AND MATERIALS

Audit of 3 hospital network. Inclusion: Consecutive. Suspected AS >18 years who had CTP. Study Period 1. 1 January-30 June 2017; Period 2. 1 January-30 June 2018. Data collection: Age, gender, hospital of presentation, triage category, NIHSS (National Institute of Health Stroke Score), symptoms / signs, time SLSW-triage, # patients reaching angiography for intended ECR (IECR), ECR performance, disposition (home / other). Number needed to scan (NNS) for 1 IECR =Total # CTP / total # IECR. Total ED presentations were calculated. Analysis: Comparison of periods 1. and 2. Student t, Wilcoxon Rank Sum and chi-square tests with significance set at $p < 0.05$.

RESULTS

A 38.6 % increase in CTP (515 in 2017, 714 in 2018) occurred with 42/515 (8.2%) and 76/714 (10.6%) proceeding to intended ECR (80.9% increase) . NNS declined from 12.3 to 9.4. 39/515 (7.6%) and 62/714 (8.7%) of patients had ECR (60.0% increase). >85% of patients in both periods were triage category 2 (CAT2) ; increase in all CAT2 ED presentations 2017-8 was 1.6%. 90/118 patients with IECR had complete data for analysis. Median time SLSW at triage differed between the two groups (median [244 mins (IQR: 95-600) in 2018 vs. 74.5 mins in 2017 (IQR: 53-205); $p < 0.0001$]. 23 and 28 patients who had ECR were discharged home in 2017 and 2018, respectively.

CONCLUSION

CTP volume grew between 2017 and 2018 well in excess of ED presentations. Median time SLSW was different between the two study periods. Reduction in NNS may reflect patient selection for CTP and/or changed decision-making after CTP. In 2018 versus 2017, 199 more CTPs were performed for an additional 5 ECR patients to be discharged home.

CLINICAL RELEVANCE/APPLICATION

Broadened temporal criteria for endovascular clot retrieval (ECR) in acute stroke (AS) are associated with substantial increase in CT perfusion utilization per ECR patient discharged home.

SSA17-07 Amide Proton Transfer Magnetic Resonance Imaging of Cerebral Infarction: Correlation with Clinico-Radiological Findings

Sunday, Dec. 1 11:45AM - 11:55AM Room: S501ABC

Participants
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PURPOSE

Amide proton transfer (APT) imaging is a kind of chemical exchange saturation transfer imaging technique based on proton exchange between amides (-NH) and bulk water. As proton exchange rate depends on tissue pH, APT imaging could detect pH reduction in cerebral infarctions. The purpose of this study was to clarify correlations between APT-weighted signal (APTws) and clinico-radiological findings in patients with infarctions.

METHOD AND MATERIALS

In this retrospective study, 29 patients (13 males and 16 females; age range 9-91 y.o.; median 65 y.o.) were examined with a 3T MR system. The infarction etiology was cardioembolic in 11 cases, atherosclerotic in 5 cases and others in 13 cases. The range of time after ictus was 1.8 to 720 h. (median 52.3 h.). The range of lesion size was 19 to 132 mm (median 50 mm). The parameters of APT imaging were as follows: saturation pulse strength = 1.5 μT, saturation time = 2.0 sec, 25 offset frequencies (±6 ppm). MTR asymmetry at 3.5ppm was defined as APTws. Regions-of-interest (ROIs) were manually drawn around the infarction and contralateral normal-appearing white matter (CNWM) on diffusion-weighted images, then these were copied onto the APT images. We measured cumulative histogram parameters, including 10th, 25th, 50th, 75th, 90th percentiles of APTws in infarction and CNWMs. Histogram parameters were compared between infarction and CNWM using Wilcoxon signed-rank test. Those were also compared between cardioembolic infarction and the other subtypes of infarctions using Mann-Whitney U test. Correlation between 10th percentile of APTws (APT10th) and time after ictus, lesion size and 10th percentile of ADC (ADC10th) were evaluated using Spearman`s rank correlation coefficient.

RESULTS

APT10th of infarction was significantly lower than that of CNWM (-1.69±1.80 vs. -1.12±1.73 %, p = 0.0381). APT10th of cardioembolic infarction were significantly lower than those of the other infarction subtypes (-2.77±2.42 vs. -1.02±0.82 %, p = 0.0144). APT10th positively correlated with ADC10th (r = 0.49, p = 0.0065) and inversely correlated with lesion size (r = -0.43, p = 0.0216). There was no significant correlation between APTws and time after ictus.

CONCLUSION

APTws was reduced in cardioembolic infarctions, large infarctions and infarctions with low ADC values.

CLINICAL RELEVANCE/APPLICATION

APT imaging could be used to evaluate tissue acidosis in cerebral infarctions.

SSA17-08 High B Values for Diffusion-Weighted Imaging at 3 Tesla Improves the Sensitivity for Acute Ischemic Stroke Detection

Sunday, Dec. 1 11:55AM - 12:05PM Room: S501ABC

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PURPOSE

MRI may be performed in the setting of acute neurological deficits, in order to diagnose ischemic stroke, rule out alternative diagnoses and select patients for further traitement. The diagnosis is based on the demonstration of diffusion weighted high-signal intensity with decreased apparent diffusion coefficient (ADC) value. The optimum b factor to use at 3T has never been defined in the literature, varying between 1000 and 2000; hence, this study compares 2 b factors : b1000, b2000 s/mm2 in evaluating recent cerebral ischemic lesions at 3T MRI.

METHOD AND MATERIALS

227 patients with a recent ongoing or transient neurological deficit (< 24h) were inclued over 3 months. We performed b1000 and

b2000 MR diffusion sequences 3T MRI in an emergency setting. These acquisitions were quantitatively and independently analysed by 2 readers, specifying the presence of an ischemic lesion and their diagnostic confidence. Inter-reader agreement, sensitivity, specificity, and positive and negative predictive values were calculated.

RESULTS

Recent ischemic lesions were detected in 78/227 patients (34.4%). The sensitivity for b2000 was significantly higher than for b1000 at 3T (98.7% vs 93.7%, p=0.05), whereas the specificty was equivalent (99.3% vs 97.3%, p=0.18). There was no statistical difference for diagnostic confidence.

CONCLUSION

MR diffusion sequence with a b factor of 2000 s/mm2 has a better sensitivity for the detection of recent ischemic lesions, compared to 1000 s/mm2 at 3T.

CLINICAL RELEVANCE/APPLICATION

DWI with a b factor of 2000 s/mm2 has a significantly higher sensitivity in diagnosing recent ischemic stroke compared to a b factor of 1000 s/mm2 and is recommended in the emergency setting.

SSA17-09 High Performance of Deep-Learning (DL) based Segmentation Model of Acute Ischemia Stroke Lesions Evaluated with ASPECTs Score on Head CT

Sunday, Dec. 1 12:05PM - 12:15PM Room: S501ABC

Participants
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PURPOSE

In this study, we aim to develop a deep-learning (DL) based model to automatically segment signs of ischemia acute stoke lesions on head CT scans. By implementing the topographic scoring system (Alberta Stoke Program Early Score, ASPECTs), we evaluated the performance of the proposed model in the detection of patients with acute ischemic stroke.

METHOD AND MATERIALS

For this retrospective study, over 36, 000 CT images were collected from 1,500 patients with and without ischemia stroke between 2012 and 2017. All patients had CT and MRI scan taken less than twenty-four hours apart for stroke diagnosis. The presence of Ischemia stroke lesions as well as the corresponding ASPECTS score per region were labeled on CT scans by board-certified radiologists as ground truth on the review of MRI images and clinical reports. Using CT scans as input, a DL-based model was developed by using Dense UNet as the backbone, integrating Deeplab architectures. ASPECTs score was automatically calculated individually over all ASPECTS regions for the segmentation of ischemia stroke lesions.

RESULTS

In total, scans of 346 patients including 240 patients with acute ischemia stroke and 106 patients without acute ischemia stroke lesions were used in the evaluation of the model performance. Sensitivity, specificity and accuracy rate in an ASPECTS regions-based analysis were 39.80%, 98.02% and 96.37%, respectively.

CONCLUSION

The proposed automated model demonstrated a high performance in the prediction of ischemia stoke lesions in head CT scans as well as in regions like cerebellum and brainstem.

CLINICAL RELEVANCE/APPLICATION

Our proposed model could serve as a useful tool for early diagnosis of ischemia stoke lesions and has the potential to influence clinical decisions to treat patients with thrombolysis and thrombectomy.

SSA18

Neuroradiology (Brain Tumors 1)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S401CD

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Leo J. Wolansky, MD, Farmington, CT (*Moderator*) Nothing to Disclose
Ramon F. Barajas JR, MD, Portland, OR (*Moderator*) Nothing to Disclose
Rajan Jain, MD, Hartsdale, NY (*Moderator*) Consultant, Cancer Panels; Royalties, Thieme Medical Publishers, Inc; Advisory Board, Neuvozen Inc

Sub-Events

SSA18-01 Glioma Grading Using Microstructural MRI: A Comparison of Diffusion Tensor, Diffusion Kurtosis, and Neurite Orientation Dispersion and Density Imaging

Sunday, Dec. 1 10:45AM - 10:55AM Room: S401CD

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PURPOSE

To evaluate the diagnostic performance of diffusion tensor imaging (DTI), diffusion kurtosis imaging (DKI) and neurite orientation dispersion and density imaging (NODDI) for in-vivo grading of gliomas according to the histomolecular integrated 2016 WHO classification.

METHOD AND MATERIALS

41 patients with histopathologically confirmed primary, treatment-naive gliomas (23 grade 2 and 18 grade 3-4 tumours; 10 IDH wild-type (IDHwt), 17 IDH mutant (IDHmut) 1p/19q retained and 14 IDHmut 1p/19q codeleted; 33 non-oligodendroglial and 8 oligodendroglial tumours) prospectively underwent a multi-shell diffusion-weighted protocol to assess the DTI, DKI, and NODDI-derived tumour features. Data were analysed with DKE, FSL and the NODDI Matlab Toolbox. Metric values were extracted from whole tumour segmentations and analysed by descriptive statistics and linear regression (Stata software).

RESULTS

Statistically significant differences were found for the average tumour mean kurtosis (MK) and apparent diffusion coefficient (ADC) between the IDHmut and IDHwt gliomas (p-value<=0.02); for the average MK, intra-cellular volume fraction (ficvf) and ADC between IDHmut 1p/19q retained and IDHwt gliomas (p-value<=0.04). The area under curve (AUC) was moderate (0.72-0.75) for all metrics. NODDI-derived parameters, inclunding CSF volume fraction (fiso) and ficvf showed weak significance for differentiating the IDHmut from the IDHwt gliomas (p-value 0.05-0.07) but significant differences between 1p/19q retained and codeleted gliomas (p-value 0.002).

CONCLUSION

Microstructural imaging provided satisfactory diagnostic value to differentiate IDHwt from 1p/19q retained IDHmut gliomas but only NODDI parameters could reliably probe the 1p/19q codeletion effect on the tumour microstructure in the IDHmut tumours.

CLINICAL RELEVANCE/APPLICATION

Microstructural DWI-based techniques offer complementary information for the non-invasive histomolecular WHO staging of gliomas and their combined use showed encouraging results in this pilot study.

SSA18-02 Prediction of Core Signaling Pathway using Physiologic MR Imaging Phenotypes in IDH Wild Type Glioblastoma

Sunday, Dec. 1 10:55AM - 11:05AM Room: S401CD

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PURPOSE

Radiogenomic analysis in gliomas informs multiple associations between genomic alteration and imaging phenotypes, but clinical implication for therapeutic options has been limited. This study aims to predict core signaling pathways in IDH-wild type glioblastoma for targeted therapy by exploring associations between MR imaging phenotypes and next generation sequencing (NGS).

METHOD AND MATERIALS

Genetic alterations were detected with NGS for 120 pathologically proven glioma patients who underwent multi-parametric MRI. First step found significant radiomics features for each genomic mutation using t-test with false discovery rate and lasso penalization. Second step predicted receptor tyrosine kinase (RTK), P53, and Rb pathways, with each pathway contains at least 1 relevant genetic mutation, by using radiogenomic features, age, sex, and locations using random forest and logistic regression classifier. The performance of radiogenomic modeling was tested in the independent validation set of IDH-wild type glioblastoma (n = 35) in prospective registry (NCT02619890) using area under the receiver-operating-characteristics curve (AUC).

RESULTS

First step found in 23, 19, and 29 features for EGFR, PI3KCA, and PTEN mutation in RTK pathway, 6 and 11 features for MDM2 and TP53 mutation in P53 pathway, and 3, 6, and 26 features for CDK4, CDKN2A, and Rb1 mutation in Rb pathway. The performance of core signaling pathway was AUC 0.875 (95% CI 0.743 - 1) for RTK pathway, AUC 0.757 (95% CI 0.592 - 0.921) for P53 pathway, and AUC 0.807 (95% CI 0.641 - 0.972) for Rb pathway in IDH-wild type glioblastoma. Age become significant predictor for RTK pathway.

CONCLUSION

Multiparametric MR imaging phenotypes can help characterize core signaling pathway and offers potential guidance to targeted therapy noninvasively for IDH-wild type glioblastoma.

CLINICAL RELEVANCE/APPLICATION

In this study, we included copy number variation, single nucleotide variation, and insertion/deletion to account the full width of genetic alterations causing alteration of core signaling pathway in gliomagenesis. The machine-learning based model provides individual probability of patients among three major signal pathways, including receptor tyrosine kinase (RTK), p53, and Rb pathway and allows more precise prediction to the patient-tailored targeted therapy.

SSA18-03 Lipid Fraction as a Novel Biomarker for Predicting Survival Outcome of Glioma

Sunday, Dec. 1 11:05AM - 11:15AM Room: S401CD

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PURPOSE

We evaluated the capability of MRI in-and opposed-phase (IOP) derived lipid fraction as a novel prognostic biomarker of survival outcome in glioma.

METHOD AND MATERIALS

The medical records and MRI images of forty-six histologically proven glioma (WHO Grade II to IV) patients using standard 3T MRI brain tumor protocol and IOP sequence were evaluated. Lipid fraction was derived from the IOP sequence signal-loss ratio. The lipid fraction of solid non-enhancing region of glioma was analyzed, using a three-group analysis approach based on volume under surface (VUS) of receiver operating characteristics to stratify the prognostic factors into three groups of low, medium, and high lipid fraction. The survival analysis was performed, using Kaplan-Meier survival analysis and Cox regression model.

RESULTS

Significant differences were demonstrated between the three groups (low, medium, and high lipid fraction groups) stratified by the optimal cut-off point (OCP) for overall survival (OS) ($p=<0.01$) and time to progression ($p=<0.01$). The OS plot stratified by lipid fraction also had a strong correlation with OS plot stratified by WHO grade ($R=0.61$, $p<0.01$).

CONCLUSION

The lipid fraction of solid non-enhancing region showed potential for prognostication of glioma. This method will be a useful adjunct

The lipid fraction of solid non-enhancing region showed potential for prognostication of glioma. This method will be a useful adjunct in imaging protocol for treatment stratification and as a prognostic tool in glioma patients.

CLINICAL RELEVANCE/APPLICATION

The addition of lipid fraction analysis to standard tumor protocol assessment has the potential to augment pre-treatment planning, especially focusing on intervention for the high-risk group. Future lipidomics anaylysis possible with a reliable bomarkers using IOP sequence

SSA18-04 Using Advanced DWI-MRI Parameters from Multi- B Values Acquisition and a Histogram Approach for Assessment of Early Therapeutic Response in Glioblastoma

Sunday, Dec. 1 11:15AM - 11:25AM Room: S401CD

Participants
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PURPOSE

To assess the utility of advanced quantitative diffusion MRI derived from multi b value acquisitions in the assessment of treatment response, using a spatially-independent approach.

METHOD AND MATERIALS

13 patients (7M,6F; mean age 56) were prospectively enrolled into our multicentre study. All patients had biopsy confirmed GBM and completed RT with adjuvant TMZ. Imaging was performed using a Siemens Verio (3T); pre-RT and mid RT. The MRI protocol included a 'low b value' acquisition (b= 0s/mm, 50s/mm, 150s/mm, 200s/mm, 500s/mm, 1000s/mm) from which monoexponential diffusion indices ADC and biexponential indices, IVIM parameters D*, D and f were calculated. A 'high b value' acquisition (b=0 s/mm, 500s/mm, 1000s/mm, 1500s/mm, 2000s/mm, 2500s/mm, 3000s/mm, 3500s/mm, 4000s/mm) was acquired to allow stretched exponential diffusion indices, DDC and alpha to be derived. FLAIR sequences were used to define ROI and clinical assessment of mid-treatment and end-treatment response using RANO criteria.Histograms were generated from voxels located within manually segmented ROIs defined by increased signal on T2 FLAIR images. Changes in histogram percentile profiles were evaluated across the two timepoints and compared with RANO assessment at the mid treatment and end treatment timepoints.

RESULTS

Following completion of treatment, 5 patients had PD, 4 SD and 4 CR. Patients with PD showed a histogram shift to the left across all diffusion models, in keeping with increasing diffusion restriction and implying increased cellularity. Patients with SD or CR showed little or no shift in the histogram.DDC and f are the most predictive of progression against RANO assessment, and appear superior to routine ADC. Reduction in 75th centile (f) and 95th centile (DDC) are the most sensitive histogram metrics for predicting early progressive disease.

CONCLUSION

Preliminary results suggest association between early changes in specific diffusion components and subsequent treatment response. Spatially-independent diffusion parameter comparisons provide unbiased sampling of tumour heterogeneity and abrogate the confound of voxel-to-voxel misregistration due to tumour growth/shrinkage.

CLINICAL RELEVANCE/APPLICATION

This is the first study to use advanced diffusion histogram analysis as a marker of early treatment response and can potentially identify patients who need to be swicthed to second line therapies earlier.

SSA18-05 Relationships between Shear Stiffness Measured by Magnetic Resonance Elastography and Perfusion Parameters Measured by Perfusion Computed Tomography of Meningiomas

Sunday, Dec. 1 11:25AM - 11:35AM Room: S401CD

Participants
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PURPOSE

To examine the relationships between stiffness measured by magnetic resonance elastography (MRE) and perfusion parameters.

METHOD AND MATERIALS

Twelve patients with meningiomas underwent 3D brain MRE and PCT examination before surgery. MRE was performed using a superconducting magnet operating at 3.0 T. PCT was performed on a 320-row multidetector CT scanner with rapid injection of nonionic iodine contrast media. Normalized ratios (normalized to normal white matter) of perfusion maps of cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT) (defined as nCBF, nCBV, and nMTT, respectively) were generated. ROIs were manually drawn on the T1-weighted image coregistered into the MRE-space for stiffness map and on the enhanced-CT image for perfusion map, including the entire lesion of the meningioma. Mean values of tumor stiffness and perfusion parameters were compared by Pearson correlation. ROC analysis was used to investigate the predictive ability of perfusion parameters for firm tumors (>2.7 kPa).

RESULTS

The mean stiffness values, nCBF, nCBV, and nMTT for 12 meningiomas were 2.6 ± 3.0 kPa, 6.1 ± 3.5, 8.1 ± 5.5, and 1.2 ± 0.2, respectively. All perfusion parameters were significantly inversely correlated with stiffness values ($r=-0.6385$ to -0.7380, $p<0.0254$). The correlation between tumor stiffness and nCBV was the most marked ($r=-0.7380$, $p=0.0061$). Regarding stiffness measurement, 5 meningiomas were firm (>2.7 kPa) and 7 were non-firm. ROC analysis revealed that nCBV was a good predictor of firm tumors, with area under the ROC curve of 0.94. Using a cutoff value of >6.4, nCBV showed 100% sensitivity (5/5) and 85.7% specificity (6/7) for predicting firm tumors (fig. 1). Color-coded stiffness and nCBV maps of meningiomas in two patients are shown (Fig. 2). A firm meningioma with stiffness of 2.8 kPa in a 62-year-old woman has lower nCBV (3.4) compared with a non-firm tumor with stiffness of 2.4 kPa in a 75-year-old woman (nCBF=8.0).

CONCLUSION

We found a significant correlation between stiffness and perfusion parameters in meningiomas. In particular, CBV was a useful method for predicting a firm meningioma.

CLINICAL RELEVANCE/APPLICATION

There was a significant correlation between stiffness and perfusion parameters in meningiomas. In particular, CBV was a useful method for predicting a hard meningioma.

SSA18-06 Static and Dynamic Gallium-68-DOTATATE PET/MRI in the Diagnosis and Management of Recurrent and Progressive Intracranial Meningiomas

Sunday, Dec. 1 11:35AM - 11:45AM Room: S401CD

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PURPOSE

Meningiomas are the most common primary intracranial tumors. Contrast enhanced MRI is the gold standard for diagnosis and treatment planning, however MRI can have limited accuracy in distinguishing recurrence from treatment effect in the postsurgical and post-radiation setting. [68]Ga-DOTATATE is a PET radiotracer targeting somatostatin receptor 2 (SSTR2) with high affinity. Meningiomas express high levels of SSTR2. The purpose of our study was to evaluate [68]Ga-DOTATATE PET/MRI in a prospective clinical cohort of patients with meningioma.

METHOD AND MATERIALS

20 patients with clinically-suspected or pathology proven meningioma were imaged over a time period of 6 months. [68]Ga-DOTATATE-PET/MRI was acquired in 3D list mode over 50 minutes, beginning 5-15 minutes post injection. SUVmax values in meningiomas and suspected post treatment change were obtained, as well as the pituitary gland (positive reference) and superior sagittal sinus (SSS, background reference). In a subset of 11 patients we generated dynamic time-activity curves binned into 5-minute frames, and analyzed time-activity and time-SUVmean curves in target lesions including meningioma, post-treatment change, pituitary glands, and SSS individually as well as across the cohort.

RESULTS

A total of 50 meningiomas were identified based on PET (median: 2 per patient, range 0-14). In 17 patients PET confirmed recurrence, while in 3 patients low avidity favored a diagnosis of post-treatment change. [68]Ga-DOTATATE PET provided improved extent of disease visualization and confirmed parenchymal and osseus invasion. Dynamic PET data demonstrated unique kinetic uptake patterns for meningiomas, pituitary glands and post treatment change across the cohort.

CONCLUSION

[68]Ga-DOTATATE PET/MRI is a promising tool in the assessment of meningiomas, particularly in the post-surgical and post-radiation setting, allowing improved diagnosis and extent of disease evaluation without increasing acquisition time. Incorporating dynamic PET data acquisition and analysis can provide additional valuable information in differentiating recurrence from post treatment change, and inform future prospective clinical trials.

CLINICAL RELEVANCE/APPLICATION

In this consecutive series of 20 cases, we report a novel clinical application of combined static and dynamic [68Ga]-DOTATATE

PET/MRI in diagnosis and treatment response assessment in recurrent and progressive meningioma.

SSA18-07 Outcomes of Treatment Induced Pseudoprogression and Correlation with MGMT Methylation Status in GBM Patients

Sunday, Dec. 1 11:45AM - 11:55AM Room: S401CD

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PURPOSE

A challenge in the management of glioblastoma is distinguishing true progression from pseudoprogression (PsP), which may have improved survival. MGMT methylation has been shown to correlate with PsP. This study aims to evaluate the rates of PsP and its outcomes, and correlate to MGMT status.

METHOD AND MATERIALS

An IRB-approved retrospective study included patients with histologically confirmed glioblastoma between 2010 and 2018. All patients underwent surgical resection followed by temozolomide and radiation. Baseline pre- and post-radiation MRIs were reviewed to assess the treatment response according to RANO criteria. Maximum dimensions and volumetric evaluations were performed. Patients were graded as partial response (PR), progressive disease (PD) or stable disease (SD). Those with initial PD who had subsequent improvement without intervention were classified as PsP. We evaluated overall survival (OS) and time to progression (TTP) from the time of diagnosis, with TTP based on subsequent MRI images and clinical response, and this was correlated with the MGMT.

RESULTS

Of 101 patients diagnosed with glioblastoma, 45 had at least 9 months follow-up. The MGMT status was methylated in 7, indeterminate in 2, unmethylated in 11, and not evaluable in 22. The response was recorded as PsP in 16, PD in 12, SD in 2, PR in 12. Patients with PsP had an excellent mean TTP and OS of 327 and 545 days. The mean TTP and OS for those with PD was 250 and 450 days, and for those with PR was 446 and 676 days. Those with MGMT methylation and PsP had TTP and OS of 437 and 560 days which was similar to those with PR. Those with PsP and unmethylated MGMT had a worse mean TTP and OS of 198 and 438 days.

CONCLUSION

Patients with PsP have improved outcomes compared to those with PD or SD, with a mean TTP and OS that is between those seen with PR/CR and PD/SD. These outcomes are further improved with MGMT promoter methylation. This data substantiates prior studies' conclusions that MGMT status may significantly influence response, and patients with PsP have improved survival compared to PD/SD.

CLINICAL RELEVANCE/APPLICATION

Pseuodprogression may predict a better overall response, and recognizing it in an earlier fashion may prevent initiation of unnecessary salvage therapies that can be reserved for later in the treatment course. Interestingly, MGMT methylation has been shown to correlate with pseudoprogression and increased survival.

SSA18-08 A Single Institution Review of Primary and Secondary Imaging Characteristics of Hypophysitis in Adult Oncologic Patients Undergoing Immune Checkpoint Inhibitor Therapy

Sunday, Dec. 1 11:55AM - 12:05PM Room: S401CD

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PURPOSE

Immune checkpoint inhibitor (ICI) therapy is becoming more prevalent in the treatment of a diverse array of malignancies. With the increasing use of ICI therapy, numerous treatment related complications, termed "immune related adverse events" (irAEs), have emerged. Hypophysitis is a rare and potentially fatal toxicity requiring prompt recognition and early treatment. The purpose of this study was to identify the primary and secondary imaging characteristics of hypophysitis in patients undergoing treatment with ICIs.

METHOD AND MATERIALS

A retrospective chart review was performed of 228 adult oncology patients undergoing treatment with ipilimumab or ipilimumab and nivolumab at a single institution from 2010-2018. Primary and secondary imaging characteristics (adrenal, thyroid, uterine/ovarian atrophy) of hypophysitis were evaluated. The patients' key clinical features, labs, and patient outcomes were assessed from the medical records.

RESULTS

Hypophysitis was diagnosed in 15 (7%) of the 228 patients reviewed with a mean-onset time of 11.2 weeks (range 5-19 weeks) after initiation of ICI therapy. The mean age of diagnosis was 61 ± 16 years with 80% of the patients being male. Sixty percent of patients were treated with ipilimumab alone, and 40% with a combination of ipilimumab and nivolumab. Most patients (14) were treated for melanoma and one was treated for chondosarcoma. Imaging indications included fatigue (85%), headache (77%), and nausea (54%). Brain imaging was performed in 13 patients during and after ICI therapy. Nine patients demonstrated diffuse pituitary enlargement. Of the 9 patients, 5 demonstrated homogenous pituitary enhancement and 3 had heterogeneous enhancement on T1 post-gadolinium images). The patients were subsequently treated with steroids with a mean of 79 days until resolution of imaging findings. All patients developed adrenal atrophy and 2 (13%) had thyroid atrophy on follow up imaging.

CONCLUSION

The expanding role of ICI therapy has resulted in the increased prevalence of irAEs such as hypophysitis. The key radiological findings in hypophysitis are often subtle, but include diffuse pituitary enlargement and adrenal and thyroid atrophy.

CLINICAL RELEVANCE/APPLICATION

Hypophysitis is a rare but potentially fatal complication in oncologic patients undergoing ICI therapy. Imaging, in conjunction with clinical findings, can aid in the rapid diagnosis of the condition.

SSA18-09 Potential Imaging Biomarkers for Assessment of Treatment Response of Metastatic Brain Lesions in Patients with Small Cell Lung Cancer Using Conventional and Diffusion Weighted MR Sequences

Sunday, Dec. 1 12:05PM - 12:15PM Room: S401CD

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PURPOSE

The purpose of the study is to evaluate changes in MR characteristics of individual small cell lung cancer (SCLC) brain metastases (BMs) pre and post inital treatment following the diagnosis of BMs. The impact of these changes on CNS progression free survival (PFS) and overall survival (OS) will be assessed in an attempt to identify MR imaging biomarkers to assess response to therapy.

METHOD AND MATERIALS

In this observational study, MR characteristics of individual SCLC BMs (n=57) were evaluated pre and post treatment in 20 patients. The MRI characteristics analyzed included lesion size, T1 and T2 weighted signal, surrounding edema, hemorrhage, and diffusivity. Initial and interval changes in imaging characteristics were correlated with OS and CNS PFS. For statistical analysis, patients undergoing systemic chemotherapy only were grouped with patients receiving chemotherapy and whole brain radiation therapy (WBRT), which together (n=11) were compared to the group that received WBRT only (n=9) following the diagnosis of BMs.

RESULTS

There was statistically significant difference between the pre and post treatment means of lesion size ($p<0.0001$, Wilcoxon Signed Rank) and ADC ($p=0.0017$, Wilcoxon Signed Rank) but there was no difference across the treatment groups within pairs or among pairs. Parametric Survival analysis for OS showed statistically significant survival difference in terms of treatment type ($p <0.001$). Analysis of the MRI features of the BMs revealed that the percent increase of ADC ($p=0.0001$) was correlated with increased OS. Survival analysis showed difference between treatment groups in terms of OS ($p=0.0122$, Wilcoxon Test) but not in terms of CNS PFS ($p=0.1371$, Wilcoxon Test). There was no difference between the treatment groups in terms of percentage change in lesions size ($p=0.9405$, Kruskal-Wallis test) and percentage change in ADC ($p=0.5635$, Kruskal-Wallis test). Regarding other MRI features, there was no difference in signal characteristics including T1 signal, T2 signal and edema before and after treatment.

CONCLUSION

Changes in diffusivity from pre to post systemic chemotherapy and/or WBRT may be a useful biomarker to assess treatment response in patients with SCLC and BMs.

CLINICAL RELEVANCE/APPLICATION

The percentage change of ADC of small cell lung cancer brain metastases pre to post treatment is correlated with increased overall survival ($p=0.0001$).

SSA19

Neuroradiology/Head and Neck (Head and Neck Tumors)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S404AB

CT HN NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSA19-01 Role of Apparent Diffusion Coefficient (ADC) Values in Differentiating Benign and Malignant Skull Lesions with Histopathological (HPE) Correlation

Sunday, Dec. 1 10:45AM - 10:55AM Room: S404AB

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PURPOSE

Assess the role of ADC in differentiating benign and malignant skull lesions and evaluate added value of ADC over conventional MRI alone, with HPE correlation as reference standard.

METHOD AND MATERIALS

53 patients (24 male,29 female; age 3-75years) with HPE proven skull lesions (24 malignant; 29 benign) were subjected to both conventional and DW MR imaging by using a single-shot SE EPI sequence with b-values of 0, 500 & 1000s/mm2 on 1.5T MR scanner. Margins of the lesion, number, soft-tissue component, local extension, periosteal reaction and enhancement pattern were the parameters used for differentiating benign & malignant lesions by conventional MRI. ADC values (mean of 3 ROIs over solid component) were calculated. Conventional MRI characteristics and ADC value of lesions were evaluated & compared using statistical analysis.

RESULTS

ADC cutoff value of 0.96x10-3 mm2/s obtained from ROC curve was found to have 75.47% accuracy, 87.5% sensitivity, 65.52% specificity, 67.74% PPV and 86.36% NPV for differentiating malignant from benign lesions. Statistically significant differences ($p<0.05$) were seen in the mean ADC values of malignant (0.64+/-0.42x10-3 mm2/s) and benign lesions (1.14+/-0.56x10-3mm2/s). The sensitivity, specificity, PPV and NPV in differentiating benign & malignant skull lesions were found to be 58.33%, 62.07%, 56% and 64.29% respectively, with diagnostic accuracy of 60.38% on using conventional MRI alone and 75%, 72.41%, 69.23% and 77.78% respectively, with diagnostic accuracy of 73.58% on using conventional MRI with ADC. Hence, employing ADC values in addition to conventional MR sequences improved sensitivity, specificity, PPV, NPV and diagnostic accuracy by 16.67%, 10.3%, 13.23%, 13.49% and 13.2% respectively more than conventional MRI alone. High ADC in low-grade chondrosarcoma & chordoma, low ADC in eosinophilic granuloma and variable ADC in metastases are potential pitfalls for DWI.

CONCLUSION

ADC is promising non-invasive parameter that facilitate differentiation between benign and malignant skull lesions and potentially narrow differentials when conventional imaging features are indeterminate.

CLINICAL RELEVANCE/APPLICATION

Addition of DWI & ADC to conventional MRI avoids unnecessary surgical resection, helps monitor treatment response and distinguish between post-treatment changes and recurrent skull lesions. Also it is effective method with short imaging time, thus can be incorporated into routine imaging.

SSA19-02 Exploring Radiomic Machine-Learning Classifiers Extracted from CT and MRI for Predicting the Risk of

Post-Operative Recurrence in Patients with an Advanced Squamous Cell Carcinoma of the Tongue

Sunday, Dec. 1 10:55AM - 11:05AM Room: S404AB

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PURPOSE

To identify optimal modalities and machine-learning methods for radiomics-based prediction of recurrence in advanced squamous cell carcinoma (SCC) of the tongue, treated with primary tumor resection and neck dissection.

METHOD AND MATERIALS

A total of 81 patients with advanced SCCs of the tongue (cT3-4 or any nodal metastasis), who underwent both contrast-enhanced CT and MRI (homogeneous CT/MRI scanner and protocol) for preoperative staging between 1/2010-11/2017, were enrolled in this retrospective study. All the patients were treated with primary tumor resection and neck dissection with a follow-up at least 1 year after operation (39 patients developed recurrence, and the remaining 42 did not). A total of 1409 radiomic features were extracted from each modality of CT and MRI [T2 weighted images (T2WI) and T1-weighted images using gadolinium-based contrast (Gd-T1WI)] with RadCloud platform for each patient. We used variance threshold, select K best, and LASSO algorithm to gradually select the optimal features. Computer-generated random numbers were used to assign 70% of the VOIs to the training data set and 30% of those to the validation data set for each imaging set. Classifications were made using six supervised learning classifiers (KNN, SVM, XGBoost, RF, LR, DT). ROC curve analysis was used to illustrate the prediction performance of the radiomic signature.

RESULTS

CT of 23 cases was excluded from this radiomic analysis due to metal artifacts, but MRI acquired sufficient VOIs in all the cases. For prediction of the postoperative outcome, AUC of the radiomics model based on the Gd-T1WI was the highest (0.854; 95% CI: 0.75 - 0.96, in training sets, and 0.827; 95% CI: 0.66 - 0.99, in validation sets) using KNN classifiers, compared to that using Contrast-enhanced CT (highest AUC was 0.667 in validation sets using SVM) and T2WI (the highest AUC was 0.654 in validation sets using KNN).

CONCLUSION

MRI (Gd-T1WI) may be optimum for building the radiomics model, especially using KNN methods, to predict the risk of postoperative recurrence in advanced SCCs of the tongue.

CLINICAL RELEVANCE/APPLICATION

MRI-based radiomics features could provide additional quantitative information on advanced SCCs of the tongue, which could be potentially used when considering post-operative adjuvant therapy.

SSA19-03 Exploratory Study for Identifying Predictors for Persistent Disease and Tumor Reoccurrence After Treatment of Head and Neck Cancers

Sunday, Dec. 1 11:05AM - 11:15AM Room: S404AB

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PURPOSE

Laryngeal cancer is treated with organ preservation therapy or total laryngectomy. However, little is known about which tumors will persist or reoccur after definitive therapy. The objective of our study is to investigate the feasibility of using radiomic and perfusion features as predictors to determine tumors that will persistent or recur at 1 year after treatment.

METHOD AND MATERIALS

Retrospective analysis of pre and post therapy CT neck scans was performed in 36 patients diagnosed with laryngeal cancer in this IRB approved study. Contouring of the tumors was performed by the computer and tumor features were generated on an internally developed/validated computer-aided detection (CAD) system. Twenty-six radiomic features including morphological and gray-level features were extracted from the computer. Five perfusion features including permeability surface area product (PS), blood flow (flow), blood volume (BV), mean transit time (MTT), and time-to-maximum (Tmax) were extracted from the computer. One year persistent/recurrent disease data were obtained from the time starting after the last treatment of definitive chemoradiation or after total laryngectomy surgery. We performed a two-loop leave one out feature selection using linear discriminant analysis classifier for radiomic and perfusion features. Receiver operator curves and standard deviation were generated.

RESULTS

All 36 lesions examined were primary laryngeal cancers. Out of the 36 patients, there were 10 patients (28%) that had reoccurrence/persistent disease at 1 year. Percent change in volume was the best predictive feature with an area under the curve (AUC) of 0.63 +/- 0.09. Selecting two features had a testing area under the curve (AUC) of 0.69 +/- 0.09. The best features selected were a combination of radiomic and perfusion features including percent change in volume and percent change in blood perfusion.

CONCLUSION

Our pilot study indicates that a combination of radiomic and perfusion features are good predictors of tumor reoccurrence/persistent disease after treatment with definitive radiation or total laryngectomy. Our next step is to expand our data set with additional patients.

CLINICAL RELEVANCE/APPLICATION

Predicting tumors that will reoccur or persist after traditional treatments is an important tool for head and neck cancer management. Good predictors can help providers determine prognosis and patients decide between therapeutic options.

SSA19-04 Diagnostic Performance of Post-Treatment Response Assessment FDG PET/CT Using NI-RADS in Head and Neck Cancer

Sunday, Dec. 1 11:15AM - 11:25AM Room: S404AB

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PURPOSE

To assess the diagnostic performance of response assessment FDG-PET/CT following definitive (chemo)radiotherapy in head & neck cancer using Neck Imaging Reporting and Data System (NIRADS).

METHOD AND MATERIALS

Pre and post-treatment response assessment FDG-PET/CT scans of 146 patients with squamous carcinoma of oropharynx & laryngo-pharynx prospectively treated with image-guided intensity modulated radiation therapy were compared and classified as per NI-RADS template. NI-RADS category 1 indicates no evidence of recurrence; category 2 suggests low suspicion of recurrence; category 3 suggests high suspicion of recurrence; and category 4 is known or proven recurrence. The diagnostic performance of NIRADS criteria was evaluated using pathologically proven loco-regional recurrence as the reference standard.

RESULTS

For disease at primary site, 67%, 25% and 8% patients were scored as NI-RADS 1, 2 and 3 respectively. For NI-RADS 1 category at primary site (n=98), the rate of local recurrence within 2 years of therapy was 20.4% with a specificity of 100% and negative predictive value (NPV) of 79.6%. Rate of local recurrence for NI-RADS 2 and 3 were 38.8%, and 83% respectively. For neck nodal disease, 78%,10% and 12% patients were scored as NI-RADS 1, 2 and 3 respectively. For NI-RADS 1 category in the neck (n=114), rate of neck nodal recurrence within 2 years of therapy was 21% with a specificity of 100% and NPV of 80%. Rate of nodal recurrence for NI-RADS 2 and 3 were 53.3%, and 70.5% respectively. There was a strong association between NIRADS score and loco-regional disease status ($p<0.001$).

CONCLUSION

There is a strong association between NI-RADS score and loco-regional disease status in head and neck cancers. Although the specificity of NI-RADS 1 is excellent, its NPV is suboptimal precluding adoption in routine clinical practice.

CLINICAL RELEVANCE/APPLICATION

There is a strong association between NI-RADS score and loco-regional disease status and is recommended as a part of post treatment response assessment FDG PET/CT in head and neck cancers.

SSA19-05 Inter-Radiologist Reliability of NI-RADS on Post-Treatment PET/CECT in Head and Neck Squamous Cell Carcinoma

Sunday, Dec. 1 11:25AM - 11:35AM Room: S404AB

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PURPOSE

The Neck Imaging Reporting and Data System (NI-RADS) was developed as a standardized reporting template for head and neck squamous cell carcinoma (HNSCC) surveillance. Previous studies have demonstrated the utility of FDG-PET/contrast-enhanced CT (PET/CECT). A NI-RADS category between 1 and 4 is assigned to the primary tumor and nodal site independently to convey the degree of suspicion for disease as well as provide management recommendations. Our purpose was to evaluate the inter-rater reliability among radiologists examining posttreatment HNSCC PET/CECTs using NI-RADS.

METHOD AND MATERIALS

Eighty HNSCC patient cases were uploaded to the American College of Radiology Cortex, with pre- and posttreatment PET/CECT studies. All images were scrubbed of all identifying information prior to upload. Each case provided a brief history of the patient, including age, sex, location of primary, staging, treatment, and timing of scan. Eight radiologists (5 neuroradiologists specialized in H&N, 1 general neuroradiologist and 2 neuroradiology fellows) independently evaluated each case and answered 4 multiple choice questions regarding the radiologic appearance of any primary or nodal disease and its associated NI-RADS category. Intraclass correlation coefficients (ICC) were calculated to assess inter-rater agreement.

RESULTS

The overall ICC for all readers for the primary site NI-RADS score (NS) was 0.58 (95% CI = 0.50 - 0.67) and for the nodal site NS was 0.65 (95% CI = 0.55 - 0.74). Among subspecialist readers, the ICC for the primary site NS was 0.61, and for the nodal site NS was 0.62. Non-specialists had an ICC of 0.55 for the primary site NS and 0.72 for the nodal site NS. The maximum pairwise kappa value was achieved between two specialist readers from different institutions who had never trained together, with an ICC of 0.72 for the primary site NS.

CONCLUSION

There was moderate agreement among the eight radiologists using NI-RADS in posttreatment HNSCC surveillance imaging. Disagreement among raters highlights the importance of training and standardization in the interpretation of post-treatment head and neck cancer surveillance imaging.

CLINICAL RELEVANCE/APPLICATION

This is the first study to examine the inter-rater reliability of NI-RADS, a standardized reporting template used in posttreatment HNSCC surveillance PET/CECTs.

SSA19-06 Implementing ACR-TIRADS to Improve Thyroid Nodule Reporting and Management

Sunday, Dec. 1 11:35AM - 11:45AM Room: S404AB

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PURPOSE

The ACR Thyroid Imaging Reporting and Data System (TIRADS) was recently indroduced in 2017 as a white paper in order to standardize the reporting of thyroid nodules. The purpose of this project was to implement ACR TIRADS at a regional medical system and evaluate thyroid ultrasound reporting before and after implementation with the goal of improving the consistency of nodule descriptor usage to aid in giving reffering providers an appropriate recommendation for follow-up. Another goal was to decrease the number of unesessary fine needle aspirations.

RESULTS

During 2017, 200 thyroid ultrasound studies were perfomed. Of these, 140 demonstrated one or more nodules. The TIRADS descriptors addressing nodule composition, echogenic foci, margin, and shape were only utilized 14-34% of the time. Echogenicity was used as a descriptor 90% of the time. Level of suspicion regarding regarding these thyroid nodules (i.e. benign or mildly/moderate/highly suspicious) was only utilized in a total of 12% of the reports. Recommendations for management including fine needle aspiration (FNA), surveillance, or benign/no further imaging was given 61%, 24%, and 9% of the time respectively. 6% of the studies with nodules were given no recommendation. 40 FNAs were performed (47% of recommended FNAs). A total of 9 biopsy-proven cancers were detected, representing 10.5% of all recommended FNAs and 22.5% of FNAs performed. During the 6 month study period following formal TIRADS reporting implementation, 103 Thyroid ultrasounds were performed. Of these, 77 demonstrated one or more nodules. 4 of the TIRADS descriptors (echogenicity, composition, echogenic foci, and margin) were utilized in 86-100% thyroid ultrasound reports. Shape was mentioned in 78% of studies, increased from 14%. Level of suspicion regarding regarding these thyroid nodules (i.e. not/mildly//highly suspicious) was utilized in a total of 19% of the studies. Recommendations for management including FNA, surveillance, or benign/no further imaging was given for 35%, 34%, and 18% respectively. 10% of the studies with nodules were given no recommendation. 12 of the recommended FNAs were performed (44% of recommended FNAs). A total of 2 biopsy or thyroidectomy-proven cancers were detected, representing 7.4% of all recommended FNAs and 16.7% of FNAs performed.

CONCLUSION

The implementation of ACR-TIRADS resulted in an improved consistency of thyroid nodule description with an overall decrease in the number of recommended FNAs. This shows that by having a system to help radiologists stratify nodule risk based on a set parameter of characteristics, more appropriate recommendations can be made to guide referring providers. A limitation to our follow-up data collection resulted from patients being lost to follow-up or following-up outside our hospital system and is a possible explanation for the low percentage of recommended biopsies being perfomed. Additional limitations included adoption of the new reporting style to some of the senior attending radiologists and the frustration some reffering providers voiced due to the increased length of the reports. The senior radiologists eventually adapted to the new style and began using it more regularly. Following the study period of TIRADS implementation, the TIRADS templates have been further revised to increase ease of interpretation for our referring clinicians while maintaining the consistency of TIRADS usage.

METHODS

Thyroid ultrasound reports for exams completed before the implementation of TIRADS reporting at the participating institution were reviewed for use of TIRADS nomenclature from 1/1/2017-12/31/2017. A standardized TIRADs template was created for the participating radiologists to ensure accurate, consistent, and appropriate use of TIRADS descriptors and recommendations post implementation from 4/1/2018-9/30/2018. Additionally, a TIRADS worksheet was developed for participating ultrasonographers, and these ultrasonographers were educated in the purpose and usage of the TIRADS criteria. Comparison was made between pre and post implementation usage of the 5 TIRADS nodule descriptors and follow-up recommendations. The hospital EMR was used to obtain information on patient follow-up and mangement by the reffering provider.

SSA19-07 Effect of Ti-Rads Standardized Reporting Calculator on Radiologist Report Consistency and Recommendation for Thyroid Nodules Management

Sunday, Dec. 1 11:45AM - 11:55AM Room: S404AB

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PURPOSE

Thyroid nodules are a common imaging finding. Though the majority of are benign, there is overlap in the imaging appearance of benign and malignant nodules. Various systems have been published to guide radiologists for their appropriate management; till recently our practice utilized the 2015 American Thyroid Association (ATA) guidelines for this purpose. Though helpful, the use of this system as inconsistent, with anecdotally high biopsy recommendation rates and an inability to classify some nodules making it difficult to provide specific recommendations. We recently adopted the American College of Radiology (ACR) Thyroid Imaging, Reporting, and Data System (TI-RADS), a newly-developed standardized system employed to unify lexicon and management recommendations for the ultrasound evaluation of thyroid nodules. In addition, a web-based calculator (Figure 1) that standardizes language, tallies scores and generates recommendations was implemented to streamline reporting and ease utilization of this system. The purpose of this project was to report effects of radiologists' adherence to and reported recommendations before and after the adoption of ACR TI-RADS criteria at a large, multi-site academic practice.

RESULTS

We reviewed the data for radiologist adherence to the department approved recommendations (ATA vs TI-RADS), the rate of providing specific recommendations and compared the specific recommendations provided (biopsy vs follow-up vs no follow-up) before and after TIRADS adoption. Brief demographics of the final database were: 1651 studies with 2017 individual nodules. Of the 1651 patients, 1234 were female, comprising 75.7% of cases. Our outcomes were that 10.8% of nodules evaluated by TI-RADS were reported without a recommendation compared to 48.7% of nodules that used ATA and 63.8% that used No Scoring System (Table 1). With our intervention, the rate for appropriate recommendations was 86.1% for TI-RADS, 44.3% for ATA and 30.3% for when No Scoring system was utilized (Table 2).

CONCLUSION

The aim of the study was to implement TI-RADS as the departmental standard guideline for assessment of thyroid nodules on ultrasound to improve standardized reporting, guideline adherence, and the rate of providing actionable recommendations for reported thyroid nodules. Standardization in reporting lexicon and management recommendations was more prevalent when a radiologist was using TI-RADS along with a web based calculator. 10.8% of nodules evaluated by TI-RADS were reported without a recommendation compared to 48.7% of nodules for ATA and 63.8% with No Scoring System, 37.9% less than the next closest system. In addition, based on our intervention, an increase in the reporting of appropriate management was significant for the TI-RADS scoring system compared to ATA and No Scoring System as it was 41.8% more than the next closest system. By having definitive recommendations established and consistent reporting of these recommendations, future patient care decisions can be made much more quickly and consistently, probably resulting in improved patient outcomes.

METHODS

Prior to its adoption, TI-RADS was internally reviewed by key radiology leaders and referring specialists including surgical endocrinology, discussed in department wide educational meetings including a journal clubs. The web-based calculator was created to streamline reporting, with a link embedded in the reporting templates. A "go-live" date was announced, at which point the system reporting templates were changed over to the new application. A power analysis was done with the basis on a change of yield of malignancy from 10 to 14%. It was concluded a minimum of 200 cases were needed before and after the "go-live" date. To determine the effectiveness, data for all US Thyroid, Neck and Soft Tissue and FNA report narratives was extracted. These 6283 cases were then semi-automatically parsed for Thyroid cases (non-procedural) using keyword identification within our structured reports, resulting in 1651 examinations. These exams were then manually reviewed and relevant data (patient and imaging) were recorded. We assessed adherence to utilizing the standard guidelines, whether a specific recommendation was made: either biopsy, follow up, or no follow up needed and if it was appropriate.

SSA19-08 Participants

Modified SHIN Classification for Grading Trachea Invasion on CT Imaging: Addressing the Resectability Issues in Thyroid Cancer

Sunday, Dec. 1 11:55AM - 12:05PM Room: S404AB

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PURPOSE

Evaluate the diagnostic value CT based modified SHIN Classification adapted from pathological SHIN grading for preoperative prediction of Tracheal invasion (TI) in patients with papillary thyroid cancer (PTC).

METHOD AND MATERIALS

Retrospective study from Jan 2012 to Dec 2016, 104 PTC patients who underwent total thyroidectomy were analysed. Preoperative CT were performed in all. TI was categorised based on contact of tumour with trachea on CT imaging. Grades of CT based SHIN Classification: I: disease abuts not invading external perichondrium. II: disease invades into the cartilage +/- destruction. III: disease extends into the tracheal mucosa with no elevation/penetration of mucosa. IV: disease is full-thickness invasion with expansion of the tracheal mucosa with a bulge. Other imaging features were: Angle of contact: grade I:0-89; II 90-179; III:180-269; IV:>270 Shape Score: I: horseshoe, elliptical, circular configuration; II: locally straightened wall; III: inward concave deformity. Grade of enhancement: None, similar, hyperenhancement Considering histopathology as the gold standard diagnostic performance of CT imaging for predicting TI.

RESULTS

84 patients (19 men, 65 women), 97 lesions (one tumor in 71 patients and two tumors in 13 patients). Mean maximum axial diameter of lesions was 3.5 ± 1.5 cm (one SD), ranging from 1.1 to 8.4 cm.CT based SHIN categories I- 39%, II- 25%, III- 21% and IV- 15%. More than 130-degree contact with trachea, soft tissue within the cartilage and score III shape were strong predictor of TI (P value < 0.05). Of the three factors, soft tissue in the cartilage was most accurate, 88% accuracy with 79% sensitivity. Intraluminal mass showed 100% specificity, the sensitivity was low 28%. SHIN showed good accuracy 93% with upwards of 90% sensitivity and specificity. Modified shin classification combined had a 96% accuracy.

CONCLUSION

CT based Modified SHIN classification has a very high negative predictive value for predicting TI and can help optimizing postoperative outcomes with efficient preoperative assessment.

CLINICAL RELEVANCE/APPLICATION

Presence Tracheal invasion (TI) alters the management plan. extensive local resection can improve survival rate and reduce local recurrence Vs. near-total tumor excision with adjuvant treatment has survival rate similar to that obtained with extensive resection Hence, assessment of extent of TI with pre-op imaging is crucial in appropriate treatment planning.

Printed on: 10/29/20

SSA20

Physics (Radiation Dose - Radiography/Fluoroscopy)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E351

PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Adam S. Wang, PhD, Baltimore, MD (*Moderator*) Research support, General Electric Company; Research support, Siemens AG; Research collaboration, Varex Imaging Corporation; Stockholder, Varian Medical Systems, Inc

Sub-Events

SSA20-01 Cohort Study of Patients Receiving Substantial Cumulative Doses from Fluoroscopically-Guided Interventional Medical Procedures Over 9 Years

Sunday, Dec. 1 10:45AM - 10:55AM Room: E351

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PURPOSE

Fluoroscopically-guided interventional (FGI) procedures deliver the highest radiation dose among all imaging procedures. This study is to explore the medical conditions of patients receiving 1-year cumulative Ka,r (air kerma at the reference point) >= 5 Gy or effective dose >= 100 mSv from FGI procedures over 9 years.

METHOD AND MATERIALS

With IRB approval, this retrospective study examined 25253 patients (average age 58.2±17.0 years, 50.6% male) who underwent 46491 FGI procedures at a tertiary referral center from January 2010 to January 2019. Data was retrieved from an in-house semiautomated dose tracking system by setting the above dose thresholds. Identified patients were characterized by medical conditions documented in longitudinal medical records. Statistical software (R, version 3.5.1) was used to determine 5 percentiles (10th, 25th, 50th, 75th, 95th) and interquartile range (IQR) of age and dose distributions.

RESULTS

Among 411 (1.6%) patients (68.6% male) with 1-year cumulative Ka,r>=5 Gy, median number of FGI procedures was 3 (range 1-34), median age at the first procedure was 59 (IQR 48-68) years, median value of 1-year cumulative Ka,r was 7047 (IQR 5755-9066) mGy, and median effective dose was 260 (IQR 142-369) mSv. Among1011 (4.0%) patients (69.6% male) with effective dose>=100 mSv, median number of FGI procedures was 2 (range 1-38), median age at the first procedure was 60 (IQR 51-69) years, median value of 1-year cumulative Ka,r was 3899 (IQR 2785-5727) mGy, and median effective dose was 177 (IQR 132-261) mSv. Patient medical conditions included trauma, stroke/brain aneurysm, medical bleeding in torso, organ transplant, cancer, benign tumor, and chronic disease. Five of 22 patients with 1-year cumulative Ka,r>=15 Gy deceased as of March 2019.

CONCLUSION

This is a first cohort study of patients receiving substantial cumulative doses from FGI procedures over a long period, revealing the use of substantial dose in the critical care of a sizeable fraction of patients under serious medical conditions. The provided cumulative dose distributions can serve purpose for dose management.

CLINICAL RELEVANCE/APPLICATION

X-ray fluoroscopy guidance can save lives in urgent or critical care of patients under serious medical conditions, and the care of 1.6%-4.0% patients may use substantial dose (1-year cumulative Ka,r>=5 Gy, or effective dose>=100 mSv).

SSA20-02 Source of Errors in Indirect Fluoroscopy Skin Dose Estimation and Peak Skin Dose Position

Sunday, Dec. 1 10:55AM - 11:05AM Room: E351

Participants
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PURPOSE

There has been an increasing shift to using dose monitoring software for tracking skin exposure during fluoroscopically-guided interventions. It was reported that indirect skin dosimetry is unlikely to be more accurate than +/-50%, while others reported that compared to direct measurements, the error can be within +/-20%. This study is to identify the source of errors and demonstrate their potential influence on the accuracy of indirect dose estimation.

METHOD AND MATERIALS

We analyzed available indirect skin dose methods using varying levels of procedural details in the patient protocol and identified potential source of errors, including but not limited to gantry angle, source-surface-distance (SSD), table-pad attenuation, and backscatter. Simple algebraic approach was applied to analyze the effects of those such as distance and attenuation, while Monte Carlo was used to simulate the effects of gantry angles (primary & secondary) combing with various field of view (FOV). We also did direct distance and attenuation measurements from a Philips Allura Xper FD10 for quantitative analysis.

RESULTS

Gantry angle shows the largest impact on the magnitude and position of peak skin dose (PSD). Simulation shows that PSD location shifts ~18cm from center with the gantry angle from 0° to 50°, independent of FOV. The ratio of PSD to reference air kerma increases from 1.2 to 1.6 (for gantry angle 0°) and from 1.38 to 1.90 (for gantry angle 40°), with the increased FOV from 5 cm to 40 cm. Both the magnitude and position of PSD with gantry angle show non-linear relationship, which increases the difficulty to accurately estimate skin dose. The simple SSD increase due to the use of the pad (in general not considered) may add up to 18% error in dose, based on its thickness and patient weight. The ratio of the exposure with pad-table to air kerma varies up to 15% as kV increase from 50 to 120 kV due to attenuation, plus about 20% backscatter changes (depending on FOV) due to increased beam energy. The use of an additional Cu filter will aggravate the results, i.e., an additional 0.2mm Cu filter can add ~5% more error in PSD estimate. .

CONCLUSION

Understanding the source of errors in indirect skin dose estimates will improve accuracy of the PSD estimation which determines notification level.

CLINICAL RELEVANCE/APPLICATION

Improving the accuracy of PSD estimation can potentially reduce unnecessary notifications or avoid missing notifications.

SSA20-03 Comparison and Image Evaluation of Mini C-Arm Fluoroscopy System Based on Cold Cathode and Hot Cathode

Sunday, Dec. 1 11:05AM - 11:15AM Room: E351

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PURPOSE

In this study, we qualitatively and quantitatively compared and analyzed the X-ray images obtained from the carbon nanotube (CNT) based cold cathode and tungsten based hot cathode ceramic tubes integrated together in mini C-arm fluoroscopy system.

METHOD AND MATERIALS

A commercialized portable type mini C-arm fluoroscopy system (figure a) was constructed with sealed ceramic type cold cathode and hot cathode X-ray tubes (figure c) and a flat panel detector (RAD icon, 0889, Teledyne Rad-icon Imaging Corp., CA, USA). We developed the CNT emitter and the brazed X-ray tubes at our own lab which can work at high anode voltage without arcing. We demonstrated the superiority of CNT based cold cathode (figure e) X-ray sources over thermionic (figure d) counterpart in terms of producing high resolution X-ray images, pulse based active control switching and quantity of radiation dose. X-ray images of alive rat (figure f) and resolution phantom was taken to compare and evaluate the images from both X-ray sources. Herceptin drug was inserted into a live rat to produce cancer cells and detect it through X-ray images from different sources. Imaging was done at various pulses to evaluate the efficiency of converting the digital signals for switching and calculate the radiation dose.

RESULTS

CNT based cold cathode X-ray source showed the 20% less radiation to produce the same quality image with the same exposure time. Cold cathode source had 40% smaller focal spot size compared to hot counterpart. The response to digital pulses was 3 times faster in CNT based cold cathode than hot cathode X-ray sources. Finally, the X-ray images obtained at 80 kV with 1mA anode current exposed, the optimal voltage to take high quality image of rat to detect cancer cells from normal tissue.

CONCLUSION

CNT based cold cathode source in Mini C-arm fluoroscopy system showed better functions, superior quality X-ray Image and safer (reduced radiation dose) compared to the hot cathode X-ray source.

CLINICAL RELEVANCE/APPLICATION

Imaging quality can be greatly improved by CNT based cold cathode source with lower radiation dose and greatly improved the imaging techniques by integrating the digital signals.

SSA20-04 The Effect on the Scattered Radiation Distribution of Moving the Centerline of the Patient Lateral to the X-Ray Beam Isocenter During Fluoroscopic Procedures

Sunday, Dec. 1 11:15AM - 11:25AM Room: E351

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PURPOSE

The scattered radiation from the patient reaching the interventionalist changes as the patient table is moved left and right of the c-arm gantry isocenter. This study investigates and quantifies the change in the scattered radiation dose distribution as the patient is moved laterally.

METHOD AND MATERIALS

EGSnrc (DOSXYZnrc) Monte-Carlo software was used to calculate the scattered radiation distribution around the Zubal anthropomorphic computational phantom of an average adult male for beams imaging the head, the chest and the abdominal regions. The distributions were calculated as a function of the lateral shift of the phantom from the c-arm isocenter for x-ray beams with different gantry angulation. All comparisons were made with the same exposure factors and each MC simulation used 3E9 primary beam photon histories.

RESULTS

For staff at a fixed distance from the isocenter, the scatter was generally reduced as the patient was moved toward the staff, since in this case the body attenuates more of the scatter, and it conversely increased as the patient is moved away from the staff. The percent differences from the centered patient when averaged over distance from the floor with a PA projection for staff on the right side were: Head, 2.4 cm shift to left, 48% increase; 2.4 cm shift to right, 37% decrease; Chest, 5 cm shift to left, 133% increase; 5 cm shift to right, 54% decrease; Abdomen, 2.5 cm shift to left, 127% increase; 2.5 cm shift to right 47% decrease. The change in scatter with shift for different LAO/RAO and CRA/CAU angles was similar. For zero degrees RAO/LAO chest projections with the patient centered, the scattered dose on the left side was lower than the right side due to differences in internal organ attenuation.

CONCLUSION

During Interventional procedures, only small table lateral movement can substantially impact the scattered dose to the staff in the room. Such changes in scatter is dependent on height from the floor and will have an effect which is dependent on where the staff is located in the room. The information from this study provides a better understanding of the changes in scattered dose distribution and facilitates improved staff dose management.

CLINICAL RELEVANCE/APPLICATION

The position of the x-ray beam relative to the patient centerline has a substantial effect on the room scatter distribution and this information can help staff manage their dose.

SSA20-05 Radiation Doses to Patients from Fluoroscopically-Guided Liver Procedures

Sunday, Dec. 1 11:25AM - 11:35AM Room: E351

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PURPOSE

To present procedure-specific distributions of air kerma at the reference point (Ka,r) and effective dose for fluoroscopically-guided liver procedures.

METHOD AND MATERIALS

With IRB approval, this retrospective study included 1090 consecutive liver cases (61.6% male) performed from May 2016 to October 2018 in adults. Patient age at the procedure time was 60.8±13.0 years for the men (median 63 years, range 22-93 years, 17.4% in 22-50 years) and 58.7±15.3 years for the women (median 62 years, range 20-90 years, 27.4% in 20-50 years). Ka,r and dose-area product (KAP) were retrieved from an in-house semiautomated dose monitoring system. Effective dose was calculated using KAP and a conversion coefficient [0.26 mSv/(Gy.cm2)] from NCRP Report No. 160. Statistical software (R, version 3.5.1) was used to determine 5 percentiles (10th, 25th, 50th, 75th, 95th) for 9 procedures - endovascular liver biopsy, transjugular intrahepatic portosystemic shunt (TIPS) creation, TIPS revision, pre-selective internal radiation therapy (SIRT), SIRT, hepatic artery embolization, transarterial chemoembolization, portogram, and portal vein embolization.

RESULTS

Number of procedures was 239, 120, 79, 184, 187, 37, 186, 32 and 26; Median Ka,r was 102, 886, 317, 615, 245, 1202, 907, 502 and 1009 mGy; median effective dose was 5.44, 56.1, 19.1, 37.2, 13.3, 48.1, 49.7, 26.9 and 47.1 mSv; ultrasound guidance usage was 99.6%, 97.5%, 91.1%, 17.4%, 19.3%, 56.8%, 22.0%, 87.5% and 96.2% for 9 procedures (in the above order), respectively. Among all cases, the lowest Ka,r was 8 mGy for a male (age 63 years, weight 73 kg) from endovascular liver biopsy under both ultrasound guidance and x-ray fluoroscopic guidance. The highest Ka,r was 11121 mGy for a male (age 65 years, weight 79 kg) from hepatic artery embolization. Effective dose range was 0.4-303 mSv.

CONCLUSION

In interventional liver procedures, ultrasound guidance is used when feasible to reduce patient dose. This is a first study to provide both Ka,r and effective dose for comprehensive liver procedures under fluoroscopy and/or ultrasound guidance.

CLINICAL RELEVANCE/APPLICATION

With the Joint Commission's standard of fluoroscopy dose review, 5 percentiles of Ka,r and effective dose provided in this study for 9 liver procedures can be used to set baselines in dose management.

SSA20-06 Radiation Exposure to Pediatric Patients and Staff During Retrograde Wedge Portography

Sunday, Dec. 1 11:35AM - 11:45AM Room: E351

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PURPOSE

Most recent surgical procedures such as the meso-Rex bypass shunt requires wedged hepatic venous portography via the transjugular approach for the assessment of the surgical patient. Retrograde Wedge Portography (RWP) is an interventional procedures performed on patients with portal vein cavernoma in cases where the Rex Recessus is not well delineated with the other non-invasive imaging techniques. Usually staff radiation doses during pediatric interventional procedures are associated with a lower occupational radiation risk because the patients are small. However patient radiation doses may be high particularly when the abdominal region is involved; pediatric procedures require the operators to be physically close and, as when transjugular approach occurs, it is often not possible to use protective screens and some more complex case also can result in a longer fluoroscopic time. These can result in increased operator doses. It is well known that a good radiation protection program in daily practice for all procedures reduces radiation risks to patients and staff and electronic dosimeters have proven to be useful for optimization purposes, for studies of radiation exposure by type of procedure or for specific aspects of a procedure. Our study aim is to provide data on radiation exposure to pediatric patients undergoing RWP and effective dose (E) of each operator performing them in a single center using a pediatric adjusted fluoroscopy protocoln in a flat-panel detector based system (FPDS).

RESULTS

Tube voltage range was 60-84 kV; Tube current range was 0.1-9.5 mA; Spectral filtration was 0.3 mmCU. Patients: mean DAP was 11.2±12.9Gy*cm2 (3rd quartile 11.9Gy*cm2); mean KA was 0.16±0.09Gy (3rd quartile 0.2Gy); mean FT was 357±181sec (3rd quartile 420sec). Staff: mean E for the radiologist was 0.50±0.46μSv (3rd quartile 0.75μSv); for the radiographer 0.12±0.11μSv (3rd quartile 0.18μSv); for the anesthesia nurse 0.08±0.17μSv (3rd quartile 0.03μSv). Figure 1 shows the mean E for all operators. Figure 2 shows the operators' positions within the angiosuite during hepatic RWP.

CONCLUSION

In conclusion, this study demonstrated that the radiation doses to the operators in RWP can be very low, remaining well within limits established by the ICRP. The difference in dose among all operators, is related to their position within the angiosuite in relation to the angiographic equipment. Operators performing RWP should be aware of the potential high radiation exposure for themselves and for patients too. Good radiation protection policies and training are necessary in interventional radiology to reduce radiation risks to both patients and staff. No other data about radiation exposure to pediatric patients and staff performing RWP are in the available literature to compare our results. However, in our experience, close liaison between radiologist and radiographer allowed us to vary technical parameters and to select a different fluoroscopy protocol from the pre-set provided by the manufacturer. Although this may have resulted in a small variation in image quality, procedures included in this study were performed safely. New technologies and in-depth knowledge of angiographic equipment can help us to achieve a low radiation dose to patients and staff according to the RWP procedure complexity.

METHODS

Between September 2016 and December 2018, 19 consecutive RWP were performed on 19 children (mean age 7±5 years, 3rd quartile 11.5 years). Two Radiologist, six radiographers and six anesthesia nurses were involved in this study. A pediatric fluoroscopy protocol optimized to produce high contrast images using 50% as threshold dose with modified parameters adjusted on

pediatric patients, 7.5 frame/sec and low image detail level was routinely employed. Magnification and normal image detail level was only used when absolutely necessary in technically challenging cases. Digital Subtraction Angiographic acquisition (DSA) was used during which all operators left the angiographic suite and went into the control room while images were acquired. Electronic personal dosimeters, placed outside the lead apron at the left upper chest position, were used to measure radiation doses to radiologist, anesthesia nurse and radiographer. Due to the transjugular access, no additional shielding was used for the interventional radiologist. The Hp(10), the personal dose equivalent at a depth of 10 mm of tissue, registered by the detectors at the end of every procedure was systematically recorded. Effective operator dose (E) was then calculated using a modified Niklason algorithm, by multiplying the Hp(10) value by 0.03, and given in µSv. Patients' radiation exposure was measured with Dose Area Product (DAP) and fluoroscopy time (FT). Descriptive statistics (mean ± SD and third quartile) of the dose area product (DAP, given in Gy*cm2), air kerma (KA, given in Gy) and fluoroscopy time (FT, given in seconds) for each procedure were recorded

SSA20-07 Clinical Evaluation of a Dose Management System-Integrated 3D Skin Dose Map by Comparison with XR-RV3 Gafchromic® Films

Sunday, Dec. 1 11:45AM - 11:55AM Room: E351

Participants
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PURPOSE

Validate the performance of peak skin dose (PSD) and skin dose map (SDM) estimation from a radiation dose management system (RDMS) (DoseWatch™, GE Healthcare) versus the gold standard of XR-RV3 Gafchromic film in interventional vascular and cardiology procedures.

METHOD AND MATERIALS

The study was conducted on a total of 38 cardiac procedures and 60 vascular embolizations between June 2018 to March 2019 on three Philips systems (two Allura Xper FD10 and one Allura Xper FD20). 'Ground truth' PSD measurements (PSDFilm) and spatial dose distributions were obtained from XR-RV3 Gafchromic film, positioned underneath patients' backs for each procedure. These were compared against PSDRDMS and SDMRDMS estimates provided by the dose management system using a triangle mesh of 0.055cm² resolution on ICRP 110 anthropomorphic phantoms, as well as on a planar phantom with a square ROI of 1cm². The RDMS used Radiation Dose Structured Report (RDSR) data to model exposure events, calculating PSD following the methodology described by K. Jones, et al. Statistical analyses were carried out to compare PSDFilm and PSDRDMS.

RESULTS

Preliminary results show that the PSDFilm median (1st quartile; 3rd quartile) was 0.573(0.411; 0.981) Gy for vascular procedures and 0.443(0.297; 0.700) Gy for cardiac procedures. For a flat phantom, the PSDRDMS was 0.553(0.375; 1.031) Gy for vascular procedures and 0.467 (0.311; 0.708) Gy for cardiac procedures, and 0.583(0.388; 1.097) Gy and 0.440 (0.305; 0.750) Gy for anthropomorphic phantom, respectively. For both phantoms, the correlation between PSDFilm and PSDRDMS was strong. For vascular procedures, the mean deviation between PSDFilm and PSDRDMS was 1 ± 16% for flat phantom and 2% ± 19% for anthropomorphic phantom and 5 ± 19% and 2 ± 18% for cardiac procedures, respectively. Dose map representations matched for most patients. Gaps identified are related to the table displacement during fluoroscopy events and the use of a wedge filter.

CONCLUSION

The results found in this patient study show that SDM tool is a suitable alternative to Gafchromic® film to calculate PSD and visualize the skin dose distribution.

CLINICAL RELEVANCE/APPLICATION

The RDMS tool can be used routinely to compute the PSD for all patients with an accuracy close to the one of Gafchromic films, effectively reducing costs and complexity of patient follow-up

SSA20-08 Radiation Dose Audit for Fluoroscopy Procedures Performed with Mobile C-Arms or Performed in Radiography/Fluoroscopy (R/F) Suites: Data From a Tertiary and Quaternary Care Hospital

Sunday, Dec. 1 11:55AM - 12:05PM Room: E351

Participants
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CONCLUSION

Data indicates that with mobile C-Arms or R/F suite, radiation utilization for routine procedures is an order of magnitude lower relative to threshold radiation dose values recommended for patient follow-up. Monitoring such low radiation dose values may not be optimal use of healthcare resources. Alternately, evidence-based exemption should be granted from the requirement of tracking

fluoroscopy doses for such low dose procedures.

Background

Accreditation agencies necessitate documenting radiation doses for fluoroscopy procedures. Our hypothesis was that procedures performed with mobile C-Arms or in R/F suites utilize radiation dose levels considerably below the recommended threshold for patient follow-up based on possibility of tissue reactions.

Evaluation

IRB waiver was obtained. All fluoroscopy procedures performed with any one of the 14 mobile C-Arms (GE:OECs, Philips:Veradius, Ziehm:Vision-R) or in an R/F suite (Siemens:Axiom-Iconos-200) from July-2017 till June-2018 were reviewed. Mobile C-Arms were used for surgical, orthopedic, pain-management, gastroenterology and urology procedures. All cases with system-reported cumulative air kerma (CAK) were included in the study. Descriptive statistics were computed from this data-set to characterize radiation utilization.

Discussion

Data from 1122 cases were included (53% female/47% male; age:53.9±17.9years; BMI:28.4±6.7). The mean (±standard deviation) and median CAK values for radiology procedures (n=102; e.g., arthrograms, aspirations, etc.) performed with mobile C-Arms were 16.5(±54.4)mGy and 2.39mGy, respectively. For surgical procedures performed in the operating room (n=549) the mean and median CAK values were 36.8(±79.6)mGy and 11.4mGy, respectively. Mean and median CAK values were 65.2(±90.2)mGy and 32.7mGy for gastroenterology procedures (n=98), 16.1(±14.6)mGy and 12.4mGy for urology procedures (n=24), and 46.3(±84.0)mGy and 28.8mGy for pain-management procedures (n=146) performed in neurosurgery department. For procedures performed in the R/F suite (n=203), the mean and median CAK values were 168.2(±262.1)mGy and 72.6mGy. Depending upon the type of procedure, the mean fluoroscopy time ranged from 71 to 497 secs.

SSA20-09 Experimental Validation of Calculated Skin Dose Variation with Incident X-Ray Beam Angle

Sunday, Dec. 1 12:05PM - 12:15PM Room: E351

Participants
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PURPOSE

The incident angle of the x-ray beam on the patient's skin varies during fluoroscopically-guided procedures and accurate estimation of skin dose is important to evaluate the risk of deterministic skin effects. Radiochromic film measurements of skin dose were made as a function of the angle of x-ray beam incidence on a phantom to validate the results of Monte-Carlo calculations.

METHOD AND MATERIALS

To estimate the dose to the skin, a sheet of Gaf-chromic XR-QA2 film was placed on the surface of a 30 cm x 30 cm block of solid water 20 cm thick. To simulate the attenuation of the overlying epidermis, a 1.25 mm thick sheet of PMMA, which is equivalent to 1.5 mm water, was placed over the film. The primary and the scatter dose was measured for incident angles from 90 to 10 degrees at 80 kVp for a field size of 10 cm x 10 cm and the primary entrance air kerma was measured without the phantom. EGSnrc Monte-Carlo (MC) software was used to calculate the skin dose as a function of incident x-ray beam angle for different beam energies and different field sizes. The incident primary dose was calculated in air at the field center and the primary and scatter dose was calculated averaged over various thicknesses of 'skin' to determine the effect on primary attenuation and scatter. All MC simulations used 5x1010 photons incident on the phantom.

RESULTS

The measured skin dose agreed with that calculated by MC with an average difference of about 3 percent over the angular range from 90 to 10 degrees. Both calculated and measured skin dose values decreased with decreasing angle of incidence due primarily to the increased path length and thus increased attenuation of the primary x-rays. In both cases, the total scatter plus primary decreased to about 40% of the primary at an angle of 10 degrees at 80 kVp.

CONCLUSION

Good agreement was obtained between the measured and calculated variation of skin dose with angle of incidence. The skin dose decreases substantially with decreasing incident angle and thus correction factors for angle of incidence should be applied when estimating skin dose for fluoroscopically-guided procedures.

CLINICAL RELEVANCE/APPLICATION

Radiochromic film measurements verified the skin dose dependence on incident angle as calculated with Monte Carlo software so skin dose from fluoroscopic procedures can be more accurately estimated.

SSA21

Physics (CT New Techniques/Systems)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E353B

CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSA21-01 A Dynamic Numerical Brain Simulation Model for CT Perfusion Optimization

Sunday, Dec. 1 10:45AM - 10:55AM Room: E353B

Participants
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Norbert J. Pelc, DSc, Stanford, CA (*Abstract Co-Author*) Research support, General Electric Company Consultant, General Electric Company Consultant, NanoX Scientific Advisory Board, RefleXion Medical Inc Scientific Advisory Board, Prismatic Sensors AB Medical Advisory Board, OurCrowd, LP Scientific Advisory Board, Izotropic, Inc Stockholder, Izotropic, Inc

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PURPOSE

Recent research to extend the time window of thrombectomy for ischemic stroke has led to a growing need to understand and optimize the accuracy of CT perfusion (CTP) imaging. This work expands the XCAT brain phantom to model regional physiology and contrast agent kinetics for use in simulating and optimizing CTP studies.

METHOD AND MATERIALS

To enable spatially varying enhancement, the existing 3D NURBS vessels and brain regions were subdivided into smaller volumes. Brain tissue was divided using a physics and constraint solver to generate a 1:1 mapping between the terminal arteries (those without any subsequent branches in the vessel tree) and brain regions fed by each branch. Utilizing the region volume and prescribed tissue perfusion parameters, the flow required by each region is calculated. This determines the flow supplied by the feeding arterial branch and upstream arteries in the vessel tree. Once the flow is determined, the regional contrast agent concentration curves are calculated by propagating the input enhancement curve through the arteries, into the tissue, and drained to the veins. Projections of each dynamic object are simulated for a given acquisition geometry and protocol with CatSim, a CT system simulator. Using the calculated concentration curves, each projection is scaled to have the desired enhancement. The individual scaled projections are then combined to generate and reconstruct the image at each timepoint.

RESULTS

The updated brain phantom contains 78 gray matter regions, 117 white matter regions, 240 vein segments, and 400 artery segments. The framework enables structure specific contrast enhancement as a function of time with flow rates determined from first principles. By identifying individual tissue regions as healthy, ischemic, or infarcted, the model automatically updates the flow in the vasculature to simulate stroke physiology. The flow model combined with a CT simulator generates CTP images compatible with commercially available post-processing software.

CONCLUSION

We have incorporated methods to model the flow physiology of stroke cases to CTP simulations. This work will enable the quantitative assessment of CTP imaging protocols and post-processing techniques.

CLINICAL RELEVANCE/APPLICATION

The validation and optimization of CT perfusion will improve diagnostic tools for stroke patients and increase physicians' ability to prescribe a plan of care driven by quantitative data.

SSA21-02 Evaluation of a Novel Artificial Intelligence Reconstruction Technology in Abdominal CT

Sunday, Dec. 1 10:55AM - 11:05AM Room: E353B

Participants
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PURPOSE

To test a new deep learning image reconstruction technique for abdominal CT.

METHOD AND MATERIALS

An anthropomorphic abdomen phantom designed for qualitative and quantitative image quality assessment was scanned on a GE Revolution CT at 120 kVp, dose levels 5, 10 and 15 mGy CTDIvol and 40 mm collimation. All scans were reconstructed with 2.5 mm slice thickness, standard kernel, FBP (ASIR-V 0) , iterative reconstruction (IR) ASIR-V 50, 70 and 90% and deep learning based reconstruction (DLIR) (TrueFidelityTM, GE Healthcare) low (L), medium (M) and high (H). Image quality was evaluated for all reconstruction techniques using noise power spectrum (NPS), Noise texture deviations (NTD), modulation transfer function (MTF), contrast to noise ratio (CNR) and image noise.

RESULTS

Preliminary results show that image noise was reduced for both IR and DLIR reconstruction compared to FBP for all dose levels and noise reduction was independent of dose. Also, image noise was on the same level for DLIR L and ASIR-V 50%, DLIR M and ASIR-V70% and DLIR H and ASIR-V 90%. However, the NPS peak frequency for all levels of DLIR reconstruction were higher than for the IR indicating less blotchiness and a finer image texture. Moreover, the NTD results indicated less artefacts using DLIR reconstruction (@5mGy: DLIR L/M/H ranges from 0.21-0.24 vs ASIR-V 50/70/ 90% 0.28-0.47, @10 mGy DLIR L/M/H ranges from 0.11-0.18 vs ASIR-V 50-90% 0.20-0.45, @15 mGy DLIR L/M/H ranges from 0.22-0.34 vs ASIR-V 50/70/ 90% 0.40-0.57). MTF @50% was at the same level independently of reconstruction techniques for all dose levels (3.5-3.8 @5mGy, 3.5-3.7 @10mGy, 3.79-3.89 @15mGy). CNR was improved using IR and DLIR reconstruction compared to FBP.

CONCLUSION

Both IR and the DLIR reconstruction techniques reduced image noise and improved image quality compared to FBP for all dose levels. In general, the DLIR reconstruction technique was superior to both FBP and IR reconstructions at all dose levels.

CLINICAL RELEVANCE/APPLICATION

New artificial intelligence reconstruction in CT improves image quality in abdominal CT; image texture, image noise, contrast noise ratio and artefact reduction.

SSA21-03 Low Noise, Thin-Slice Chest CT Imaging Using Prior Knowledge Aware Iterative Denoising

Sunday, Dec. 1 11:05AM - 11:15AM Room: E353B

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PURPOSE

The intrinsic trade-off between image noise and radiation dose hampers the adoption of thinner slice thicknesses for diagnostic tasks that could benefit from decreased volume averaging, such as chest CT. This work aimed to quantify the ability of prior-knowledge-aware iterative denoising (PKAID) to enable low-noise, thin-slice chest CT without increase radiation dose.

METHOD AND MATERIALS

PKAID exploits spatially redundant information along z-axis direction, using a prior image with a larger thickness to denoise a thinner-slice image. Phantom and patient studies were conducted to assess the performance of this technique. An anthropomorphic chest phantom was scanned on a 192-slice clinical CT system (Siemens Force). Images were reconstructed using a clinical kernel (Bv49) and 1024 matrix at two slice thicknesses (0.75/1.5 mm). The standard clinical image thickness (1.5 mm) was used as a prior by PKAID to process the 0.75 mm image. The modulation transfer function (MTF), slice sensitivity profile (SSP) and noise power spectra (NPS) were determined before and after PKAID. PKAID was applied to 3 patient cases and the image quality of critical anatomy and pathology was qualitatively assessed.

RESULTS

MTF and SSP showed that PKAID preserved in-plane and z-axis spatial resolution, maintaining the sharpness of 0.75 mm image. The shape of the NPS was preserved even though the amplitude was decreased, demonstrating that PKAID decreases image noise without altering noise texture. In patient cases, 0.75 mm PKAID images allowed better delineation of various pathologies compared to the clinical standard of 1.5 mm images, yet maintained the lower image noise level of the 1.5 mm images.

CONCLUSION

In this work, we demonstrate the ability to decrease image thickness in chest CT, without increasing image noise, by use of a technique that exploits spatial data redundancy in the z-axis direction to reduce image noise. Phantom and in vivo results showed that this technique preserved the spatial resolution and noise texture of 0.75-mm thick chest CT images while reducing the image noise to that of the clinical standard of 1.5 mm images, thereby improving the clarity of very fine anatomic detail in the lungs.

CLINICAL RELEVANCE/APPLICATION

PKAID may better delineate various anatomies and pathologies in chest CT by enabling low noise, thin-slice imaging. It may also be used to maintain a given spatial resolution at lower radiation dose.

SSA21-04 Radiation Dose and Contrast Dose Reduction in Combined Coronary CT Angiography and Iliac Artery

CT Angiography with Personalized Scan Protocol for Preoperative Assessment of Renal Transplant Patients

Sunday, Dec. 1 11:15AM - 11:25AM Room: E353B

Participants
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PURPOSE

To compare the image quality, radiation dose and contrast medium (CM) dose in combined coronary CT angiography (CTA) and iliac CTA for renal transplant patients with personalized and standard scan protocols.

METHOD AND MATERIALS

A total of 77 patients needing assessment for coronary and iliac arteries before renal transplantation were prospectively enrolled. All patients underwent one-stop combined scans on a 256-row CT scanner with automatic tube current modulation, 50% pre-ASIR-V to control radiation dose. CCTA was performed first using one heartbeat axial scan mode with bolus tracking technique and iliac CTA was performed 3-5 seconds after CCTA using a spiral scan. Group A (n=40) used the standard protocol: 100kVp, 60 ml of 350 mgI/ml CM at the flow rate of 4.5 ml/s. Group B (n=37) used a personalized protocol: kVp: 80 (BMI<24) and 100 (BMI>=24) and CM: 19mgI/kg (BMI<18); 21mgI/kg (18<=BMI<24); and 22mgI/kg (BMI>=24). After scanning, all images were reconstructed with 50%ASIR-V.

RESULTS

There was no significant difference in patient demographic data. The contrast dose and radiation dose in the personalized protocol were significantly lower than that in the standard protocol (3.9ml/s vs. 4.5ml/s in flow rate, P<0.01; 31.16ml vs. 60ml in total volume, P<0.001 and 3.85±1.38mSv vs. 4.78±1.17mSv in effective radiation dose, p<0.05). The personalized group had better objective CCTA image quality than the standard protocol group (CNR: 27.37±15.47 vs. 15.47±3.86, P<0.01; SNR: 38.74±16.80 vs. 30.08±20.92, P=0.05). Mann-Whitney test showed that there was no significant difference in the subjective scores of arteries between the two scans (all P>0.05), except the left crown trunk where the standard scan protocol had a higher score (p=0.02).

CONCLUSION

Personalized scan protocol in tube selection and contrast medium selection can significantly reduce the radiation dose and contrast medium dose while maintaining diagnostic image quality for renal transplant patients.

CLINICAL RELEVANCE/APPLICATION

Preoperative assessment of coronary and iliac artery CTA in kidney transplant patients can be completed at a single dose with very low radiation dose and contrast agent dose.

SSA21-05 X-ray CT Image Reconstruction Using Feature Aware Deep Learning Method

Sunday, Dec. 1 11:25AM - 11:35AM Room: E353B

Participants
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PURPOSE

In conventional CT, it is difficult to generate consistent organ specific noise and resolution with a single reconstruction. Therefore, it is necessary in principle to reconstruct a single scan multiple times using different reconstruction parameters such as reconstruction kernel and regularization parameters of model based iterative reconstruction (MBIR) in order to obtain clinical diagnosis information for different anatomies. We provide a deep learning solution which can obtain organ specific noise and resolution balance with a single reconstruction. We propose image reconstruction using a deep convolution neural network (DCNN) trained by a specific feature aware reconstruction target.

METHOD AND MATERIALS

The entire framework of our proposed feature aware deep learning reconstruction method can be found in Fig. 1(a). DCNN takes the conventional filtered backprojection (FBP) image as input and outputs an image with desirable properties. The choice of training target is critical to DCNN. We propose to use a feature aware training target in Fig. 1(b). First, we need to obtain organ specific feature reconstruction. This can be done by reconstructing the image using different regularization parameters of MBIR. The number of feature images can vary depending on the number of anatomies required for clinical purposes. We combine these into a single image as the feature aware training target. We adopted the U-Net as our DCNN. Our training data consists of five dose patient scans. In order to handle different dose levels, for each full dose scans we simulated four low dose scans corresponding to 75%, 50%, 25% and 12% full dose. Then we extract a total number of two hundreds thousand training pairs. We ran 150 epochs in total to ensure effective convergence.

RESULTS

We evaluate our proposed method using two typical real low dose cases. We compare the proposed method to FBP and MBIR with a single adjustable regularization parameter. Fig. 2 shows the comparison for a low-dose pelvis scan. Fig. 3 shows another example of

a low dose chest scan.

CONCLUSION

The proposed method can generate consistent noise and resolution tradeoff which is suited for the specific organs compared to FBP and MBIR.

CLINICAL RELEVANCE/APPLICATION

The proposed method delivers noise consistent image reconstruction with a single reconstruction. Thus, it potentially improving CT work flow while still satisfying clinical diagnostic requirements.

SSA21-06 Assessment of Spatial Resolution as a Function of Focal Spot Size in an Ultra-High Resolution CT System with 6 Selectable Focal Spots

Sunday, Dec. 1 11:35AM - 11:45AM Room: E353B

Participants
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PURPOSE

Most conventional CT systems use two focal spots, but for a ultra-high resolution (0.150 mm pixel dimensions) CT system the focal spot plays a more important role in spatial resolution. The purpose of this study was to evaluate the spatial resolution using the MTF over a range of focal spot sizes and for both super high resolution "SHR" (0.25 mm nominal slice width) and normal resolution "NR" (0.50 mm nominal slice width) modes.

METHOD AND MATERIALS

A ultra-high resolution CT scanner (Aquilion Precision, Canon Medical) was recently installed and evaluated as part of the commissioning process. A modular phantom was developed previously and used for this study, and specifically a series of thin air slits in PMMA were used to produce line spread functions (LSF). The phantom was placed near the isocenter of the system and imaged using all available focal spot settings in both NR and SHR modes. Sufficient mAs values were used at 120 kV to produce LSF images with low noise, and mA and rotation time settings were selected as a function of focal spot mode. A bone kernel was used for filtered backprojection reconstruction. Images were downloaded to a workstation for analysis using Matlab. The air slits were arranged at a slight angle relative to the image matrix to allow for oversampling the LSF to produce the pre-sampled MTF.

RESULTS

The MTF's showed monotonic improvement as the focal spot size got smaller, especially for the SHR mode (1024 matrix with zoom reconstruction) where 4 focal spot sizes were used. The MTFs for the NR mode (512 matrix) showed lower impact from the focal spot sizes, where 6 spots were used.

CONCLUSION

With the advent of high-resolution CT systems for whole body applications, the role of the focal spot dimensions is shown to be much more important than for previous normal resolution scanners.

CLINICAL RELEVANCE/APPLICATION

Because the focal spot size is a selectable parameter on this high resolution CT scanner, system operators need to fully understand the resolution capabilities and constraints of the various focal spot selections to achieve the full high resolution performance of the scanner.

SSA21-07 Detection of Myocardial Infarction Using a Spectral Imaging Method Derived from a Single KV Scan with Deep Learning

Sunday, Dec. 1 11:45AM - 11:55AM Room: E353B

Participants
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PURPOSE

Currently, to detect myocardial perfusion defects, nuclear medicine imaging methods are used in clinical practice. CT based imaging

methods such as CT myocardial perfusion and dual-energy CT are limited by confounding factors such as motion artifacts, radiation dose, and cumbersome clinical workflows. In this work, a deep learning based method was developed to generate iodine maps from a single kV scan and thus enable myocardial infarction detection from a single contrast-enhanced cardiac CT scan.

METHOD AND MATERIALS

A novel deep neural network architecture, referred to as deep spectral imaging network (DSI-Net), was designed and trained to generate two material basis maps from the projection data acquired from a single kV CT scan. To validate the quantitative accuracy of iodine concentration, an anthropomorphic phantom (Lungman) and iodine inserts were scanned using a clinical 64-slice MDCT scanner (Discovery CT750HD, GE Healthcare). The combination of 80kV and 140kV was used to perform the routine dual-energy decomposition to generate a reference iodine map. Iodine maps were then generated from the single 80kV data set and the trained DSI-Net. To demonstrate clinical feasibility, a swine model (N=8) with myocardial defects was scanned using myocardial perfusion CT imaging and PET imaging. The derived myocardial defect zones from these two modalities were compared against the myocardial defect detected by the developed DSI-Net.

RESULTS

Physical phantom studies show that the overall relative mean square error of iodine concentration quantification is 3.2% for the DSI-Net. Quantification of each iodine insert is summarized in the figure caption. As shown in the figure, the defect region derived from DSI-Net is highly correlated with that derived from the myocardial blood volume (MBV) and the defects diagnosed from PET images. The Dice coefficient of the affected territory between the MBV from MPI-CT and the iodine map from DSI-Net is 0.84.

CONCLUSION

It is feasible to use the deep learning based spectral CT imaging method from a single kV acquisition to generate quantitative iodine maps for myocardial perfusion defect detection.

CLINICAL RELEVANCE/APPLICATION

From a single kV CT acquisition, the developed deep spectral CT imaging can enable all of the currently available CT scans be used to generate spectral CT imaging information for quantitative diagnosis without modifications to the current scanner hardware or clinical workflow.

SSA21-08 Phase-Locked Physiological Data for 4D CT: The Application of Standard Video Collection and Motion Enhancement

Sunday, Dec. 1 11:55AM - 12:05PM Room: E353B

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CONCLUSION

Extracting cardiorespiratory signals from standard video recording is a promising technique for synchronizing and visualizing the physiological state of a patient during dynamic medical imaging.

Background

To facilitate precise interpretation of dynamic medical imaging, synchronized physiological parameters, such as cardiorespiratory phase, need be integrated into the collected dynamic images. While some aspects of this information may be visible during acquisition (e.g. respiratory gating in MRI, and EKG in MRI/CT), it is often difficult to obtain this raw data for post-processing. At our center, interpreting 4D airway scans critically requires the respiratory trace to be overlaid for each scan. Since the Force CT scanner has no ability to collect respiratory data or export cardiac signals, we developed a solution using simple video collection and Eulerian video magnification. Using enhanced motion and color data from video, we demonstrate the ability to generate automated physiological traces that can be integrated with CT images for clinical interpretation.

Evaluation

Eulerian video magnification functions to extract cardiorespiratory phase information by enhancing color and motion. This phase information is easily synchronized with the dynamic CT time-course to facilitate physiologically relevant interpretation. To validate derived data, anesthesia-monitor EKG and respiratory traces were compared to extracted video-signals. This approach has been demonstrated in infants and other patient groups with airway complications. In addition, the best-practice conditions for video capture and the limits of processing parameter choices will be presented.

Discussion

Standard video recordings are easy and inexpensive to obtain. Given the relative inability to collect or extract these signals on a broad range of imaging equipment, the exploitation of Eulerian video magnification and developed approach for re-integration of this data with the DICOM data-set, provides a roadmap for widespread use. Since audio data can be similarly processed, scenarios where this may be useful for artifact confirmation (e.g. crying) or diagnostic enhancement (e.g. linked laryngeal activity) will also be discussed.

SSA21-09 High Temporal Resolution C-Arm Cone-Beam CT Perfusion Imaging

Sunday, Dec. 1 12:05PM - 12:15PM Room: E353B

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PURPOSE

C-arm cone-beam CT perfusion (CBCTP) imaging is key to enable one-stop-shop stroke imaging in angio-suite for ischemic stroke patients. Due to slow gantry motion, inadequate temporal resolution and temporal sampling in CBCTP acquisitions may limit the accuracy of the generated perfusion maps and thus limit accurate diagnosis of perfusion deficit in interventional suite. In this work, a new reconstruction technique was developed to achieve 30x improvement of temporal resolution for CBCTP perfusion imaging.

METHOD AND MATERIALS

With the SMART-RECON method, multiple CT volumes can be reconstructed from a single acquisition to achieve 4-5 temporal resolution improvement, however, in CBCTP acquisitions, multiple scans are performed by rotating the C-arm gantry in a back-and-forth manner. In this scheme, limited view artifacts demonstrate a strong intrinsic periodicity. In this work, this a priori knowledge of periodicity was incorporated into SMART-RECON, resulting in a significantly enhanced performance for SMART-RECON (eSMART-RECON). A digital anthropomorphic phantom was used to quantify the achievable temporal resolution of eSMART-RECON. The proposed method was also applied to human subject data to demonstrate clinical feasibility. Under IRB approval and written consent, each patient underwent both multi-detector CT perfusion (MDCTP) and CBCTP imaging. The MDCTP and CBCTP images were co-registered and processed with the same software to compute parametric perfusion maps.

RESULTS

The achievable temporal resolution of eSMART-RECON was quantified in the digital phantom as 7.5 fps. Given the gantry rotation speed of 4.2s (corresponding to approximately 0.25 fps), eSMART-RECON yields 30x temporal resolution improvement. The human subject studies demonstrate that eSMART-RECON can accurately capture the temporal variation of cerebral tissues as perfusion maps derived from eSMART-RECON CBCTP closely resemble MDCTP maps (see figure).

CONCLUSION

A new technique, eSMART-RECON, was developed and validated to achieve significantly improved temporal resolution to enable accurate CBCT perfusion imaging.

CLINICAL RELEVANCE/APPLICATION

With the ability to produce accurate perfusion maps in interventional suite, the workflow of endovascular treatment for acute ischemic stroke patients can be further optimized to reduce the time from stroke onset to treatment such that more brains can be saved since time is brain in ischemic stroke patient management.

Printed on: 10/29/20

SSA22

Physics (MRI - New Techniques and Image Quality)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E353A

MR PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSA22-01 Hybrid MR-OR Siting and Safety

Sunday, Dec. 1 10:45AM - 10:55AM Room: E353A

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CONCLUSION

The hybrid MR-OR environment provides many clinical advantages but is not free of a certain degree of risk. The risk is further compounded with lack of consistent safety standards. Engineering MR safety into the practice design and strict adherence to MRI safety checklists, policy enforcement and regular personnel training is critical to maintaining MR safety in this complex multidisciplinary procedural environment.

Background

Hybrid MR-OR for interventional and intraoperative procedures has emerged from its infancy to a standard setup at major academic medical centers. The American College of Radiology (ACR) white paper on MR Safety is a primary reference used by most sites for designing MR safety best practices; unfortunately, it is lacking specific guidance on hybrid MR-OR siting and safety. We attempt to provide a template for hybrid MR-OR siting and safety that builds on the ACR white paper terminology and covers unique considerations regarding design, layout, access, training, screening, infection control and procedural considerations when developing hybrid MR-OR siting and safety practices.

Evaluation

A key challenge of hybrid MR-OR environment is its multidisciplinary, interdepartmental nature, and as such requiring a strong collaborative approach in the design of the hybrid environment and implementation of education and safety protocols. Safety not only has to be forefront in awareness, but also engineered into the workflow. We highlight three key elements of engineering safety into the practice design through 1) siting considerations 2) workflow and training considerations and 3) procedural safety considerations.

Discussion

Siting considerations should include architectural layout, scanner choice (on rails vs stationary), zone designs, and screening equipment. Workflow and training consideration should include staff training (with emphasis on hands-on training), access control, and patient/staff movement. Procedural safety considerations should include level 2 personnel staffing, patient screening, procedural pause, surgical equipment screening, and infection control. Ongoing evaluation of procedural process is critical as new procedures are added.

SSA22-02 Lower Risk of Hearing Loss Without Sacrificing Image Quality in Fetal MR Imaging: A Feasibility Study Using Acoustic Reduction Technique

Sunday, Dec. 1 10:55AM - 11:05AM Room: E353A

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PURPOSE

The purpose of this study was to evaluate whether ART is reliable and applicable in fetus brain imaging.

METHOD AND MATERIALS

We collected from September 2017 to October 2018 using 3.0T MR scannerfor fetal head exams. 10 subjects underwent ART sequences (group A), the matched 10 subjects underwent traditional sequences (group B). The protocol of tradition sequences includes T2 single short fast spin echo (SSFSE) (axial, sagittal, coronal); while the ART sequences contains ART T2 SSFSE (axial, sagittal, coronal) (Table1). A quantitative assessment by the ROI of 1 mm was manually placed on the different layers of the brain (Fig 1A). A qualitative evaluation including eight criteria (1. Delineation of germinal zone and gray matter, 2. Delineation of white matter, 3. Delineation of internal and external CSF spaces, 4. Delineation of amniotic fluid adjacent to the skull, 5.Delineation of brain stem, 6. Delineation of cerebellum, 7. Severity of motion artifacts, 8. Overall image quality) were evaluated on an ordinal scale regarding signal characteristics, potential dysmorphism and developmental anomalies (5= optimal diagnostic quality; 4= very good image quality;3= diagnostic image quality, 2= image quality below diagnostic standards; 1= image quality too poor to correctly identify anatomy.

RESULTS

The maximum differences of peak and equivalent sound pressure between the two groups are 18.1dBA and 16.1dBA respectively, indicating the ART sequences have lower noise than traditional sequences. Comparative ratios calculated between germinal matrix/air, periventricular layer/air, subplate layer/air, and cortical layer/air for group A (33.97±17.52, 42.45±16.65, 46.37±22.46, 43.03±20.89) were lower than that of group B (52.54±25.61, 33.39±12.91, 69.17±35.21, 64.76±32.53), but with no significant difference (P=0.09,0.20, 0.12, 0.11) . The qualitative results showed that the image quality of group B and group A scored 4.42 + 0.37 and 4.36 + 0.49 respectively. There was no significant difference in image quality score between the two groups.

CONCLUSION

Acoustic reduction sequence can acquire high quality images in 3.0T scanner, meanwhile decrease hearing loss risk in fetal head examinations compared with the conventional method.

CLINICAL RELEVANCE/APPLICATION

Acoustic reduction sequence can acquire high quality images in 3.0T scanner, meanwhile decrease hearing loss risk in fetal head examinations compared with the conventional method.

SSA22-03 Multi-Site, Multi-Vendor, and Multi-Platform Assessment of Accuracy of Quantitative Proton-Density Fat Fraction (PDFF) at 1.5 and 3 Tesla with a Standardized Spherical Phantom: Results from a Study by the RSNA QIBA PDFF Committee

Sunday, Dec. 1 11:05AM - 11:15AM Room: E353A

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PURPOSE

Proton Density Fat Fraction (PDFF) is a popular MRI/S biomarker of hepatic steatosis. The QIBA PDFF Committee was formed in 2015. In this work, the committee conducted a multi-center and multi-vendor phantom study. The objective was to characterize the accuracy of PDFF as a robust biomarker, as measured by various SPGR chemical-shift-encoded sequences against a standardized phantom with known PDFF values.

METHOD AND MATERIALS

9 sites with multiple commercial 1.5T and 3T systems were invikved. The phantom contained 12 vials of known PDFF. Sites were asked to test several protocols, to their best capability. P1: a vendor-sourced 'out-of-the-box' liver PDFF protocol. Each site ran P1 'as is', using default parameters for GE's IDEAL-IQ, Siemens' LiverLab, and Philips' mDIXON-Quant. P2: a complex-based QIBA recommended protocol. P3: a magnitude-based Liver Imaging of Phase-interference signal Oscillation and Quantification protocol. Each site acquired P1-P3 data, which were reviewed by an independent reader. For P1 and P2, each vendor's online multi-fat-peak complex-based data reconstruction algorithm and software was used for PDFF generation, with no modifications to reconstruction parameters. No work-in-progress software was used. For P3, data were sent to an additional independent site for multi-fat-peak magnitude-based reconstruction. A single analyst made all PDFF measurements. Linear regression was performed against reference values.

RESULTS

149 scans of the phantom were performed, 45 on 1.5T (15xP1, 12xP2, 18xP3), and 104 on 3T (33xP1, 24xP2, and 47xP3). Pooled P1 data for 1.5T: (slope=0.97, bias=0.15, r2=0.99), for 3T: (slope=0.99, bias=-0.69, r2=0.99); pooled P2 data for 1.5T: (slope=0.99, bias=-0.35, r2=1.0), for 3T: (slope=1.0, bias=-1.01, r2=0.99); pooled P3 data for 1.5T: (slope=0.96, bias=-0.25, r2=1.0), for 3T: (slope=0.97, bias=-0.02, r2=0.99). Lin's concordance correlation coefficient for all 1.5T data was 0.9973 and 0.9972 for all 3T data.

CONCLUSION

Quantitative PDFF data collected in a standardized phantom are accurate using vendor-source and QIBA-recommended complex-based water-fat separation protocols and an independent magnitude-based protocol.

CLINICAL RELEVANCE/APPLICATION

The PDFF from MRI and MRS is a robust and accurate quantitative imaging biomarker of hepatic steatosis across different magnet field strengths, imager manufacturers, and reconstruction methods.

SSA22-04 Effect of Post Labelling Delay on Arterial Spin Labelling

Sunday, Dec. 1 11:15AM - 11:25AM Room: E353A

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CONCLUSION

Single PLD ASL is a robust technique in obtaining CBF values but the accuracy is still confounded by the PLD settings. This study showed that CBF values at different PLD could be significantly different. 2000ms was the most appropriate settings (27/29 cases) which agreed well with the white paper. We also noticed that ATA signs could present after 2000ms. Radiographers should take up the role in real time image interpretation. If ATA were spotted, repeated examination with a longer PLD would be necessary.

Background

Arterial Spin Labelling (ASL) is a MRI perfusion technique utilizing magnetically labelled blood as endogenous tracers. Post Labelling Delay (PLD) is applied to ensure an equilibrium state is reached. However, a short PLD could not ensure an equilibrium state while a long PLD could lead to reduced SNR. Failure to account for could compromise the accuracy.

Evaluation

29 dementia patients in December 2018 were prospectively recruited. Pseudo-continuous ASL was acquired in a 3T scanner (Achieva, Philips Healthcare) with 3 PLD settings (TR=4000ms, TE=11ms, labeling-duration=1600ms, PLD=1800/2000/2500ms). Data analysis were done by MRIcloud online.

Discussion

Recommended single compartment model should give the same CBF values regardless of the PLD settings but our data showed that CBF values at each PLD were significantly different (Repeated measures ANOVA, p=0.000). After referencing with the buxton's kinetic model, 5 conditions were recognized and summarized in the figure. 2 cases showed 'steady state' in which CBF values were similar at each PLD. 10 cases showed 'ATA effects' in which equilibrium was reached after 2000ms. CBF values at 1800ms was erroneous as it violated the model assumption. 9 cases showed 'SNR penalty' in which there might be measurement errors due to reduced SNR at 2500ms leading to abnormally low CBF values. CBF values could not converge in the remaining 8 cases.'Mixed effects' (n=6) might be due to a combination of 'ATA effects' and 'SNR penalty' where 2000ms, theoretically, would be the acceptable setting. In 'severe ATA effects' (n=2), CBF values at 2000ms were abnormally high due to an incorrect model inversion. 2500ms would be the appropriate choice.

SSA22-05 Using Water-In-Oil Emulsions in Phantom for Quality Control of Diffusion-Weighted Magnetic Resonance Imaging

Sunday, Dec. 1 11:25AM - 11:35AM Room: E353A

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CONCLUSION

We developed a phantom containing control substances with predefined apparent diffusion coefficients ranging from normal tissue to benign and malignant lesions. The use of W/O emulsions as a part of the phantom allowed modeling a restricted diffusion represented in the image by a high-intensity signal in a wide range of the b-value. The proposed substances also allow evaluating the effectiveness of fat suppression.

Background

To control the quality of diffusion-weighted magnetic resonance imaging (DWI), phantoms with control substances (with stable physical characteristics and known diffusion coefficients) are used. According to literature, aqueous solutions of polymer are used to achieve different diffusion coefficients. These materials model only hindered diffusion, while the diffusion of water molecule inside the cell is restricted. In this work we give results of combination water-in-oil (W/O) emulsions and polymer solutions to model not only restricted, but also hindered diffusion.

Evaluation

As a hindered diffusion model, we used aqueous solutions of polyvinylpyrrolidone (PVP) with concentrations of 0-50%. We created W/O emulsions to simulate a restricted diffusion based on substances with high time T2 - siloxanes: cyclomethicone (Cycl) and caprylyl methicone (Cap). We chose emulsions with equal proportions of water/fatty phases: 1:1 Cap:Water and 1:1 Cycl:Water. According to the dispersion analysis, the size of micelles in the emulsions was 4.8±1.8 μm. The apparent diffusion coefficient (ADC) of emulsion depends on the true diffusion coefficient inside micelles and the time interval between diffusion gradients Δ. We also included silicon oil in phantom to control fat suppression. To estimate the effectiveness of phantom, we scanned it on different MR scanners.

Discussion

With the increase of Δ from 44.4 ms to 60 ms, we restated the decrease of ADC of emulsion by 0.02 μm2/ms, whereas this effect wasn't observed for water and Cap. True diffusion coefficients of material were determined with the accuracy of 4%. When comparing the ADC results of different MR scanners, the mean variation reached 5.1%, and the relative error was 9.3%. The use of correction factor allow decreasing the error to 2.5 %.

SSA22-06 Improvement of Late Gadolinium Enhancement Image Quality Using a Novel, Deep Learning Based, Reconstruction Algorithm and Its Influence on Myocardial Scar Quantification

Sunday, Dec. 1 11:35AM - 11:45AM Room: E353A

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PURPOSE

The aim of this study was 1) to evaluate myocardial late gadolinium enhancement (LGE) image quality using a deep learning (DL) based magnetic resonance image reconstruction algorithm and 2) to assess its effect on the quantification of myocardial scar.

METHOD AND MATERIALS

Thirty-five patients (46±17y, 51% male) with suspected ischemic or non-ischemic cardiomyopathy underwent cardiovascular magnetic resonance imaging (CMR) with gadolinium contrast (0.15 to 0.2 mmol/kg; Gadovist) on a 1.5T scanner (SIGNA Artist, GE Healthcare). Short axis 2D LGE images were reconstructed twice: once with the vendor standard reconstruction, and once with vendor supplied DLRecon prototype. The DL reconstruction is based on a deep convolutional residual encoder network trained from a database of over 10.000 images to reconstruct images with high signal-to-noise ratio (SNR) and high spatial resolution. The

network offered tunable noise reduction (NR) factors from 0-100% to accommodate user preference. Two observers scored image quality and myocardial nulling of both original images and reconstructed images with 75% NR level using a 5 point scale (1=poor to 5=excellent). SNR and contrast-to-noise ratio (CNR) were measured. In 20 patients with LGE, scar size was quantified using thresholding by 2, 4, and 6 standard deviation (SD) above remote myocardium, and using full width at half maximum (FWHM) technique in images with 25%, 50%, 75% and 100% NR levels.

RESULTS

Both image quality and myocardial nulling improved by DLRecon method (3.3±0.6 vs. 3.7±0.6, p<0.001 and 3.3±0.6 vs. 3.4±0.6, p=0.03). SNRscar and CNRscar-remote increased significantly with 150% and 158%, respectively at a NR level of 75% (both p<0.001). Due to reduction in noise, scar size increased significantly with increasing NR levels using SD methods, however with the FWHM method no difference in scar size was found (figure).

CONCLUSION

Using a novel, deep learning based, reconstruction algorithm myocardial LGE image quality improved significantly. However, these algorithms have important impact on scar size quantification depending on technique used. The FWHM method is preferred because it is independent of the level of noise.

CLINICAL RELEVANCE/APPLICATION

LGE by CMR is the gold-standard technique for assessing myocardial scar and by using a novel, deep learning based, image reconstruction algorithm image quality can be improved.

SSA22-07 Comparison Between Readout Segmented Diffusion Weighted Imaging and Single Shot Echo Planar Imaging in Image Quality

Sunday, Dec. 1 11:45AM - 11:55AM Room: E353A

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PURPOSE

To compare difference of readout segmented diffusion weighted imaging (RS-EPI) and single shot echo planar imaging (SS-EPI) on image quality with ultra-high b value for prostate cancer detection.

METHOD AND MATERIALS

37 patients with prostate disease who underwent both RS-EPI and SS-EPI were enrolled in this study. All data were collected on a 3T MR scanner (MAGNETOM Skyra, Siemens Healthcare, Erlangen, Germany) with the b value of 0, 1000 ,2000 , 3000s/mm2. The image quality including lesions clarity, anatomical distortion, image sharpness, detail display based on diffusion weighted imaging (DWI) were classified according to Likert score into 1 to 5 grade.(Grade 1 : cannot be used for diagnosis; Grade 2: poor; Grade 3: acceptable; Grade 4: good; Grade 5: very good.) All the images were analyzed by two experienced radiologists blinded to any clinical information as well as MR sequence type. The classification was provided from two radiologists separately. The signal-to-noise ratio (SNR), and contrast ratio, and contrast to noise ratio (CNR) were also measured on workstations by the radiologist.

RESULTS

The scores concluded by the two radiologists have good consistency, Kappa value>0.80. The image quality including lesions clarity, anatomical distortion, image sharpness, detail display obtained from RS-EPI sequences were higher than those obtained from SS-EPI regardless of 1000, 2000, 3000s/mm2 (P<0.001). The signal-to-noise ratio (SNR), and contrast ratio, and contrast to noise ratio (CNR) measured on RS-EPI sequences were also higher than those measured on SS-EPI (P<0.001) (table1).

CONCLUSION

Compared with the SS-EPI sequence, ultra-high b value RS-EPI sequence significantly improves the image quality, which is more conducive to the detection of prostate lesions.

CLINICAL RELEVANCE/APPLICATION

Compared with the SS-EPI sequence, ultra-high b value RS-EPI sequence significantly improves the image quality, which is more conducive to the detection of prostate lesions.

SSA22-08 Radiologic Technologists' Decision-Making for Protocol Repetition in Whole-Body MR Imaging and the Potential for Automated Image Quality Assessment: A Large Population-Based Cohort Study

Sunday, Dec. 1 11:55AM - 12:05PM Room: E353A

Participants
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PURPOSE

Cost-effectiveness in health care delivery and diagnostic medical imaging have become increasingly important. Such considerations are relevant when repeating protocols in Whole-Body MR imaging, especially when conducting large cohort studies. We studied the frequency of protocol repetition by radiologic technologists who performed whole-body MR imaging protocols in the multi-center German National Cohort (GNC), and the impact of automation on the need for protocol repetition, considering the local, staffing, and technical factors involved. Additionally, we studied its impact on scan time, automated image quality assessment, and protocol repetition.

METHOD AND MATERIALS

A total of 11,347 subjects underwent whole-body MRI as part of the MR sub-study of the GNC cohort (2014-2016). Whole-body imaging was conducted at five sites using a uniform set of twelve protocols. Image acquisitions were independently conducted by radiologic technologists (RT), whose decisions for protocol repetition was compared with image quality parameters that were automatically derived.

RESULTS

At least one repeat protocol by the RT occurred in 12% (n=1,365) of subjects. The frequency of repetition differed across protocols ($p<0.0001$), and across sites (range: 5.28%-24.34%, $p<0.0001$), and varied over time ($p<0.0001$). Mean total scan time of 62.6min increased by 4.8min (95%CI: 4.5-5.2min) in subjects needing protocol repetition. The automatically-derived image quality parameters that retrospectively predicted the need for protocol repetition included image sharpness and signal-to-noise ratio. However, their predictive value was not uniform across all protocols.

CONCLUSION

The need to repeat MR protocols, even in highly standardized settings such as population study cohorts, is highly prevalent. Our findings indicate that automated image quality assessment has predictive value, and reduces the need for protocol repetition, thereby improving workflow efficiency and cost-effectiveness in the conduct of such studies.

CLINICAL RELEVANCE/APPLICATION

Patients find MRI studies daunting, hence MRI protocol repetition by radiologic technologists increase not only costs, but also patient discomfort. Automation of MRI image workflow has the potential to improve both.

SSA22-09 An Experimental Study of MRI Induced Heating in Conductive Loops

Sunday, Dec. 1 12:05PM - 12:15PM Room: E353A

Participants
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CONCLUSION

This work indicates that size and presence of a gap are factors to consider in the risk assessment of piercings. It has important implication for dermal piercings since there may be unknown gap in the piercing under the skin.

Background

Patients who are unable or reluctant to remove metallic piercings before MRI are at risk of injuries due to magnetic force and radiofrequency (RF) heating. While magnetic force risk can be reduced by screening with a ferromagnetic detector, it is harder to assess the risk of RF burn from piercing. The purpose of this investigation is to conduct experiments to evaluate the relationship of RF heating with the size and configuration of conductive loops to provide a better understanding of the factors related to RF heating in piercings.

Evaluation

The study was conducted on a GE 3T MR system. Circular loops of diameter 5cm, 8cm and 11cm with an air gap of 0, 0.3mm or 2.5mm for each diameter were constructed from copper wire (gauge 10). They were placed one at a time horizontally in a container with the loop touching the skin of a pig knuckle specimen at the loop gap position. The setup was mounted on top of a 27cm spherical phantom and scanned using a fast spin echo sequence for 10:33 minutes. Temperature at the contact point between each loop and the specimen skin was measured with a Philips patient monitor temperature sensor. The results show temperature rise of 1.4 and 1.8 deg C in the 8cm loops with a gap of 0.3mm and 2.5mm respectively, and temperature rise of 5.0 and 5.2 deg C in the 11cm loops with a gap of 0.3mm and 2.5mm respectively. There was no measured temperature increase in all loops with zero gap and in the 5cm loops with a gap.

Discussion

This study shows that RF heating risk increases with the size of conducting loops and with the presence of a gap. The result indicates high induced electric field at the gap of the larger loops causes current to flow in the skin with high resistance leading to the heating. However, this study does not imply MRI safety for piercings smaller than a certain size or without a gap since RF heating depends also on other factors and settings not covered in this study.

SSA23

Radiation Oncology (Radiobiology/Science)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S502AB

RO

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSA23-01 Imaging and Treatment of Primary and Metastasized Tumor via Abscopal Immunotherapy Effect, and Reduction of Circulating Tumor Cell Using Targeted Antigen-Capturing Nanoparticles Containing Chitosan and Anti-sema7a Antibodies Directed by Radiation

Sunday, Dec. 1 10:45AM - 10:55AM Room: S502AB

Participants
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PURPOSE

The aim of this study was to image and treat primary and metastasized tumors, by immuno-radiotherapy via dendritic cell (DC)-mediated T-cell priming under PD-L1 blockade and to reducing circulating tumor cells (CTCs) via CHI3L1 inhibition, using nanocapsules that release antigen-capturing nanoparticles (AC-NPs) containing chitosan nanoparticles (ChNPs) and an anti-Sema 7a antibody (Ab) in two radiation sessions.

METHOD AND MATERIALS

For session 1, nanocapsules generated by modifying iopamiron and 400 μg anti-PD-L1 antibody (Ab) were mixed with 1.0 mL of a 4% alginate, 3% hyaluronate, and 1 μg/mL P-selectin solution and sprayed into 0.5 mmol/L FeCl2, supplemented with 1 μg/mL anti-a4ß1 Ab. Nanocapsules were injected intravenously (IV) into BALB/c mice with primary LM17 tumors in the left hind leg and lung metastases. After 9 h, primary tumors were exposed to 10 or 20 Gy 60Co γ-rays. For session 2, ChNPs were prepared by electrospraying and were encapsulated in poly(lactic-co-glycolic) acid (PLGA) AC-NPs using a nanoprecipitation method. The particles and 350 μg/mL anti-Sema 7a Ab were further mixed with the above cocktail and sprayed into 0.5 mmol/L FeCl2, supplemented with 1 μg/mL anti-P-selectin Ab. Nanocapsules (1 × 1010) were injected IV. After 9 h, tumors were irradiated as before.

RESULTS

In session 1, anti-a4ß1 nanocapsules accumulating around primary and metastatic tumors were detected by CT. Nanocapsules released P-selectin and anti-PD-L1 Ab upon irradiation. In session 2, nanocapsules accumulated around primary tumors via a P-selectin Ag-Ab reaction and released PLGA AC-NPs containing ChNPs and Sema-7a Ab. PLGA AC-NPs captured and transported tumor-derived protein antigens released by the second radiation dose to DCs, which intensified DC-mediated CD8+ T-cell priming. The primed CD8+ T-cells attacked primary and metastatic tumors, in which PD-L1 was suppressed in session 1. Further, Sema-7a Ab and ChNPs from PLGA AC-NPs inhibited CHI3L-induced CTCs, which reduced new metastases. These treatments showed antitumor effects (EF 1.7) and reduced metastasis by 86.5%.

CONCLUSION

Our nanocapsule improved both tumor diagnosis and treatment.

CLINICAL RELEVANCE/APPLICATION

Targeted AC-NPs, ChNPs, and Sema-7a Ab under PD-L1 blockade showed antitumor effects on primary and metastatic tumors.

SSA23-02 Significance of Manipulating Tumor Hypoxia and Radiation Dose Rate in Terms of Local Tumor Control and Distant Lung Metastasis

Sunday, Dec. 1 10:55AM - 11:05AM Room: S502AB

Participants
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PURPOSE

To evaluate the influence of manipulating intratumor oxygenation status and radiation dose rate on local tumor response and distant lung metastases following radiotherapy, referring to the response of quiescent (Q) cell populations within irradiated tumors.

METHOD AND MATERIALS

B16-BL6 melanoma tumor-bearing C57BL/6 mice were continuously given 5-bromo-2'-deoxyuridine (BrdU) to label all proliferating (P) cells. They received γ-ray irradiation at high dose-rate (HDR) or reduced dose-rate (RDR) following treatment with the acute hypoxia-releasing agent nicotinamide or local hyperthermia at mild temperatures (MTH). Immediately after the irradiation, cells from some tumors were isolated and incubated with a cytokinesis blocker. The responses of the Q and total (= P + Q) cell populations were assessed based on the frequency of micronuclei using immunofluorescence staining for BrdU. In other tumor-bearing mice, 17 days after irradiation, macroscopic lung metastases were enumerated.

RESULTS

Following HDR irradiation, nicotinamide and MTH enhanced the sensitivity of the total and Q cell population, respectively. The decrease in sensitivity at RDR irradiation compared with HDR irradiation was slightly inhibited by MTH, especially in Q cells. Without γ-ray irradiation, nicotinamide treatment tended to reduce the number of lung metastases. With γ-rays, in combination with nicotinamide or MTH, especially the former, HDR irradiation decreased the number of metastases more remarkably than RDR irradiation.

CONCLUSION

Both manipulating tumor hypoxia and irradiation dose rate showed the potential to influence lung metastasis. In HDR than RDR irradiation, the combination with the acute hypoxia-releasing agent nicotinamide may be promising in terms of reducing the number of lung metastases. Further, control of the acute hypoxia-rich total cell population in the primary tumor in addition to control of the primary tumor as a whole with HDR, rather than RDR irradiation, has an impact on the potential to reduce the numbers of lung metastasis.

CLINICAL RELEVANCE/APPLICATION

Treatment for manipulating tumor hypoxia in a way like MTH and irradiation at higher dose rate may show the potential to not only improve local control rate but also suppress the possibility of distant lung metastasis.

SSA23-03 Radiation Boosts to EPR pO2 Image Based Hypoxia Improves Tumor Control in Two Preclinical Cancer Models

Sunday, Dec. 1 11:05AM - 11:15AM Room: S502AB

Participants
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PURPOSE

Hypoxic resistance to radiation in living cells has been known for over a century, but boosting with extra radiation to localized hypoxic tumor subregions - dose painting - has never been shown beneficial. Using quantitative electron paramagnetic resonance (EPR) pO2 imaging and novel rapidly printed tungsten loaded plastic blocks to direct boosts, we randomized radiation boosts to well oxygenated vs hypoxic tumor in two tumor types to determine if the hypoxic boost enhanced tumor control.

METHOD AND MATERIALS

54 FSa fibrosarcoma and 48 MCa4 mammary carcinomas were grown to ~0.35 ml volume in C3H mouse legs and treated with whole tumor radiation dose sufficient to control 15% of tumors using an XRAD225Cx radiator. Immediately prior T2 MRI to define tumor location and EPR pO2 images were registered with the XRAD. Tungsten loaded plastic blocks were 3D printed randomly designed to provide additional boost dose sufficient to control 95% of tumors to either 99% of hypoxic tumor voxels (pO2<=10 torr) or well

oxygenated tumor regions of equal volume with opposed oblique fields. Mice were then followed for 90 days (FSa) or 180 days (MCa4) for local tumor recurrence. Kaplan-Meier survival analysis determined the significance of differences between boost radiation to hypoxic or well oxygenated tumor portions of ~equal volume for each tumor type.

RESULTS

Two consecutive tumor types were tested with mature tumor control data. Both tumor types showed radiation boosts directed to hypoxic tumor defined by EPR pO2 images increased tumor control by a significant (p=0.04 & p=0.013 respectively) factor of at least two relative to boosts directed to well oxygenated tumor as shown in the figure. Limitations: 1) single fraction radiation treaments. 2) Boost doses chosen equal to that for whole tumor 95% cure. Clearly, other factors than hypoxia produce resistance to radiation.

CONCLUSION

EPR pO2 images identified hypoxic tumor portions and randomly directed boosts (hypoxic vs well oxygenated) in two consecutive mouse tumor types giving highly significant doubling of long term tumor control and thereby the first mammalian justification for radiation dose painting within a tumor volume.

CLINICAL RELEVANCE/APPLICATION

Radiation dose painting enhances therapeutic ratio by protecting critical structures. This work presents the first mammalian justification of dose painting within a tumor to potentially reduce integral radiation dose necessary for tumor cure.

SSA23-04 DNA Double-Strand Break Induction and Repair of Proton Computed Tomography in Normal Human Cells

Sunday, Dec. 1 11:15AM - 11:25AM Room: S502AB

Participants
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PURPOSE

Proton computed tomography (pCT) offers a promising solution for reducing range uncertainties from X-ray CT planning and allowing daily pre-treatment verification. There is already evidence for increased dosimetric accuracy of pCT, but experimental biological data on the RBE of pCT for DNA double-strand break (dsb) induction and repair is scant. The purpose of this work is to provide such data.

METHOD AND MATERIALS

DNA dsb induction and repair were investigated in normal human astrocytes (NHA) and human umbilical vascular endothelial (HUVEC) cells. We hypothesized that the RBE for induction and repair of DNA dsbs is less than 1 with respect to kV x-ray CT. Moreover, genotoxicity will be assessed by the repair studies. DNA dsbs were detected using the γH2AX foci assay using confocal laser scanning imaging of radiation-induced foci. Cells were exposed to 200 MeV protons behind a mock-setup of a pCT scanner in a tissue equivalent cube inserted into the posterior fossa of a rotating head phantom. Proton CT dose calibrations performed in this head phantom set-up corroborated standard clinical dosimetry methods. γH2AX dose-response curves and repair curves were obtained. For repair experiments, cells were exposed to 1 Gy and then permitted to repair the damage at 37oC for varying durations. The pCT data were compared to DNA dsb induction and repair in both cell lines after exposure to radiation from a single energy CT and dual energy CT.

RESULTS

Fewer DNA dsbs per Gy were found in NHA cells compared to HUVEC cells after exposure to pCT but both cell lines had essentially repaired all of the DNA dsbs by 10-15 hours post exposure. Initial results seem to indicate that the RBE of proton CT for dsb induction is, in fact, lower than 1 compared to x-ray CT in agreement with recent computational modeling studies.

CONCLUSION

Altogether the results of this team effort provide a valuable estimation of RBE for DNA dsbs and genotoxic effects from exposure to proton CT.

CLINICAL RELEVANCE/APPLICATION

Proton CT will become available clinically soon. It will significantly improve the accuracy of proton therapy, reduce the dose from daily image guidance, and potentially have a lower RBE. This work has been supported by a research grant from IBA International.

SSA23-05 Radiosensitization of Human Cancer Cells in Vitro with Focused Ultrasound Induced Hyperthermia

Sunday, Dec. 1 11:25AM - 11:35AM Room: S502AB

Participants
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PURPOSE

Hyperthermia (HT; 40-46°C) is known to sensitize cancer cells to radiation therapy (RT) but the temperature rise cannot be quantified clinically. MR guided Focused ultrasound (MR-FUS) allows to generate local HT in a quantifiable way. In this study, impact of combined FUS-HT and RT treatment on human cancer cells was investigated in vitro to provide the base of the clinical use.

METHOD AND MATERIALS

Human glioblastoma (T98G) and prostate (PC-3) cancer cells were seeded in ultrasound-penetrable 96-well plates (Greiner Bio One). We have used a special sonicator for cell culture plates developed at IMSaT (University Dundee) and modified by us comprised by a programmable VXM motor controller and a NEMA 17 stepper motor (VELMEX Inc.). FUS-HT (45°C, 30 min) was induced with a customized 1.14 MHz transducer at 214 W/cm2. Temperature was monitored by thermal camera (Optris). HT (45°C, 30 min) in incubator worked as control. Single RT was applied at 10 Gy with an X-Ray device (DARPAC 150-MC; 1.28 Gy/min) within 60 min after RT. Effects on metabolic activity (WST-1, Roche) and DNA double-strand breaks (γH2A.X, Cell signalling) were evaluated.

RESULTS

Combination of FUS-HT and RT leads to decreased metabolic activity (T98G: 52 %; PC-3: 45 %) compared to single RT (T98G: 72 %; PC-3: 76 %) 72h after treatment. In contrast, classic HT+RT reduced metabolic activity to a lower extend (T98G: 57 %; PC-3: 50 %). FUS-HT combined with RT significantly ($p < 0.05$) enhance the number of initial DNA double-strand breaks (T98G: 21; PC-3: 11 foci/nucleus) compared to RT alone (T98G: 14; PC-3: 6 foci/nucleus) 1h post treatment.

CONCLUSION

Our data imply that FUS-HT shows potential to radiosensitize cancer cells. Increased DNA damage suggests an inhibition of repair mechanism and is further investigated. A new in vitro high throughput FUS system will now be completed.

CLINICAL RELEVANCE/APPLICATION

Focused ultrasound is an non-invasive way to generate precise local hyperthermia and sensitize cancer cells for radiation therapy or chemotherapy by synergistic effect.

SSA23-06 Demystifying the Radiation Risk in Pregnancy: How Much is Too Much?

Sunday, Dec. 1 11:35AM - 11:45AM Room: S502AB

Participants
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PURPOSE

To gain knowledge about the established guidelines and protocols while imaging pregnant women and to deal with the radio-phobia associated with it. To assess the knowledge of radiology department staff with regards to radiation safety in pregnancy.

METHOD AND MATERIALS

• The knowledge of the radiology departmental staff (consultants, residents, technicians, clinicians) in regards to doses, effects of radiation and imaging protocol in pregnancy,etc.,were assessed by analyzing their response to a set of questionnaires (1st audit). • Lectures were conducted for the departmental staff regarding the established guidelines and fallacies related to radiation risk in pregnancy. • 2nd audit conducted (3 months after 1st audit) for the assessment of progress • Results & observations: Significant improvement in awareness was observed in second audit results among radiology consultants (60 % vs. 100 %) radiology residents (30 % vs. 100%), technicians (40 % vs. 80%) and clinicians (30% vs. 80 %)

RESULTS

Significant interval improvement in awareness is demonstrated among residents, technicians and clinicians.

CONCLUSION

Imaging studies that can provide significant diagnostic information should not be withheld in case of pregnancy.

CLINICAL RELEVANCE/APPLICATION

Imaging in pregnancy is a challenging situation due to the hazards related to exposure of ionizing radiation to the fetus in-utero. However, in typical diagnostic radiological examinations such a risk is very minimal. At times, diagnostically useful imaging studies are denied to the pregnant women because of unsubstantiated fears mostly based on erroneous data, inspite of clinical benefits greatly outweigh the hypothetical risks. Dose in a typical diagnostic study rarely exceed >25mGy while as per ACR and ICRP criteria, exposures up to 100 mGy, should not be considered for termination of pregnancy.

SSA23-07 Influence of Different Iodinated Contrast Material on the Induction of DNA Damage by Cardiac CT

Sunday, Dec. 1 11:45AM - 11:55AM Room: S502AB

Participants
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PURPOSE

The purpose of this study was to assess the influence of different iodinated contrast materials on the induction of DNA damages and chromosome aberrations in peripheral blood lymphocytes after a cardiac CT examination.

METHOD AND MATERIALS

We obtained institutional review board approval and the written informed consent from 39 patients, who were prospectively enrolled in this study. All patients underwent contrast-enhanced cardiac CT examination. The type of contrast materials administrated to each patient was selected from iomeprol, iopamidol, and iopromide based on clinical decision. Blood samples were obtained before and 15 min after CT scan. The number of γ-H2AX foci, maker of DNA damages, and chromosome aberrations in lymphocytes was quantified by immunofluorescent staining of γ-H2AX and by fluorescence in situ hybridization using PNA probes, respectively. Significant differences between the number of foci were tested by using Kruskal-wallis test.

RESULTS

Iomeprol, iopamidol, or iopromide was applied to 13, 20, 6 patients, respectively. There were no significant difference in the patient characteristics and radiation dose of each group, except patient body weight which was considered for the selection of contrast materials. There were no significant difference in the DLP standardized increment of γH2AX foci and chromosome aberrations ($p= 0.55$ and $p=0.37$, respectively).

CONCLUSION

There were no significant difference in the increment of DNA damages and chromosome aberrations by cardiac CT scan with three different iodinated contrast material.

CLINICAL RELEVANCE/APPLICATION

The difference of contrast materials did not affect the enhancement of DNA damage by CT scan.

SSA23-08 Assessment of DNA Damage Induced by Different Tube Voltage CT Scan Using γH2AX Focus Assay

Sunday, Dec. 1 11:55AM - 12:05PM Room: S502AB

Participants
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PURPOSE

The purpose of this study was to assess the effect of CT examination with different tube voltage on the induction of DNA damages in peripheral blood lymphocytes.

METHOD AND MATERIALS

We obtained blood samples from five healthy volunteers. Each sample was divided and exposed to CT scans at a sham (0 mGy), low-dose (10 mGy), standard-dose (40 mGy), or high-dose (200 mGy) with different tube voltages (80, 100, 120, and 135 kVp). To equalize the exposed dose at different tube voltages, we adjusted the scan parameters by using a dosimeter. After irradiation, lymphocytes were isolated and subjected to immunofluorescent staining using anti-γH2AX antibodies. The number of γH2AX foci in at least 4,000 lymphocytes was counted automatically with fluorescence microscopy. Significant differences between the numbers of foci were tested by using Friedman test.

RESULTS

The number of γH2AX foci were significantly increased from baseline level after standard- and high-dose exposure. The difference of tube voltages did not affect the increase of γH2AX foci at low- and standard-dose exposure. At high-dose exposure, the increase of γH2AX foci with 135 kVp was significantly higher than those with 80 and 100 kVp.

CONCLUSION

There was a significant difference at the higher dose exposure than clinical usage. The difference of tube voltage, however, did not affect the increase of γH2AX foci after exposure within the dose range in common clinical settings.

CLINICAL RELEVANCE/APPLICATION

Our results may support the safety of low tube voltage CT scan.

SSA23-09 Explore Immunological Biomarkers by Low Dose Radiation Exposure: Preliminary Results in Animal

Study

Sunday, Dec. 1 12:05PM - 12:15PM Room: S502AB

Participants
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PURPOSE

To explore immunological biomarkers by low dose radiation exposure in animal experiment

METHOD AND MATERIALS

Five- to seven-week-old male BALB/C mice were irradiated with different doses (0.1, 0.5, 1, 2 Gy) using irradiator x-rad 320 (Precision, USA). Mice were sacrificed 0.5, 12, 24, and 48 hours (hr) after irradiation and the spleen was harvested. Lymphocytes were isolated from the spleen and DNA double strand break down (DSB) was assessed by immunohistochemistry of r-H2A.X. Cell viability was assessed by CCK-8 assay according to exposed radiation dose and time lapse from the irradiation. Inflammatory cytokines including interleukin 6 (IL-6), IL-1a and tumor necrosis factor a (TNF-a) were measured with real time PCR. Statistical analysis was performed with Kruskal-Wallis test and P value greater than 0.05 was considered as statistically significant.

RESULTS

The number of DSB in DNA increased as increasing exposed radiation dose (1.8±0.8 in 0.1 Gy, 3.8±1.5 in 0.5 Gy, 5.7±1.3 in 1 Gy, 10±3.1 in 2 Gy, $P<0.001$, compared to control: 1.0). Cell viability was significantly reduced as increasing exposed radiation dose ($P<0.01$). The decrease in cell viability was 48 hr less than 12 and 24 hr after irradiation, possibly due to proliferation of viable cells. IL-6 level was significantly increased even after lowest dose exposure (0.1 Gy) both in 24 and 48 hr after irradiation (0.1 Gy:0.5 Gy:1 Gy:2 Gy; 2.0±0.5: 2.6±0.2: 2.3±0.2: 2.0±0.8 in 24 hr; 1.7±0.4: 1.8±0.6: 2.0±0.4: 3.0±0.6 in 48 hr, compared to control: 1.0), whereas TNF- a was significantly increased only when the cells were exposed to 2 Gy of radiation (1.6±0.6 in 24hr; 1.9±0.4 in 48 hr, compared to control: 1.0). There was no significant difference in IL-1a compared to control at all irradiated doses and elapsed time after irradiation.

CONCLUSION

Pro-inflammatory cytokine IL-6 can be a biomarker of DNA damage to low dose radiation exposure.

CLINICAL RELEVANCE/APPLICATION

IL-6 can be used as a biomarker for monitoring of DNA damage caused by low dose radiation exposure during the development of radiation protection strategies

Printed on: 10/29/20

SSA24

Vascular/Interventional (Liver Cancer Science)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S404CD

CH CT IR SQ VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSA24-01 Safety of Shortened Observation Time Without Radiographic Follow-Up for Patients After CT-Guided Lung Biopsy

Sunday, Dec. 1 10:45AM - 10:55AM Room: S404CD

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PURPOSE

To determine safety of shortened observation without follow up chest X-ray (CXR) after CT-guided lung biopsy in patients without immediate post-procedure pneumothorax (PTX).

METHOD AND MATERIALS

Consecutive patients that underwent CT-guided lung biopsies under moderate sedation between 01/05/2015 and 06/19/2017 in a tertiary academic center were included in this IRB-approved HIPAA-compliant study. "Immediate post-procedure PTX" was defined as one detected by CT at the end of the biopsy; "observation PTX" and "delayed PTX" defined as pneumothorax detected by CXR during and after the post-procedural monitoring period, respectively.

RESULTS

441 lung biopsies for 409 patients (average age 68 ± 11yrs, 231 (56%) female patients) were performed; 76 biopsies were excluded due to immediate post-procedure PTX, 6 due to insufficient documentation in the electronic medical records and 6 due to lack of follow up after biopsy. Average duration of monitoring for outpatients (n=293) was 2.01 ± 0.74 hrs . In 20/353 (5.7%) biopsies, the patient became symptomatic (chest pain, shortness of breath) during post-procedural observation with 1/20 (5%) developing PTX. In 313/333 biopsies, the asymptomatic patients did not undergo CXR after the procedure, with 7/309 of these patients (2.3%) developing delayed PTX 2-10 days after the procedure (average 4.9 ± 4.0 days). In 24/333 biopsies (7.2%), the asymptomatic patients underwent CXR within 4 hours with no PTX detected and despite that 1/24 of these patients (4.2%) presented with delayed PTX 7 days after the procedure. When no immediate post procedural PTX was present, the rate of observation PTX and delayed PTX was 1/353 (0.3%) and 8/353 (2.3%), respectively.

CONCLUSION

Obtaining routine post-procedure CXRs in patients without immediate post-procedural PTX after CT-guided lung biopsies is not necessary given the low likelihood of PTX. Furthermore, shortening monitoring to 2 hour appears to be safe for these patients.

CLINICAL RELEVANCE/APPLICATION

A decrease in observation time for these subset of patients will allow improved utilization of hospital resources.

SSA24-02 Transthoracic Ultrasound Guided Lung Biopsy: Accuracy and Safety

Sunday, Dec. 1 10:55AM - 11:05AM Room: S404CD

Participants
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PURPOSE

Variables affecting performance of ultrasound-guided transthoracic needle biopsy (USG-TTNB) are not well established. The aim is to determine the clinical and imagery variables affecting sensitivity and rate of complications with USG-TTNB.

METHOD AND MATERIALS

From 2008 to 2017, a total of 542 consecutive USG-TTNB were reviewed. Mediastinal and chest wall lesions were excluded. 14 patients had incomplete data. Cubic splines were used to test the functional relationship between pleural contact length with sensitivity and complications. Multivariate logistic regression was used to account for possible confounding variables on that relationship.

RESULTS

Of the 528 biopsies, 312 diagnosis were obtained by USG-TTNB, including 285 malignant and 27 specific benign diagnosis, yielding a diagnostic accuracy of 59.2% (95%CI 54-62%) and sensitivity of 72.5% (95%CI 68-77%), respectively. Positive biopsies were associated with lesion size (p<0.001), pleural contact length (p<0.006), absence of pneumothorax (p=0.001), chest wall invasion (p=0.005) and core biopsy needle <=18G versus >18G (p=0.024). Graphical inspection of a cubic spline showed that the probability of positive biopsies rose sharply for increasing pleural contact length up to 30 mm, then a flattening of risk. A similar reverse relationship was observed for pneumothorax. After adjusting for lesion size, chest wall invasion, and core biopsy needle, there was a significant effect of increasing pleural contact length up to 30 mm predicting positive biopsy (HR 1.07 {1.02, 1.12}, p=.002 per 1mm) with a non-significant effect of pleural contact size past 30 mm. Pneumothorax occurred in 14.6% (95%CI 11.7-17.9%) and chest tube was placed in 1.7% (95%CI 0.8-3.2). Variables associated with pneumothorax were lesion size (p<0.001), pleural contact length (p<0.001) and upper/middle lobes (p=0.002). On multivariate analysis, none of the above were significant at 5% level. No variables were associated with hemorrhagic complications, which occurred in in 3.3% (95%CI 1.8-4.8).

CONCLUSION

Pleural contact length and target lesion size were the key variables predicting diagnostic accuracy and pneumothorax rate.

CLINICAL RELEVANCE/APPLICATION

Efficacy and safety outcomes are both affected by pleural contact length and lesion size. Therefore, choosing US-TTNB as a diagnostic procedure must consider these variables.

SSA24-03 Ultrasound- versus CT-Guided Peripheral Lung Biopsies: A Comparison of Safety, Effectiveness, and Wait Times

Sunday, Dec. 1 11:05AM - 11:15AM Room: S404CD

Participants
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PURPOSE

To compare the safety, effectiveness and wait times of CT-guided percutaneous lung biopsies with ultrasound (US) guidance for peripheral lung lesions that abut or arise from the pleura.

METHOD AND MATERIALS

Consecutive CT- and US-guided biopsies performed at our institution between January 2017-January 2019 were retrospectively reviewed. Lesion size, the degree of pleural contact, wait time for the procedure, the number of needle passes, procedure duration, complications and final pathology diagnosis were recorded. Chi-square and Mann-Whitney U tests were used for statistical analysis. Research ethics board approval was obtained.

RESULTS

A total of 228 imaging-guided lung biopsies were performed by 5 interventional radiologists. Of these, 117 were for peripheral or pleural-based lesions. US guidance was used for 38 cases (20 men, 18 women, mean age 71.1). CT guidance was used for 70 cases (39 men, 40 women, mean age 69.9). Overall, the mean maximum axial diameter of pulmonary lesions sampled under US guidance was greater than for CT (4.8±2.5 cm vs 3.7±1.8 cm, p = 0.007). Similarly, the length of pleural contact was also greater for US (4.1±2.4 cm) than CT (2.6±1.7 cm, p < 0.001). Procedure time was shorter for lesions localized with US than CT (28.7±16.9 min vs 36.6±20.2 min, p = 0.017). In contrast, the mean number of needle passes per lesion was less for CT than US (3.1±0.9 vs 3.5±1.1, p = 0.019). The adequacy of biopsy samples was determined to be equivalent for both modalities (97.4% for US and 97.5% for CT). The wait time for both procedures was not significantly different (11.7±8.3 days for US vs 14.9±8.0 days for CT, p = 0.059). Finally, the frequency of significant complications requiring chest tube insertion and/or hospital admission was similar between US and CT (2.6% vs 3.8%).

CONCLUSION

US-guided peripheral lung biopsies are safe and reliable with comparable results to CT-guided biopsies and similar wait times, but

US-guided peripheral lung biopsies are safe and reliable with comparable results to CT-guided biopsies and similar wait times, but shorter procedure times.

CLINICAL RELEVANCE/APPLICATION

US is relatively low cost, does not require ionizing radiation and allows for real-time needle visualization, making it a viable alternative to CT guidance for biopsy of peripheral lung lesions.

SSA24-04 CT-Guided Percutaneous Biopsy of Ever Smaller Lung Nodules: Diagnostic Yield and Complication Rate as a Function of Nodule Size

Sunday, Dec. 1 11:15AM - 11:25AM Room: S404CD

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PURPOSE

The number of CT-guided percutaneous lung biopsies performed is rapidly growning, in part due to the advent of lung cancer screening CT. However, not only are we performing more lung biopsies, but we are biopsying ever smaller nodules. Given that subcentimeter nodules have not routinely been biopsied, the diagnostic yield and complication rates are not known. The purpose of this project was to evaluate the diagnostic yield and complication rate of percutaneous lung biopsy as a function of nodule size.

METHOD AND MATERIALS

This IRB approved study involved retrospective review of 625 patients who underwent percutaneous, CT-guided lung biopsy. Patients were identified via search of our electronic medical records system (Montage). Biopsies were performed by one of fifteen attending radiologists specializing either in interventional radiology or body imaging. Data recorded included nodule size, distance from the pleura, needle type, number of passes peformed, pneumothorax rate, chest tube rate, hospital admission rate, diagnostic yield as well as history of smoking or prior malignancy.

RESULTS

Overall, a diagnostic specimen was obtained in 91.5% of patients (572/625). However, diagnotic yield for lesions <1 was 80% compared to 92.1% for nodules > 1 cm ($p < 0.05$). For every 1 cm increase in lesion size, the odds of achieving a diagnsotic specimen increased 21% ($p < 0.05$). Pneumothorax complicated 11% of biopsies (69/625) and 5.6% of patients (35/625) required chest tube placement. However, 22.5% of procedures were complicated by pneumothorax when lesions were <1 cm, compared to 10.3% of procedures when the nodule was >1 cm ($p < 0.05$). For every 1 cm increase in nodule size, the odds of pneumothorax decreased 24% ($p < 0.05$). Although there was no statistically significant difference in patients requiring chest tubes in the two groups, the odds of requiring a chest tube decreased 21% for ever 1 cm increase in lesion size ($p < 0.05$).

CONCLUSION

Percutaneous CT-guided lung biopsy is a safe and effective procedure, however the diagnsotic yield decreases and the complication rate increases as the size of the biopsy target decreases.

CLINICAL RELEVANCE/APPLICATION

As the number of CT-guided lung biopsies increases across the country it is crucial that physicians and patients understand that diagnostic yield and complication rates are directly related to nodule size.

SSA24-05 Efficacy of Thermal Ablation versus Stereotactic Radiotherapy for Stage I Lung Cancer: Subgroup Analyses Based on Tumor Histology

Sunday, Dec. 1 11:25AM - 11:35AM Room: S404CD

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PURPOSE

To assess the effectiveness of thermal ablation (TA) versus stereotactic body radiotherapy (SBRT) for stage I lung cancer depending on histology.

METHOD AND MATERIALS

The National Cancer Database was queried for patients with AJCC stage I lung cancer diagnosed from 2004-2015. Adenocarcinoma, squamous cell carcinoma (SCC), unspecified non-small cell lung cancer (NSCLC) und other histology (except carcinoid) were included. Treatment was stratified as TA (radiofrequency ablation, or grouped laser/cryo ablation) and SBRT (beam-based radiation of the lung). Patients age < 18yo, chemotherapy, and unknown survival /follow up were excluded. SBRT and TA patients were 5:1 propensity score matched to account for confounders, separately for each histology. Overall survival (OS) was compared in the matched cohort.

RESULTS

55,336 patients were included: n=68,693 receiving SBRT (97.3%) and n=1,836 receiving TA (2.7%). Histology was adenocarcinoma n=24,085 (35.1%), SCC n=20,736 (30.2%), NSCLC n=10,515 (15.3%), and other histology n=13,357 (19.4%). TA patients were more likely to be younger Caucasians with private insurance and more comorbidities and treated at academic centers in New England states for smaller adenocarcinomas.For each histology, a matched cohort was obtained with balanced distribution of confounders. TA and SBRT demonstrated comparable OS in all subgroups: adenocarcinoma (p=0.297; 1-year OS: 86 vs 86%; 3-year OS: 49 vs 52%), SCC (p=0.086; 1-year OS: 67 vs 67%; 3-year OS: 27 vs 30%), NSCLC (p=0.732; 1-year OS: 83 vs 83%; 3-year OS: 49 vs 47%), and other histologies (p=0.094; 1-year OS: 85 vs 83%; 3-year OS: 59 vs 50%).

CONCLUSION

Utilization of thermal ablation techniques for stage 1 lung cancer varies with tumor and patient variables. For adenocarcinomas, squamous cell carcinomas and tumors classified as unspecified NSCLC, overall survival was comparable for TA and SBRT. Future studies should prospectively evaluate optimal patient selection criteria in stage I lung cancer to offer individualized treatment approaches.

CLINICAL RELEVANCE/APPLICATION

Thermal ablation shows comparable OS to SBRT in stage I lung cancer and should be considered as an alternative treatment option, independent of histological subtype.

SSA24-06 Percutaneous Cryoablation of Lung Metastasis:15 Year Experience of Feasibility, Safety and Recurrence Parameters

Sunday, Dec. 1 11:35AM - 11:45AM Room: S404CD

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PURPOSE

To report our long-term experience with CT guided percutaneous cryoablation using intensive freeze parameters for lung metastasis, including factors affecting complications and local recurrence rates.

METHOD AND MATERIALS

Following IRB approval under HIPAA compliance, 192 CT fluoroscopic-guided, percutaneous cryoablation procedures were performed for 262 masses in 107 outpatients. Primary sites of lung metastasis included colorectal (N=57), renal cell carcinoma (N=38), sarcoma (N=103), gynecologic (N=17), hepatobiliary (N=8) and other (N=24). Tumor size and location (central vs peripheral) with relationship to major vasculature. Hydrodissection and/or were utilized for protection of adjacent structures (ie: esophagus). All complications were graded according to standardized CTCAE criteria. Patients were followed by CT and/or MRI at 1, 3, 6, 12, 18, 24 months and yearly thereafter.

RESULTS

Average tumor diameter of 2.0 cm was treated by average cryoprobe number of 3.1, which produced CT-visible ice ablation zone diameters averaging 4.1 cm. Grade >3 complications were 3.6% [N=7/192]. There were greater complications in tumors greater/less than 3 cm [9.8% (4/41) vs. 2.0%(3/151)], p<0.025). No deaths occurred in our series for ablation of metastatic lesions. Hydrodissection and/or warming catheter utilization was used in 7.8% (15/192). At a mean follow-up of 24 months, overall local tumor recurrence was 5.7%(15/262), but significantly greater for tumors above 3cm (i.e.,16% (7/44); p<0.005).

CONCLUSION

With appropriate pretreatment evaluation and PFT criteria, percutaneous lung cryoablation is safe and produces very low local recurrence rates, especially for tumors <3 cm.

CLINICAL RELEVANCE/APPLICATION

Appropriately delivered thoracic metastasis cryoablation is affected by tumor size yet still produces low recurrence and complication rates.

SSA24-07 Innovative Technique for CT-Guided Presurgical Lung Nodule Marking: High Efficacy and Safety

Sunday, Dec. 1 11:45AM - 11:55AM Room: S404CD

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PURPOSE

To assess outcomes of CT-guided localization for preoperative lung nodule marking prior to video-assisted thoracoscopic surgery and robotic video-assisted thoracoscopic surgery.

METHOD AND MATERIALS

25 CT-guided lung nodule localization procedures were performed on 26 nodules in 25 patients prior to surgical resection. The procedures were performed by a fellowship trained radiologist 1 to 2 hours prior to scheduled surgery under local anesthesia. Approximately 4 to 6 ml of methylene blue/collagen solution was injected in a perinodular location under CT-guidance with a 19g trocar needle. Post procedure CT images with increased perinodular consolidation confirmed appropriate marking. Patients were then transferred back to surgery.

RESULTS

Accurate perinodular CT- guided needle trocar placement was achieved in all marking procedures. Increased perinodular consolidation was also demonstrated in all patients on the post procedural localized CT scans. One patient with moderate emphysema developed a small to moderate sized pneumothorax and a 8F thoracentesis catheter was placed under CT guidance prior to return to surgery. There was no noted bleeding or hemoptysis in any of the patients. Methylene blue/collagen solution was readily visible by the thoracic surgeon in association with all target nodules. One patient required conversion to open procedure due to advanced disease. Of the 26 identified nodules, pathology specimens confirmed adequacy of nodule resection in all cases.

CONCLUSION

Intraoperative identification of pulmonary nodules/ tumors, especially deep nodules and patients undergoing VATS or robotic surgery, may be challenging. Perinodular localization by CT guided methylene blue/ collagen solution injection offers a safe technique with high efficacy.

CLINICAL RELEVANCE/APPLICATION

CT-guided methylene blue/ collagen localization allows thoracic surgeons to readily identify nodules/tumors, improve outcomes and decrease morbidity in patients undergoing thoracic surgery.

SSA24-08 Percutaneous CT-Guided Microwave Ablation of Non-Operable Pulmonary Metastases: Role of Apparent Diffusion Coefficient in Assessment Early Treatment Response

Sunday, Dec. 1 11:55AM - 12:05PM Room: S404CD

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PURPOSE

To determine retrospectively the early treatment response of MWA in patients with pulmonary metastases using Apparent diffusion coefficient(ADC) value.

METHOD AND MATERIALS

51 patients with 76 lung metastatic lesions were included &treated with MWA according to the guidelines. lesions were evaluated by diffusion weighted imaging (DWI) and ADC value before and 24 hours after MWA. DWI was obtained with b-values (50,400, 800:mm2/s) using 1.5& 3 tesla MRI. Postablation follow-up by chest CT and/or MRI with ADC value measurement was done after 24 hours, 3, 6 months, 1 year and every 6 months onwards to determine responsive and local progression cases with residual tumor activity.Immediate postablation changes in ADC values were compared to the net response based on CT and/or MRI follow-up

RESULTS

50 lesions(65.8%) showed complete response to treatment and 24 lesions(34.2%)with local progression.We reported statistical significance difference of ADC value measured 24 hours after ablation between the responding(1.7 ± 0.2x 10-3 mm2/s) and non-responding groups(1.4 ± 0.2x10 0-3 mm2/s) with significant relatively higher values at the former(P0.001); a cut-off ADC value (1.41) has been suggested as reference point to predict the response (66.65% Sensitivity, 84.22%Specificity, 66.72%PPV& 84.21%NPV). No significant difference of ADC value performed before the ablation as a prognostic factor for the response (P0.85). No significant difference in post- ablation ADC values of different types of pulmonary metastases (P 0.321)

CONCLUSION

ADC value calculated 24 hours post-treatment is a good quantitative measurement that may allow early prediction of the treatment efficacy of MWA of pulmonary metastases before changes in tumor size become detectable on Conventional CT or MRI.

CLINICAL RELEVANCE/APPLICATION

ADC can evaluate early MWA efficacy in treatment of pulmonary tumors and Can predict tumor recurrence after treatment.

ADC can evaluate early TACE efficacy in treatment of pulmonary tumors and can predict tumor recurrence after treatment.

SSA24-09 Palliative Role of Non-Selective Intra-Aortic Transarterial Chemoperfusion (TACP) in the Management of Inoperable Cases of Advanced Lung Cancer

Sunday, Dec. 1 12:05PM - 12:15PM Room: S404CD

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PURPOSE

To evaluate the initial tumor response, local control, and survival after the treatment of primary lung malignancies using non-selective intra-aortic transarterial chemoperfusion (TACP) in palliative intent.

METHOD AND MATERIALS

Forty-two patients (mean: 63±11 years; 19 females and 23 males) with advanced unresectable lung cancer (stage III=8 & stage IV=34), underwent repetitive TACP, as third- or further-line therapy, between November 2006 and January 2016. The mean number of sessions was 5.3±2.5. The treated pathologies were non-small cell lung cancer (n=29), small cell lung cancer (n=1) and 12 cases of bronchogenic carcinoma with unknown histology. Bilateral lung involvement was present in 61.9% of cases and the median number of lesions was four. Regional delivery was achieved by injecting the chemotherapeutic agents intra-aortic, as a bolus with maximum hand pressure, in close vicinity to the origins of the main tumor-supplying arteries. The treatment regimen included a combination of mitomycin C and Gemcitabine with (n=37) or without cisplatin (n= 3). Two patients received other combinations after their oncologists' recommendations. The treatment was performed in a palliative setting and patients who underwent subsequent ablation were excluded. The response was evaluated according to the revised RECIST criteria and local tumor progression and patient survival were analyzed using the Kaplan-Meier estimator.

RESULTS

Partial response (PR) was achieved in 4.8% (n=2), stable disease (SD) in 69% (n=29) and progressive disease (PD) in 26.2% (n=11). The estimated mean survival time (MST), median survival time and mean and median time to progression were 20±5.5, 9.5±0.6, 10.7±1.8 and 6.7±2.2 months, respectively. Technical success was achieved in all patients and no intervention-related complications were recorded.

CONCLUSION

Transarterial chemoperfusion is a feasible and well-tolerated treatment in patients with advanced lung cancer who failed prior systemic chemotherapy and have the potential to improve local control and survival, when compared to the published results of other third - and further-line therapies.

CLINICAL RELEVANCE/APPLICATION

TACP is a minimally invasive treatment option that can positively affect the local control and survival in patients with advanced lung cancer.

SSA25

Vascular/Interventional (Embolization)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S405AB

IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSA25-01 Hepatic Pseudoaneurysm Formation after Blunt and Penetrating Traumatic Liver Injury: A Level 1 Trauma Centre Experience

Sunday, Dec. 1 10:45AM - 10:55AM Room: S405AB

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PURPOSE

At our institution, we have developed an imaging protocol for liver injury patients which involves repeat computed tomographic (CT) angiography of the liver at 48-72 hours to assess specifically for HPAs. The purpose of this study was to evaluate the utility of our imaging pathway in liver trauma with a focus on detection of hepatic pseudoaneurysms (HPAs).

METHOD AND MATERIALS

A retrospective analysis was performed on patients who were admitted to St Mary's Hospital, London over a four-year period found to have either blunt or penetrating liver injury on initial CT imagining. Data collection included initial and follow-up CT findings, mechanism of injury, injury severity score (ISS), American Association for the Surgery of Trauma (AAST) liver injury score and further intervention.

RESULTS

Between January 2014 and January 2018, 149 major trauma patients were admitted with liver injuries (mean age 35.6 years; 72% male, 28% female). 72% patients suffered blunt (mean ISS=27.2; mean AAST=2.89) and 28% patients suffered penetrating injuries (mean ISS=26.9; mean AAST=2.88). Mean time to follow up CT was 46.05 hours. Follow-up CT identified 8 HPAs (62.5% blunt vs 37.5% penetrating injuries) and 1 (0.671%) arteriovenous malformation. 6 (4.03%) of these patients were treated with embolisation. ISS and AAST did not predict pseudoaneurysm formation according to logistic regression analysis. ISS (OR 1.06 [1.02, 1.09; p=0.002]) and AAST (OR 2.24, [1.31, 3.83; p=0.003]) were predictors of requirement for embolisation.

CONCLUSION

Our experience indicates a role for early detection of HPAs using a dedicated trauma imaging pathway. Interestingly, ISS and AAST are predictors for patients who will undergo interventional radiology procedures and could be used to stratify patients who should be planned for interventional procedures.

CLINICAL RELEVANCE/APPLICATION

Hepatic pseudoaneurysm (HPA) is a rare but potentially life-threatening sequelae of blunt or penetrating liver trauma.

SSA25-02 Performance of a Novel, Bioengineered, Retrievable Endovascular Gel Embolic in a Swine Model: Long Term Survival Data

Sunday, Dec. 1 10:55AM - 11:05AM Room: S405AB

Participants
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PURPOSE

Coil embolization is used today to treat hemorrhage resulting from trauma, aneurysm rupture, or bleeding tumor. However, these coils are often ineffective in a state of anticoagulation. The purpose of this study was to study the long term effects of embolization using a bioengineered gel embolic material in a swine model.

METHOD AND MATERIALS

Yorkshire pigs weighing 50-60kg were used and anticoagulated with IV heparin (ACT 250-500). Briefly, via carotid artery access under US guidance, a catheter was delivered to the pelvic arteries or renal arteries. On one side, coil embolization was performed. On the other side, approximately 3 cc of the embolic material was injected. On day of sacrifice, Day 0, Day 7, Day 14 and Day 28, all animals underwent CTA using a Force CT scanner and embolized arteries were harvested and histology was performed. CBC, Chem-7, coagulation tests, cytokine arrays were performed pre and post embolization. Extensive image analysis was performed using standard CT scanner and a high resolution micro-CT scanner.

RESULTS

Arteries embolized with all types of coils demonstrated persistent flow. Arteries embolized with 3 cc of biomaterials achieved instant hemostasis and complete embolization regardless of anticoagulation state. Injection of 1-2 cc of biomaterial to the coiled arteries was able to rescue and achieve instant hemostasis. In addition, injected biomaterial could be successfully retrieved. Embolization with biomaterial was 40X faster than with coils ($P<0.05$). Histology of the embolized arteries demonstrated complete filling of the artery; however, there was progressive biodegradation of the biomaterial over time with its replacement with fibrotic tissue. CBC and chemistry labs as well as inflammatory markers were not significantly different pre and post embolization ($P<0.05$). Scanning electron microscope images, micro-CT and CT analysis of the embolized arteries showed absence of recanalization of the biomaterial.

CONCLUSION

Novel gel embolic outperforms coil technologies in every aspect tested. Biomaterials can also be retrieved suggesting that temporary embolization could be possible.

CLINICAL RELEVANCE/APPLICATION

We present data on >130 embolized swine arteries and demonstrate its superiority over coils and their efficacy. This biocompatible biomaterial is also easy to deliver and easy to use compared to coils.

SSA25-03 Selective Bariatric Arterial Embolization with Calibrated 100-200 µm Radiopaque Microspheres Suppresses Weight Gain in Swine

Sunday, Dec. 1 11:05AM - 11:15AM Room: S405AB

Participants
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PURPOSE

To assess whether calibrated radiopaque microspheres used for bariatric arterial embolization (BAE) enable fundal coverage assessment and weight gain suppression over an 8-week period in swine.

METHOD AND MATERIALS

BAE was performed in 5 healthy swine (~23kg) under X-ray guidance by selective infusion of calibrated 100-200 µm radiopaque microsphere (BTG) into the left gastroepiploic artery and right gastric artery. Control pigs (n=3) underwent a sham procedure. Weight was obtained at baseline and weekly until 8 weeks after embolization. Cone beam CT (CBCT) images of the stomachs were acquired immediately after embolization, at 8 weeks prior to sacrifice and postmortem to examine the persistence of embolic microspheres. Endoscopy was performed at 1-2 weeks after embolization to examine mucosal ulceration. Plasma ghrelin levels were assessed using a radioimmunoassay.

RESULTS

BAE with radiopaque microspheres was technically feasible in all embolized animals with the visualization of microspheres on both X-ray and CBCT during the procedure and up to 8 weeks after embolization. Superficial mild mucosal ulcers restricted mainly to the stomach fundus and body were noted in all BAE pigs. One BAE animal had minimal embolics delivered in the fundus as assessed by CBCTs with concurrent normal weight gain as control pigs. Overall, a significant reduction of the percentage of weight gain was noted in embolized pigs as compared to controls (42.3% ± 5.7 BAE vs. 51.6% ± 2.9 controls, $p=0.04$). Similarly, the plasma ghrelin levels of embolized animals were significantly lower than those of controls (1709 ± 172 BAE vs. 4343 ± 1555 controls at 8 weeks, $p<0.01$).

CONCLUSION

The radiopacity of the embolics enabled qualitative assessment of the fundal coverage. The significantly suppressed percentages of

weight gain and systemic plasma ghrelin levels suggests that the calibrated 100-200 µm microspheres may be the optimal embolics for effective weight management via BAE.

CLINICAL RELEVANCE/APPLICATION

Calibrated radiopaque microspheres could facilitate image-guided BAE for treating obesity.

SSA25-04 Digital Subtraction Angiography versus Digital Variance Angiography for Image Guidance of Prostatic Artery Embolization (PAE)

Sunday, Dec. 1 11:15AM - 11:25AM Room: S405AB

Participants
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PURPOSE

Kinetic imaging is defined as a novel X-ray image processing method for the visualization of contrast motion. The algorithm produces so-called Digital Variance Angiography (DVA) images. The study objective was to compare the performance of DVA versus standard digital subtraction angiography (DSA) for vascular intervention in Prostatic Artery Embolization (PAE) of benign prostatic hyperplasia.

METHOD AND MATERIALS

81 angiographic acquisitions of 26 patients (mean age 67.47, SD 9.76, range 42-82) undergoing PAE at our institution were evaluated. Signal-to-noise ratio (SNR) of DSA and DVA pairs was compared using regions of interest. Comparison of clinical image quality was performed by three experienced interventional radiologists in a randomized blinded trial comparing the DSA- and DVA-videos, using a 5-point-Likert-scale consisting of clinically relevant criteria (e.g. visibility of feeding- and collateral-branches, size of examinable arteries). Fleiss' kappa-test was used to determine interrater agreement.

RESULTS

DVA images provided 1.79 times higher SNR than DSA (median value, Q1-Q3 interval was 1.46-2- 32). The visual evaluation indicated that DVA-videos provided higher quality images than DSA-videos, since in 80.6% of comparisons evaluators preferred DVA over DSA. The interrater agreement was 83.8% and Fleiss's kappa was 0.38 ($p<0.001$).

CONCLUSION

In PAE setting, DVA-imaging enhances visualization of anatomical structures, compared to DSA- imaging, via significant SNR increase, thereby the new technology might improve the safety and efficacy of the intervention. As an additional advantage, the observed quality reserve of DVA might provide opportunity also for the reduction of radiation-dose and the amount of contrast agent, as an attempt to solve these major issues related to PAE procedures.

CLINICAL RELEVANCE/APPLICATION

DVA may improve safety and confidence during PAE interventions, by reducing image-noise and enhancing the visibility of small vascular structures, thus facilitating the reduction of radiation-dose and contrast agent, which is one of the major concerns for safety of PAE interventions.

SSA25-06 Detection of Reperfused Pulmonary Arteriovenous Malformations on Dynamic Ultrafast Contrast Enhanced Magnetic-Resonance-Angiography (MRA) and High Resolution Static CE MRA

Sunday, Dec. 1 11:35AM - 11:45AM Room: S405AB

Participants
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PURPOSE

The recommended treatment of pulmonary AV-Malformations in patients with HHT (Osler disease) is catheter embolization using platinum coils or vascular plugs. However, in up to 30 percent of patients, reperfusion may occur due to opening of collateral vessels or reopening of the treated vessel itself.The aim of our study was to investigate patients post treatment of pulmonary

AVM's for possible reperfusion using dynamic and high resolution CE MRA.

METHOD AND MATERIALS

72 patients with previous treatment of PAVMs by either coil embolization or implantation of Amplatzer vascular plugs underwent follow-up studies for detection of reperfused PAVM by contrast enhanced MRA. A time-resolved MRA-study was performed with injection of a small contrast medium bolus (0.025 mmol/kg BW MultiHance, Bracco). The temporal resolution of the sequence was < 3 sec/dataset with a total number of 72 slices. Thereafter a high resolution CE MRA (0.075 mmol/kg BW MultiHance) was performed. Images were evaluated regarding enhancement of the AVM and if detected, time of enhancement of the draining vein was further evaluated.

RESULTS

In 22 pts 33 reperfused PAVM were diagnosed based on both time-resolved and high-resolution MRA. If findings were unclear on high resolution images, evaluation of the enhancement kinetics of the draining vein was helpful to distinguish between retrograde filling, filling of the still dilated draining vein via normal lung tissue and reperfusion by reopening of shunt vessels or new collateral supply. All reperfused PAVM were confirmed by DSA and underwent reembolization. The mean diameter of reperfused vessels was 4.5 mm (SD 1.4). Reperfusion was detected both after coil embolization and implantation of Amplatzer vascular plug 4. Interestingly reperfusion may even occur after longer time intervals of completely occluded vessels.

CONCLUSION

Contrast-enhanced MR-Angiography can reliably depict reperfusion / recanalization of treated PAVM. Reperfusion might even occur after longer time intervals after initial complete occlusion, thus regular follow-up studies are mandatory.

CLINICAL RELEVANCE/APPLICATION

Reperfusion of PAVM can occur in up to 30 percent of cases and early detection is mandatory to avoidcomplications. Dynamic CE MRA directly depicts early enhancement of the draining vein as a sign ofreperfusion and thus can give important additional information not gained in conventional acquisitions or CT.

SSA25-07 Quantitative 2D DSA: A Novel Method for Determining Treatment Endpoints during Transarterial Embolization

Sunday, Dec. 1 11:45AM - 11:55AM Room: S405AB

Participants
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PURPOSE

Treatment endpoints during transarterial embolization (TAE) are subjective and rely on visual recognition of contrast stasis post-embolization. 2D DSA provides the necessary spatial resolution and dynamic contrast information to visualize the hepatic vasculature during liver-directed therapies. This study sought to evaluate temporal 2D DSA velocity variations and contrast stasis post injection as quantitative endpoints during TAE.

METHOD AND MATERIALS

A left hepatic TAE was performed to complete stasis on an ~50kg female domestic swine using 100-300 µm microspheres. 2D DSA velocity and pulsatility persistence values (n=3 each per time point) were evaluated on two projection angles before (time point 1), sequentially during (time points 2 & 3) and after TAE (time point 4). For the 2D DSA acquisitions, iodinated contrast medium was injected at 2.5 mL/s for 15 mL with respiration suspended. Velocity was derived from a shifted least-square method that relies on the pulsatility of opacified blood from an intra-arterial iodine injection. Pulsatility persistence (contrast stasis metric) was defined as the time interval between the final left hepatic (LH) contrast peak (50% greater than baseline) and the time of common hepatic artery (CHA) contrast clearance.

RESULTS

Sequential 2D DSA velocity measurements during TAE (time points 2 & 3) decreased on both projection angles. The average variation of velocity was 3.1% for the first 3 time points and 20.4% for the final time point. Velocity was not accurately quantified on the final time point when stasis was achieved due to reflux disturbing the baseline pulsatility. The average contrast clearance time calculated for the CHA was 10.0 ± 0.2 sec. Pulsatility persistence was zero for the first 2 time points, increased on the 3rd time point and was highest on the 4th time point when stasis was reached.

CONCLUSION

2D DSA can provide quantitative measurements of velocity and pulsatility persistence in vivo. A combination of these metrics could help define more objective endpoints during TAE.

CLINICAL RELEVANCE/APPLICATION

2D DSA velocity, when combined with pulsatility persistence post contrast injection, may facilitate development of quantitative endpoints for transarterial embolization.

SSA25-08 Emergency Endovascular Treatments for Delayed Hemorrhage after Pancreaticobiliary Surgery: Indications, Outcomes and Follow-Up of a Retrospective Cohort

Sunday, Dec. 1 11:55AM - 12:05PM Room: S405AB

Participants

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PURPOSE

To evaluate the outcomes of emergency endovascular treatments for delayed bleeding after pancreaticobiliary surgery.

METHOD AND MATERIALS

We retrospectively evaluated 21 patients (M:F=13:8, median age=64 years) undergoing 23 endovascular treatments, performed from 2010 to 2017 in a single center. Data collected were: patient characteristics; surgery; pathology; incidence of postoperative pancreatic fistulas (POPF); bleeding signs on CT and angiography; damaged artery; endovascular tools used; technical and clinical success; intervals between surgery, endovascular treatment and discharge; survival rates. Sixteen patients had pancreatoduodenectomy, three hepaticojejunostomy, two distal pancreatectomy. Indications to surgery were mainly biliary (33%), pancreatic (19%) or duodenal (10%) malignancies.

RESULTS

Seventeen patients had 'grade C' POPF, three suffered a biliary leak, one had no POPF. Active bleeding was present in 17/23 CTs and in 22/23 angiographies, mostly from hepatic (43%), gastroduodenal (22%) and splenic (13%) arteries. Embolizations were performed with coils (26%), glue (22%), stent-graft or vascular prostheses (22%) and their combinations (30%). Sixteen patients had a single endovascular treatment, one underwent a second embolization, three had surgery, one had repeat embolization followed by surgery. Relaparotomy rate was 19%. Median hospital stay was 37 days (range 12-75); median intervals among pancreaticobiliary surgery, endovascular treatment and discharge were 21 (2-36) and 12 (8-47) days, respectively. We observed 4/21 intrahospital deaths (median: 31 days from endovascular treatment, 4-53); one-year survival rate of discharged patients was 71%.

CONCLUSION

In our experience, endovascular treatment using embolization and/or stent-graft placement is a useful first-line intervention to halt postoperative hemorrhage after pancreaticobiliary surgery.

CLINICAL RELEVANCE/APPLICATION

Avoiding hazardous relaparotomy, the endovascular treatment should be considered the first-line intervention for patients suffering from delayed hemorrhage after pancreaticobiliary surgery.

SSA25-09 4D-Cone Beam Computed Tomography(4D-CBCT) for Image Guidance during Prostatic Artery Embolization (PAE): Feasibility and Comparison to Magnetic Resonance Angiography (MRA)

Sunday, Dec. 1 12:05PM - 12:15PM Room: S405AB

Participants
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PURPOSE

To evaluate pelvic 4-Dimensional-ConeBeamComputedTomography (4D-CBCT)-DigitalSubtractionAngiography (DSA) for intraprocedural application of prostatic artery embolization (PAE). Our aim was to test this novel techniques performance against established preinterventional MagneticResonanceAngiography(MRA).

METHOD AND MATERIALS

21 patients(age range: 47-81years; mean: 66years) undergoing PAE at our institution were included. 4D-CBCT volumes were reconstructed from a single contrast-injection 5-second-conebeamCT run, which was using the altered locoregional distribution of contrast-agent between the volumes' single images, to calculate visualization of real-time temporal-resolution DSA. Image-quality of 4D-CBCT was compared by three independent readers to established prostatic MR-angiography in terms of visualization of prostatic vessels, collaterals to neighboring organs, reproducibility of image-quality(IQ) and general, or contralateral, prostatic parenchymal enhancement prior to embolization.

RESULTS

Success rates of MRA-acquisitions in identifying feeding vessels were 17 of 21 versus 28 of 29 4D-CBCT-acquisitions. In 12 patients 4D-CBCT provided additional information compared to MRA, which influenced the treatment decision in 9 cases of 21 patients, by dynamically visualizing crossflow, anatomical variants of prostatic arteries, preventing potential nontarget embolization. Variants in blood-supply were found in 6 patients, multiple feeding prostatic arteries in in 4 patients and contralateral perfusion in 2 patients. Prostatic perfusion was confirmed before embolization for all patients. Spatial resolution of 4D-CBCT was 0.1mm compared to 0.9mm for the MRA.

CONCLUSION

Time-resolved 4D-CBCT is a feasible method to create vascular volumes with exceeding image-quality for PAE-procedures, compared to common MRA and DSA alone. The 4D-CBCTs maximum-intensity-projections' spatial- and temporal-resolution surpasses that of MRA-acquisitions especially with small vessels, such as the prostatic arteries, also with a higher contrast compared to conventional DSA.

CLINICAL RELEVANCE/APPLICATION

4D-CBCT is a novel approach for intraprocedural image guidance during prostatic artery embolization, that generates additional information and safety, compared to MRA and DSA alone.

Printed on: 10/29/20

SSC01

Cardiac (CT: Fractional Flow Reserve)

Monday, Dec. 2 10:30AM - 12:00PM Room: S402AB

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC01-01 CAD-RADS in the Era of FFR-CT - An Observational Study in an Acute Chest Pain Population

Monday, Dec. 2 10:30AM - 10:40AM Room: S402AB

Participants
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PURPOSE

CAD-RADS (Coronary Artery Disease Reporting and Data System) is increasingly used to communicate findings at coronary computed tomography angiography (CTA) in a standardized fashion. The aim of this study was to investigate the impact of fractional flow reserve (FFR-CT) derived from CTA on CAD-RADS stratifications in patients presenting with acute chest pain.

METHOD AND MATERIALS

This observational, retrospective study was approved by the institutional review board. FFR-CT analysis was included in the diagnostic workup of 42 patients (mean age 63.6 ± 11.2 years) who presented to the emergency department (ED) with acute chest pain and were referred for CTA. We evaluated the rate of CAD-RADS reclassifications from initial interpretation of the CTA study alone to until after FFR-CT (HeartFlow, Redwood City, CA) results were revealed. Other recorded data included downstream resource use and 90-day clinical outcomes.

RESULTS

Four patients (10%) were initially classified as CAD-RADS 2 (i.e., mild stenosis not warranting further work-up), 29 (69%) as CAD-RADS 3 (i.e., moderate stenosis requiring functional assessment), and 9 (21%) as CAD-RADS 4 (i.e., severe stenosis requiring intervention), based on CTA alone. CAD-RADS 2 classifications (4 of 4) all remained concordant between CTA alone and with FFR-CT results added. Similarly, only limited reclassification (11%) occurred in CAD-RADS 4 patients, where CTA and FFR-CT results agreed in 8/9 patients. However, in patients with CAD-RADS 3, 55% (18/29) were reclassified to CAD-RADS 4 or CAD-RADS 2 after FFR-CT results were revealed. This assessment may have decreased the rate of additional diagnostic testing by 45%. No clinical events occurred in the group of patients with FFR-CT > 0.80 within 90 days.

CONCLUSION

Adding FFR-CT analysis in patients presenting with acute chest pain substantially decreases equivocality in CTA interpretation, drastically reduces CAD-RADS 3 classifications, and has potential to obviate unnecessary downstream testing. One should consider an update to the CAD-RADS classification to account for the availability of FFR-CT.

CLINICAL RELEVANCE/APPLICATION

Adding FFR-CT analysis in patients presenting with acute chest pain rationalizes patient management and has potential to obviate unnecessary downstream testing.

SSC01-02 Diagnostic Performance of a Machine Learning FFRct Prototype Across Multiple CT Vendors

Monday, Dec. 2 10:40AM - 10:50AM Room: S402AB

Participants
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PURPOSE

Recent studies have demonstrated that a prototype machine learning based computed fractional flow reserve (ML-FFR) algorithm significantly boosts the diagnostic performance of coronary computed tomography (CCTA). However, this data is based on results from a single CT vendor, limiting generalizability. We sought to determine the diagnostic performance of a prototype ML-FFR algorithm on CCTA datasets acquired from multiple CT vendors.

METHOD AND MATERIALS

This was a multicenter retrospective study of patients in a large integrated health system undergoing both CCTA and invasive FFR/iFR within 45 days. The study cohort consisted of 110 patients and a total of 120 vessels. Measurement of ML-FFR was performed using workstation-based software, with blinding to the invasive FFR/iFR results. CT scanners were dichotomized as either 'premium' or 'standard.' The 'premium' CT scanners included GE Revolution (n=18), Siemens Flash (n=17), and Siemens Force (n=8). The 'standard' CT scanners included Toshiba Aquilion 64 (n=56), Toshiba Prime 160 (n=2), and GE Lightspeed VCT (n=1).

RESULTS

Baseline characteristics of patients did not significantly differ between 'premium' and 'standard' CT scanners. Per-vessel ML-FFR results obtained on 'premium' CT scanners demonstrated significantly higher sensitivity (p=0.02) compared to ML-FFR from 'standard' CT scanners (Figure 1). There were no significant differences in the specificity (p=0.32) or accuracy (p=0.83) of ML-FFR between 'premium' and 'standard' CT scanners.

CONCLUSION

The sensitivity of a prototype ML-FFR algorithm performed on 'premium' CT scanners is significantly greater than 'standard' CT scanners, with overall similar specificity and accuracy. Future studies with larger number of patients should be performed to determine the reproducibility of these results.

CLINICAL RELEVANCE/APPLICATION

A prototype ML-FFR algorithm demonstrates signficantly imrpoved accuracy compared to standard coronary CTA. The sensitivity of the prototype ML-FFR algorithm performed on 'premium' CT scanners is significantly greater than 'standard' CT scanners.

SSC01-03 CTCA-Based Coronary FFR, Plaque Progression Prediction and Virtual Stenting: An All-Inclusive On Cloud Decision Support System for CAD Management

Monday, Dec. 2 10:50AM - 11:00AM Room: S402AB

Participants
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PURPOSE

A comprehensive on cloud platform for clinical decision support (CDS) in stable coronary artery disease (CAD) has been developed within SMARTool EU funded project, including several models and tools based on CT coronary angiography (CTCA) imaging.

METHOD AND MATERIALS

CTCA images are processed using an in-house 3D reconstruction tool which provides automatically the lumen, outer wall, calcified and non-calcified plaque of the coronary tree. The geometries are used for the non-invasive calculation of SmartFFR index. The pathologic SmartFFR is taken as a marker of obstructive CAD requiring revascularization and the stenosed arteries are used for real-time virtual stenting simulation. Additionally, the reconstructed segments are used in a prognostic model including CTCA and computational modeling features as well as non-imaging patient data to predict patient/plaque-specific CAD progression.

RESULTS

The above implemented methodologies have been validated in SMARTool clinical trial (263 stable CAD patients recruited at two time points with an interscan period of 6±1 years). Data from 27 patients were used for the validation of 3D reconstruction comparing results with manual annotations. The DICE coefficient and the Hausdorff distance are 0.72±0.08 and 1.95 ±0.45, respectively. The

SmartFFR methodology was validated using 88 coronary segments where invasive FFR was available (r=0.86, P<0.0001). Diagnostic performance of SmartFFR has 90.9, 88.9, 91.8, 82.8 and 94.9 for Accuracy, Sensitivity, Specificity, PPV and NPV, respectively. Virtual stenting methodology has also been proved to accurately simulate inflation and re-expansion of the stenotic segments, while the prognostic model based on the analysis of 480 coronary segments from 187 patients has 80% accuracy for plaque progression prediction.

CONCLUSION

The CTCA imaging-based models developed in SMARTool on cloud CDS empower current management of stable CAD patients. This work is partially funded by the European Commission: Project SMARTOOL, 'Simulation Modeling of coronary ARTery disease: a tool for clinical decision support - SMARTool' [GA number: 689068].

CLINICAL RELEVANCE/APPLICATION

SMARTool CDS is expected to enhance the diagnostic and prognostic yield of CTCA imaging and support stent implantation planning.

SSC01-04 Comparison of Invasive FFR, CT-FFR, and Benchtop FFR Using 3D Printed Patient Specific Coronary Phantoms

Monday, Dec. 2 11:00AM - 11:10AM Room: S402AB

Participants
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PURPOSE

Diagnosis tools based on computational fluid dynamics, have been proposed to predict fractional flow reserve (FFR) in patients with coronary artery disease. These tools use segmented 3D geometry obtained via CT-angiography and various boundary conditions for flow. Regardless of the approach or computational particularities, tool validation and optimization is done using a reference standard invasive FFR. This development approach can be lengthy due to incomplete knowledge of all factors affecting the human physiology complexity. In this study we propose to determine whether it is feasible to use patient specific 3D printed patient specific coronary phantoms to validate a CT-FFR software.

METHOD AND MATERIALS

Using multi-material 3D printing capabilities, we built 33 patient specific cardiac phantoms from CCTA scans in patients who underwent clinically indicated elective invasive coronary angiography. Each phantom was used in a controlled flow system where patient specific flow conditions were provided by a programmable cardiac pump. Flow parameters were adjusted such that the aortic pressures were 100-120 mmHg and coronary total flow was 500mL/min. Each phantom had pressure sensors embedded in the main coronary arteries and the flow rate was monitored. The benchtop FFR was recorded between the aorta and distal to the stenosis. Benchtop FFR was compared with the invasive FFR and a CT-FFR research software (Canon Medical Systems).

RESULTS

The AUC for benchtop FFR and CT-FFR compared with invasive FFR as the 'gold standard' was 0.72 and 0.83, respectively, with less than or equal to FFR of 0.8 being true for diseased.

CONCLUSION

3D printed patient specific coronary phantoms can be used to replicate the human arterial anatomy as well as blood flow conditions. Above all they offer the unique opportunity to control and precisely measure physiological conditions which can be used to optimize and validate diagnostic software.

CLINICAL RELEVANCE/APPLICATION

Benchtop flow testing using 3D printed patient specific coronary phantoms provide precise and cost effective tools which could accelerate effectiveness and accuracy studies for image based diagnostic technologies.

SSC01-05 Diagnostic Performance of a Machine-Learning-Based Fractional Flow Reserve Derived from Coronary Computed Tomography Angiography for the Detection of Functionally Obstructive Coronary Artery Disease

Monday, Dec. 2 11:10AM - 11:20AM Room: S402AB

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PURPOSE

To evaluate the diagnostic performance of a novel machine learning approach for computed tomography (CT) angiography-based fractional flow reserve (FFRCT), using different scanner profiles, in the detection of functionally obstructive coronary artery disease (CAD) assessed by invasive FFR (FFRi).

METHOD AND MATERIALS

This retrospective study comprised patients clinically referred to CT and subsequently to invasive coronary angiography with FFRi measurement for CAD assessment at Sirio-Libanes Hospital, Sao Paulo, Brazil. CT acquisitions were performed using two scanner profiles: Siemens Somatom Definition Flash (75ms/0.30mm) and AS+ (150ms/0.30mm). On a dedicated software (cFFR version 3.0.0, Siemens Healthineers, Forchheim, Germany) installed in a standard desktop, FFRCT and the minimum luminal area (MLA) were calculated. Obstructive CAD was defined as CT with stenosis >50% and functionally obstructive CAD as FFRi <=0.8.

RESULTS

Ninety-three consecutive patients (152 vessels) were included. Bland-Altman analysis showed high agreement between FFRCT and FFRi, with mild systematic overestimation of FFRCT values (bias:-0.02; limits of agreement: 0.14-0.09) (Figure 1A). Images acquired in different CT's did not modify the relationship between FFRCT and FFRi values (p for interaction=0.73) (Figure 1B). Compared with visual anatomically obstructive CAD by CT, both ALM (AUC 0.75 vs. 0.61, p<0,001) and FFRCT (AUC 0.93 vs. 0.61, p<0,001) demonstrated a higher performance. The best cutoff point using a Youden index was 0.84 for FFRCT (Sens 87%, Spec 85%, PPV 73%, NPV 93%), leading to a 70% reduction of false-positive when compared to obstructive CAD by CT.

CONCLUSION

FFRCT based on a machine learning algorithm can accurately identify patients with flow-limiting stenosis. This new tool is available for standard PC and seems to have consistent results even in CT with different profiles.

CLINICAL RELEVANCE/APPLICATION

FFRCT based on machine learning algorithms promises to speed up the clinical implementation of non-invasive functional CAD assessment. Given its reproducibility and diagnostic accuracy, it allows users to install dedicated software on a standard desktop, reducing post-processing time and providing functional information.

SSC01-07 Incremental Value of Coronary Artery Assessment from 70 kVp Stress Dynamic Myocardial CT Perfusion Data: Validation by Invasive Fractional Flow Reserve

Monday, Dec. 2 11:30AM - 11:40AM Room: S402AB

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

To investigate the diagnostic performance of 70 kVp stress dynamic myocardial CT perfusion as an innovative low-dose, one-stop cardiac CT examination in clinical application.

METHOD AND MATERIALS

Consecutive symptomatic patients were prospectively recruited and scanned with ATP-stress dynamic myocardial CTP using third-generation dual-source CT. The image quality (IQ) and diagnostic confidence of CTP were analyzed using a 4-point score for each myocardial segment based on the AHA model. The CTP phase with the best enhancement of the coronary arteries was selected and extracted as the CTP-derived single-phase coronary CTA (SP-CTA). The diagnostic performance of CTP and CTP+SP-CTA for functionally significant coronary artery disease were assessed. Invasive coronary angiography and fractional flow reserve (ICA/FFR) were used as the reference standard for the myocardial ischemia evaluation. The effective radiation dose of CTP were recorded.

RESULTS

In total, 71 patients (43 men and 28 women; 63.61±8.77 years) underwent the stress dynamic myocardial CTP examination. According to ICA/FFR, 63 vessels (36.2%) from 42 patients (59.2%) were identified as causing ischemia. The average score of segment-based IQ and diagnostic confidence of the CTP images was 1.11± 0.34. On a per-vessel basis, the sensitivity, specificity, PPV, NPV and diagnostic accuracy were 77.78%, 93.69%, 87.50%, 88.14%, 87.93% and 84.13%, 93.69%, 88.33%, 91.23%, 90.23%, respectively, for CTP and CTP+SP-CTA. The area under the receiver operating characteristic curve of CTP+SP-CTA (AUC=0.963,95%CI: 0.938-0.989) was significantly superior to that of CTP (AUC=0.922,95%CI: 0.880-0.964) and that of SP-CTA (AUC=0.833,95%CI: 0.765-0.900) alone (all P<0.01). The mean radiation dose of the CTP examination was 3.85±1.35 mSv.

CONCLUSION

CTP-derived SP-CTA improved the diagnostic value of CTP. With a promising performance of myocardial ischemia detection and

advanced techniques allowing low radiation dose, the innovative low-dose, one-stop CTP examination is clinically feasible for patients who need to receive a myocardial perfusion assessment.

CLINICAL RELEVANCE/APPLICATION

The CTP-derived SP-CTA improved the diagnostic value of CTP alone, which makes it clinically feasible to be applied as an innovative one-stop cardiac CT examination for patients with intermediate to high CAD risk, providing the convenience in clinical procedure and the advantage of dose and contrast media saving.

SSC01-08 CT-FFR Profiles in Patients without Coronary Artery Disease

Monday, Dec. 2 11:40AM - 11:50AM Room: S402AB

Participants
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PURPOSE

To evaluate the effect of measurement location and lumen area changes on CT-FFR values in patients without coronary artery disease (CAD).

METHOD AND MATERIALS

Patients who underwent calcium scoring (CACS) and CCTA with CT-FFR were retrospectively included. Patients were excluded if their CACS was not zero, there were elevated troponin levels, or any cardiac abnormality on the CCTA studies. On-site CT-FFR based on an artificial intelligence, deep-learning algorithm (Siemens Healthineers) was computed for each coronary artery at proximal, mid, and distal segments. At each measurement location, the lumen area and Hounsfield Unit (HU) value was measured. CT-FFR was considered positive with values <0.75. The relationship between lumen areas, HU values, and CT-FFR was evaluated for each coronary artery and each location. Ratios between mid and distal values compared to proximal values for lumen and HU parameters were calculated.

RESULTS

A total of 106 patients were included. In 39 (37%) patients, the LAD had CT-FFR values <0.75, with a decrease in CT-FFR from 0.97 (SD 0.04) proximally to 0.62 (SD 0.10) distally in the abnormal patients. The Cx showed a limited number of patients with CT-FFR values <0.75 (n=16, 15%), with a decrease in CT-FFR values from 0.96 (SD 0.04) proximally to 0.65 (SD 0.09) distally in those patients. The RCA had 36 (34%) patients with CT-FFR <0.75, with distal CT-FFR values of 0.61 (SD 0.12) and proximal CT-FFR values of 0.98 (SD 0.02). 12 abnormal CT-FFR values were measured at mid segment, while all others were measured at distal segments. Lumen area was not significantly different between the abnormal and normal CT-FFR groups, while both HU and HU ratios were significantly lower in the abnormal CT-FFR group for all three major coronary arteries.

CONCLUSION

CT-FFR values in patients without coronary artery disease can become abnormal at a distal location without indicating flow-limiting stenosis, which depends strongly on HU values.

CLINICAL RELEVANCE/APPLICATION

CT-FFR values measured distally should always be interpreted in combination with the CCTA images in order to avoid false positives and over treatment.

SSC01-09 Coronary Computed Tomography Angiography and CT-Fractional Flow Reserve for Heart Team Decision-Making in Multivessel Coronary Artery Disease: Syntax III Score

Monday, Dec. 2 11:50AM - 12:00PM Room: S402AB

Participants
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PURPOSE

Coronary computed tomography angiography (CTA) has emerged as a non-invasive complex coronary artery disease remains to be

Coronary computed tomography angiography (CTA) has emerged as a non-invasive complex coronary artery disease remains to be investigated. The present study sought to determine the agreement between separate heart teams on treatment decision-making based on either coronary CTA or conventional angiography.

METHOD AND MATERIALS

Separate heart teams composed of a cardiologist, a cardiac surgeon, and a radiologist were randomized to assess the coronary artery disease with either coronary CTA or conventional angiography in patients with de novo left main or three-vessel coronary artery disease. Each heart team quantified the anatomical complexity using the SYNTAX score and integrated clinical information using the SYNTAX Score II to provide a treatment recommendations based on mortality prediction at 4 years. The primary endpoint was the agreement between heart teams on the revascularization strategy. The secondary endpoint was the impact of fractional flow reserve derived from coronary CTA (FFRCT) on treatment decision and procedural planning. Overall, 223 patients were included.

RESULTS

A treatment recommendation of CABG was made in 28% of the cases with coronary CTA and in 26% with conventional angiography. The agreement concerning treatment decision between coronary CTA and conventional angiography was high (Cohen's kappa 0.82, 95% confidence interval 0.74-0.91). The heart teams agreed on the coronary segments to be revascularized in 80% of the cases. FFRCT was available for 869/1108 lesions (196/223 patients). Fractional flow reserve derived from coronary CTA changed the treatment decision in 7% of the patients

CONCLUSION

In patients with left main or three-vessel coronary artery disease, a heart team treatment decision-making based on coronary CTA showed high agreement with the decision derived from conventional coronary angiography suggesting the potential feasibility of a treatment decision-making and planning based solely on this non-invasive imaging modality and clinical information.

CLINICAL RELEVANCE/APPLICATION

The addition of coronary CTA to standard medical therapy leads to an incremental benefit; in particular, reducing invasive angiography demonstrating no obstrucitve CAD and allowing for the appropriate immediate targeting of revascularisation strategies. To aid this process, a heart-team approach and clinical tools such as the Syntax Scores are advocated to objectively quantify CAD burden and clinical co-morbiditiy.

SSC02

Cardiac (Nonischemic Cardiomyopathies)

Monday, Dec. 2 10:30AM - 12:00PM Room: S401CD

CA MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC02-01 The Left Ventricular Flow Patterns and Trabecular Complexity in Hypertrophic Cardiomyopathy: Assessment with Multi-Modality Cardiac Magnetic Resonance

Monday, Dec. 2 10:30AM - 10:40AM Room: S401CD

Participants
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PURPOSE

This paper aims to assess left ventricular flow patterns and trabecular complexity of obstructive hypertrophic cardiomyopathy (HOCM) and non-obstructive hypertrophic cardiomyopathy (NOHCM) patients using multi-modality cardiac magnetic resonance (CMR) including 4D Flow, fractal analysis and feature tracking.

METHOD AND MATERIALS

CMR was performed in 76 HCM patients stratified into HOCM (22-65 years; males, n=25) and NOHCM group (26-59 years; males, n=24) based on LV outflow tract obstruction (>=30 mmHg) and 30 healthy subjects (21-65 years; males, n=18). Fast imaging employing steady state acquisition (FIESTA) images and 4D flow were acquired at 3.0T MRI. All data was evaluated by the postprocessing software (cvi42, Circle Cardiovascular Imaging, v. 5.6, Calgary, AB, Canada). The LV blood flow path lines were separated into four different components: Direct Flow, Retained Inflow, Delayed Ejection Flow and Residual Volume. The degree of LV trabeculation was assessed by fractal dimension (FD), a dimensionless measure of trabeculation complexity. Myocardial deformation was evaluated by feature tracking.

RESULTS

The Retained Inflow, Delayed Ejection Flow and Residual Volume of LV showed significant differences between the HOCM group and the NOHCM group (18.48 ± 8.37 VS. 9.59 ± 4.68,P = 0.038;14.39 ± 6.63 VS. 28.30 ± 10.23,P = 0.021;57.11 ± 7.26 VS. 46.65 ± 8.84,P = 0.047). Mean global FD of the left ventricle was higher in the HOCM and the NOHCM group than in the healthy group (1.304 ± 0.038 VS.1.292 ± 0.039 VS. 1.236 ± 0.024, P = 0.433, P<0.001, P<0.001). Max apical FD was higher in the HOCM group than the NOHCM group (1.400 ± 0.077 VS. 1.338 ± 0.067, P = 0.001). Myocardial deformation analysis showed that increased global FD was associated with changed myocardial deformation across global strain value (circumferential: r =0.567, P<0.001; radial: r =-0.622, P<0.001; and longitudinal: r =?0.535, P<0.001).

CONCLUSION

Our results demonstrate that LV retained blood remains more in HOCM patients, and the degree of the apical trabecular complexity is increased compared with NOHCM.

CLINICAL RELEVANCE/APPLICATION

The trabecular complexity and retained blood flow in the left ventricular are promising to be remarkable risk factors for assessment in sudden cardiac death, and guide the clinical management for hypertrophic cardiomyopathy.

SSC02-02 Magnetic Resonance Fingerprinting for Multiparametric Quantitative Assessment in Hypertrophic Cardiomyopathy: Comparison with Conventional Cardiac Relaxometry

Monday, Dec. 2 10:40AM - 10:50AM Room: S401CD

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PURPOSE

The objective of this study is to evaluate cardiac magnetic resonance fingerprinting (MRF) in the assessment of myocardial relaxation times compared to standard relaxometry.

METHOD AND MATERIALS

64 Pts (55m,56+/-12.3y) with suspicion/known HCM underwent CMR at 3T. Midventricular SAX T1/T2 values were evaluated with pre-(5(3)3) and post-contrast (4(1)3(1)2) modified Look-Locker inversion recovery (MOLLI) and T2-prep fast low-angle shot (FLASH) techniques. MRF was performed at identical SAX slice position pre-/post-contrast (15 heartbeats). Post-contrast imaging was done >10min after injection of Gadobutrol (0.15mmol/kg). Inline motion correction with pixel-wise fitting was performed for MOLLI/T2-prep FLASH based T1/T2 maps. Acquired MRF raw data was reconstructed off-line for creation of T1/T2 maps. All maps were visually assessed for general image quality using a 5-point Likert scale (1=non-diagnostic/5=excellent). Quantitative Map evaluation was performed using dedicated software and extracellular volume fraction (ECV) calculated with patients' hematocrit. Statistical analysis was performed including Wilcoxon rank-sum test and Spearman's correlation. Data presented as median and IQR.

RESULTS

Image quality of MOLLI T1 was superior to MRF T1 in pre- (5 vs. 4;p=.0029) and post-contrast data (5 vs. 4;p=.0004). T2 FLASH showed better image quality than MRF T2 (5 vs 4;p<.0001). MRF T1 values were significantly longer than MOLLI T1 in pre-contrast (1385ms [IQR:1336/1437ms] vs. 1250ms [IQR:1220/1290ms];p<.0001) and post-contrast (514ms [IQR:458/542ms] vs. 485ms [IQR:435/523ms];p<.0001) settings. MOLLI T1 based ECV values (23% [IQR:21/27%]) were significantly lower than MRF T1 based data (27% [IQR:23/31%]) (p<.0001). MRF T2 values were significant different to T2 FLASH data (32.5ms [IQR:30.2/35.2ms] vs. 39.9ms [IQR:38.6/41.8ms];p<.0001). Significant correlations between MRF and standard cardiac relaxometry were found for all evaluated parameters (figure).

CONCLUSION

Single breath-hold MRF allows for simple and faster quantitative multiparametric evaluation of the myocardium than conventional fitting based relaxometry with significant correlations. Automatic co-registration of MRF maps may provide further benefits.

CLINICAL RELEVANCE/APPLICATION

MRF allows robust single breath-hold multiparametric mapping with intrinsic co-registration. Thus, it may allow improved distinction/differential diagnosis of various cardiomyopathies including HCM.

SSC02-03 Antimalarial-Induced Cardiomyopathy Resembles Fabry Disease on Cardiac MRI

Monday, Dec. 2 10:50AM - 11:00AM Room: S401CD

Participants
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PURPOSE

Antimalarials (AM) are frequently used in the treatment of patients with systemic lupus erythematosus (SLE). AM-induced cardiomyopathy (AMIC) is associated with high mortality and is likely under-recognized in clinical practice. The purpose of this study was to evaluate cardiac magnetic resonance imaging (MRI) findings in AIMC.

METHOD AND MATERIALS

Cardiac MRI studies were compared between 11 SLE patients with AMIC (63.0±7.8 years, 90.9% female) and 32 SLE patients without AMIC (42.8±16.5 years, 90.3% female). The diagnosis of AMIC was confirmed by endomyocardial biopsy and/or autopsy in 4 patients and presumed based on concordant history and abnormal cardiac biomarker levels that improved after AM cessation in 7 patients.

RESULTS

Patients with AMIC were significantly older (p<0.001) and had longer AM treatment duration (26.1±11.7 years vs. 5.4±6.9 years, p<0.001) compared to those without. There were no significant differences in left ventricular (LV) end-diastolic volumes and ejection fraction between groups (p=0.515 and p=0.489, respectively). However, indexed LV mass was significantly higher and concentric LVH was more common in patients with AMIC compared to those without (68.9±17.4 g/m2 vs. 52.3±11.0 g/m2, p=0.001 and 80.0% vs. 26.7%, p=0.007, respectively). Late gadolinium enhancement (LGE) was present in all 10 patients with AMIC who had undergone LGE imaging (vs. 22.6% of those without AMIC, p<0.001). In patients with AMIC, the pattern of LGE was most commonly mid-wall located at the basal to mid inferior lateral segment (90.0%). Native T1 values outside areas of LGE were low in patients with AMIC who had undergone T1 mapping (1062 ms at 3T and 997 ms at 1.5T).

CONCLUSION

To our knowledge this is the largest cardiac MRI study in AMIC to date. Typical cardiac MRI findings in AMIC include concentric LVH, LGE at the basal to mid inferior lateral segment and low native T1 values. This cardiac MRI appearance is similar to Fabry

disease (a lysosomal storage disease). The resemblance is striking given previously described histopathological similarities between AMIC and Fabry disease and supports the hypothesis that AMIC may be caused by reversible inhibition of myocyte lysosomal activity.

CLINICAL RELEVANCE/APPLICATION

These results may allow for earlier detection of AMIC, and support the necessity for future larger studies to evaluate the prognostic significance of MRI findings and correlation with histopathology.

SSC02-04 Role of Cardiac MRI in Identification of Myocardial Fibrosis in Patients of Non-Ischemic Dilated Cardiomyopathy

Monday, Dec. 2 11:00AM - 11:10AM Room: S401CD

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PURPOSE

To study the prevalence of myocardial scar and its quantification on Cardiac MRI (CMRI) and its utility in predicting clinical outcomes in patients of non-ischemic dilated cardiomyopathy (NIDCM)

METHOD AND MATERIALS

In this prospective observational study we enrolled 88 consecutive patients of clinically diagnosed NIDCM. Routine CMR sequences was done including black blood imaging T1W and T2W, Steady state free precession Cine images, first pass perfusion images at rest and post contrast (10-15 minutes) 2D segmented inversion recovery gradient recalled echo (GRE) imaging during diastole, inversion time set to null normal myocardium. Myocardial scar was defined as late gadolinium enhancement (LGE) and it's extent was quantified using visual scoring method. Patients were followed-up for major adverse cardiac events (MACE), including cardiovascular death, aborted sudden death and heart failure for a mean period of 12 months. ROC curve was generated to know the accuracy of LGE extent in predicting MACE.

RESULTS

Of 88 patients (median age: 42 years, 66% male), mainly presenting with congestive heart failure symptoms (79%) and palpitations (16%). On CMR 50% of patients showed LGE of variable pattern out of which mid myocardial enhancement was most frequent. The percentage of LGE in these patients ranged from 1.4% to 88%, with a median of 25%. With LGE cut off of 26%, MACE can be predicted with 70% sensitivity and 73.5% specificity (AUROC=0.75). During 12 months follow-up, 16 patients developed MACE,out of which 10 were LGE+ and 6 were LGE-ve.The higher event rate was observed in patients with LGE volume of >26% compared to LGE <26% (43.6% vs 10.7%).

CONCLUSION

In NIDCM, presenting with heart failure or ventricular arrhythmias, presence of myocardial scar and its extent gives additional prognostic information compared to left ventricular ejection fraction (LVEF) and other traditional risk factors. Even though the final diagnosis is uncertain in NIDCM, extensive amount of LGE should be considered as a sign of poor prognosis.

CLINICAL RELEVANCE/APPLICATION

Risk stratification depending solely on LVEF in NIDCM patients may be fallacious, as most patients who experience sudden cardiac death (SCD) did not have severely reduced LVEF. Identification and quantification of myocardial fibrosis could be used as an adjunct for more accurate risk stratification in these patients.

SSC02-05 Chemotherapy Induces Left Ventricular Hypertrophy and Increases T1 Relaxation Times in Female Patients with Breast Cancer

Monday, Dec. 2 11:10AM - 11:20AM Room: S401CD

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PURPOSE

To detect and monitor cardiomyopathy by cardiac magnetic resonance (CMR) in female patients with first-time radiochemotherapy treatment of breast cancer.

METHOD AND MATERIALS

39 female patients (51 ±11 years) with newly diagnosed breast cancer underwent serial 3 Tesla CMR (Ingenia, Philips Medical Systems). Baseline (BL) CMR was performed 10 ±9 days before the start of therapy. First follow-up (FU1) CMR was 13 ±12 days and second follow-up (FU2) 8 ±2 months after completion of chemotherapy. SSFP cine sequences were performed to determine cardiac volumes and function. T1 mapping CMR was performed using a 5s(3s)3s MOLLI sequence. CMR data were analyzed using the commercially available software cmr42 (Circle Cardiovascular Imaging Inc., Calgary, Alberta, Canada). LV end-diastolic and end-systolic volumes were obtained from cine-CMR short-axes to calculate LV stroke volumes (LVSV) as well as LV ejection fraction (LVEF).

RESULTS

The mean dose of chemotherapeutic agents used was as follows: epirubicin 663 ±60 mg/m2, cyclophosphamid 4421 ±398 mg/m2 and paclitaxel 1646 ±275 mg/m2. High sensitive Troponin T increased on FU1 (5 ±4 vs. 8 ±4 pg/ml, P<0.05) and remained high at FU2 (8 ±11 pg/ml, P=0.845). Creatine kinase remained unchanged at FU1 (68 ±29 vs. 78 ±51 pg/ml, P=0.189) and increased at FU2 (97 ±33 pg/ml.) NT-proBNP remained unchanged throughout the observation period. LVEF was constant between FU1 (61 ±5 vs. 62 ±6%, P=0.712) and FU2 (60 ±6%, P=0.094). LV mass increased at FU1 (48 ±5 vs. 52 ±7%, P<0.01) and remained high at FU2 (52 ±7%, P<0.01). T1 relaxation times were increased at FU1 (1258 ±31 vs. 1283 ±44 ms, P<0.01) and declined at FU2 (1269 ±26 ms, P=0.123). ECV did not show any differences between BL and FU2 (28 ±2 vs. 29 ±2%, P=0.519).

CONCLUSION

Chemotherapy treatment in breast cancer patients can lead to myocardial hypertrophy, which is stable on a 8 month follow-up. Increase in T1 relaxation times of LV myocardium can be detected immediately after completion of radiochemotherapy, but subside on a 8 month follow-up.

CLINICAL RELEVANCE/APPLICATION

Increase in LV mass and T1 relaxation times of myocardium might be used as early indicators of subclinical cardiomyopathy in asymptomatic patients with breast cancer undergoing chemotherapy.

SSC02-06 Correlation Between Quantitative Left Ventricular Myocardial Scar Volume and Left Ventricular Ejection Fraction in Cardiac Sarcoidosis

Monday, Dec. 2 11:20AM - 11:30AM Room: S401CD

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PURPOSE

The purpose of this study was to utilize cardiac MRI (cMRI) to determine if there is an association between quantitative left ventricular myocardial scar volume and left ventricular function, as measured by left ventricular ejection fraction (LVEF), in patients with suspected cardiac sarcoidosis.

METHOD AND MATERIALS

IRB approval was obtained for this HIPAA compliant study. cMRIs of 355 cases with a clinical suspicion for cardiac sarcoidosis were reviewed by 2 cardiothoracic imaging trained radiologists. cMRI based LVEF, and quantitative myocardial scar volume were calculated for all cases and compared between patients with and without cMRI findings suggestive of cardiac sarcoidosis. Correlation between LVEF and myocardial scar volume was assessed with Pearson Correlation Coefficient test. Significance was set at P value=0.05.

RESULTS

A total of 355 patients with a clinical suspicion of cardiac sarcoidosis were included in this study (mean age 58.0 +/- 12.2). Ninety (25.4%) patients demonstrated cMRI imaging findings suggestive of cardiac sarcoidosis (mean age 60.0 +/- 12.6; 26.7% female, 73.3% male; 47% African American, 50% Caucasian). Myocardial scar volume determined by cMRI was significantly higher in sarcoid positive cases (11.9% +/-10.8% vs. 2.7%+/-6.7%, P<0.001) vs sarcoid negative cases. LVEF was significantly lower in the sarcoid positive group when compared to the sarcoid negative group (46.7%+/-16.1 vs. 54.8+/-13.4, P<0.001). Additionally, in those with cMRI findings suggestive of cardiac sarcoidosis, myocardial scar mass volume was significantly correlated (P<0.001) to the left ventricular ejection fraction with Pearson Correlation Coefficient of R= -0.630. In those with cMRI findings suggestive of cardiac sarcoidosis, African Americans demonstrated larger quantitative scar volumes and greater reduction in MRI LVEF than Caucasians (14.1% vs. 9.95; 41.7% vs. 51.4%).

CONCLUSION

In patients with cMRI findings of sarcoidosis, left ventricular myocardial quantitative scar volume was negatively correlated with left ventricular ejection fraction. In patients with cMRI findings of sarcoidosis, African Americans demonstrated a greater scar volume and a higher decline in ejection fraction when compared to Caucasians.

CLINICAL RELEVANCE/APPLICATION

Quantitative myocardial scar volume may be a useful quantitative parameter for prediction of LVEF in patients with suspected

Quantitative myocardial scar volume may be a useful quantitative parameter for prediction of LVEF in patients with suspected myocardial sarcoidosis.

SSC02-07 The Effects of Left Ventricular Remodeling, Myocardial Perfusion and Tissue Characteristic on Cardiac Motion in Diabetic Cardiomyopathy: A Multimodal Cardiac Magnetic Resonance Study

Monday, Dec. 2 11:30AM - 11:40AM Room: S401CD

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PURPOSE

This study was to determine the effects of left ventricular(LV) remodeling, myocardial perfusion and tissue characteristic on cardiac motion in type 2 diabetes mellitus(T2DM), and to explore the risk factors affecting systolic and diastolic functions, based on a multimodal cardiovascular magnetic resonance (CMR) study.

METHOD AND MATERIALS

A total of 85 clinically diagnosed T2DM patients and 39 healthy controls underwent CMR examination. The CMR parameters including morphological structure (LV mass and remodeling index), motion (peak strain(PS), peak systolic strain rate, and peak diastolic strain rate), perfusion (upslope, MaxSI, TTM, and perfusion-index), T1 mapping and T2 mapping were analyzed and compared between controls and T2DM patients. The univariable and multivariable analysis was performed to identify the imaging and clinical variables affecting motion functions.

RESULTS

Compared with controls, T2DM patients presented significantly decreased motion function in radial, circumferential and longitudinal direction (PS radial, 32.16±8.80 vs. 39.32±9.51, p=0.001; PS circumferential, -19.67±3.83 vs. -21.00±3.35, p=0.036; and PS longitudinal, -11.93±3.50 vs. -15.85±3.79, p=0.000), decreased perfusion function (perfusion index, 0.11±0.04 vs. 0.13±0.03, p=0.010), increased myocardial fibrosis (extracellular volume fraction, 31.36±7.83 vs. 27.52±3.05, p=0.000), increased myocardial edema(41.88±5.12 vs. 40.34±2.67, p=0.044) and increased LV mass(59.46±17.49 vs. 42.57±10.38, p=0.000). With univariable and multivariable analysis, myocardial perfusion function is related to both systolic and diastolic motion, while LV remodeling, myocardial fibrosis and edema significantly affected diastolic motion.

CONCLUSION

The cardiac motion, perfusion, tissue characteristic and remodeling of T2DM patients are impaired. Both systolic and diastolic motion were related to myocardial perfusion function, while diastolic dysfunction is more susceptible to LV remodeling and myocardial fibrosis and edema.

CLINICAL RELEVANCE/APPLICATION

Cardiac motional disorder is the final path of all cardiac pathophysiological changes and is the driving factor of heart failure. Diabetes mellitus and its associated risk factors contribute to cardiac motional disorder by causing damage to different pathophysiological processes in the heart. However, the relationship between cardiac pathophysiological changes and cardiac motion has rarely been studied.

SSC02-08 Relation of Regional Myocardial Perfusion and Systolic Strain in Hypertrophic Cardiomyopathy and Cardiac Amyloidosis: A Cardiovascular Magnetic Resonance Analysis

Monday, Dec. 2 11:40AM - 11:50AM Room: S401CD

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PURPOSE

To investigate the microvascular dysfunction and its relation with myocardial strains in cardiac amyloidosis (CA) and hypertrophic cardiomyopathy (HCM) with increased wall thickness.

METHOD AND MATERIALS

We included 25 biopsy-proven CA (65.4 ± 10.7 years, 54% female) and 35 patients with HCM (65.4 ± 10.7 years, 59% female). Segments with a wall thickness (WT) >12mm were considered thickened. Perfusion parameters including slope, time to maximum signal intensity (TTM) and time to 50% maximum signal intensity (50%TTM) were obtained from the myocardial signal intensity-time

curve. Myocardial strain indices including circumferential (CS) and longitudinal (LS) strain were derived from the tissue tracking model on cine images. The AHA 16-segment model was used for regional perfusion and strain analyses.

RESULTS

In total, 169 thickened segments in CA and 228 in HCM with WT >12mm (WT 14.7 ± 2.2 mm in CA vs. 16.4 ± 3.9 mm in HCM, p<0.05) were evaluated. Thickened CA segments demonstrated more impaired myocardial strain and microvascular function compared with HCM segments. Multivariable linear regression analysis showed that CS had association with slope [beta 0.8, 95% confidence interval (CI) 0.3-1.3; P<0.001], wall thickness and hypertrophic phenotype (HCM or CA) (P<0.001 for both). The ROC analyses demonstrated that 50%TTM performed best in differentiating CA from HCM (AUC 0.92, sensitivity 81.7%, and specificity 91.7%, cut-off value 22.3).

CONCLUSION

Our results demonstrated that amyloid infiltration impairs the regional microvascular system and systolic function more seriously than HCM characterized with cellular hypertrophy. Regional myocardial mechanics are significantly influenced by microvascular function.

CLINICAL RELEVANCE/APPLICATION

Amyloid infiltration causes more severe myocardial perfusion disorder and systolic dysfunction. Myocardial perfusion parameters have great performance in differentiating cardiac amyloidosis from hypertrophic cardiomyopathy.

SSC02-09 Diagnostic Value of Quantitative Tissue-Tracking Cardiac Magnetic Resonance of Myocardium Deformation in Hypertrophic Cardiomyopathy

Monday, Dec. 2 11:50AM - 12:00PM Room: S401CD

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PURPOSE

To explore the diagnostic value of quantitative tissue-tracking cardiac magnetic resonance (CMR) of left ventricular global myocardium deformation in hypertrophic cardiomyopathy (HCM).

METHOD AND MATERIALS

18 cases of essential HCM (HCM group,13 males, 5 females, aged 25~72 years with a mean of 40.89±15.13) and 19 cases of normal subjects (control group, 16 males, 3 females, aged 21~71 years with a mean of 39.58±13.57) were enrolled. All patients were subjected to CMR. The CMR bright blood cine sequences were including short-axis, long-axis and four-chamber of left ventricle(Balance turbo field echo, B-TFE). All DICOM images were performed with the Circle Cardiovascular software(cvi42 version 5.10.1, Calgary, Alberta, Canada) to get left ventricular muscle mass (LVMM), left ventricular end-diastolic volume(LVEDV), left ventricular end-systolic volume (LVESV), stroke volume(SV),cardiac output (CO) and left ventricular ejection fractions(LVEF) in the Short 3D modular, get left atrial minimal volume (LAVmin)and left atrial maximal volume (LAVmax) in the Biplanar LAX modular, and get global peak radial strain (GPSR), global peak circumferential strain (GPSC) and global peak long strain(GPSL) of left ventricle in the Tissue Tracking modular.

RESULTS

1. There were no significant differences in the clinical profiles (gender, age) between the HCM group and control group (P>0.05).2. LVMM in the HCM group were significantly greater than in the control group [(193.74±44.68)g, 125.18±29.34]g, P=0.00)]. LAVmin and LAVmax in the HCM group were significantly greater than in the control group. [(40.25±20.64)ml,(18.63±8.65)ml, P=0.00 and (71.66±27.98)ml, (47.69±12.53)ml, P0.05).3. In correlation analysis in HCM group, LVMM did not correlate significantly with GPSR, GPSC and GPSL.4.The area under ROC curve of GPSR, GPSC and GPSL in diagnosis of HCM were 0.199, 0.807 and 0.857, and the area under ROC curve of GPSL was the largest.

CONCLUSION

CMR feature tracking technology can quantitatively evaluate cardiomyopathy deformation of HCM. The ventricular diastolic dysfunction of HCM is earlier than that of systolic dysfunction. Left ventricular myocardial mass is not significantly correlated with myocardial deformation. GPSC and GPSL have favorable effective functions for the diagnosis in HCM.

CLINICAL RELEVANCE/APPLICATION

CMR feature tracking technology can quantitatively evaluate cardiomyopathy deformation of HCM.

SSC03

Chest (Radiomics - Malignancy)

Monday, Dec. 2 10:30AM - 12:00PM Room: E451A

AI CH CT OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC03-01 Impact of Interobserver Variability in Manual Segmentation of Non-Small Cell Lung Cancer (NSCLC) on Computed Tomography

Monday, Dec. 2 10:30AM - 10:40AM Room: E451A

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PURPOSE

Discovery of predictive and prognostic radiomic features in cancer is currently of great interest to the radiologic community. Since there is no reliable automated means of segmenting lung cancer, tumor labeling is typically performed by imaging analysts, physician trainees and attending physicians. Here we examine the impact of level of specialty training on interobserver variability in manual segmentation of non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

A public dataset of computed tomography (CT) imaging (NSCLC-Radiomics-Genomics- LUNG3) which contains 88 patients (61 males and 28 females) with NSCLC (adenocarcinoma (n=42), squamous cell carcinoma (n=32), and other NSCLC (n=12). For each CT, tumors were labeled in 3D using ITkSnap (ver 3.6.0). Segmentation was performed by three raters with differing levels of radiologic experience: an imaging analyst (BY;no formal experience), a radiology trainee (MH;5 yrs.) and a specialty-trained thoracic radiologist (SK;18 yrs.). For each tumor segmentation, 429 radiomic features (including grey-level intensity, co-occurrence, run-length, binary patterns, and wavelet features) were extracted. Principal component analysis was further performed on the extracted features. Interoberver variability in radiologic features between the 3 raters was then examined using the senior radiologist as the ground truth (GT). The Sørensen-Dice (SD) coefficient was used to evaluate spatial agreement of segmentations and the Pearson correlation was estimated between the first principal components of the extracted features from each rater's segmentations.

RESULTS

The SD coefficient between the BY-SK(GT) and MH-SK(GT) segmentations was indicated 0.894 (STD: ±0.25) and 0.839 (STD: ±0.20), respectively, showing high agreement. The corresponding PCs were also highly correlated with Pearson's correlations of 0.88 and 0.92, respectively.

CONCLUSION

Routine interobserver variability in tumor segmentation may not result in substantial spatial disagreement of 3D tumor delineation, while subsequently extracted radiomic features are also highly correlated.

CLINICAL RELEVANCE/APPLICATION

Radiomic feature extraction may be robust to interobserver variability in tumor segmentation from lung CT data, resulting in robust prognostic and predictive biomarkers of NSCLC.

SSC03-02 Deep Learning Algorithm for Reducing CT Slice Thickness: Effect on Reproducibility of Radiomics in Lung Cancer

Monday, Dec. 2 10:40AM - 10:50AM Room: E451A

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PURPOSE

To retrospectively assess the effect of CT slice thickness on the reproducibility of radiomic features (RFs) of lung cancer, and to investigate if convolutional neural network (CNN)-based super-resolution (SR) algorithms can improve the reproducibility of RFs obtained from different slice thicknesses.

METHOD AND MATERIALS

CT images from 100 pathologically proven lung cancers acquired between July 2017 and December 2017 were evaluated, including 1, 3, and 5 mm slice thicknesses. CNN-based SR algorithms using residual learning were developed to convert thick-slice images into 1 mm slices. Lung cancers were semi-automatically segmented and a total of 702 RFs (tumor intensity, texture, and wavelet features) were extracted from 1, 3, and 5 mm slices, as well as the 1 mm slices generated from the 3 and 5 mm images. The stabilities of the RFs were evaluated using concordance correlation coefficients (CCCs).

RESULTS

All CT scans were successfully converted to 1 mm slice images at a rate of 2.5 s/slice. The mean CCCs for the comparisons of original 1 vs 3 mm, 1 vs 5 mm, and 3 vs 5 mm images were 0.41, 0.27, and 0.65, respectively (all, $P<0.001$). Tumor intensity features showed the best reproducibility and wavelets the lowest. The majority of RFs failed to reach reproducibility (CCC>=0.85; 3.6%, 1.0%, and 21.5%, respectively). In terms of nodule type, GGNs had better reproducibility than solid nodules in all RF classes and in all slice-thickness pairings ($P < 0.001$ for 1 vs 3 mm and 1 vs 5 mm, and $P = 0.002$ for 3 vs 5 mm). After applying CNN-based SR algorithms, the reproducibility significantly improved in all three pairings (mean CCCs: 0.58, 0.45, and 0.72; all, $P<0.001$). This improvement was also observed in the subgroupings based on the classes of RFs and nodule types. The reproducible RFs also increased (36.3%, 17.4%, and 36.9%, respectively).

CONCLUSION

The reproducibility of RFs in lung cancer is significantly influenced by CT slice thickness, which can be improved by the CNN-based SR algorithms.

CLINICAL RELEVANCE/APPLICATION

On the basis of the findings of our study, the comparisons of radiomics results derived from CT images with different slice thicknesses may be unreliable. As our convolutional neural network-based image conversion algorithm is easily applicable and reliable, this algorithm may be used for enhancing reproducibility of radiomic features when the CT slice-thicknesses are different.

SSC03-03 Correlation-Incorporated Hierarchical Clustering of High-Dimensional Radiomic Features for Prognostic Phenotype Identification of EGFR-Mutated Non-Small Cell Lung Cancer

Monday, Dec. 2 10:50AM - 11:00AM Room: E451A

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PURPOSE

We propose a correlation-incorporated unsupervised hierarchical clustering algorithm and evaluate it in identifying computed tomography (CT) radiomic phenotypes of EGFR-mutated non-small cell lung cancer (NSCLC) in association with patient overall survival.

METHOD AND MATERIALS

The NSCLC-*radiogenomic* dataset publicly available from the National Cancer Institute's Cancer Imaging Archive (TCIA) was analyzed, including 204 patients (age range: 69 [±11], male/female: 132/72, event: death [41], adenocarcinoma/squamous cell carcinoma/unspecified: 166/34/4, EGFR mutation status: wild-type/mutant/unknown: 125/42/37). Tumor regions were verified by an experienced radiologist and segmented in 3D using the *ITKSnap* semi-automated toolkit. A total of 429 radiomic features were extracted (grey-level intensity, co-occurrence, run-length, binary patterns, and wavelets) using the *pyRadiomics* toolkit. An unsupervised method was applied based on a correlation-incorporated hierarchical clustering algorithm (CHCA) to determine the truncation distance in the resulting dendrogram and assign features to robust cluster groups. Low-rank dimensionality reduction

was further performed by principal component analysis (PCA) to estimate the first principal component (PC) of each feature cluster and create a radiomic signature for each tumor. Differences between radiomic signature scores and EGFR mutation status was evaluated using Student's t-test. Survival probabilities across the extracted PCs were evaluated using Kaplan-Meier curves, and a Cox proportional hazards (CPH) model was fitted based on the estimated PCs.

RESULTS

Using CHCA, dimensionality was reduced from 429 to 67 PCs for a dendrogram truncation distance of 0.1. Three significant radiomic phenotypes were identified, which were associated with EGFR mutation status (p-value < 0.05). The best multivariable CPH model had a C-statistic of 0.71 based on the 67 PCs. Combining radiomic signatures with all available clinical covariates (age, sex, histology, EGFR mutation) yielded a C-statistic of 0.78.

CONCLUSION

CHCA effectively reduces the high dimensionality of radiomic features while allowing for robust identification of CT-based phenotypes of EGFR-mutated NSCLC that are associated with patient survival.

CLINICAL RELEVANCE/APPLICATION

Radiomic phenotypes of EGFR-mutated NSCLC, efficiently extracted by CHCA, could aid in identifying NSCLC patients likely to benefit from targeted EGFR inhibitor therapy.

SSC03-04 Radiomics-Based Prognostic Nomogram for the Prediction of Progression-Free Survival in Stage IV Non-Small Cell Lung Cancer Treated with Platinum-Based Chemotherapy

Monday, Dec. 2 11:00AM - 11:10AM Room: E451A

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PURPOSE

We aimed to establish an effective radiomics-based prognostic nomogram for the prediction of progress-free survival (PFS) in stage IV non-small cell lung cancer (NSCLC) treated with platinum-based chemotherapy.

METHOD AND MATERIALS

A total of 308 stage IV NSCLC patients without an EGFR-sensitizing mutation or ALK gene rearrangement were enrolled and divided into a discovery cohort (n=159) and a validation cohort (n=149). All patients had received at least 2 cycles of platinum-based chemotherapy as first-line treatment. 1182 radiomics features were extracted from pre-treatment CT images of each patient. Then, radiomics signature was constructed using LASSO Cox regression analysis based on discovery cohort, and was validated in validation cohort. Furthermore, an individualized prognostic nomogram incorporating the radiomics signature and clinicopathologic risk factors was proposed.

RESULTS

The established signature consisted of 14 features showed good discrimination for classify patients with high-risk and low-risk progression treated by platinum-based chemotherapy. On the multivariable Cox regression, independent factors for PFS were radiomics signature, PS, and N stage, which were all selected into the nomogram. The calibration curve for probability of PFS showed good satisfactory. The C-index of the nomogram for predicting PFS was 0.721(95%CI:0.713-0.729), which was statistically higher than clinicopathologic-based model (C-index: 0.641, 95%CI:0.631-0.651). Decision curve analysis revealed that the nomogram significantly outperformed the clinicopathologic-based model in terms of clinical usefulness.

CONCLUSION

This study establishes a radiomics-based prognostic nomogram that can be conveniently used to achieve individualized prediction of PFS probability for stage IV NSCLC patients treated with platinum-based chemotherapy, which holds promise of guiding the personalized pre-therapy of stage IV NSCLC.

CLINICAL RELEVANCE/APPLICATION

The developed radiomics-based prognostic nomogram could be conveniently used to achieve individualized prediction of PFS probability for stage IV NSCLC patients treated with platinum-based chemotherapy.

SSC03-05 A Primary Study of Predicting Spread through Air Space in Lung Adenocarcinoma Using a CT-Base Radiomics Model

Monday, Dec. 2 11:10AM - 11:20AM Room: E451A

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PURPOSE

Spread through air space (STAS), a novel invasive pattern of lung adenocarcinoma, is a risk factor for recurrence and worse prognosis of patients with early stage adenocarcinoma who underwent limited resection. Therefore, preoperative prediction of STAS in lung adenocarcinoma can facilitate surgeons' treatment decision making. The aim of this study is to develop and validate a CT-based radiomics model for preoperative prediction of STAS in lung adenocarcinoma.

METHOD AND MATERIALS

This retrospective study was approved by institutional review board and included 437 patients with pathological confirmed lung adenocarcinoma, which consisted of 186 males and 251 females with a mean age of 58.2 years. Two experienced radiologists retrospectively reviewed the tissue sample slices in consensus to determine whether there was STAS in lung adenocarcinomas. Two experienced radiologists segmented and extracted radiomics features on preoperative thin-slice CT images using the 3D Slicer with Pyradiomics extention (www.slicer.org) independently. Intra-class correlation coefficients (ICC) and Pearson's correlation were used to roll out those low reliability (ICC<0.76) and redundant (r>0.9) features. Univariate logistic regression was used to select radiomics features and clinical metrics which were associated with STAS. Multivariate logistic regression analysis was used to develop a predictive model. The diagnostic performance of the model was measured by area under curve (AUC) of recerver operating characteristic (ROC) and calibrated with five-fold cross-validation.

RESULTS

STAS was identified by the pathologists in 85 patients (19.5%). At univariate analysis, 26 radiomics features and age were found to be associated with STAS. Multivariate logistic regression showed that age and one radiomics feature (Skewness) were independent predictors for STAS. The CT-base radiomics model achieved a AUC of 0.81 with a sensitivity of 0.737 and a specificity of 0.838 for predicting SATS (Figure. 1).

CONCLUSION

CT-base radiomics model can preoperatively predict STAS in lung adenocarcinoma with high diagnosis performance, which provide guides for patients therapeutic decision making.

CLINICAL RELEVANCE/APPLICATION

The result of present study showed CT-based radiomics model could preoperatively predict STAS in lung adenocarcinomas with high diagnosis performance which could facilitate surgeons' operation decision making.

SSC03-06 Can DECT Quantitative and Radiomics Features Differentiate Benign and Malignant Lymphadenopathy?

Monday, Dec. 2 11:20AM - 11:30AM Room: E451A

Participants
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PURPOSE

Dual Energy CT tumor analysis prototype (DE-TA, eXamine, Siemens) was developed to evaluate DECT quantitative and DECT radiomics features. We assessed the accuracy of these features for differentiating benign and malignant lymph nodes on DECT of the chest and abdomen using histology as reference.

METHOD AND MATERIALS

With IRB approval, we identified 80 adult patients (mean age 62 ± 15 years; 42 men, 38 women) from our Radiology Information System who had lymph nodes > 1 cm in short axis and had a tissue biopsy of the lymph nodes. All patients had contrast enhanced, dual-source DECT (SOMATOM Flash or Force, Siemens) of the chest (n = 70) and abdomen (n= 10). DECT images were de-identified and exported to the DE-TA. Lymph nodes were identified and delineated and segmented into 4 inner peels and 4 outer rims. For each segment, DECT quantitative metrics and 585 radiomics features (including first and higher order statistics) were derived. Logistic regression, receiver operating characteristics and random forest classification were performed.

RESULTS

We observed a significantly higher volume, RECIST diameter and WHO area for the malignant nodes (13.9± 12.5 ml, 25.3± 9.4 mm, 500.9± 469.0 mm2) as compared to the benign nodes (mean values-2.3± 3.0, 18.8± 6.3 mm, 271.7+/-177.0 mm2) (p< 0.02). Malignant nodes had a greater iodine uptake and concentration as compared to the benign nodes (AUC 0.83 ; p=0.001). A total of 1643 radiomics parameters were significantly different between benign and malignant nodes (AUC=0.87 ; p=0.00008-0.04). Rim 3 (the peel before the outermost segment) showed the largest number of statistically significant radiomics parameters for differentiating benign and malignant lesions (p<0.02). Random forest classification revealed an AUC of 0.85 (p = 0.002) for differentiating benign and malignant lymph nodes.

CONCLUSION

Dual-energy quantitative and radiomics features enable accurate differentiation of benign and malignant lymph nodes on contrast-enhanced chest and abdomen CT.

CLINICAL RELEVANCE/APPLICATION

DECT quantitative and radiomics features can help in accurate lymph nodal staging for neoplastic diseases of chest and abdomen.

SSC03-07 Development of Predictive Models for Lymph Node Metastasis in Pre-Surgical Stage IA Patients with Non-Small Cell Lung Cancer

Monday, Dec. 2 11:30AM - 11:40AM Room: E451A

Participants
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PURPOSE

To develop and validate predictive models by use of clinical/CT findings, radiomics features and combination of the both for lymph node metastasis (LNM) in pre-surgical stage IA patients with a non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

This retrospective study included 649 pre-surgical stage IA patients with NSCLC from September 2017 to January 2019 in our hospital. All patients had a thin-section venous CT scan before surgery. There were 138 (21%) of the 649 patients who had LNM after surgery. A training group included 455 patients (97 with and 358 without LNM) and a test group included 194 patients (41 and 153, respectively). Clinical/CT features (such as age, gender, smoking status, size, vacuole sign, marginal spiculation, marginal lobulation, and pleural indentation) were identified by a study radiologist, selected by Mann-Whitney U test and $\chi 2$ test, and used to develop a clinical model. A total of 396 radiomics features were extracted from venous CT scans. Mann-Whitney U test and univariate analysis of variance were used for radiomics feature dimension reduction. The least absolute shrinkage and selection operator (LASSO) algorithm was used for radiomics feature selection. Three models (a clinical model, a radiomics model, and a combined model) were developed to predict LNM in the early-stage NSCLC. The receiver operating characteristic (ROC) curve was used to evaluate the performance in LNM classification by use of the three models.

RESULTS

The area under the curve (AUC) value of radiomics model based on seven best features in predicting LNM was 0.898 (95% CI, 0.890-0.906) in the training group, compared with 0.851 in the test group. The AUC values of the clinical model (main based on size and spiculation) were 0.739 (95% CI, 0.725-0.753) and 0.614, respectively, in the training and test group. The AUC values of the radiomic-clinical model were 0.911 (95% CI, 0.904-0.918) and 0.860, respectively, in the two groups.

CONCLUSION

A radiomics-clinical model in venous CT was superior for predicting LNM in pre-surgical Stage IA patients with NSCLC than that models developed by radiomics and clinical features only.

CLINICAL RELEVANCE/APPLICATION

Approximately 20% of pre-surgical Stage IA patients with NSCLC may have LNM; a radiomics-clinical model has the potential to predict the LNM and may help to improve treatment plans.

SSC03-08 CT-Derived Prognostic Radiomics Phenotype of Tumor Habitat is Closely Associated with Interaction of Tumor Infiltrating Lymphocytes (TILs) and Cancer Nuclei on H&E Tissue as Well as PD-L1 Expression in NSCLC

Monday, Dec. 2 11:40AM - 11:50AM Room: E451A

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PURPOSE

While radiomic analysis of lung nodules to predict outcome has been increasingly prevalent, the underlying tumor morphology that these features highlight is often not understood or explored. In this multi-modality analysis, we discovered unique radiomic-histologic-molecular phenotypes for early-stage non-small cell lung cancer(ES-NSCLC) patients which could successfully stratify patients based on their disease-free survival(DFS).

METHOD AND MATERIALS

After retrospective chart review, we trained a radiomic model to predict recurrence for 316 ES-NSCLC pts. using 124 radiomic textural features from the Gabor, Laws, Laplace, Haralick, and Collage feature families extracted from a 0-3 mm annular ring immediately adjacent to the nodule-Peritumoral(PT) features. The radiomics model had an AUC=0.74($p<0.01$) in predicting recurrence. Among 70 pts in this cohort, we had available tissue derived PD-L1 expression as well as H&E stained Whole slide images (WSIs). In order to build the radiomic-histologic-molecular phenotype of the tumor habitat, we also extracted 242 Quantitative Histomorphometric (QH) features related to the nuclear shape, texture, orientation, spatial architecture of TILs and features quantifying TI-cancer nuclei interaction. Unsupervised clustering of the top 20 most discriminative features from 0-3mm outside the tumor was done, and correlations of the clusters were calculated for QH and PDL-1 expression.

RESULTS

We obtained two significant clusters corresponding to high-risk and low-risk patients based on their risk of recurrence. The two clusters had significant disease-free survival(DFS) differences based on Kaplan-Meier analysis($p<0.05$). The two clusters were also correlated with nuclear morphology features($p<0.05$) and spatial architecture of TIL patterns ($p<0.05$) as well as PD-L1 expression($p<0.001$). We found that the high-risk cluster had increased PD-L1 expression and increased intensity of the QH features

CONCLUSION

We built a radio-histo-molecular phenotype of the tumor habitat stratified according to the risk of recurrence in ES-NSCLC. We found that radiomic tumor habitat features were strongly correlated with TIL-cancer nuclei interaction and PD-L1 expression.

CLINICAL RELEVANCE/APPLICATION

The prognostic usefulness of radiomics of the tumor habitat can be complemented by understanding the underlying morphology in the tissue patterns which lead to the expression of these features, which we have shown in this work.

SSC03-09 CT-Based Analysis Using Radiomics for Predicting Pathological Response after Preoperative Chemotherapy in Patients with Locally Advanced Esophageal Cancer

Monday, Dec. 2 11:50AM - 12:00PM Room: E451A

Participants
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PURPOSE

To investigate the application of radiomics in a group of patients with locally advanced esophageal cancer (LAEC) and distinguish those who will respond to preoperative chemotherapy from those who will not, using histopathologic results as the reference standard.

METHOD AND MATERIALS

For this retrospective study, a radiomics model was developed based on a primary cohort of 133 patients with LAEC, who underwent contrast-enhanced CT from October 2013 to November 2018, followed by preoperative chemotherapy. All patients underwent surgery after chemotherapy and were divided into two groups based on the pathological evaluation of surgically resected specimens; a poor response group (Grade 0/1) and a good response group (Grade 2/3). A total of 1409 quantitative imaging features were extracted from the CT images using Radcloud platform. We used variance threshold, SelectKBest and LASSO algorithm methods to gradually select the most optimal features and reduce their dimensionality. Six machine learning algorithms (KNN, SVM, XGBoost, RF, LR, DT) were adopted to establish a radiomics nomogram. The predictive performances of the radiomics signature were evaluated by ROC curve analysis in both cohorts: training (n=99 VOIs) and validation (n=41 VOIs).

RESULTS

Out of 1409 features, 6 optimal ones were selected using the LASSO method. The area under the ROC curve (AUC) of the XGBoost model used for predicting the good response in a group was 0.893 (95% CI; 0.79 - 0.99) in the training cohort and 0.761 (95% CI; 0.65 - 0.87) in the validation cohort.

CONCLUSION

A radiomics model derived from CT imaging could be potentially useful for predicting the effect of preoperative chemotherapy in patients with LAEC.

CLINICAL RELEVANCE/APPLICATION

CT-based radiomics features could provide additional quantitative information on disease progression and may help to improve clinical decision making for the preoperative management of LAEC patients.

SSC04

Science Session with Keynote: Emergency Radiology (Imaging Algorithms and Technique)

Monday, Dec. 2 10:30AM - 12:00PM Room: S102CD

AI CT ER

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Krystal Archer-Arroyo, MD, Decatur, GA (*Moderator*) Nothing to Disclose
Savvas Nicolaou, MD, Vancouver, BC (*Moderator*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

Sub-Events

SSC04-01 Emergency Radiology Keynote Speaker: Acute Care - Why Care for Algorithms and Technique?

Monday, Dec. 2 10:30AM - 10:50AM Room: S102CD

Participants
Krystal Archer-Arroyo, MD, Decatur, GA (*Presenter*) Nothing to Disclose

SSC04-03 Reducing the Incidence of Venous Air Embolism in Contrast-Enhanced CT Angiography Using Preflushing of the Power Injector

Monday, Dec. 2 10:50AM - 11:00AM Room: S102CD

Participants
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PURPOSE

To evaluate the incidence of venous air embolism (VAE) incidence with or without implementation of preflushing before connecting a power injector to a patient's catheter, aiming to reducing the VAE in contrast-enhanced CT angiography (CTA)

METHOD AND MATERIALS

The control group underwent the conventional injection procedure. In the preflushing group, the injector tubes were flushed at high speed (10 ml/s) with saline before being connected to the patients' indwelling catheters. The locations, number and sizes of VAE were analyzed. The difference in the incidence of VAE between the 2 groups was compared.

RESULTS

A total of 4900 adults (control/preflushing, 2190/2710) were included. A total of 228 (4.65%) patients were found to have 318 VAEs (285 bubbles and 33 gas-liquid plane VAEs). The incidence of VAE in the preflushing group (3.21%) was lower than that in the control group (6.44%); a similar trend was observed for multiple VAEs ($P<0.05$). VAEs occurred in the following locations from high to low frequency: right atrium>pulmonary artery trunk>superior vena cava>right ventricle>left brachial vein>right brachial vein. There was no significant difference in the location, shape or diameters ($P=0.19$) of VAEs between the two groups.

CONCLUSION

The proposed preflushing procedure is simple yet effective in reducing the incidence of VAE by 50.16% in patients with CTA thus improving safety during power injection.

CLINICAL RELEVANCE/APPLICATION

The first reported effective measure of preflushing power injector tubing at a high flow rate with saline can significantly reduce the incidence of VAE.

SSC04-04 Combination of Rapid Scanning with Wide-Detector and Adaptive Statistical Iterative Reconstruction-V Algorithm in Low Dose Chest CT for Unconscious Patients

Monday, Dec. 2 11:00AM - 11:10AM Room: S102CD

Participants
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PURPOSE

To explore the value of combining rapid scanning with wide-detector and new adaptive statistical iterative reconstruction (ASIR-V) in low dose chest CT for unconscious patients.

METHOD AND MATERIALS

Prospectively randomized 46 unconscious patients for chest CT into 2 spiral-scan groups: Group A (n=23) with 80mm collimation and 0.28s gantry rotation speed; Group B (n=23) with 40mm collimation and 0.5s speed to simulate conventional scan protocol. Both groups used the 120kV and AutomA technique (10-500mA) and 50% pre-ASIR-V to obtain a noise index of 14HU.The 0.625mm images were reconstructed with 50%ASIR-V and different kernels. Standard deviations of the antero-subcutaneous fat and back muscle of different scan modes and reconstructions were measured and compared with LSD-t test. The maximum diaphragmatic displacements were measured on sagittal images of the lung-kernel reconstruction and compared. Two radiologists performed 4-level subjective assessments of image quality and motion artifact. The Wilcoxon test and Kappa test was used for image goodness and score consistency, respectively.

RESULTS

The mean scan time in Group A was 1.17s, 70% faster than the conventional protocol (3.91s) resulting in better overall image quality and no measurable diaphragmatic displacement in Group A, compared with the 4.70±5.29mm in Group B ($p<0.05$). There was no difference in radiation dose (1.33 vs. 1.48mSv) and image noise between the two scan groups.

CONCLUSION

The combination of fast scanning with 80mm collimation, 0.28s rotation speed and ASIR-V significantly reduces motion artifacts and image noise in low-dose chest CT for unconscious or uncooperative patients.

CLINICAL RELEVANCE/APPLICATION

The use of 80mm wide-detector and fast rotation speed combined with ASIR-V can significantly reduce motion artifacts and maintain image quality at low radiation dose, and is more suitable for the chest CT examination for unconscious or uncooperative patients.

SSC04-05 Comparison of Baseline, Bone-Subtracted, and Edge-Enhanced Chest Radiographs for Detection of Pneumothorax

Monday, Dec. 2 11:10AM - 11:20AM Room: S102CD

Participants
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PURPOSE

To assess detectability of pneumothorax on unprocessed baseline (Up), bone-subtracted (B-), and edge-enhanced (E+) frontal chest radiographs (CXR).

METHOD AND MATERIALS

Our retrospective IRB approved study included 202 patients (mean age 53 ± 24 years; 132 men, 70 women) who underwent frontal CXR and had trace (<5mm), moderate (>=5mm, <3cm), large (>=3cm), or tension pneumothorax. All patients (except those with tension pneumothorax) had concurrent chest CT performed within 1-7 days of CXR for clinically indicated reasons. Two radiologists reviewed the CXR and chest CT for pneumothorax on Up CXR (ground truth). All Up CXR were processed to generate B- and E+ images (ClearRead X-ray, Riverain Inc). Two separate thoracic radiologists (R1, R2) sequentially assessed the Up, B- and E+ images and separately recorded the presence of pneumothorax (side, size and confidence for detection) for each image type. Area under the curve (AUC) was calculated with ROC analyses to determine the accuracy of pneumothorax detection.

RESULTS

There were 120 right, 95 left, and 13 bilateral pneumothoraces with 53 trace, 87 moderate, 29 large, and 46 tension pneumothoraces. B- images had the lowest accuracy for detection of pneumothorax compared to Up and E+ images ($p<0.01$). With B-, the sensitivity dropped from 91% to 84% on the right side and 83% to 77% on the left for R1 but remained relatively unchanged for R2 (87% vs 86%). Highest detection rates, and confidence was noted for the E+ images (empiric AUC for R1 and R2 0.95-0.99). No false positive pneumothorax was noted on either B- or E+ images.

CONCLUSION

Enhanced CXRs are superior to bone subtraction and unprocessed radiographs for detection of pneumothorax.

CLINICAL RELEVANCE/APPLICATION

Enhanced CXRs improve detection of pneumothorax over unprocessed images; bone subtracted images must be cautiously reviewed to avoid false negatives.

SSC04-06 FFR-CT in the Evaluation of Acute Chest Pain - Concepts and First Experiences

Monday, Dec. 2 11:20AM - 11:30AM Room: S102CD

Participants
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PURPOSE

Fractional flow reserve derived from coronary CTA (FFR-CT) is becoming rapidly established in the evaluation of patients with chronic stable angina in an elective setting. However, the utility of FFR-CT in the work-up of patients presenting to the Emergency Department (ED) with acute chest pain (ACP) is insufficiently studied. We evaluated the hospital course and treatment decisions along with the 30-day rate of major adverse cardiovascular events (MACE) in ACP patients undergoing cCTA and FFR-CT in the ED.

METHOD AND MATERIALS

Patients between the ages of 18-95 years who presented to our ED with ACP and underwent clinically indicated cCTA and FFR-CT were included, if their cCTA interpretation showed coronary artery stenosis between 30-90% luminal narrowing. cCTA was acquired using 3rd generation dual-source CT and FFR-CT was performed using the commercially available computational fluid dynamics approach (HeartFlow®, Redwood City, CA). Subjects were evaluated for patient management decisions, 30 day MACE, repeat presentation to the ED, and 30 day additional testing for evaluation of chest pain. They were subsequently compared to a control group of patients who also presented to the ED with ACP, but underwent alternative evaluation strategies.

RESULTS

The average turnaround time for completing FFR-CT analyses was 3h 22min. 16/31 patients (52%) with stenosis grade of 30-90% by cCTA had negative FFR-CT (>0.80), of whom 9 (56%) were discharged from the ED and 2 of whom underwent invasive coronary angiography (ICA) during the index ED visit, with 1 being revascularized. In comparison, 10/15 patients with FFR-CT <0.80 underwent ICA. Out of the 16 patients without functionally significant coronary artery disease (CAD) by FFR-CT, 15 (93%) did not undergo revascularization and did not experience MACE during the 30-day follow-up. One patient was referred for ICA in the setting of severe stenosis on cCTA, albeit with negative FFR-CT, where ICA showed severe multivessel disease prompting subsequent revascularization. Conversely, 3 patients with FFR-CT <0.80 experienced MACE during follow-up. Within 30-days 2 patients with FFR-CT <0.80 were readmitted, versus none in the FFR-CT>0.80 group. Overall, a negative FFR-CT analysis translates into a high negative predictive value to exclude 30-day MACE occurrence of 94% in this preliminary cohort.

CONCLUSION

These preliminary data suggest that FFR-CT could be utilized for a more rational risk stratification and disposition of patients who present to the ED with ACP than with cCTA alone, helping to differentiate those who would benefit from admission and further invasive management versus those who could be safely discharged. While prior studies have demonstrated utility in the stable chest pain population, to our knowledge this represents the first reported experience in the ACP, ED setting.

CLINICAL RELEVANCE/APPLICATION

cCTA with subsequent FFR-CT demonstrate potential for accurate and safe evaluation of CAD in patients presenting to the ED with ACP.

SSC04-07 Comparison of ASPECTS by Human Observers and Automated ASPECTS in Prediction of Final Infarct Volume in Anterior Circulation Emergent Large Vessel Occlusion

Monday, Dec. 2 11:30AM - 11:40AM Room: S102CD

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PURPOSE

To compare human non-contrast CT ASPECTS, human CT angiography ASPECTS and automated ASPECTS as predictors of final infarct volume in emergent large vessel occlusion in anterior circulation

METHOD AND MATERIALS

CT studies at presentation of consecutive patients (n=98) presenting with emergent large vessel occlusion in the anterior circulation (terminal ICA, M1, proximal M2) were reviewed. ASPECTS readings were made by two radiologists on non-contrast CT and CT angiography studies independently in a blinded fashion. The observers were blinded from each other, other imaging studies and clinical and patient data. Automated ASPECTS readings were recorded from a research based software package. The observers later made consensus ASPECTS readings on follow-up CT or MRI performed within 7 days of presentation. Spearman's rank correlation was performed. Kappa statistic was calculated to test inter-observer agreement among the human readers.

RESULTS

Substantial correlation with final ASPECTS was found for human NCCT ASPECTS ($r=0.713$, $p<0.001$) and human CTA ASPECTS ($r=0.718$, $p<0.001$) readings. The correlation was good for automated ASPECTS ($r=0.543$, $p<0.001$). Good interobserver agreement was seen for NCCT ASPECTS (kappa = 0.628) and CTA ASPECTS (kappa = 0.611).

CONCLUSION

Compared to automated ASPECTS, the ASPECTS by human observers correlates better with final infarct volume in anterior circulation emergent large vessel occlusion. NCCT ASPECTS and CTA ASPECTS show good agreement among the human observers.

CLINICAL RELEVANCE/APPLICATION

ASPECTS is a valuable prognostic marker and important tool to make clinical decisions in acute ischemic stoke. Ongoing validation of machine learning based research applications is important.

SSC04-08 Unsupervised Detection of Various Intracranial Diseases on Brain CT Using Generative Adversarial Networks (GANs)

Monday, Dec. 2 11:40AM - 11:50AM Room: S102CD

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PURPOSE

The main obstacles in applying supervised learning to imaging diagnosis are limited number of abnormal images and effort to annotate training set. In this study, we aim to assess value of simplified AnoGAN (anomaly detection with generative adversarial networks) model in detecting various intracranial disease on brain CT in an unsupervised manner.

METHOD AND MATERIALS

We trained a Progressive Growing of GAN (PGGAN) to generate realistic artificial CT images, using the training set of 1,159 normal brain CT scans (37,324 slices). Test set consisted of total 200 axial slices of brain CT images (100 abnormal images and 100 normal images). Using our simplified AnoGAN model, PGGAN-trained generator yields a corresponding realistic fake image to a given test image by minimizing mean square error between the fake and the test images. The differences between the fake and the test image on attention maps can detect and localize abnormal findings. For evaluation of the detection performance, we classified various intracranial diseases into 4 groups: intracranial hemorrhage, acute infarction including hypoxic brain injury, tumor including primary brain tumor and metastasis, and other diseases. If the attention map partially included the abnormal lesions, it was considered a positive detection.

RESULTS

Total per-slice sensitivity was 89.0% (89/100) and total per-lesional sensitivity was 87.2% (102/117). For each disease group, sensitivity was 91.3% (21/23) for hemorrhage, 85.2% (23/27) for acute infarction, 96.8% (30/31) for tumor and 78.9% (15/19) for other diseases. Evaluation for other performance characteristics was limited due to difficult quantification and calculation of non-pathologic false positive detections.

CONCLUSION

We suggest that unsupervised learning of GANs using healthy dataset can be used to detect various intracranial diseases on unseen data and has high sensitivity to detect anomalies.

CLINICAL RELEVANCE/APPLICATION

We propose that this model can be useful for screening and triaging emergency patients with various intracranial diseases by detecting anomalies on CT.

SSC04-09 Color-Coded Virtual Non-Calcium Dual-Energy CT for the Depiction of Bone Marrow Edema of the Calcaneus in Patients with Acute Tarsal Trauma: A Multireader Diagnostic Accuracy Study

Monday, Dec. 2 11:50AM - 12:00PM Room: S102CD

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PURPOSE

To evaluate the diagnostic accuracy of a dual-energy computed tomography (CT) virtual non-calcium (VNCa) technique for the depiction of traumatic bone marrow edema of the calcaneus.

METHOD AND MATERIALS

Data from 62 patients with acute tarsal trauma who had undergone third-generation dual-source dual-energy CT and 3-T magnetic resonance imaging (MRI) within seven days between January 2017 and July 2018 were retrospectively analyzed. Five radiologists, blinded to clinical and MRI information, independently assessed conventional grayscale dual-energy CT series for the presence of fractures; after at least eight weeks, readers re-evaluated all cases using color-coded VNCa reconstructions for the presence of bone marrow edema for four calcaneal regions. Quantitative analysis of CT numbers on VNCa reconstructions was performed by a sixth radiologist. Two additional experienced radiologists (32 and 20 years of experience in musculoskeletal imaging), blinded to clinical and CT information, assessed MRI series in consensus to define the reference standard. Sensitivity, specificity and the area under the curve (AUC) were the primary indices for diagnostic accuracy.

RESULTS

MRI revealed a total of 62 areas with focal posttraumatic bone marrow edema in 39 patients. Fractures were present in 11 patients. In the qualitative analysis, VNCa showed high overall sensitivity (286/310 [92%]), specificity (899/930 [97%]), positive predictive value (286/317 [90%]), negative predictive value (899/923 [97%]) and accuracy (1185/1240 [96%]) for the depiction of bone marrow edema. Inter-reader agreement was excellent (κ=0.84). CT numbers obtained from VNCa were significantly different in areas with or without edema (p<.001). The overall AUC was 0.98. A cut-off value of -53 Hounsfield units (HU) provided a sensitivity of 82 % (51/62) and specificity of 95% (176/186]) for differentiating bone marrow edema.

CONCLUSION

In both quantitative and qualitative analyses, dual-energy CT VNCa reconstructions show excellent diagnostic accuracy for the depiction of traumatic calcaneal bone marrow edema compared to MRI by enabling direct color-coded visualization.

CLINICAL RELEVANCE/APPLICATION

Bone marrow edema may be visualized using color-coded VNCa reconstructions during dual-energy CT performed for detection of fracture in patients with acute tarsal trauma, potentially replacing MRI in patients with contraindications.

Printed on: 10/29/20

SSC05

Gastrointestinal (Hepatocellular Carcinoma)

Monday, Dec. 2 10:30AM - 12:00PM Room: N228

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSC05-01 How Frequently Does HCC Develop in At-Risk Patients with a Negative Liver MRI Examination?

Monday, Dec. 2 10:30AM - 10:40AM Room: N228

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PURPOSE

Guidelines for hepatocellular carcinoma (HCC) screening typically recommend imaging surveillance at 6 month intervals. For patients who undergo US screening and have a liver MRI for other reasons, or are screened with MRI due to poor quality US (obesity or hepatic steatosis), a longer interval after may be appropriate. The purpose of this study was to determine the rate of development of significant liver lesions after a negative MRI in a screening population.

METHOD AND MATERIALS

This retrospective study included patients from 2013 at risk of developing HCC, who underwent MRI surveillance, with follow up CTs or MRIs for at least 12 months read using the Liver Imaging and Reporting Data System (LI-RADS)[3]. Patients with baseline focal liver lesions categorized not LR-1, history of primary liver cancer, prior treatment of a liver lesion, or liver transplant were excluded. All available CTs and MRIs that were compliant with the LI-RADS technical guidelines were included in the follow-up assessment. Follow-up examinations were classified as negative (no lesions or only LR-1 lesions) or positive (at least one observation of any category other than LR-1). Time to first positive examination and observation types were recorded.

RESULTS

204 patients (mean age 58 ± 11 years, 128 women, 168 patients with cirrhosis, most with non-alcoholic steatohepatitis (n=117), were included. Median follow up duration was 28 (range 12-60) months. 5.9% (12/204) of patients developed a lesion at follow-up ("became positive"). At 6-9 months, one patient (0.5%, 1/204) became positive, with new LR-3 nodules measuring up to 11 mm. At 12±3 months, three additional patients (cumulative 2%, 4/204) became positive: a 12 mm LR-3 nodule, a 10 mm LR-4 nodule, and a 29 mm LR-M nodule. By two years, two additional patients became positive with LR-3 nodules.

CONCLUSION

Clinically significant (LR-4, LR-5, LR-M) liver nodules develop in a minority (1%) of patients in the first year following negative MRI. While ongoing surveillance is necessary, after a negative MRI it may be reasonable to perform the screening imaging at 1 year.

CLINICAL RELEVANCE/APPLICATION

In patients at risk for HCC with a negative MRI, the next imaging surveillance for HCC could be delayed until one year after the MRI

SSC05-02 Hepatobiliary Phase Hypointense Nodule without Arterial Phase Hyperenhancement on Gadoxetic Acid-Enhanced MRI: Risk of HCC Intrahepatic Distant Recurrence after Radiofrequency Ablation or

Hepatectomy: A Systematic Review and Meta-Analysis

Monday, Dec. 2 10:40AM - 10:50AM Room: N228

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PURPOSE

To perform a systematic review and meta-analysis to determine intrahepatic distant recurrence (IDR) risk of hepatobiliary phase (HBP) hypointense nodules without arterial phase hyperenhancement (APHE) on pretreatment gadoxetic-acid enhanced MRI in patients with hepatocellular carcinoma (HCC) treated with either hepatectomy or radiofrequency ablation (RFA).

METHOD AND MATERIALS

Pubmed and EMBASE databases were searched up to April 6th 2019. We included studies that evaluated HBP hypointense nodules without APHE as risk factors for IDR in HCC patients treated with either hepatectomy or RFA. Hazard ratios (HR) were meta-analytically pooled using random-effects model. Subgroup analyses stratified to clinicopathologic variables were performed to explore heterogeneity. Methodological quality of included studies was assessed using Quality in Prognostic Studies (QUIPS) tool.

RESULTS

Eight studies with 842 patients were analyzed. The overall pooled HR for IDR was 2.44 (95% CI, 1.99-2.98) and were (2.14 (95% CI, 1.66-2.76) and 3.07 (95% CI, 2.19-4.31) for patients that underwent hepatectomy and RFA, respectively. No significant heterogeneity was present (I2 = 0%). The presence of these nodules was consistently shown to be significant factors for IDR in other subgroups (HR = 1.74-3.07). Study quality was generally moderate.

CONCLUSION

HBP hypointense nodules without APHE are risk factors for IDR in HCC patients treated with either RFA or hepatectomy. Stratification of patient management with regard to performing additional tests or treatment for these nodules and modification of proper follow-up strategies may be required in patients with HCC who have these nodules on pretreatment gadoxetic acid-enhanced MRI.

CLINICAL RELEVANCE/APPLICATION

HBP nodules without APHE in pretreatment gadoxetic acid-MR should be recognized as a significant risk factor for increased IDR after curative treatment for HCCs and therefore, it may require stratification of patient management with regard to deciding whether to perform additional pathologic test or treatment to these nodules and modification of proper follow-up strategies after curative treatment for HCCs in patients who harbor these nodules.

SSC05-03 Prospective Intraindividual Comparison of CT, MRI with Extracellular Contrast and Gadoxetic Acid for Diagnosis of HCC

Monday, Dec. 2 10:50AM - 11:00AM Room: N228

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PURPOSE

We prospectively evaluated the diagnostic performance of computed tomography (CT), magnetic resonance imaging (MRI) with extracellular contrast agents (ECA-MRI), and MRI with hepatobiliary agents (HBA-MRI) for the diagnosis of hepatocellular carcinoma (HCC) using the Liver Imaging Reporting and Data System (LI-RADS) with pathological confirmation.

METHOD AND MATERIALS

Between November 2016 and February 2019, we enrolled 125 patients with chronic liver disease who underwent CT, ECA-MRI, and HBA-MRI within one month before surgery for initial hepatic nodules detected via ultrasound. Two radiologists evaluated the presence of major and ancillary HCC features and assigned LI-RADS categories (v2018) based on CT and MRI. We then compared the diagnostic performance for LR-5 for each modality alone and in combination.

RESULTS

In total, 163 observations (124 HCCs, 13 non-HCC malignancies, and 26 benign lesions; mean size, 20.7 mm) were identified. ECA-MRI showed a higher rate of identifying arterial phase hyperenhancement (16.1% and 8.1%), washout (5.6% and 6.5%), and enhancing capsule (51.6% and 44.4%) compared with CT and HBA-MRI, respectively. ECA-MRI showed better sensitivity and

accuracy (83.1% and 86.5%) than either CT (63.7% and 71.8%) or HBA-MRI (69.4% and 76.1%), while all imaging modalities achieved 97.4% specificity. When combining CT with ECA-MRI or HBA-MRI, sensitivity (89.5% and 83.1%) and accuracy (91.4% and 86.5%) were increased compared with CT alone.

CONCLUSION

ECA-MRI showed better sensitivity and accuracy than CT or HBA-MRI for the diagnosis of HCC with LI-RADS. We achieved better diagnostic performance when applying CT in combination with one of the two MRI compared with CT alone.

CLINICAL RELEVANCE/APPLICATION

Our study confirms that significant discrepancy of HCC imaging features across the imaging modality, and clinicians need to select the appropriate imaging modality for their preferred sensitivity/specificity trade off.

SSC05-04 Long-Term Evolution of Hepatocellular Adenomas at MR Imaging Follow-Up

Monday, Dec. 2 11:00AM - 11:10AM Room: N228

Awards
Trainee Research Prize - Fellow

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PURPOSE

Hepatocellular adenomas (HCAs) are rare benign liver tumors. Guidelines recommend continued surveillance for patients diagnosed with HCAs, but these recommendations are mainly based on uncontrolled studies or experts' opinion. The aims of this study were to analyze the long-term course of evolution of HCAs including solitary and multiple lesions, and to identify predictive features of progression.

METHOD AND MATERIALS

In a retrospective cohort study performed at a tertiary care hospital, we included 118 patients (mean 40±10 years old) with HCAs proven at biopsy or surgery: 41 patients had solitary HCAs and 77 patients had multiple HCAs. Imaging follow-up with MR was analyzed and tumor evolution was evaluated using the Response Evaluation Criteria in Solid Tumors (RECISTv1.1) thresholds.

RESULTS

Median follow-up of the entire study population was 5.0 years. Overall, 37/41 (90%) solitary HCAs and 55/77 (71%) patients with multiple HCAs showed stable or regressive disease (i.e. >30% size decrease). After resection of solitary HCAs, new lesions appeared only in 2/29 (7%) patients, both with HCAs at-risk of malignancy. In the multiple HCAs cohort, HNF-1A inactivated HCAs showed a higher rate of progression compared to inflammatory HCAs (11/26 [42.3%] vs. 7/37 [18.9%], p = 0.043), lower use of oral contraceptives (28/32 [87.5%] vs. 45/45 (100%), p =0.027) and lesser duration of oral contraception intake (mean 12.0 years ± 7.5 vs. 19.2 years ± 9.2, p = 0.001).

CONCLUSION

Seventy-eight percent of HCAs showed long-term stability or size regression. After resection of solitary HCAs, tumor progression occurred only in HCAs at-risk of malignancy. Patients with multiple HCAs were more likely to show progressive disease, with HNF-1 A inactivated HCAs being the most common subtype showing progression.

CLINICAL RELEVANCE/APPLICATION

This is the first study demonstrating the long-term evolution of hepatocellular adenomas (HCAs). In patients with resected solitary HCAs, surveillance may be potentially discontinued after resection, except in case of ß-catenin mutated HCAs or foci of malignancy within the tumor. In patients with multiple HCAs, progressive disease may occur in up to 31% of cases, and, therefore, continued surveillance is suggested regardless of surgery.

SSC05-05 Clinical Outcomes of Patients with Elevated Alpha-Fetoprotein Level but Negative CT or MRI Findings in the Post-Treatment Surveillance After Curative-Intent Surgery or Radiofrequency Ablation for Hepatocellular Carcinoma

Monday, Dec. 2 11:10AM - 11:20AM Room: N228

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PURPOSE

To evaluate the outcomes of patients with elevated alpha-fetoprotein (AFP) but negative CT or MRI findings in the post-treatment surveillance after curative-intent surgery or radiofrequency ablation (RFA) for hepatocellular carcinoma (HCC) and to determine predictive factors for subsequent detectable recurrence.

METHOD AND MATERIALS

This single-center retrospective study analyzed 76 patients who presented elevated AFP (>=20 ng/mL) without detectable recurrence on concurrent CT or MRI during surveillance after receiving curative-intent surgery or RFA. Time to imaging progression (development of detectable recurrence) after initial event of AFP elevation was estimated by the Kaplan-Meier method and was compared using univariate Cox regression analysis according to following parameters: surgery versus RFA, AFP elevation >50 ng/mL, prior post-treatment AFP <20 ng/mL, and negative imaging results on CT versus MRI.

RESULTS

In patients with post-treatment AFP elevation but without detectable recurrence on concurrent CT or MRI, the median time to imaging progression was 7.0 months (95% confidence interval: 6.0~9.0 months). Of the 76 patients enrolled, 57 patients (75.0%) developed either intra-hepatic (n=55) or extra-hepatic (n=2) recurrence detected on the average 2.6th follow-up CT or MRI studies after a mean of 7.9 months, whereas the other 19 patients (25.0%) did not develop any recurrence during average 4.4th CT or MRI studies for a mean follow of 15.9 months. Patients with prior post-treatment AFP <20 ng/mL showed significantly shorter time to imaging progression than those without (median 6.0 versus 16.0 months, P=0.001), while no significant differences were found according to prior treatment options, AFP elevation degrees, and imaging modalities showing negative results (Ps>0.05).

CONCLUSION

Elevated AFP (>=20 ng/mL) but negative CT or MRI findings in the post-treatment surveillance for HCC was frequently associated with subsequent imaging detectable recurrence in a short-term period. In addition, interval increment of post-treatment AFP from <20 to >=20 ng/mL was a significant risk factor for early recurrence.

CLINICAL RELEVANCE/APPLICATION

Elevated AFP after HCC treatment requires intensive follow-up to timely detect tumor recurrence, even if imaging studies show negative results at the time of initial AFP elevation.

SSC05-06 Intra Individual Prospective Comparison of Extracellular and Hepatobiliary MR Contrast Agent for the Diagnosis of HCC

Monday, Dec. 2 11:20AM - 11:30AM Room: N228

Participants
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PURPOSE

Hepato-biliary (HB) contrast agent became part of international guidelines for the non-invasive diagnostic of hepatocellular carcinoma (HCC). The aim of this study was to compare performances of MRI with extra-cellular contrast agent (ECA-MRI) to HB contrast agent (HBA-MRI) for the diagnostic of small HCCs in a face to face comparison.

METHOD AND MATERIALS

All patients gave written informed content and this prospective study was approved by IRB. Between August 2014 and October 2017, 172 patients with cirrhosis, each 1 to 3 nodules from 1 to 3 cm large, were included in 8 centers. All patients had both ECA-MRI and HBA-MRI within a month. The non-invasive diagnostic of HCC was made when nodule was hyper-vascularized at arterial phase (HA) with wash-out at portal phase (PP) and/or delayed phase for ECA-MRI, or PP and/or HB phase (HBP) for HBA-MRI. The Gold Standard was defined by a composite algorithm previously published (CHIC study).

RESULTS

225 nodules, among them 153 HCCs and 72 not HCCs, were included. Both MRI sensitivities were similar (71.2%). Specificity was 83.3% for ECA-MRI and 68.1% for HBA-MRI. Concerning HCCs: on ECA-MRI, 138 were HA, 84 had wash-out at PP and 104 at DP; on HBA-MRI, 120 were HA, 79 had wash-out at PP and 105 at HBP. For nodules from 2 to 3 cm, sensitivity and specificity were similar with respectively 70.9% and 75.0%. For nodules from 1 to 2 cm, specificity drop down to 66.1% for HBA-MRI vs 85.7% for ECA-MRI.

CONCLUSION

HBA-MRI specificity is lower than HCA-MRI for the diagnostic of small HCC on cirrhotic patients. These results must question about the proper use of HBA-MRI in algorithm for the non-invasive diagnostic of small HCCs.

CLINICAL RELEVANCE/APPLICATION

The use of HBA-MRI in international guidelines for the non-invasive diagnostic of HCC should be used with caution.

SSC05-07 Can Baseline MR Imaging Biomarkers Enhance Survival Prediction of Hepatocellular Carcinoma (HCC) Patients?

Monday, Dec. 2 11:30AM - 11:40AM Room: N228

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PURPOSE

To evaluate role of baseline ADC and tumor margin as independent predictors of overall survival (OS) in HCC patients and assess how incorporating these variables to current staging systems may enhance survival prediction in these group of patients.

METHOD AND MATERIALS

In a retrospective IRB approved study clinical, laboratory and imaging parameters of 273 randomly selected HCC patients were collected. Cox regression model was utilized to identify parameters that were significantly related to survival. Patients were stratified based on BCLC and CLIP. Recursive partitioning test were applied on a test set of patients (70%) to identify the optimal cutoff of ADC in stratifying patient based on difference is survival. The estimated cutoff was validated on the validation set of patients. Binary ADC value (above or below the cutoff) and tumor margin were integrated in to BCLC and CLIP. Kaplan- Myer curves were drown and overall survival was measured for patients based on BCLC, CLIP, combined model of BCLC + ADC + margin and CLIP + ADC + margin. Predictive performance of each model was measured and compared using C statistical analysis.

RESULTS

At baseline, patients with Low tumor ADC and well- defined tumor margin (favorable imaging biomarkers) had longer survival compared with those with high ADC and ill-defined tumor margin (unfavorable imaging biomarkers) (median OS of 63 months and 6 months, respectively). Tumor ADC and tumor margin remained as the two strong independent predictors of survival in HCC patients after adjustment for other clinical variables. Incorporating ADC (at cutoff of 1390 × 106mm/s) and tumor margin into BCLC and CLIP improved performance of survival prediction by 10% in BCLC group (0.63 Vs 0.73; $p<0.001$) and 7% in CLIP group (0.68 vs 0.75; $p<0.001$), Table 1. Regardless of BCLC and CLIP stage patients with unfavorable ADC and TM had significantly shorter OS compared to patients with both favorable ADC and TM ($p<0.001$), Figure 1.

CONCLUSION

Incorporating ADC and tumor margin to currently used staging systems for HCC significantly improve prediction performance of these criteria. Also, it could potentially change prediction of OS regardless of patient clinical status.

CLINICAL RELEVANCE/APPLICATION

ADC and tumor margin are two imaging biomarkers that can improve prediction performance of current staging systems, help to better stratify patients at baseline and define optimized treatment plan for them

SSC05-08 Comparison of the Diagnostic Performance of Imaging Criteria for Early-Stage Hepatocellular Carcinoma on Gadoxetate Disodium-Enhanced MRI

Monday, Dec. 2 11:40AM - 11:50AM Room: N228

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PURPOSE

We aimed to compare the diagnostic performance of imaging criteria for early-stage hepatocellular carcinoma (HCC) on gadoxetate disodium-enhanced MRI.

METHOD AND MATERIALS

We retrospectively evaluated 570 nodules (440 HCCs, 25 other malignancies, 105 benign nodules) of 3.0 cm or smaller from 418 patients at risk for HCC who underwent gadoxetate disodium-enhanced MRI from July 2015 to December 2016. Final diagnosis was assessed histopathologically or clinically (marginal recurrence after treatment or change in lesion size on follow-up imaging). We compared the sensitivity and specificity for diagnosing HCC among the latest versions of four imaging criteria, including Liver Imaging Reporting and Data System (LI-RADS), European Association for the Study of the Liver (EASL), Asian Pacific Association for the Study of the Liver (APASL), and Korean Liver Cancer Association-National Cancer Center (KLCA-NCC), using the generalized estimating equations.

RESULTS

For >=10 mm nodules, APASL showed the highest sensitivity (85.0%), significantly higher than LI-RADS category 4 or 5 (75.9%), LI-RADS category 5 (64.2%), and EASL (63.4%) ($P <= .001$). Regarding the specificity, LI-RADS category 5 was highest (94.7%), significantly higher than KLCA-NCC (83.0%) and APASL (78.7%) ($P < .001$). For <10 mm nodules, the sensitivity and specificity of LI-RADS category 4 or 5 were 17.1% and 97.2%, respectively, and those of APASL were 73.2% and 83.3%, respectively ($P < .001$ for sensitivity, and $P = .1$ for specificity). For histopathologically confirmed lesions, the results of subgroup analysis were similar to

those of all lesions.

CONCLUSION

Of the four international imaging criteria, APASL had the highest sensitivity and LI-RADS category 5 showed the highest specificity for diagnosing early-stage HCC in high-risk patients on gadoxetate disodium-enhanced MRI.

CLINICAL RELEVANCE/APPLICATION

To improve diagnostic performance of gadoxetate disodium-enhanced MRI for early-stage HCC, it is important to understand the differences of various imaging criteria for HCC.

SSC05-09 Hepatobiliary Phase Hypointensity as Predictor of Progression to Hepatocellular Carcinoma for Intermediate-High Risk Lesions

Monday, Dec. 2 11:50AM - 12:00PM Room: N228

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PURPOSE

To determine the prognostic performance of hepatobiliary phase hypointensity, and Liver Imaging Reporting and Data System (LI-RADS) major imaging features in the prediction of progression to hepatocellular carcinoma (HCC) in LR-3 and LR-4 hepatic lesions with arterial phase hyperenhancement (APHE) measuring >= 10 mm in patients at high risk of HCC.

METHOD AND MATERIALS

This retrospective dual-institution study included 160 LR-3 and 26 LR-4 lesions measuring more than 10 mm and having APHE in 136 consecutive patients (mean age(SD), 57 (11) years old; mean lesion size (SD), 14 (4) mm). A composite reference standard of pathologic analysis and imaging follow-up was used. The prognostic performance (sensitivity and specificity) of hepatobiliary phase hypointensity and LI-RADS version 2018 major imaging features other than APHE for the prediction of probability of progression to HCC and time to progression to HCC was assessed and compared by means of Log-rank test, Cox-regression and Kaplan-Meier curves.

RESULTS

Hepatobiliary phase hypointensity was a predictor of progression to HCC at univariate ($p<0.0001$) and multivariate ($p<0.0001$) analysis, with an odds ratio of 20.6. Median time to progression to HCC was 284 days [95%CI: 266-363). In LR-3 and LR-4 lesions >= 10 mm with APHE that progressed to HCC, the presence of hepatobiliary phase hypointensity, nonperipheral washout or enhancing capsule did not predict time to progression to HCC.

CONCLUSION

Hepatobiliary phase hypointensity is an independent predictor of progression to HCC in intermediate-high risk lesions measuring >= 10 mm and having APHE in patients at risk for HCC.

CLINICAL RELEVANCE/APPLICATION

Intermediate and high risk lesions not fulfilling definitive imaging criteria for HCC account for about 40% of observations during interpretation of CT and MR imaging studies. Natural history of these lesions may be extremely variable. The prognostic information provided by hepatobiliary phase hypointensity in terms of prediction of progression to HCC allows for more tailored management.

SSC06

Gastrointestinal (Advanced Response Evaluation)

Monday, Dec. 2 10:30AM - 12:00PM Room: N230B

BQ GI OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSC06-01 Immunotherapy Response Evaluation with Magnetic Resonance Elastography (MRE) in Advanced HCC

Monday, Dec. 2 10:30AM - 10:40AM Room: N230B

Participants
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PURPOSE

To determine whether stiffness change on magnetic resonance elastography (MRE) can detect immunotherapy response in advanced HCC.

METHOD AND MATERIALS

This was a prospective study of 15 patients with advanced HCC who were treated with anti-PD-1 therapy, (Pembrolizumab). All patients had a standard of care liver MRI with MRE, and liver biopsy at baseline and after 6 weeks of therapy. HCC stiffness was measured on MRE elastograms. Increase in HCC stiffness was compared with a decrease in HCC ADC, size and enhancement on MRI. Change in HCC stiffness was compared with the time to disease progression, overall survival, and the total number of intratumoral T lymphocytes (CD3+ positive by immunohistochemistry) on targeted liver biopsy. Analysis was performed using descriptive statistics and Spearman correlation (R); p-value <0.05 was considered statistically significant.

RESULTS

Nine evaluable patients (6 men; 3 women) were analyzed. Median age was 71 years (range, 54-78). Etiology of liver disease was HCV (n=4), HBV (n=1) and NASH (n=4). HCC was well-differentiated in 2 of 9 patients, moderately differentiated in 6 and poorly differentiated in 1. Average HCC size was 4 cm (range, 1.5 - 8.5), and change in size at 6 weeks was -0.32 (range, - 2.2 - 0.4). Median time to progression (TTP) was 13 weeks (range, 9-48) and overall survival (OS) was 44 weeks (range, 16-70). Average baseline HCC stiffness and change in HCC stiffness were 5.0 kPa (range, 2.4 -9.1) and 0.12 kPa (range, [-2.1] - 2.8), respectively. Increase in HCC stiffness on MRE correlated significantly with a decrease in ADC (p=0), but there was no correlation with change in HCC size (p=0.5) or enhancement (p=1). HCC stiffness correlated significantly with intratumoral T lymphocytes on biopsy (R = 0.79, p = 0.007). Change in HCC stiffness at 6 weeks correlated significantly with TTP (R = 0.88 and OS (R = 0.81), p <0.01. Baseline non-tumor liver stiffness and HCC size tended toward inverse correlation with overall survival (p < 0.055).

CONCLUSION

Increased HCC stiffness on MRE was associated with longer time to disease progression and survival in advanced HCC and may be useful as a biomarker of early immunotherapy response.

CLINICAL RELEVANCE/APPLICATION

Development of noninvasive functional MRI biomarkers of early immunotherapy response would improve therapeutic management in advanced hepatocellular carcinoma.

SSC06-02 Role of Tumor Morphology and ADC Change in Defining the Need for Additional TACE after Initial

Treatment in Patients with Unresectable HCC

Monday, Dec. 2 10:40AM - 10:50AM Room: N230B

Participants
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PURPOSE

To evaluate the survival benefit of sequential transarterial chemoembolization in different subgroups of patients with unresected hepatocellular carcinoma

METHOD AND MATERIALS

For this IRB approved, HIPPA compliant retrospective cohort study, our institutional database was searched for patients with hepatocellular carcinoma diagnosed during 2005-2016. Patients who had MR imaging, received transarterial chemoembolization (TACE), and did not undergo liver resection or transplantation were included. Data on baseline liver function, number of TACE, and survival status was retrieved from our clinical database. Lesions were categorized to well-defined or ill-defined for subgroup analysis. Baseline tumor volume and volumetric apparent diffusion coefficient (ADC) of tumors at baseline and after first TACE were measured. After adjustment for demographics, baseline liver function, and tumor volume, the correlation between number of TACE and OS was tested using multiple Cox regression in different subgroups of patients.

RESULTS

A total of 159 patients met the inclusion criteria. 52 patients had well-defined and 107 patients had ill-defined HCC tumors. The median number of TACE sessions was comparable between groups (p=0.35). Tumor volume was larger in patients with ill-defined lesions, as compared to well-defined lesions (p=0.001). The median OS was 340 days for all patients, 663 days for those with well-defined lesions, and 257 days for those with ill-defined lesions (HR=1.64, p<0.001). After adjusting for confounders including the tumor size, Cox model showed that patients with ill-defined lesions take survival benefit from an increase in number of TACE sessions (HR=0.86, p=0.020). Higher number of TACE did not improve OS in patients with well-defined lesions (HR=0.91, p=0.173). In patients with well-defined tumors, a cutoff value of >=25% increase in ADC after first TACE was shown to predict better OS (p= 0.023). When categorizing these patients based on this cutoff value, a higher number of TACE did not show any survival benefit (HR=1.12, p=0.422) in patients with >=25% ADC increase (responders). In patients with <25% ADC increase (non-responder to first TACE), an increase in the number of subsequent TACE sessions was shown to significantly improve patients' OS (HR=0.73, p=0.031).

CONCLUSION

Survival benefit of sequential TACE is different for ill- vs well-defined HCC. This benefit is limited in lesions that respond well to first treatment by >=25% increase in ADC. Patients with ill-defined or non-responding well-defined lesions would benefit from additional TACE.

CLINICAL RELEVANCE/APPLICATION

Patients with ill-defined HCC or well-defined lesions with <25% ADC-increase after first TACE will benefit from additional TACE. This benefit is limited in those with adequate response to first TACE.

SSC06-03 Early Survival Prediction Using 3D Quantitative Tumor Response Analysis on MRI in Patients with Advanced Stage Hepatocellular Carcinoma Undergoing Systemic Therapy with Sorafenib

Monday, Dec. 2 10:50AM - 11:00AM Room: N230B

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PURPOSE

To compare uni- (1D) and three-dimensional (3D) quantitative tumor response criteria on multi-parametric magnetic resonance imaging (mpMRI) in patients with hepatocellular carcinoma (HCC) that underwent systemic therapy with sorafenib and to evaluate their ability to predict overall survival (OS) outcomes.

METHOD AND MATERIALS

This IRB-approved retrospective, single-institution analysis included twenty-three patients with advanced stage HCC who received sorafenib for at least 60 days. All patients underwent baseline (BL) and Follow-Up (FU) MRI 19-140 days after initiation of therapy (median 65 days, standard deviation ±33.58). Response to sorafenib was assessed in 37 target lesions using 1D criteria such as Response Evaluation Criteria in Solid Tumors (RECIST) and modified RECIST (mRECIST). In addition, a segmentation-based 3D quantification of enhancing lesion volume (volumetric quantitative European Association for the Study of the Liver, vqEASL) was performed on arterial-phase MRI, and the enhancement fraction of total tumor volume (percentage-based qEASL, pqEASL) was calculated. Accordingly, patients were stratified into groups of Disease Control (DC, which included Complete Response, Partial Response, and Stable Disease) and Disease Progression (DP, included Progressive Disease). Overall survival was evaluated using Kaplan-Meier curves with log-rank test.

RESULTS

The survival analysis showed that stratification of patients in DC vs. DP according to vqEASL was successfully predicted (DC n=22, DP n=15) and stratified overall survival (median OS of 15.4 months for DC, 10.7 months for DP; p=0.01, see Figure 1). Stratification according to RECIST (DC n=20, DP n=17), mRECIST (DC n=27, DP n=10) and pqEASL (DC n=36, DP n=1) did not correlate with OS (p=0.2416, p=0.6945 and p=0.8055, respectively).

CONCLUSION

The study identified vqEASL as an accurate predictor of overall survival early after initiation of sorafenib treatment. This data provides early evidence for potential advantages of 3D quantitative tumor response analysis over conventional techniques regarding early identification of response to or failure of sorafenib.

CLINICAL RELEVANCE/APPLICATION

The use of 3D quantitative vqEASL may optimize clinical decision making and provide more personalized therapeutic algorithms in patients undergoing systemic therapy of advanced stage HCC.

SSC06-04 Multi-Parametric DECT Assessment of Therapeutic Response to Neo-Adjuvant Chemoradiation in Pancreatic Cancer Patients to Determine Surgical Resectability

Monday, Dec. 2 11:00AM - 11:10AM Room: N230B

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PURPOSE

To study if iodine quantification and CTTA can detect histologic response in pancreatic cancer following neoadjuvant chemoradiation

METHOD AND MATERIALS

This IRB approved study prospectively included patients with borderline resectable or locally advanced pancreatic ductal adenocarcinoma (PDAC) undergoing neo-adjuvant chemoradiation (NACT/RT) prior to surgical resection. Patients underwent multiphase abdominal dual energy (DECT) at baseline and a presurgical DECT within 2 weeks of completion of NACT/RT. Based on post-surgical pathology the patients were divided into good histologic response and poor histologic response. The tumor morphology (RECIST 1.1), Iodine quantification and CT texture analysis (CTTA) were compared between these two groups using student t-test and Mann Whitney U test. Multiple regression was used to identify the strongest independent predictor of histological response.

RESULTS

Final patient cohort included 25 patients of which 13 had good histologic response and 12 had poor histologic response. Morphological response by RECIST 1.1 was associated with good histologic response (5/13 vs 0/12 respectively, p=0.039). CTTA parameters were significantly different between the good and poor histologic response groups at baseline, but more frequently after NACT/RT (Figure). On multivariate analysis, CTTA was a strong (rpartial=0.68; p=0.007) and independent predictor of histological response after NACT/RT. There was no significant difference in the quantitative iodine values at baseline, early treatment and after completion of chemoradiation both in the arterial/pancreatic phase and portal venous phase.

CONCLUSION

CT texture analysis performed on post processed DECT images is a strong marker for assessing and predicting histologic response after neoadjuvant chemoradiation in pancreatic and outperforms morphologic features of tumor size and vascular involvement.

CLINICAL RELEVANCE/APPLICATION

The detection of post NACT/RT treatment effects in PDAC is very challenging and can not be reliably assessed on conventional imaging. This study shows that CTTA can reliably predict and assess the histologic response.

SSC06-05 Yttrium-90 Radioembolization for Hepatocellular Carcinoma: Outcome Prediction with MRI Derived Fat-Free Muscle Area

Monday, Dec. 2 11:10AM - 11:20AM Room: N230B

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PURPOSE

Sarcopenia is associated with adverse outcomes in gastrointestinal malignancies and liver cirrhosis. We aimed at investigating the utility of magnetic resonance imaging (MRI) derived fat-free muscle area (FFMA) to predict clinical outcome in patients receiving yttrium-90 radioembolization (RE) for treatment of hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

Consecutive patients with unresectable HCC and pre-interventional liver MRI undergoing salvage RE between December 2007 and October 2014 were retrospectively evaluated. Using axial T2-weighted turbo spin echo sequences, FFMA was calculated by subtraction of the intramuscular adipose tissue area from the total cross-sectional area of paraspinal skeletal muscles at the superior mesenteric artery level. FFMA values lower than 3582 mm2 in male and 2301 mm2 in female patients were defined as low FFMA. Main outcomes were progression-free survival (PFS) and overall survival (OS). For outcome analysis, the Kaplan-Meier method with log rank test and multivariate cox regression analysis were used.

RESULTS

Fifty-eight patients (13 female, mean age 68+-12 years) were included. Mean time from pre-interventional MRI to RE was 27 ± 20 days. Median OS and PFS after RE were 250 (range: 21-1230 days) and 156 days (range: 21-674 days), respectively. Patients with low FFMA showed significantly reduced OS (197 vs. 294 days, P=0.024) and tended to have shortened PFS (109 vs. 185 days, P=0.068). Low FFMA (HR 2.675; P=0.011), estimated liver tumor burden (HR 4.058; P=0.001), and Eastern Cooperative Oncology Group (ECOG) performance status (1.763; P=0.009) were independent predictors of OS on multivariate analysis.

CONCLUSION

FFMA might represent a promising new biomarker for survival prognosis in patients undergoing RE for treatment of unresectable HCC.

CLINICAL RELEVANCE/APPLICATION

In this study, we offer an easy applicable MRI-based measurement of lean muscle mass as a measure of sarcopenia which is capable to predict outcome in patients receiving RE for treatment of unresectable HCC.

SSC06-06 Early Tumor Viability Prediction Following Y90 Radioembolization Segmentectomy for Hepatocellular Carcinoma Using Automated 3D Tumor Sub-Volume Segmentation and Texture Analysis

Monday, Dec. 2 11:20AM - 11:30AM Room: N230B

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PURPOSE

Tumor viability (TV) after radioembolization segmentectomy (RS) is often not definitive on follow-up MRI until several months later.

Given an array of available treatment options for early and advanced HCC, sooner determination of RS efficacy is needed to facilitate optimal disease management.

METHOD AND MATERIALS

83 patients with initial RS 1/1/14 - 12/31/17 were retrospectively reviewed. Patients with prior TACE, TARE, systemic therapy or target lesion (TL) retreatment after first follow-up (FU1) and before second follow-up (FU2) were excluded. All FU MRIs were assessed using mRECIST criteria. Tumor viability (TV) was defined as PR, SD or PD. Using Slicer's GrowCut tool duplicate tumor and normal parenchymal segmentations were made on T1 arterial phase (T1 AP) and ADC on pre-RS and FU1 MRI. Automated calculation of 3D hypo- and hyperintense sub-volumes and first order texture features were performed using SimpleITK, Numpy and PyRadiomics. Segmentation time and intraclass correlation (ICC) of segmentations was assessed. Metrics were compared to TV at FU2 and time to TL TV. Univariate Mantel-Cox time to event, logistic regression and ROC analysis were performed using R and Prism.

RESULTS

47 patients were selected with a mean age of 70 (66% male). 5, 27, 10 and 5 were BCLC 0, A, B, and C. Mean TL size (mm) and dose (mCi) were 26 (SD19) and 49 (SD27), respectively. Pre-RS MRI was performed a mean 44 (SD 13) days before treatment. FU1 and FU2 MRIs were performed a mean 51 (SD 15) and 136 (SD 38) days after intervention. 373 tumor segmentations were made taking a mean 3.4 (SD 2.1) minutes each with ICC of 0.83 (95CI 0.78-0.88). At FU2 36 and 11 had CR and tumor viability, respectively. Median overall survival was 30 months. On logistic regression analysis, difference in T1 AP and ADC kurtosis between pre-RS and FU1 were significantly predictive of TV on FU2 with AUC 0.77 ($p<0.05$) and 0.76 ($p<0.05$). There were no significant differences on median-split, univariate time to TV for all measures.

CONCLUSION

On early follow-up MRI after RS hyper- and hypointense sub-volume sizes do not appear correlated with TV, however, 3D tumor texture analysis do appear to be predictive of TV.

CLINICAL RELEVANCE/APPLICATION

Texture analysis may provide insight into tumor viability earlier than mRECIST. If validated prospectively, adoption of routine tumor segmentation and MR-based quantitative analyses may hasten and improve HCC treatment decision making.

SSC06-07 Dual-Energy CT Vital Iodine Tumor Burden as a Quantitative Response Parameter in Patients with GIST Undergoing Tyrosine-Kinase-Inhibitor Therapy - A Comparison to Standard CT and FDG-PET Criteria

Monday, Dec. 2 11:30AM - 11:40AM Room: N230B

Participants
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PURPOSE

o determine whether dual-energy CT (DECT) vital iodine tumor burden (VITB) allows reliable response assessment in patients with a Gastrointestinal Stromal Tumor (GIST) undergoing Tyrosine-Kinase Inhibitor therapy (TKI), compared to established CT and [18F] fluorodeoxyglucose (FDG) positron emission tomography (PET) criteria.

METHOD AND MATERIALS

An anthropomorphic phantom equipped with spherical GIST lesions of 3 different iodine concentrations (1, 2 and 5mg/mL) and a non-enhancing central necrotic core (40HU at 120kVp) was scanned on a second generation dual-source DECT platform. 40 patients with 155 metastatic GIST lesions underwent a portal phase DECT on the same platform. Each patient had a pre-treatment and a 3-4-months follow-up DECT and FDG-PET after TKI-treatment. Up to 5 target lesions were selected using mRECIST 1.1 guidelines. Tumor burden was assessed using different tumor response criteria, including mRECIST 1.1, mChoi, VTB, and VITB. Standardized uptake value (SUVmax) on the FDG-PET datasets, which is the current reference standard for metabolic response assessment in patients with GIST. Progression-free survival (PFS) in responders (complete, partial response and stable disease) and non-responders (progressive disease) according to each response criteria was compared by using the Cox proportional hazard ratio (HR).

RESULTS

The anthropomorphic phantom revealed a cut-off of 0.5mg/mL (15HU on the iodine image) to differentiate necrotic from vital tumor tissue. The median PFS was significantly different between non-responders and responders and comparable among the SUVmax criteria (632days; HR=4.6; 95%CI:2.2-10.1; $p<.001$), the VITB criteria (521days; HR=28.4; 95%CI:7.8-184.9; $p<0.001$) and VTB criteria (501days; HR=8.1; 95%CI:3.4-21.2; $p<.001$). VITB allowed a significant better differentiation between non-responders and responders compared to mRECIST 1.1 (414days; HR=2.5; 95%CI:1.3-5.0; $p<.010$). and mChoi criteria (151days; HR=1.1; 95%CI:0.5-2.1; $p<.001$).

CONCLUSION

The VITB criteria showed comparable performance to FDG-PET criteria for response assessment of patient with GIST under TKIs while outperforming mRECIST 1.1 and mChoi criteria.

CLINICAL RELEVANCE/APPLICATION

VITB is a quantitative DECT imaging biomarker that captures the effects of TKI therapy and predicts tumor response (PFS) in

patients with GIST and could be used to guide treatment management.

SSC06-08 Dynamic Control of Chelation Therapy in Transfusion Dependent and Non-Transfusion Dependent Patients Using Hepatic MRI and DECT

Monday, Dec. 2 11:40AM - 11:50AM Room: N230B

Participants
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PURPOSE

To show the possibilities of DECT as well as MRI in the diagnostic of iron overload (IOL) and monitoring of chelation therapy. To determine sufficient time intervals between dynamic hepatic DECT and MRI in controlling of chelation therapy results in Transfusion Dependent (TD) and Non-Transfusion Dependent (NTD) patients with IOL.

METHOD AND MATERIALS

We examined 75 patients with suspected IOL. 14 of them were NTD, the other 61 - TD. We conducted T2* MRI study of the liver by 1.5T scanner for assessment of liver iron concentration (LIC) and performed DECT procedures with 80kV and 140kV on the limited area of the liver of the same patients with the slice thickness of 5mm and calculation of Dual Energy indicators. Chelation therapy was prescribed for all examined patients in doses depending on body weight. 6 and 12 months later, we repeated the same procedures to the earlier examined patients who received iron chelators. For various reasons, only 26 of them were able to undergo CT and MRI studies at appointed times.

RESULTS

We calculated IOL severity for the examined patients. Using correlation and regression analysis, it was found that the calculation of the dual-energy difference (HU) gives high correlation coefficient (r=0.93) with IOL severity, it means that the predicted values of IOL by CT fall into all ranges of IOL according to MRI. Using the data of 26 patients after 6 and 12 months chelation, in all DECT-results we also established the conformity of our findings to the MRI data. In both control CT and MRI study of NTD patients with HH (n=9), degree of LIC decrease significant - average 12% in 6 months, and 33% in a year. When analyzing similar control MRI data in TD patients (n=17), we had extremely slow dynamics of reducing the LIC (average 2,75% in 6 months, 7% in a year). MRI data show that there is some dynamic, while DECT data demonstrate no significant dynamic either in 6 or in 12 months of treatment (less than 1% decreasing).

CONCLUSION

DECT, like MRI, is a useful technique for controlling chelation therapy. However, such studies in NTD patients should be more frequent to avoid hyper-chelation. The use of DECT for the annual control of chelation therapy in TD patients is not justified.

CLINICAL RELEVANCE/APPLICATION

Recommended to undergo hepatic MRI or DECT for NTD patients no less than every 6 months to control chelation therapy results, especially with light or moderate IOL severity, to avoid over-chelation.

SSC06-09 Post-TACE Changes in the Mean Value and Kurtosis of Apparent Diffusion Coefficient Histograms are Independent Predictors of Overall Survival in Patients with Hepatocellular Carcinoma

Monday, Dec. 2 11:50AM - 12:00PM Room: N230B

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PURPOSE

To identify MR imaging parameters that can be used for evaluating early tumor response and overall survival (OS) after transarterial chemoembolization in patients with hepatocellular carcinoma

METHOD AND MATERIALS

In this IRB approved, HIPAA compliant retrospective cohort study, our institutional database was searched for patients with confirmed HCC, diagnosed during 2005-2016. Imaging data were reviewed by a radiologist and patients with well-defined tumors were recruited initially (n=151). Patients with available apparent diffusion coefficient (ADC) map at baseline and 3-4 weeks after first TACE were included (n=99). Demographic data, HCC etiology, baseline Child score, treatment modalities, and survival status were retrieved from clinical database. Volumetric MRI metrics including tumor volume, mean ADC, skewness and kurtosis of ADC were measured at baseline and 1 month post-TACE. Change in variables was calculated by subtracting baseline values from post-TACE measures. Univariate and multiple Cox models were used to test the independent role of change in imaging parameters to predict OS. $p<0.05$ was considered significant.

RESULTS

In unadjusted survival model, baseline tumor volume, changes in ADC and ADC-kurtosis were potential imaging predictors of survival. After adjusting for baseline liver function, tumor volume, number of TACE sessions, and treatment modality, incremental percent change in ADC was an independent predictor of better OS (HR=0.98, p=0.020). In overall, a decremental change in ADC-kurtosis (increase in heterogeneity) showed a strong trend in predicting better prognosis (HR=0.92, p=0.051). Categorizing patients to responders (>=25% ADC increase) and non-responders (<25% ADC increase) based on change in mean ADC provided a good prediction of OS (c-index: 0.791). Responders had the best survival profile (HR=0.42, p=0.021). Subgroup analysis showed that in non-responders, change in ADC-kurtosis (Δ kADC) as an indicator of change in tissue homogeneity, could distinguish between poor and fair prognosis (cutoff=0.5). It was not a measure of difference among responders (p=0.86). Non-responder patients with Δ kADC >=0.5 (homogeneous post-TACE tumor) had the worst prognosis (HR=3.03, p=0.007), as compared to responders and those of non-responders who had Δ kADC <0.5 (log-rank p=0203).

CONCLUSION

A >=25% increase in ADC demonstrated favorable response to TACE in patients with HCC. In non-responder patients, an increase in tumor heterogeneity, as measured by ADC-kurtosis, could distinguish patients with relatively better prognosis from those with the worst survival profile.

CLINICAL RELEVANCE/APPLICATION

Change in mean ADC and ADC-kurtosis, as a measure of change in tissue heterogeneity, can be used to monitor early response to TACE in well-defined HCC and to identify patients with treatment failure and poor prognosis

Printed on: 10/29/20

SSC07

Science Session with Keynote: Genitourinary (Prostate MRI in Biopsy, Therapy, and Surveillance)

Monday, Dec. 2 10:30AM - 12:00PM Room: E260

GU MR OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC07-01 Genitourinary Keynote Speaker: Next Generation Prostate Imaging

Monday, Dec. 2 10:30AM - 10:40AM Room: E260

Participants
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PURPOSE

Prostate imaging has transformed over the past decade, with the advent of iterations on multiparametric MRI in addition to small-molecule PET agents targeting the extracellular domain of prostate specific membrane antigen (PSMA) and high-resolution ultrasound. These innovative magnetic resonance imaging techniques both facilitate new treatment methods, and more importantly, allow for assessment of the efficacy of these new treatments. From MRI-ultrasound image fusion targeted biopsy and ablation to quantitative assessment of treatment response of medical and ablative therapies, the field of prostate imaging is rife with novel applications. These techniques individualize patient care through more accurate identification of the location and stage of prostate cancer so that only significant cancers receive treatment, and then monitor the response to directed therapies. Perhaps most intriguing is the application of artificial intelligence, which augments the radiologist's acumen, improving the value we deliver to our patients. We stand on the cusp of the age of radiologist-driven prostate cancer management.

SSC07-02 MR-US Fusion Prostate Biopsy: The Added Value of Systematic Core Biopsy to MR-Targeted Cores for Prostate Cancer Grading

Monday, Dec. 2 10:40AM - 10:50AM Room: E260

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PURPOSE

To investigate the value of the systematic core biopsy (S-Bx) to MR-US fusion targeted core biopsy (MR-F Bx) for detection and grading of prostate cancer (PCa) using whole mount histopathology (WMHP) as reference.

METHOD AND MATERIALS

This IRB approved, HIPAA compliant observational study cohort comprises 295 patients with 716 pathology PCa lesions, who underwent MR-F bx prior to radical prostatectomy, between 7/2010-2/2019. All patients had MR-F Bx and S-Bx. The pathology reports of all of the cores were evaluated and the characteristics of patients with higher reported Gleason score (GS) for S-Bx as compared to MR-F bx were assessed.

RESULTS

Mean patient age and PSA were 62.9±6.3 years and 8.9±10.5 ng/ml, respectively. Mean PCa lesion number on WMHP was 2.4 (1-6). Mean S-Bx and MR-F bx cores were 11.4 (6-16) and 5.3 (1-10), respectively. Mean positive cores for S-Bx was 3 (0-12) and for MR-F Bx was 3.3 (0-10). The per-patient performance of S-Bx and MR-F Bx for PCa detection were 82.4% (243/295) and 95.6% (282/295), respectively. Overall, 37.6% (111/295), 48.8% (144/295) and 13.6% (40/295) of cases had similar GS in S-Bx and MR-F Bx, higher GS in MR-F Bx and higher GS in the S-Bx, respectively. In 4.1% (12/295) of all cases, S-Bx cores upgraded PCa from GS 6 to GS>6. Among cases with higher GS in S-Bx, 32.5% (13/40) cases had benign findings on MR-F bx. 82.5% (33/40) of the higher GS cases in S-Bx were taken from the same lesion as MR-F Bx as a result of wider sampling and the characteristics of these lesions

were as follows: 51.5% (17/33) PIRADSv2 score 3, 33.3% (11/33) score 4 and 15.2% (5/33) score 5; 14.5% (15/33) in apex, 33.3% (11/33) in midgland and 21.2% (7/33) in base; 42.4% (14/33) in a different sextant for the same lesion in contralateral side (3/14) or a different level (11/14). In 22.5% (9/40) of all cases with higher GS in S-Bx and in 8.3% (1/12) of upgraded cases from GS 6 to >6 in S-Bx, the report of the higher GS was false considering WMHP.

CONCLUSION

Although S-Bx at the time of MR-F Bx can slightly improve PCa grading, however, in almost one quarter of the cases, we found false upgrading. The true rate of upgrading with S-Bx is minimal and significant portion of the upgraded lesions are ipsilateral to the target.

CLINICAL RELEVANCE/APPLICATION

PCa treatment selection depends on the results of the prostate biopsy. S-Bx improves diagnostic yield only slightly for clinically significant disease over MR-F Bx.

SSC07-03 Manual Adjustment in mpMRI-Guided Prostate Biopsy Significantly Improves the Detection Rate of Prostate Cancer: Experience in 400 Patients

Monday, Dec. 2 10:50AM - 11:00AM Room: E260

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PURPOSE

to compare the results of software-guided sampling with those obtained after manual adjustment in multiparametric MRI-guided prostate biopsy (mpMRI-PB) and to evaluate whether manual adjustment improves the detection rate of prostate cancer (PCa).

METHOD AND MATERIALS

We enrolled 400 consecutive patients between November 2014 and February 2018, who underwent mpMRI-PB of the target lesion visible on previous mpMRI (average 11.6 mm, range 4-40mm). All mpMRI-PBs were performed on a 1.5T MR scanner (Magnetom Avanto, Siemens Healthineers, Germany) using a commercially available MR transrectal biopsy device (DynaTRIM, Invivo, USA). After calibration of the biopsy device, the first sample was obtained using the coordinates provided by the device software to guide the needle along a trajectory to the target lesion. The trajectory was then manually adjusted to improve localization to the target lesion for further biopsy samples.

RESULTS

225 out of 400 patients were positive for PCa after mpMRI-PB, with PCa diagnosed in 55/62 PI-RADS 5 (88.7%), 136/188 PI-RADS 4 (72.3%), 33/127 PI-RADS 3 (25.9%) and 1/23 PIRADS 2 lesions (4.3%). The first sample was positive for PCa in just 117 cases. After manual adjustment, an additional 108 positive biopsies were obtained, corresponding to an increase in the detection rate of 92.3% ($p < 0.0001$; McNemar's Test). The core involvement averaged 50.3% (range 1-100%). To date, 101 of the 225 PCa patients have undergone surgery, with an average lesion diameter in the surgical specimen of 15.7 mm (range 5-40mm).

CONCLUSION

Manual adjustment of needle trajectory significantly improves the detection rate of PCa when performing mpMRI-PB.

CLINICAL RELEVANCE/APPLICATION

mpMRI guided prostate biopsy is associated with an improvement of detection rate of prostate cancer after manual adjustment of needle trajectory.

SSC07-04 Deep Learning-Based Automated Segmentation of Prostate Cancer on Multiparametric MRI: Comparison with Experienced Uroradiologists

Monday, Dec. 2 11:00AM - 11:10AM Room: E260

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PURPOSE

To compare the performance of deep learning based prostate cancer (PCa) segmentation with manual segmentation of experienced uroradiologists.

METHOD AND MATERIALS

From 2011 Jan to 2018 Apr, 350 patients who underwent prostatectomy for prostate cancer were enrolled retrospectively. To collect histopathological ground truth, pathologic slides of whole resected prostate were scanned and PCa lesions were drawn by a uropathologist with 25 years' experience. With reference to the histopathological lesion, radiological ground truth of PCa was drawn on the T2 weighted image by a uroradiologist with 19 years' experience. A U-Net type deep neural network, in which the encoder part has more convolution blocks than the decoder, was trained for segmentation. Four different MR sequences including T2 weighted images, diffusion weighted images (b = 0, 1000), and apparent diffusion coefficient (ADC) images, were used as input images after affine registration. Besides the automatic segmentation by the deep neural network, two experienced uroradiologists marked suspected sectors of PCa among 39 sectors provided by PIRADS-v2 after reviewing same images of four MR sequences. The manual segmentation performance of uroradiologists was measured using the number of sectors that coincided with the ground truth PCa lesion.

RESULTS

The dice coefficient scores (DCSs) achieved by two uroradiologists were 0.490 and 0.310 respectively. The DCS was calculated based on the number of sectors. The DCS of automatic segmentation by a deep neural network was 0.558 (calculated by the number of pixels) which is slightly better than the average (0.40) DCSs of uroradiologists.

CONCLUSION

Automated segmentation of PCa on multiparametric MR based on histopathologically confirmed lesion label achieved comparable performance with experienced uroradiologist.

CLINICAL RELEVANCE/APPLICATION

The automated segmentation of prostate cancer using a deep neural network not only reduce time consuming work but also provide reliable location and size information required for treatment decision.

SSC07-05 Multiparametric MRI Can Exclude Prostate Cancer Progression in Patients Under Active Surveillance

Monday, Dec. 2 11:10AM - 11:20AM Room: E260

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PURPOSE

To assess the ability of multiparametric MRI (mp-MRI) of the prostate to exclude prostate cancer (PCa) progression in patients under active surveillance.

METHOD AND MATERIALS

One hundred and forty-seven consecutive patients under active surveillance with known PCa with a Gleason score of 3+3=6 or 3+4=7a were initially enrolled and received mp-MRI (T2WI, DWI, DCE-MRI) of the prostate at 3T. Of these patients, fifty-five received follow-up MRI after a minimum interval of 12 months with subsequent targeted MR/US fusion-guided (FUS-GB) plus systematic transrectal ultrasound-guided (TRUS-GB) biopsy. Primary endpoint was negative predictive value (NPV) of the follow-up mp-MRI to exclude tumor progression. Secondary endpoints were positive predictive value (PPV), sensitivity, specificity, and cancer upgrade after initial mp-MRI.

RESULTS

Of 55 patients 28 (51%) had a Gleason score upgrade in the re-biopsy. All of the 28 patients showed findings in the follow-up mp-MRI that were suspicious of tumor progress. 16 of 55 patients (29%) showed signs of tumor progress in the follow-up MRI but had a stable re-biopsy. 11 of 55 patients (20%) showed no signs of progress in follow-up MRI and none of these patients had a Gleason score upgrade in the re-biopsy. NPV was 100%. PPV was 64%. Sensitivity was 100% and specificity 59%.

CONCLUSION

MP-MRI can reliably exclude PCa progression in patients under active surveillance. Over 60% of the patients with signs of tumor progress in follow-up mp-MRI had a Gleason score upgrade in repeat biopsy.

CLINICAL RELEVANCE/APPLICATION

Patients under active surveillance should receive follow-up MRI to monitor tumor progress. Standard re-biopsy protocols might be waived if follow-up mp-MRI is stable.

SSC07-06 Post-ablation Prostate Imaging Reporting and Data System (PAPI-RADS): Preliminary Results at 12 Months After Whole-Gland MRI-Guided Transurethral Ultrasound Ablation (TULSA)

Monday, Dec. 2 11:20AM - 11:30AM Room: E260

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PURPOSE

PI-RADS v2 criteria do not specifically address evaluation of the prostate gland after non-surgical treatment. We present a modified scoring system for MRI detection of prostate cancer (PCa) in the post-ablation setting (PAPI-RADS), comparing the preliminary diagnostic performance of PAPI-RADS and PI-RADS v2 against histopathology.

METHOD AND MATERIALS

PAPI-RADS was defined by consensus among radiologists participating in an IRB-approved, HIPAA-compliant 13-center pivotal trial of whole-gland MRI-guided transurethral ultrasound ablation (TULSA) in 115 men with PCa. The proposed system uses a 5-point likelihood score for residual/recurrent PCa, with the same MRI acquisition parameters recommended by PI-RADS v2. PAPI-RADS criteria give emphasis to focal early enhancement on dynamic contrast-enhanced images, over abnormal T2-weighted hypointensity or diffusion restriction. We present the interpretation by 13 on-site radiologists, in addition to a separate blinded central radiologist who scored all 12-month MRIs according to PI-RADS v2 and PAPI-RADS. Diagnostic accuracy was assessed against histopathology obtained at 12-month post-ablation 10-core biopsy.

RESULTS

At time of this submission, local PI-RADS v2 was available for 111/111 men with 12-month MRI and biopsy, central PI-RADS v2 for 76/111. At 12 months, local and central radiologists identified PI-RADS v2 score >=3 and >=4 lesions in 28/111 (25%) and 13/111 (12%) men, vs. 23/76 (30%) and 15/76 (20%) men, respectively. Local and central PAPI-RADS was available for 55/111 and 29/55 men, with score >=3 and >=4 lesions identified in 12/55 (22%) and 9/55 (16%) of men, vs. 7/29 (24%) and 5/29 (17%). Preliminary diagnostic performance of both criteria against 10-core biopsy (median sampling density 1.0 cores/cc) are listed in Table 1, with higher negative predictive values for PAPI-RADS (local: 96% vs. 89% for score >=4, central: 92% vs. 90%). Results from all patients will be available in December.

CONCLUSION

Preliminary results of 12-month post-ablation mpMRI with the proposed PAPI-RADS scoring system provided improved diagnostic performance for detection of prostate cancer over PI-RADS v2.

CLINICAL RELEVANCE/APPLICATION

PI-RADS v2 was designed for treatment-naïve prostates. The proposed modified post-ablation MRI criteria improves accuracy by addressing prostate tissue changes following ablative therapy for PCa.

SSC07-07 Pivotal Trial of MRI-Guided Transurethral Ultrasound Ablation (TULSA) in Patients with Localized Prostate Cancer

Monday, Dec. 2 11:30AM - 11:40AM Room: E260

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PURPOSE

MRI-guided transurethral ultrasound ablation (TULSA) is an incision-free method for customized prostate ablation using directional ultrasound under MRI thermometry feedback control. We report 12-month (12mo) outcomes from the TULSA-PRO Ablation Clinical Trial (TACT) Pivotal study.

METHOD AND MATERIALS

TACT enrolled 115 men with localized prostate cancer at 13 sites. Treatment intent was whole-gland ablation sparing the urethra and urinary sphincter. Primary endpoints were adverse events and proportion of men with PSA reduction >=75%. Secondary endpoints included 12mo 10-core biopsy, mpMRI, prostate volume reduction, and quality of life.

RESULTS

Median (IQR) age was 65 (59-69) years and PSA 6.3 (4.6-7.9) ng/ml. Pre-treatment, 72/115 (63%) men had Grade Group 2 (GG2) disease. PI-RADSv2 score >=3 lesions were present in 98/115 (85%) men, >=4 in 77 (67%). Ablation times were 51 (39-66) min for targeted prostate volumes of 40 (32-50) cc. MRI thermometry during treatment indicated 98% (95-99%) thermal coverage with ablation precision of ±1.4 mm, confirmed qualitatively by post-treatment CE-MRI. Grade 3 adverse events occurred in 8% of men (all resolved), with no rectal injuries or Grade >=4 events. At 12mo, 1% of men were incontinent (>1 pad/day), and 69/92 (75%) maintained erections sufficient for penetration (IIEF Q2 >=2). PSA reduction >=75% was achieved in 110/115 (96%), with median reduction of 95% and nadir of 0.34 ng/ml. Median perfused prostate volume decreased from 41 to 4 cc at 12mo MRI. Of 68 men with baseline GG2 disease, 54 (79%) were free of GG2 on 12mo biopsy. Overall, 72/111 (65%) had no evidence of any cancer. Of 98 men with PI-RADSv2 >=3 at baseline, 26 had MRI lesions at 12mo, 11/26 with biopsy-confirmed GG2 (negative predictive value, NPV 93%). Multivariate predictors of residual GG2 included intraprostatic calcifications at screening, MRI thermal coverage of target volume, and PI-RADSv2 >=3 at 12mo ($p<0.05$).

CONCLUSION

The TACT Pivotal study of MRI-guided TULSA for whole-gland ablation in men with localized prostate cancer met its primary PSA endpoint in 96% of patients, with low rates of severe toxicity and residual GG2 disease. MRI at 12mo detected residual disease with NPV of 93%.

CLINICAL RELEVANCE/APPLICATION

Whole-gland ablation using MRI-guided TULSA achieves predictable PSA and prostate volume reduction. Multiparametric MRI is promising for post-TULSA follow-up.

SSC07-08 Early Diffusion and Perfusion Changes of Prostate Cancer on IVIM MR Imaging after ADT Therapy

Monday, Dec. 2 11:40AM - 11:50AM Room: E260

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PURPOSE

To investigate the usefulness of intravoxel incoherent motion (IVIM) MR in early detection of therapeutic changes from androgen deprivation therapy (ADT) in prostate cancer patients.

METHOD AND MATERIALS

MR examinations in 22 patients with advanced prostate cancer were performed before and three months after ADT treatment, using a 3.0T system (Ingenia, Philips Healthcare) equipped with a 16-channel body coil. The imaging protocol included axial T1WI ,axial T2WI , coronal T2WI and axial IVIM. The IVIM was performed at 11 b values of 0, 10, 20, 30, 50, 75, 100, 250, 500, 750 and 1000s/mm2. T2WI and IVIM images were qualitatively reviewed by an experienced radiologist. The prostate-specific antigen (PSA) levels were also assessed. The diffusion coefficients (D), perfusion fractions (f) and the perfusion-related diffusion Coefficient (D*) values were quantitatively measured in the prostate cancer area and bone metastasis. Changes in these IVIM measurements between pre- and post-treatment timepoints were evaluated using a paired Student t test. $P<0.05$ indicated a significant difference.

RESULTS

Prostate and tumor volume of the patients showed different degrees of reduction after ADT therapy except for 3 patients. T2-weighted images signal was diffusely reduced after therapy. The signal intensities of most cancerous and non-cancer areas were visually similar. The mean PSA level was significantly reduced. At 3 months after treatment, the D value of cancer area ((0.902±0.118)×10-3mm2/s) was significantly increased as compared with the pretreatment value ((0.585±0.142)×10-3 mm2/s), ($p < 0.001$). The f value of cancer area (0.299±0.074) was significantly increased compared with the pretreatment one (0.254±0.064) ($P < 0.05$). The D and f value of bone metastases was significantly increased after treatment ($P < 0.05$). D* showed no significant changes before and after treatment.

CONCLUSION

T2WI images after ADT therapy are of little value for determining the location and boundary of the tumor. The IVIM MR allows non-invasive quantitative characterization of biological changes (both diffusion and perfusion fraction) of prostate cancer after treatment. This technique may potentially be useful for the evaluation of therapeutic effect and risk for recurrence.

CLINICAL RELEVANCE/APPLICATION

It may have potential technique in the evaluation of therapeutic effect and early prediction of efficacy.

SSC07-09 Baseline Multiparametric MRI Characteristics of Exceptional Pathologic Response to Neoadjuvant Enzalutamide for High-Risk, Localized Prostate Cancer

Monday, Dec. 2 11:50AM - 12:00PM Room: E260

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PURPOSE

To assess multiparametric MRI (mpMRI) characteristics of high-risk prostate cancer patients demonstrating minimal residual disease (MRD) at radical prostatectomy (RP) after neoadjuvant androgen deprivation therapy (ADT) + enzalutamide.

METHOD AND MATERIALS

Patients with untreated high risk prostate cancer enrolled on a clinical trial evaluating neoadjuvant ADT + enzalutamide (160mg/day), receiving mpMRIat baseline and 6-months post-treatment followed by RP. RP specimens were sectioned in same plane as MR using a patient-specific 3D printed mold. Fixed tissue sections of baseline biopsy and tumor on RP specimens were stained, laser capture microdissected, and analyzed using whole exome sequencing to define clonally independent tumors. Non-responding tumors were pathologically defined by residual tumor burden >0.05 cc, measured by an expert GU pathologist. All mpMRI imaging was interpreted by a single expert radiologist. Regions encompassing suspected lesions were contoured at baseline and follow-up. Quantitative characteristics including volume, Apparent Diffusion Coefficients (ADC), and perfusion (Ktrans; calculated using a two compartment Tofts model with standardized arterial input function) were collected. Association between metrics and residual disease was evaluated using appropriate nonparametric statistical testing.

RESULTS

31 patients completed all imaging and RP, with 49 lesions detected on baseline mpMRI, of which 39 remained measurable at 6-mo. follow-up imaging. Two patients had at least 2 clonally independent lesions distinguishable on baseline imaging showing differential response at RP assessment. Lesion burden at both mpMRI timepoints was strongly associated with residual cancer (N=16) on pathology (p=0.002 vs p=0.003, respectively). Baseline summary diffusion (ADC) and perfusion (Ktrans) characteristics showed modest association to residual disease, further enhanced when assessing heterogeneity of signal intensity (ADCentropy 0.003, Ktrans,entropy 0.056).

CONCLUSION

While quantitative mpMRI metrics have shown correlation to Gleason grading and disease burden in untreated cases, distinct features also correlate with likelihood of residual cancer burden after intensive neoadjuvant therapy.

CLINICAL RELEVANCE/APPLICATION

Selection of patients based on these parameters may improve overall responses to treatment in subsequent clinical trials.

SSC08

Informatics (Artificial Intelligence: Bleeding Edge)

Monday, Dec. 2 10:30AM - 12:00PM Room: E450A

IN AI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSC08-01 MULAN: Multitask Universal Lesion Analysis Network for Joint Lesion Detection, Tagging, and Segmentation in CT Images

Monday, Dec. 2 10:30AM - 10:40AM Room: E450A

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PURPOSE

We present and validate an integrated algorithm which can detect, predict multiple tags (attributes), and segment a variety of lesions on CT images.

METHOD AND MATERIALS

When reading medical images such as a CT scan, radiologists generally search across the image to find lesions, characterize and measure them, and then describe them in the report. We aim to automate this process with an end-to-end framework. We propose a multitask universal lesion analysis network (MULAN) for joint detection, tagging, and segmentation of lesions in a variety of body parts. MULAN is based on an improved Mask R-CNN with a backbone CNN and three head branches. In the backbone, we adopt DenseNet-121 and use the feature pyramid strategy to encode fine-level detail information. We also propose a 3D feature fusion strategy to add 3D context information in the backbone. The detection branch and segmentation branch are similar to those in Mask R-CNN. In the tagging branch, we predict scores for 185 tags describing the body part, type, and attributes of the lesions. We also propose a score refinement layer in MULAN to fuse the detection and tagging scores since they are correlated. To train MULAN, we use the DeepLesion dataset which contains 32K lesions in a variety of body parts on CT. We extract tags from DeepLesion's associated radiology reports to train the tagging branch. The long and short axes of the RECIST diameters in DeepLesion are used to generate pseudo-masks to train the segmentation branch.

RESULTS

In the test set of DeepLesion, MULAN achieved a detection sensitivity of 84.83% at 1 false positive per image, whereas the previous state-of-the-art is 73.37%. For lesion tagging, MULAN's AUC is 96.01%. We also computed the lesions' RECIST diameters based on the segmentation results and got an absolute error of 1.97+-2.24mm. We further analyzed the interaction between the three tasks and discovered that: 1) Tag predictions improved detection accuracy via the score refinement layer; 2) The detection task improved tagging accuracy but impaired segmentation performance.

CONCLUSION

We proposed an algorithm for joint lesion detection, tagging, and segmentation in diverse CT images with good accuracy.

CLINICAL RELEVANCE/APPLICATION

The proposed framework is helpful for radiologists to find, characterize, and measure lesions in CT images.

SSC08-02 AUC and Enriched Datasets are Not Good Enough Anymore: Presenting an Alternative Metric to Evaluate Radiology AI Models

Monday, Dec. 2 10:40AM - 10:50AM Room: E450A

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PURPOSE

Area under receiver operating curve (AUC) is commonly used to evaluate and select artificial intelligence (AI) models for radiology. Artificially balanced/enriched datasets are also usually used to estimate AUC to maximize confidence interval to sample size ratio. In this work, we show that such evaluation of model performance has reached saturation and propose alternate performance evaluation schemes.

METHOD AND MATERIALS

Receiver operating curve (ROC) is a curve where false positive rate (1 - specificity) and sensitivity of model at different thresholds are plotted on x and y-axes respectively. Similarly, precision recall curve (PRC) is plotted with recall (sensitivity) and precision (positive predictive value) on x and y-axes respectively. AUC is defined as area under ROC while average precision (AP) is defined as area under PRC.To illustrate the proposed evaluation scheme, two different high-performance models to detect fractures from head CT scans were created. In addition, two datasets were created by uniformly sampling scans and artificially enriching scans with fractures respectively. AUCs and APs were computed for the model-dataset pairs. We propose that AP computed on uniformly sampled dataset is more useful for model selection than other options.

RESULTS

AUCs for all four (model, dataset) pairs were >92%. For both the datasets, difference in AUCs between the models was less than 3%. APs on enriched dataset were high for both models (95% & 92% respectively). However, APs on uniformly sampled dataset were lower than expected (80% & 69% respectively). The difference in models' performance was the highest (difference of 11%) when performance was measured using AP on uniformly sampled dataset.

CONCLUSION

AUC, although a commonly used performance metric for models, saturates early. Therefore, it is not suitable for model selection among high performance models (i.e. AUC > 0.9). Similarly, model selection using artificially enriched datasets is not a good practice as both AUC and AP saturate early. Average precision measured on a uniformly sampled dataset shows the deficiencies in models' performance well and therefore, is a better metric for model selection.

CLINICAL RELEVANCE/APPLICATION

Average precision and uniformly sampled datasets should be used to evaluate artificial intelligence models in radiology instead of AUC and enriched datasets.

SSC08-03 Effectiveness of Multi-Class Pretraining to Improve Performance of Deep Learning Models for Radiography

Monday, Dec. 2 10:50AM - 11:00AM Room: E450A

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PURPOSE

To compare the performance of deep learning models initialized with 2 pretraining strategies: 1) with general object classification ImageNet and 2) with acuity and body part prediction on RhodyNet.

METHOD AND MATERIALS

The RhodyNet database consisted of 285,565 radiographs across 136,761 studies performed at 3 hospitals for any indication. CNNs were trained to predict both a radiologist-assigned acuity score and the body region imaged. We evaluated the DenseNet121 (D121) and InceptionV3 (IV3) architectures on 2 tasks with publicly available datasets: pneumonia detection (RSNA) and musculoskeletal abnormality detection (MURA). All models were trained using the same training schedule, with data augmentation and early stopping on a held-out validation set. The standard area under the receiver operating characteristic curve (AUC) was used to compare model performance for pneumonia and musculoskeletal abnormality detection. To study the data efficiency of each initialization strategy, for each task we randomly sampled the training set at progressively larger sizes, doubling after each trial from n=100 up to n=X, the size of the training set, and compared model performance when trained with each sampled training set.

RESULTS

Pneumonia detection: When less than 3200 training examples are provided, for D121 and IV3 RhodyNet weights outperformed

ImageNet weights by 2.0-7.0% and 1.8-6.3%, respectively. With at least 6400 examples, ImageNet weights outperformed RhodyNet weights by 0.3-0.6% (D121) and 0.7-1.4% (IV3).Musculoskeletal abnormality detection: For D121, RhodyNet weights outperformed ImageNet weights up to n=6400 by 0.4-14.6%, after which a 0.3-2.1% decline was observed. For IV3, RhodyNet weights outperformed ImageNet weights by 0.7-17.0%, except for n=1600 (-0.1%) and n=3200 (-0.6%).

CONCLUSION

Models initialized with RhodyNet weights outperformed their ImageNet counterparts at lower training set sizes for the pneumonia and musculoskeletal abnormality detection tasks. As the training set increased, the performance gap decreased, shifting slightly in favor of ImageNet weights. Our RhodyNet weights and experiments will be made publicly available.

CLINICAL RELEVANCE/APPLICATION

Multi-class learning on clinical images can substantially boost performance of clinical deep learning models with smaller training sets.

SSC08-04 Can Machine Learning Algorithm Detect and Classify Specific Abnormalities on Frontal Chest Radiographs?

Monday, Dec. 2 11:00AM - 11:10AM Room: E450A

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PURPOSE

To assess accuracy of machine learning (ML) algorithm for detection and classification of abnormalities on frontal chest radiographs (CXR).

METHOD AND MATERIALS

The ML prototype (DNetLoc, not commercially available) was trained for detection and classification of chest radiographic findings on 112,120 frontal projection CXR from the NIH CXR14 data and 185,421 frontal CXR from the Prostate, Lung, Ovarian, and Colon Cancer (PLCO) data. Then, we processed separate 689 de-identified CXR from adult patients The ML generated scores and prediction statistics and heat maps for mass, nodule, atelectasis, consolidation, pleural effusions and enlarged cardiac silhouette. Two thoracic radiologists assessed all 689 CXR in a blinded fashion for presence or absence of these findings. Descriptive statistics and free-choice receiver operating characteristics analyses were performed.

RESULTS

About 51% (350/ 689), 25% (172/689) and 24% (167/689) CXR had no, single and multiple findings, respectively. Distribution of findings was: pleural effusion (130/689, 19%), enlarged cardiac silhouette (117/689, 17%), atelectasis (149/689, 22%), nodule (102/689, 15%), consolidation (62/689, 9%), and mass (44/689, 6%). The area under the curve (AUC), sensitivities and specificities with optimized cut-off prediction scores were: pleural effusion (0.94, 0.93, 0.81), enlarged cardiac silhouette (0.93, 0.88, 0.84), atelectasis (0.83, 0.73, 0.82), consolidation (0.85, 0.81, 0.76), mass (0.86, 0.89, 0.68) and nodule (0.77, 0.62, 0.81).

CONCLUSION

The ML algorithm accurately detects and classifies CXR abnormalities with higher accuracy for pleural effusion and cardiac silhouette than the pulmonary findings.

CLINICAL RELEVANCE/APPLICATION

The ML algorithm has high accuracy for evaluation of CXR abnormalities and can serve as a second reader for radiologists to improve their accuracy.

SSC08-05 Predicting Outcomes After Uterine Fibroid Embolization with Deep Learning Based on Magnetic Resonance Imaging

Monday, Dec. 2 11:10AM - 11:20AM Room: E450A

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PURPOSE

To develop and validate a deep learning model based on routine pre-procedure magnetic resonance imaging to predict volume reduction and clinical outcome of uterine fibroid embolization.

METHOD AND MATERIALS

Clinical data were collected on patients treated with uterine artery embolization for fibroids at a large academic center from 2007 to 2018. Only patients with both pre and post-procedure magnetic resonance imaging were included. The fibroids for each patient was manually segmented by an abdominal radiologist on T2-weighted and post-contrast T1-weighted sequence of pre and post-procedure magnetic resonance imaging, and fibroid size reduction was calculated as percentage change in fibroid volume after uterine fibroid embolization. A residual convolutional neural network model to predict fibroid volume reduction and clinical outcome was trained using pre-procedure magnetic resonance images.

RESULTS

The inclusion criteria were met by 727 fibroids in 409 patients. The average clinical follow up time was 116 days. Of the 727 fibroids, 76.2% (n=554) had a volume reduction of 10% or more, and 23.8% (n=173) had a volume reduction under 10% or increased in size. At clinical follow-up, 85.6% (n=350) of the 409 patients (590 of 727 fibroids, 81.1%) experienced symptom resolution or improvement, and 14.4% (n=59) patients (137 of 727 fibroids, 18.9%) no improvement or worsening symptom. The final ensemble model combining T2-weighted images, post-contrast T1-weighted images and clinical variables achieved a test accuracy of 78.1%, F1 score of 0.875, and area under the precision-recall curve of 0.865 in predicting volume reduction and a test accuracy of 84.7%, F1 score of 0.912, and area under the precision-recall curve of 0.916 in predicting clinical outcome.

CONCLUSION

Deep learning based on routine pre-procedure magnetic resonance imaging has potential in predicting outcomes post uterine fibroid embolization. This will help clinicians identify patients who benefit the most from this therapy.

CLINICAL RELEVANCE/APPLICATION

Deep learning based on routine pre-procedure MRI has potential in predicting outcomes post uterine fibroid embolization and help clinicians identify patients who benefit the most from this therapy.

SSC08-06 Thyroid Nodule Classification by Ultrasound Images Based on Clinical-Experience Guided Network

Monday, Dec. 2 11:20AM - 11:30AM Room: E450A

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PURPOSE

Deep neural network models are currently facing problems in medical image analysis due the weak interpretability of predicted results, which is important in evidence-based medicine. Therefore, an interpretable classification model based on clinical-experience guided loss function is proposed in this paper.

METHOD AND MATERIALS

In order to incorporate clinical knowledge into the classification model, we propose a multitask model. One task is the classification of benign and malignant tumor of thyroid(carcinoma classification task); and the other one is clinical features classification (TI-RADS task) based on Thyroid Imaging, Reporting and Data System(TI-RADS) such as irregular, hyperechoic , etc. We take turns in training in two groups of datasets: pathological labeled (benign or malignant) group and clinical features labeled group. The pathological labeled datasets was used to train both carcinoma classification task and TI-RADS task. Clinical features label is absent in pathological labeled datasets. Objective functions of TI-RADS task was minimizing the distance between the predicted value of carcinoma classification task (Pmalignant), and predicted value of TI-RADS task (Ptirads). The Ptirads was defined as the Σ{k in set C}Pk+ Σ{k in set C}(1-Pk),where C={k1,k2,...,kn} is a combination of clinical features under which the output TI-RADS grad is most similar to Pmalignant(the best combination). The candidate combinations is determined based on clinical knowledge. The clinical features labeled dataset was used to train TI-RADS task only and was seriously unbalanced. Therefore, a rotation training was proposed for TI-RADS task.

RESULTS

A multicenter dataset consisting of 14,867 images from 5,131 patients(14,420 for training dataset and 647 for test dataset) was

analyzed.The clinical-experience guided model offered significantly improved performance (accuracy: 0.821), compared to a clinical feature detection model without pathological labeled datasets (accuracy: 0.753), and radiologists' diagnosis (average accuracy: 0.764).

CONCLUSION

In this paper, we propose a novel clinical-experience guided model for thyroid nodules classification based on ultrasound images. It was an effective interpretable classification method for clinical application.

CLINICAL RELEVANCE/APPLICATION

The research proposed an interpretable machine learning model, which makes the machine learning model suitable for the evidence-based medicine.

SSC08-07 Detection of Lung Cancer in subjects with Positive Screening CT Scans in the National Lung Screening Trial (NLST) Dataset by Leveraging the Lung Image Database Consortium (LIDC-IDRI) Dataset

Monday, Dec. 2 11:30AM - 11:40AM Room: E450A

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PURPOSE

To develop a model for non-invasive determination of the likelihood of lung cancer among NLST subjects with positive CT screening exams with lung nodules > 4 mm in diameter based on current and previous CT scans only.

METHOD AND MATERIALS

Among the 7096 patients who screened positive at the first screening time-point T0 with lung nodules > 4 mm in diameter from the CT arm of the NLST, we selected a cancer-positive (C+) cohort of 620 subjects (M: 357, F: 263, ages 64±5 yrs) who were diagnosed with cancer during the study, and a cancer-negative (C-) cohort of 620 (M: 357, F: 263, ages 64±5 yrs) subjects who were never diagnosed with cancer during the study but were demographically matched to the cancer-positive cohort. Excluding patients with unavailable or low-quality CT scans, we had 553 and 585 subjects in the C+ and C- cohorts, respectively. Next, we built a two-stage Machine Learning (ML) model for cancer prediction using CT images in three ways by using one, two and three screening time-points, respectively. The first ML stage, common to all three models, is a Convolutional Neural Network (CNN) for detecting nodules and predicting malignancy scores, trained on a subset of the LIDC-IDRI dataset. The second ML stage uses Xgboost to predict cancer probability using the locations and malignancy scores of the subject's lung nodules predicted by the first stage. We used a 50:50 train-test split for training and evaluating the Xgboost model. We repeated this for 1000 random splits to obtain robust performance estimates for cancer prediction.

RESULTS

The areas under the receiver operating characteristics curves improved significantly ($p<0.01$) from 0.75 (±0.03, 95% CI) when predicting based on CT scans from one time-point to 0.80 (±0.03) when predicting based on scans from two time-points, to 0.85 (±0.02) when predicting on scans from all three time-points in the NLST.

CONCLUSION

It is possible to predict whether a subject with lung nodules > 4 mm has or will develop cancer in subsequent years based on screening lung CT scans only. Further, the prediction performance improves if CT imaging data from multiple screening time-points are incorporated into the model.

CLINICAL RELEVANCE/APPLICATION

CT screening for lung cancer has a high false positive rate leading to unnecessary follow-up procedures. Our model may reduce the numbers of false positive screens, resulting in less cost and risk for patients with screen-detected lung cancer.

SSC08-08 Accelerating Whole-Body Diffusion-Weighted MRI with Artificial Intelligence

Monday, Dec. 2 11:40AM - 11:50AM Room: E450A

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PURPOSE

Whole-body diffusion-weighted imaging (WBI) is the current state-of-the-art for monitoring patients with metastatic bone disease. Scans last approximately 30 minutes as 9-12 repeat acquisitions (NEX=9-12) are needed to overcome inherent low signal-to-noise ratio (SNR). We show that artificial intelligence (AI) can be used to improve image quality of NEX=1 images, considerably reducing

WBI acquisition times.

METHOD AND MATERIALS

WBI was acquired in 17 patients with metastatic prostate cancer at b=50/600/900 s/mm2 at 1.5T (NEX=1): 160-200 axial images covered skull-base to mid-thigh. This was repeated 9 times to derive the arithmetically averaged standard clinical images for each slice location (NEX=9). We trained a deep network (U-Net with linear activation function in final layer and mean absolute error cost function) to approximate NEX=9 (target) images from NEX=1 (input) images. We randomly selected 3 patients as an independent test set (15120 images) and trained the network on the remaining 14 patients (59400 images). An expert radiologist (>10 years' experience) blindly scored test images for SNR, contrast-to-noise ratio, tumor detection, image artefacts, and overall image quality (Likert scale: 1-poor to 5-excellent). The mean apparent diffusion coefficient (ADC) of bone disease (segmented on test NEX=9 images) was compared between the NEX=1, NEX=9 and AI-generated images.

RESULTS

The AI method radiologically outperformed NEX=1 and NEX=9 images in all test patients (average Likert score across all 5 criteria 3.73 [3.6-4.0] vs 1.6 [1.2-1.8] and 2.53 [2.4-2.6] respectively), thus improving image quality. Mean ADC values measured within bone disease from AI-generated images deviated from mean disease ADC calculated from NEX=9 images by an average of 2.4% [0.6-4.5] (within previously reported repeatability limits for mean ADC measurements).

CONCLUSION

AI can be used to improve WBI image quality and reduce acquisition times from ~30 minutes to ~5 minutes. Estimates of mean ADC within bone disease calculated from AI-generated WBI images may be sufficiently robust for monitoring treatment response.

CLINICAL RELEVANCE/APPLICATION

Using AI can lead to better and faster WBI studies, reducing scanning costs, rendering WBI appropriate for screening studies and sparing patient time and/or discomfort.

SSC08-09 Prediction of Future Healthcare Expenses from Chest Radiographs Using Deep Learning

Monday, Dec. 2 11:50AM - 12:00PM Room: E450A

Awards
Trainee Research Prize - Medical Student

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CONCLUSION

We showed that our deep learning model can predict order-of-magnitude 5-year health care expenditure as well as identify top healthcare spenders with reasonable performance using chest radiographs. This suggests that our model is able to extract useful healthcare cost-associated indicators from chest radiographs.

Background

As healthcare reimbursement models change, hospitals and healthcare providers are taking on greater risk. In negotiating contracts with payers, healthcare entities need tools to estimate healthcare expenses that their populations will incur annually; the healthcare requirement of any population can vary substantially and 50% of the total population account for about 97% of total US healthcare expenditures. We hypothesize that chest radiographs capture many general health indicators and thus may be utilized to predict future medical costs. In addition, the prediction harnessed from chest radiographs could be used for proactive preventive care for high-risk groups. To test this hypothesis, we trained two computer vision models based on chest radiographs in order to predict worth of medical treatment and identify top 50% spenders within 5 years after the chest radiographs were taken.

Evaluation

We used 16,533 anterior-posterior chest radiographs from a single institution paired with the corresponding patient's total spending within the following 5 years. The training set, consisting of 13775 images, was augmented by random adjustment of brightness, inversion, and rotation. For both classification and regression, a Resnet152 model, initialized with weights pretrained on ImageNet was used for feature extraction. For classification, cross-entropy loss function is used. For regression, two more affine layers were added before the mean squared loss (MSE). After hyperparameter tuning and training, the models were validated against a test set consisting of 1877 samples.

Discussion

Using our regression model we were able to predict 5-year expenditures with Spearman R of 0.67 (p-value < 1e-16) and Pearson R of 0.67 (p-value < 1e-16) in log-transformed test data. We were able to identify top-50% spenders with ROC-AUC of 0.8476, mean average precision of 0.7157, and F1 score of 0.7744.

SSC09

Musculoskeletal (Body Composition)

Monday, Dec. 2 10:30AM - 12:00PM Room: E450B

AI MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Robert D. Boutin, MD, Davis, CA (*Moderator*) Nothing to Disclose
Ronnie A. Sebro, MD,PhD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSC09-01 Utilizing Artificial Intelligence to Determine Bone Mineral Density via Chest CT

Monday, Dec. 2 10:30AM - 10:40AM Room: E450B

Participants
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PURPOSE

To validate the efficacy of an artificial intelligence (AI) prototype application in determining bone mineral density (BMD) from chest computed tomography (CT) as compared to dual-energy X-ray absorptiometry (DEXA).

METHOD AND MATERIALS

In this IRB-approved study, we analyzed data of 65 patients (57 female, mean age: 67.4 years) who underwent both DEXA and chest CT (mean time between scans: 1.31 years). From the DEXA studies, T-scores for L1-L4 (lumbar vertebrae 1-4) were recorded. Patients were then divided based on their T-scores into normal control, osteopenic, or osteoporotic groups. An AI algorithm based on wavelet features, AdaBoost, and local geometry constraints independently localized thoracic vertebrae from chest CT studies and automatically computed average Hounsfield Unit (HU) values with kVp-dependent spectral correction. Pearson's correlation evaluated the correlation between the T-scores and HU values. Mann-Whitney U test was implemented to compare the HU values of normal control versus osteoporotic patients.

RESULTS

Overall, the DEXA-determined T-scores and AI-derived HU values showed good correlation ($r = 0.55$; $p < 0.001$). The patient population was divided into three subgroups based on their T-scores. The mean T-scores for the three subgroups (normal control, osteopenic, osteoporotic) were 0.77 ± 1.50, -1.51 ± 0.04, and -3.26 ± 0.59, respectively. The mean DEXA-determined L1-L4 BMD measures were 1.13 ± 0.16 g/cm2, 0.88 ± 0.06 g/cm2, and 0.68 ± 0.06 g/cm2, respectively. The mean AI-derived attenuation values were 145 ± 42.5 HU, 136 ± 31.82 HU, and 103 ± 16.28 HU, respectively. Using these AI-derived HU values, a significant difference was found between the normal control patients and osteoporotic group ($p = 0.045$).

CONCLUSION

Our results show that this AI prototype can successfully determine BMD in good correlation with DEXA. Combined with other AI algorithms directed at evaluating cardiac and lung diseases, this prototype may contribute to future comprehensive preventative care based on a single chest CT.

CLINICAL RELEVANCE/APPLICATION

This AI prototype may be able to successfully screen for osteoporotic disease using chest CT.

SSC09-02 Significance of Acquisition Parameters for Adipose Tissue Quantification on Computed Tomography

Monday, Dec. 2 10:40AM - 10:50AM Room: E450B

Participants
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PURPOSE

To evaluate the effect of tube current, kVp, intravenous contrast and slice thickness on computed tomography (CT) adipose tissue measurements.

METHOD AND MATERIALS

Cross-sectional area (CSA) and mean attenuation of subcutaneous (SAT), intermuscular (IMAT) and visceral adipose tissue (VAT) were measured with threshold-based segmentation (-190 to -30 HU) on 244 axial CT images. Images were obtained at the level of the third lumbar vertebral body in 105 adult patients on the same day and on the same scanner, and varied only with regards to one parameter, either tube current (diagnostic vs. low dose), tube potential (100kVp vs. 150kVp), presence of intravenous contrast (non vs. portal-venous phase) or slice thickness (2mm vs. 5mm). Differences were evaluated using mean or median differences, paired t-tests or Wilcoxon signed rank tests, as applicable, and the Bland Altman approach. Intra- and inter-reader agreement was assessed.

RESULTS

Diagnostic scans had a median effective mAs of 313.5 (IQR 274-348.25) and low dose scans had a median effective mAs of 33 (IQR 33-90), both at 120kVp. Compared to diagnostic scans, low dose technique significantly affected adipose tissue CSA (SAT -3.2%; VAT -12.55%; IMAT +58.8%; all $p<0.001$) and attenuation (-2.4% to -8.7%; all $p<0.001$). Higher tube potential also significantly affected CSA (IMAT +8.8%; $p=0.006$; SAT -5.6%; $p<0.001$; VAT -2.8%; $p=0.001$) and attenuation (+6.2% to +20.8%; all $p<0.001$). Presence of intravenous contrast significantly reduced CSA (SAT -0.7% $p=0.04$; IMAT -9.3% $p<0.001$; VAT $p>0.05$) while increasing attenuation (+0.8% to +1.1%; all $p<0.05$). Thinner slices significantly increased CSA compared to thicker slices (IMAT +17.3% $p<0.001$; VAT +1.3% $p=0.02$; SAT $p>0.05$) and significantly decreased attenuation (-1.0% to -5.4%; all $p<0.001$). Intra- and inter-reader agreement were excellent (>99% for all compartments).

CONCLUSION

Acquisition parameters significantly and critically affect adipose tissue CSA and attenuation measurements on CT. Body composition studies need to be conducted with consistent CT scan protocols to avoid systematic error. Creation of protocol-dependent reference values should be considered.

CLINICAL RELEVANCE/APPLICATION

The effect of mAs, kVp, IV contrast and slice thickness on CT adipose tissue measurements needs to be considered for body composition study design and data interpretation to avoid systematic error.

SSC09-03 3T CSE-MRI Identifies Variation in Fatty Acid Composition in Subcutaneous Fat, Muscle, and Bone Marrow in Subjects with SLE, GIO, and Primary Osteoporosis

Monday, Dec. 2 10:50AM - 11:00AM Room: E450B

Participants
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PURPOSE

Advances in Chemical Shift Encoded-MRI (CSE-MRI) allow assessment of the quantity and composition of adipose tissue, which permits investigation of the role of amount of fat (PDFF), saturated (SFA), poly/mono-unsaturated (PUFA/MUFA) fatty acids metabolism in diseases such as osteoporosis, muscular dystrophy, obesity, and other metabolic disorders. Our purpose was to quantify and compare the FA profile in in subcutaneous adipose tissue (SAT), muscle (MUS), and bone marrow fat (BMF) in three groups: subjects with systemic lupus erythematous (SLE), glucocorticoids users with secondary osteoporosis and SLE (GIO), and subjects with postmenopausal osteoporosis (OP)

METHOD AND MATERIALS

This study had institutional review board approval and written informed consent was obtained. A multi gradient echo sequence at 3T (scan time = 3:32min) was used to acquire images of the pelvis in post-menopausal women with osteoporosis (n= 20, 50.5y+/-15.6), in subjects with SLE (n=10, 52.6y+/-11.2) and in glucocorticoids users (n=13, 45.2y+/-15.4, 10 to 40?mg prednisolone equivalent during at least 24 months use due to SLE). A dedicated reconstruction workflow for CSE-MRI was used to reconstruct

parametric maps and regional AT in SAT, MUS, and BMF were semi-automatic segmented by active contours and k-mean clusters. Intergroup comparisons were carried out using Kruskal-wallis test to assess differences between groups.

RESULTS

Results Within SAT, subjects with SLE had higher SFA compared to those with GIO (+17%, $p < 0.05$). Within MUS, subjects with SLE had lower SFA (-49.1%), MUFA (-47.8%), and PUFA (-57%) compared to subjects with GIO and they had lower PUFA (-72.5%) ($p < 0.01$ for all) compared to subjects with OP. Within MUS, subjects with GIO compared to OP had higher SFA (+41%) higher MUFA (+45%) ($p < 0.01$ for both)). In addition, MUS volume of SLE subjects was lower than that of GIO subjects (-74%, $p<0.05$). Within BMF no significant difference was assessed.

CONCLUSION

CSE-MRI can separate SAT, BMF and MUS and detect regional variation and differences in fat composition and quantity in clinically feasible scan times.

CLINICAL RELEVANCE/APPLICATION

Chemical Shift Encoded MRI allows assessment of fatty acids in subcutaneous tissues, muscle, and bone marrow and the identification of disease-specific lipid profiles for osteoporosis and lupus.

SSC09-04 Opportunistic CT-Imaging for Assessment of Fat-Free Muscle Fraction Predicts Outcome in Patients Undergoing Transcatheter Aortic Valve Implantation

Monday, Dec. 2 11:00AM - 11:10AM Room: E450B

Participants
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PURPOSE

Sarcopenia is strongly interrelated with frailty, which is considered a major risk factor for poor outcomes in patients undergoing Transcatheter Aortic Valve Implantation (TAVI). We aimed at investigating the predictive value of amount and quality of skeletal muscles, measured from preinterventional computed tomography (CT), in patients undergoing TAVI.

METHOD AND MATERIALS

A total of 937 consecutive patients (mean age: 81.10±6.21 years, mean EuroSCORE II: 6.75±6.34 %) undergoing TAVI were retrospectively investigated. Amount and quality of skeletal muscles (including assessment of fat-free muscle fraction (FFMF)) and abdominal adipose tissue compartments were quantified from pre-interventional CT using dedicated software. 1-year survivors had a significantly higher FFMF compared to non-survivors (45.72±15.29% vs. 40.38±14.89%, $P<0.001$). According to their FFMF values, patients were divided into tertiles and were defined to have high (>51.76%), medium (51.76-37.29%), and low FFMF (<37.29%), respectively.

RESULTS

Following TAVI, low FFMF was related to major bleedings (6.4% vs. 2.2% vs. 1.6%; $P=0.001$) as well as increased 1-year (20.8% vs. 14.7% vs. 9.3%, $P<0.001$), 2-year (27.2% vs. 20.4% vs. 15.7%; $P=0.004$), and 3-year mortality (30.8% vs. 24.0% vs. 19.2%; $P=0.009$). On multivariate Cox regression analysis, low FFMF (hazard ratio (HR), 2.450; $P=0.001$), medium FFMF (HR, 1.879; $P=0.019$) and EuroSCORE II (HR, 1.039; $P<0.001$) were identified as independent prognosticators of 1-year mortality.

CONCLUSION

In this study, we propose the opportunistic determination of FFMF as a promising new imaging parameter to predict outcome in patients undergoing transcatheter aortic valve replacement. FFMF was shown to be strongly related to dismal outcomes following TAVI and was identified as an independent and strong prognosticator of 1-year mortality, outperforming several established factors for survival prognosis. The potentially outstanding value of FFMF as a biomarker of frailty is underscored by the fact that it can be easily and objectively assessed from routine preinterventional CT and therefore may have the potential to substantially improve risk stratification in patients receiving percutaneous aortic valve replacement for treatment of severe, symptomatic aortic stenosis.

CLINICAL RELEVANCE/APPLICATION

FFMF is a strong predictor of dismal outcomes in patients undergoing TAVI. It can be easily assessed from pre-interventional CT and may be a promising new imaging parameter for outcome prediction.

SSC09-05 ACR Database Evaluation of 67,392 Accreditation Examinations: Implications for Opportunistic CT Diagnosis of Osteoporosis

Monday, Dec. 2 11:10AM - 11:20AM Room: E450B

Participants
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PURPOSE

With the increased use of opportunistic CT, there is an unmet need for multisite assessment of quantitative biomarker integrity across imaging platforms. Our purpose is to investigate if there is a systematic bias in reported attenuation (CT number, HU) among four CT manufacturers.

METHOD AND MATERIALS

American College of Radiology (ACR) CT accreditation phantom (Gammex model 464, module 1) data were collected retrospectively in a blinded fashion for four CT manufacturers (A: n=8,500; B: n=18,575; C: n=8,278, D: n=32,039) between January 2011 and August 2018. For each manufacturer, an adult abdomen CT technique (with typical acquisition parameters of 120 kV, 240 mA, 50-cm FOV, standard reconstruction algorithm, 5-mm reconstruction width) was used to analyze the CT number of three materials: water, acrylic (surrogate for trabecular bone), and teflon (surrogate for cortical bone). Extreme outliers (HU values > 1.5 x interquartile range) were excluded, representing < 4% of the HU measurements averaged across all manufacturer and material combinations. Comparisons were made to assess for systematic differences using a linear fixed effects regression model.

RESULTS

The CT number of water ranged from a mean of -0.3 to 2.7 HU, with mean differences between manufacturers that were small but highly significant ($p < 0.001$). For the trabecular bone surrogate, mean differences in CT numbers across all manufacturers were small but highly significant ($p < 0.001$), with mean values [standard deviation, SD] of 120.9 [3.5], 124.6 [3.3], 126.9 [4.4], and 123.9 [3.4] for manufacturers A, B, C, and D, respectively. For the cortical bone surrogate, highly significant mean differences in CT numbers also were observed across all manufacturers ($p < 0.001$), with mean values [SD] of 939.0 [14.2], 874.3 [13.3], 897.6 [11.3], and 912.7 [13.4] for manufacturers A, B, C, and D, respectively.

CONCLUSION

CT number measurements between manufacturers have a systematic offset when compared to each other. Knowledge of these offsets may be useful in order to harmonize HU values across platforms for optimizing the accuracy of opportunistic diagnosis of osteoporosis.

CLINICAL RELEVANCE/APPLICATION

CT scanners made by different manufacturers show systematic HU offsets. The small offsets relating to trabecular bone HU supports the integrity of CT for the opportunistic diagnosis of osteoporosis.

SSC09-06 Patients with Type 2 Diabetes Exhibit a More Mineralized Deep Cartilage Layer Compared to Nondiabetic Controls: A Pilot Study

Monday, Dec. 2 11:20AM - 11:30AM Room: E450B

Awards
Trainee Research Prize - Fellow

Participants
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PURPOSE

The aims of our study were (i) to assess differences in biochemical composition of the deep cartilage layer in subjects with type 2 diabetes mellitus (T2DM) and nondiabetic controls using UTE T2* mapping and (ii) to investigate the association of vascular health and deep cartilage layer UTE T2* measurements.

METHOD AND MATERIALS

Ten subjects with T2DM were recruited for our study and matched for age, sex and body mass index (BMI) with ten non-diabetic controls. A 3D multiecho UTE sequence with 6 echo times was acquired in all subjects using 3T MRI of the knee. For UTE T2* analysis, the deep cartilage layer was segmented and analyzed in five compartments (patella, medial and lateral femur and tibia). The Ankle Brachial Index (ABI) was obtained in all subjects as a measure of vascular health. Linear regression analyses were used to assess associations of T2DM and UTE T2* relaxation times and to assess the associations of ABI measurements and UTE values.

RESULTS

Both study groups were similar in age (53.7 vs. 51.8 years; p=0.431), BMI (29.5 vs. 28.9 kg/m2; p=0.712) and sex (p=1.000). Compared to nondiabetic controls, T2DM subjects had significantly lower mean T2*-UTE in the patella (mean difference 4.87 msec [95% confidence interval (CI) 1.09, 8.65]; p=0.015), the lateral tibia (mean difference 2.26 msec [95% CI 0.06, 4.45]; p=0.045), and the lateral femur (mean difference 4.96 msec [95% CI 0.19, 9.73]; p=0.043). Averaged over all compartments, the mean T2*-UTE was significantly lower in those with T2DM compared to nondiabetic controls (mean difference 3.24 msec [95% CI 0.36, 6.12]; p=0.030). Moreover, independent of diabetic status, subjects with higher ABI values, indicating better vascular health, had higher T2*-UTE of the patella (coefficient: 15.2; 95% CI: 3.3-21.4; p=0.017), the medial tibia (coefficient: 9.8; 95% CI: 1.0-18.6; p=0.031), and the lateral femur (coefficient: 18.8; 95% CI: 3.3-34.3; p=0.021) compared to subjects with lower ABI values.

CONCLUSION

T2*-UTE measurements of the deep cartilage layer were consistently lower in subjects with T2DM and in subjects with impaired vascular health, likely indicating increased mineralization of this layer.

CLINICAL RELEVANCE/APPLICATION

More mineralization of the deep cartilage layer could be an important pathophysiological pathway contributing to degeneration by inhibiting the subchondral bone - cartilage flow of nutrients.

SSC09-07 MRI Evaluation of Skeletal Muscle Mass and Fat Fraction for the Assessment of Sarcopenia in Psoriatic Patients: Preliminary Results of a Pilot Case-Control Study

Monday, Dec. 2 11:30AM - 11:40AM Room: E450B

Participants
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PURPOSE

Quantitative MRI evaluation of muscle quality and adipose tissue has recently emerged as a research topic of great interest to evaluate sarcopenia induced by several chronic metabolic and inflammatory diseases. The purpose of our study was to evaluate the correlation between clinical features and skeletal muscle characteristics (area and fat fraction) as instrumental MR imaging index of sarcopenia in patients affected by psoriasis

METHOD AND MATERIALS

In this cross-sectional case-control study we enrolled 31 psoriatic patients (18 M, 13 F, mean age 44.6 years, range 24-63) with mean disease duration of 15.3 years (range 2-37), not under systemic medical treatments and without other known conditions able to influence muscle composition. Clinical evaluation included assessment of patient characteristics, disease severity with PASI score and blood-chemistry investigations. Instrumental MRI evaluation was performed with standard axial T2 sequences and chemical shift encoding-based water-fat sequences with fat fraction mapping acquired at the level of L3 and with segmentation of paraspinal and abdominal muscles for the evaluation of MSI (Skeletal Muscle Mass Index) and skeletal muscle fat fraction. We also enrolled 30 healthy subjects, matched by sex and age, used as a control.

RESULTS

Mean skeletal muscle mass index values were 47.08 cm2 in psoriatic patients and 46.23 cm2 in healthy controls. Fat fraction analysis showed fat fraction values of 18.6% in psoriatic patients and 16.4% in healthy controls. There was no statistically significat difference in terms of skeletal muscle features between study population and controls. Considering patients with psoriasis, statistical analysis showed a significant correlation between the presence of psoriasis, its severity (PASI score) and inflammation markers (CRP) with muscle fat fraction ($p<0.005$).

CONCLUSION

These preliminary results suggest a qualitative change in muscle composition in patients with psoriasis, mainly correlated with disease severity and inflammation grade.

CLINICAL RELEVANCE/APPLICATION

The chronic low-grade inflammation status induced by the disease could be a predisposing factor for the development of sarcopenia. Further long term studies on a larger study population are needed to corroborate our findings and evaluate the possible prognostic role of quantitative skeletal muscle MRI as a marker of sarcopenia in the risk stratification of psoriatic patients

SSC09-08 Psoas Volume and Fat Fraction in Cancer Patients: Dynamics and Association with Severity of Cachexia Progression

Monday, Dec. 2 11:40AM - 11:50AM Room: E450B

Participants
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Dimitrios C. Karampinos, Munich, Germany (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV

PURPOSE

Cancer cachexia, characterized by weight loss due to skeletal muscle wasting with or without fat loss, is associated with increased morbidity and mortality. Despite its high clinical significance, approaches in stratifying the risk for developing cachexia are sparse. The purpose of this study was to evaluate how the magnetic resonance imaging (MRI)-based proton density fat fraction (PDFF) of skeletal muscle correlates with cachexia development and evolves during the course of the disease.

METHOD AND MATERIALS

Thirty patients (24 male, mean age 63 years) with different tumor entities received a 3T-MRI using a 6-echo multi-echo gradient echo sequence of abdomen/pelvis for PDFF-mapping. 9 patients underwent between 1 and 4 follow-up scans (range of time interval: 49-335 days), resulting in 14 follow-up scans. Psoas muscle was segmented manually on one slice at the level of the 4th lumbar vertebra bilaterally. Psoas volume and PDFF were extracted. Body mass index (BMI) was calculated as weight (kg)/height (m)². Linear regression analysis was used to evaluate associations between the parameters.

RESULTS

Mean baseline values were: BMI 25.3±4.6 kg/m², psoas PDFF 9.2±3.6%, psoas volume 13.2±4.2 cm³. In the follow-ups, mean relative changes compared to baseline were: BMI -8±8%, PDFF 19±25%, volume -12±16%. At baseline, PDFF correlated with age (R^2=0.21, p=0.01) and volume correlated with BMI (R^2=0.2, p=0.01). In patients with follow-up scans, baseline PDFF correlated with the maximum change (i.e., in cases with >1 follow-up the highest relative change) in volume (R^2=0.81, p<0.001) and tended to correlate with the maximum change in BMI (R^2=0.38, p=0.08).

CONCLUSION

The present study demonstrates that in cancer patients, psoas volume correlated with BMI, while psoas PDFF correlated with age at baseline. Higher initial psoas PDFF was strongly associated with the severity of psoas volume loss and tended to correlate with the severity of loss of BMI, which is in line with previous studies reporting on muscle attenuation in computed tomography being a predictor of cancer outcome. These findings point to psoas PDFF representing a potential biomarker for predicting the severity of body composition changes during the course of the disease in cancer patients.

CLINICAL RELEVANCE/APPLICATION

Psoas muscle PDFF could represent a biomarker for risk stratification regarding the development and severity of cancer cachexia.

SSC09-09 A Machine Learning Algorithm for the Assessment of Osteoporosis on Chest Radiographs

Monday, Dec. 2 11:50AM - 12:00PM Room: E450B

Participants
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PURPOSE

Assessment of bone mineral density has typically relied on dual-energy x-ray absorptiometry (DEXA). While osteopenia can be detected on radiographs, assessment is subjective with high interreader variability. The purpose of this study was to assess the ability of deep convolutional neural networks (DCNNs) to detect osteopenia and osteoporosis on chest radiographs (CXRs) based on objective bone mineral density measurements.

METHOD AND MATERIALS

Our dataset was comprised of 875 post-menopausal females who had undergone a DEXA scan and a PA and lateral CXR within 3 months of the DEXA scan. DEXA-derived T-scores of the lumbar spine were considered ground truth and used as labels for DCNN training on radiographs. Radiographs were split into 70% training and 30% testing, ensuring no patient overlap. Weighted augmentation was performed on the images using random geometric manipulations to increase data size. An attention-based network architecture was built on a variety of standard DCNNs including ResNet50 and VGG-16 and used for (1) classification between normal bone mineral density, osteopenia, and osteoporosis and (2) linear regression prediction of T-score. Classifier performance was measured using area under the curve (AUC) and regression assessed with the mean absolute error. Attention maps were produced to highlight areas of decision-making.

RESULTS

DCNNs trained on PA radiographs outperformed those trained on lateral radiographs. Classification algorithms detected osteopenia or osteoporosis (defined as T-score < -1.0) with AUC of 0.78 on PA radiographs and 0.73 on laterals (Fig. 1a,b). When limited to classifying between osteoporotic and normal radiographs, AUC reached 0.87. Best performing regression-based algorithms predicted T-scores with a mean absolute error of 1.89 on PA radiographs and 1.96 on laterals. Class activation maps primarily localized to structures such as the medial clavicles, spine, and sternum (Fig. 1c).

CONCLUSION

DCNNs, which can be trained on bone mineral measurements, can provide an objective method for the prediction of osteopenia and osteoporosis on chest radiographs, which suggests potential use for opportunistic screening of these conditions.

CLINICAL RELEVANCE/APPLICATION

We illustrate the potential for deep learning to objectively estimate bone mineral density on standard chest radiographs.

SSC10

Neuroradiology (Diffusion/Perfusion)

Monday, Dec. 2 10:30AM - 12:00PM Room: S502AB

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC10-01 Super-Resolution Reconstruction from Orthogonal Slice-Undersampled Diffusion MRI Data

Monday, Dec. 2 10:30AM - 10:40AM Room: S502AB

Participants
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Geng Chen, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
Pew-Thian Yap, PhD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
Dinggang Shen, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Diffusion MRI (dMRI) is a powerful imaging technique for characterizing the brain white matter tissue microstructure. However, dMRI requires longer acquisition times for sufficient coverage of the *q*-space. Each point in *q*-space corresponds to a diffusion-weighted image (DWI), and a sufficient number of DWIs are required for accurate characterization of the microstructure. To accelerate acquisition, we introduce a super-resolution (SR) reconstruction that only requires a subsample of slices for each DWI, instead of scanning full DWIs. Each DWI is subsampled with a different slice offset and imaging plane, so that the volume captures complementary information that can be used to improve the reconstruction of other DWIs.

METHOD AND MATERIALS

We selected 16 subjects from the HCP database and performed 4-fold cross-validation with 12 subjects for training and 4 subjects for testing. For each subject, 90 DWIs with b=2000 s/mm2 were used for evaluation. DWIs were retrospectively undersampled by factors R=3, 4 and 5. The mapping from the undersampled to the full DWIs is learned using a graph convolutional neural network (GCNN). We fully exploit the relationships of neighboring sampling points in the spatial domain and *q*-space in the form of a graph. To learn the target with better perceptual quality, we employ the GCNN as the generator in a generative adversarial network.

RESULTS

We compared our SR method with two conventional methods: Bicubic interpolation and 3D U-Net. Representative reconstruction results for GFA at R=4, shown in the figure, indicate that the proposed SR recovers more structural details compared with the two conventional methods which exploit only spatial correlation. We measure the reconstruction accuracy of the reconstructed dMRI by mean absolute error (MAE), peak signal-to-noise ratio (PSNR), and structural similarity index (SSIM). The quantitative results are summarized in the figure.

CONCLUSION

We have proposed to employ slice-undersampling for acceleration of dMRI. The non-linear mapping from undersampled DWI to the full DWIs is learned using GCNN. The spatio-angular relationship is jointly considered when constructing the graph. The experimental results demonstrate that the proposed SR outperforms the conventional interpolation and a 3D U-Net based SR.

CLINICAL RELEVANCE/APPLICATION

The proposed method can efficiently accelerate the acquisition of dMRI data and reconstruct DW images with minimal information loss.

SSC10-02 Prediction of Multi-Shell Diffusion MRI Data Using Deep Neural Networks with Diffusion Loss

Monday, Dec. 2 10:40AM - 10:50AM Room: S502AB

Participants
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PURPOSE

Acquisition of multi-shell (MS) diffusion MRI (dMRI) data requires longer acquisition time, beyond what is typical in clinical settings. Deep learning can be used to reduce scan time by predicting MS data from data with fewer shells. Existing deep learning methods utilize an l1 loss function as the network optimization target. This is effective in constraining the prediction to match the target MS data but may not ensure the quality of microstructure indices estimated from the predicted data. To overcome this limitation, we propose a novel loss function, called diffusion loss, to explicitly take into account microstructural properties in dMRI prediction. The diffusion loss consists of two parts, including an l1 loss for the predicted dMRI data and another l1 loss for microstructure indices.

METHOD AND MATERIALS

An overview of our network is shown in Fig. 1. Overall, the network consists of two parts, including a sub-network for MS dMRI data prediction and another sub-network for microstructure estimation. We aim to learn a non-linear function fP for predicting the expected MS dMRI data, SMS from the input dMRI data SIn. The microstructure estimator fE predicts microstructure indices from the dMRI data. We demonstrate the effectiveness of diffusion loss using data from the Baby Connectome Project. Our dataset consists of 13 subjects. We utilize 5 of them for training, 5 for testing, and another 3 for validation. All the data were acquired using a Siemens MR scanner with two imaging protocols, including (i) a 2-shell protocol with 74 gradient directions and (ii) a 6-shell protocol with 144 gradient directions.

RESULTS

In this work, we aim to predict the 6-shell data from their 2-shell counterpart. The data predictor, trained without the microstructure estimator, was utilized as the comparison baseline. The results, shown in Fig. 2, indicate that the diffusion loss reduces the mean square error value of not only the predicted dMRI data but also a variety of microstructure indices. Furthermore, the results, shown in Fig. 3, indicate that the diffusion loss reduces GFA errors significantly.

CONCLUSION

We have proposed a novel loss function specifically designed for predicting MS dMRI data. The experimental results demonstrate the effectiveness of our method.

CLINICAL RELEVANCE/APPLICATION

The proposed method predicts high-quality MS data from the dMRI data with fewer shells, allowing analysis with advanced microstructure models.

SSC10-03 White Matter Changes Near to and Distant from Chronic Black Holes in Multiple Sclerosis

Monday, Dec. 2 10:50AM - 11:00AM Room: S502AB

Participants
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PURPOSE

Histopathological evidence show that anterograde and retrograde degeneration follows focal axonal transection in brains of persons with multiple sclerosis (MS). However, quantifying and characterizing this damage in vivo is challenging due to lack of imaging techniques sensitive to axonal and myelin injury. We propose to use quantitative magnetization transfer imaging (qMT), Spherical Mean Technique (SMT) and Neurite Orientation Dispersion and Density Imaging (NODDI) to identify and characterize myelin and axonal injuries following focal lesional transection, in vivo.

METHOD AND MATERIALS

In this prospective case-control study 18 persons with MS and nine age-and-sex-matched healthy controls (HCs) were included. T2-lesions with and without an associated chronic black hole (cBH) were identified. Region of interests (ROIs) on T2-lesions and cBHs as well as on adjacent normal appearing white matter (NAWM) referred as border zone hereafter and contra-lateral NAWM were drawn. ROIs were then co-registered on SIR-qMT, SMT and NODDI maps. Differences between tissues types were measured using paired t-tests as appropriate.

RESULTS

Preliminary results indicate differences in PSR ($p<0.001$) and Vax ($p<0.001$) between NAWM adjacent to cBHs compared to contralateral anatomically matched NAWM ROIs.(Fig1) No significant associations were seen between PSR and Vax values within each tissue type.

CONCLUSION

Our preliminary findings suggest that border zones adjacent to cBHs have reduced values of PSR and Vax. Which confirms the ability of MRI metrics to capture anterograde and retrograde degeneration following a focal MS lesion. However, no correlation was observed with PSR and Vax in each tissue subtypes. In border zones and NAWM in general typically myelin loss is secondary to axonal degeneration thus an association between the two measures should be expected. We postulate that different scales of the two metrics may contribute to our finding. It is also conceivable that longitudinal, rather than cross-sectional measurements may

better capture such an association. Last, it may be plausible that the degree of axonal and myelin loss seen in NAWM are not sufficient to result into significant associations between the two.

CLINICAL RELEVANCE/APPLICATION

NAWM near cBHs has a different composition as compared to NAWM. Targeting border zones disease may serve as measure of outcome during clinical trials exploring reparative effects of experimental molecules.

SSC10-04 Visualization and Microstructural Investigation of the Vestibulocochlear Nerve and Central Hearing Pathways Using MR Diffusion Tensor Imaging

Monday, Dec. 2 11:00AM - 11:10AM Room: S502AB

Participants
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PURPOSE

Diffusion Tensor Imaging (DTI) is an MRI based method for non-invasive visualization and characterization of nerve tracts. It allows to study the microstructure of white matter pathways and to analyze changes related to different pathologies. While it has had great impact in the field of neuroradiology and psychiatry, there are only few studies involving DTI in otorhinolaryngology. This study was performed to investigate whether DTI is feasible in the vestibulocochlear nerve (VN) and auditory pathways.

METHOD AND MATERIALS

We investigated fourteen healthy, normal hearing volunteers on a 3 T MRI scanner (Magnetom Skyra, Siemens Healthcare, Erlangen, Germany). Diffusion weighted images at an isotropic resolution of 1.5 mm, 96 slices covering the whole brain, and with 30 diffusion directions were acquired. A special diffusion sequence using readout segmentation of long variable echo-trains (RESOLVE) was used which reduces distortion and signal loss in regions with field inhomogeneity. Acquisition time was 76 min. After manually defining and applying regions of interest, two-tensor tractography was used to identify the VN, arcuate fasciculus and the interhemispheric auditory pathway of the corpus callosum. Subsequently, diffusion parameters, namely fractional anisotropy (FA), trace, axial, and radial diffusivity, were calculated. Parameters were statistically tested for side and gender differences.

RESULTS

The desired auditory pathways could be isolated from the datasets in all subjects and were visualized. For the left VN, we found a gender difference: men showed significantly lower FA values than women [mean FA =.32 ± .5 vs. .38 ± .04; $F(1,12) = 7.989$, $p < 0.05$]. The right VN did not show a significant gender difference: group mean values of FA were .33 ± .05 in men and .36 ± .05 in women.

CONCLUSION

Despite its small size and challenging location, we were able to visualize and characterize the vestibulocochlear nerve (VN). Moreover, the arcuate fasciculus and the interhemispheric auditory pathway were displayed. Surprisingly, significant gender differences were found for FA in the left VN of normal-hearing subjects.

CLINICAL RELEVANCE/APPLICATION

DTI is a promising new tool for microstructural analysis of vestibulocochlear nerve and central hearing pathways and might provide new insights for the investigation of different hearing impairments.

SSC10-05 Mapping the Cortical Connections of the Ventral Intermediate Nucleus (VIM) with Tractography in Patients Undergoing MRI-Guided High Intensity Focused Ultrasound (HIFU) Thalamotomy

Monday, Dec. 2 11:10AM - 11:20AM Room: S502AB

Participants
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PURPOSE

MRI-guided high-intensity focused ultrasound (HIFU) is an effective therapeutic approach for the ablation of the ventral

intermediate nucleus (VIM) of the thalamus in drug refractory tremor. Cortical connections of VIM might differ from person to person. For treatment planning best seeds points at cortex are not defined. The aim of this study was to assess the cortical connections of VIM nucleus using diffusion tensor Imaging (DTI)-based tractography that overlap with the lesion location.

METHOD AND MATERIALS

Twenty-two consecutive patients (20 right-handed) with medication-refractory ET (n=17) or PD (n=5) were recruited. All of them underwent VIM ablations contralateral to the patient's hand dominance using HIFU equipment compatible with the 3-T MR scanner. Pre-treatment and immediately after treatment structural and DTI MRI data were acquired. Pre-treatment DTI was co-registered with the post-treatment 3D T2WI sequences. The treatment-induced VIM lesion was used as seed for the DTI-based tractography. Topography of the VIM lesions and cortical connections were registered. Distance to the mid-sagittal plane was quantified at the juxtacortical white matter on axial T2WI.

RESULTS

Overall, HIFU was effective for immediate tremor control, awaiting for a longer follow-up. Mean size of the focused-sonography lesions was 6.3±2.7mm on axial 3D-T2WI. Mean distances to the midline and lateral wall of the third ventricle were 14.7±1.1 and 10.5±0.6 mm, respectively. Lesions were 1.6±1.4 mm above the intercommissural plane and 6.8±1.2 anterior to the posterior commissure. According to the cortical connections of the VIM nucleus, patients were allocated in 4 groups: medial aspect of the primary motor cortex (mM, n=7); intermediate region of the primary motor cortex (between m-M and hand-knob, iM, n=10); hand-knob region of the primary motor cortex (hM, n=2) and medial premotor area (preM, n=3). Mean distance from mid-sagittal plane at these sites were 10.7±1 (mM), 17.9±3.4 (iM), 21.9±4.5 (hM) and 8.6±3.1 (preM) mm.

CONCLUSION

Seeding of the VIM lesions on pre-treatment DTI shows connections predominantly to the primary motor cortex, usually medial to the hand-knob region.

CLINICAL RELEVANCE/APPLICATION

DTI tractography defines the topography of juxtacortical white matter projections of the VIM. For treatment planning, cortical seeds should more frequently be placed at the primary motor cortex, medial to the hand-knob region.

SSC10-06 Comparison between Readout-Segmented EPI and Single-Shot Turbo Spin Echo Diffusion-Weighted Imaging for Cholesteatoma Diagnostics

Monday, Dec. 2 11:20AM - 11:30AM Room: S502AB

Participants
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PURPOSE

Comparison of the diagnostic value of readout-segmented diffusion-weighted imaging (rsDWI) and single-shot turbo spin echo diffusion-weighted imaging (tseDWI) for cholesteatoma diagnostics.

METHOD AND MATERIALS

30 patients with clinically suspected cholesteatoma were examined with a protocol including a rsDWI and a single-shot tseDWI sequence at 1.5 T. Acquisition parameters of both diffusion-weighted sequences were: b = 1000 s/mm², axial and coronal slice orientation, slice thickness 3 mm. Image quality was evaluated by two readers on a 5-point Likert scale with respect to subjective image resolution, lesion conspicuity, and for the presence of artifacts mimicking cholesteatomas. Sensitivity and specificity were calculated using histology results as the gold standard.

RESULTS

30 patients with clinically suspected cholesteatoma were examined with a protocol including a rsDWI and a single-shot tseDWI sequence at 1.5 T. Acquisition parameters of both diffusion-weighted sequences were: b = 1000 s/mm², axial and coronal slice orientation, slice thickness 3 mm. Image quality was evaluated by two readers on a 5-point Likert scale with respect to lesion conspicuity, for the presence of artifacts mimicking cholesteatomas and overall subjective image quality. Sensitivity and specificity were calculated using histology results as the gold standard.

CONCLUSION

Our data indicate that the use of tseDWI is advisable for cholesteatoma diagnostics in comparison to rsDWI.

CLINICAL RELEVANCE/APPLICATION

In cholesteatoma diagnostics, the use of single-shot turbo spin echo DWI is recommended over readout-segmented DWI.

SSC10-07 Machine Learning for Definition of Optimal Timing and Duration of CT Perfusion Scanning: Recommendations Based on Evaluation of 1400 Patients

Monday, Dec. 2 11:30AM - 11:40AM Room: S502AB

Participants
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Kristine A. Blackham, MD, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

CT Perfusion used in imaging of patients suspected for an ischemic stroke is a dose intensive examination as it involves numerous scans in order to enable a complete acquisition of the first pass of iodinated contrast medium through brain tissue, nevertheless, the radiation exposure should be limited to abide by the ALARA principle. We present a proposal for optimal timing and scan duration based on evaluation of more than 1400 examinations.

METHOD AND MATERIALS

More than 1400 examinations performed with our standard CT Perfusion protocol consisting of 28 scans were included. 54 seconds of scanning was started with a fixed delay of 6 seconds after beginning of injection of iodinated contrast medium (50 ml, flow of 5 ml/s). Syngo.Via (Siemens) was used for depiction of vessel attenuation changes. Retrospective analysis using machine learning was performed.

RESULTS

Statistical analysis revealed that in the majority of the patients the attenuation values at first time point stayed at the baseline and thus could be omitted without affecting arterial time-attenuation curve. The venous time attenuation-curve on the other hand was truncated in 5% of the patients. Machine learning with a "nearest-neighbour analysis" determined that a 60 second scan duration would allow for full coverage of venous output of this subgroup.

CONCLUSION

A scan time of 54 seconds allows for acquisition of attenuation changes of arterial input function but based on analysis of our data, the start of CTP scanning could be initiated with a longer delay after contract injection (7,5 seconds) or the initial scans could be acquired with a lower sampling rate (resulting in lower radiation exposure). Conversely, using this length of scan time results in truncation of venous output function curve in some patients and this in turn might lead to over/underestimation of infarct core and penumbra volume, depending on CT perfusion parameters used for its calculation; therefore, an additional 2 scans at the end, with a temporal resolution of 1 scan every 3 seconds, should be considered.

CLINICAL RELEVANCE/APPLICATION

Acquisition of complete arterial input and venous output is necessary for proper calculation of CT perfusion maps. Failure to do so might lead to over/underestimation of infarct core and penumbra. At the same time limiting the number of scans leads to lower radiation exposure of patients.

SSC10-08 Diagnostic Value of Multiple Post-Labeling Delay Arterial Spin Labeling for Cerebrovascular Reactivity in Steal Phenomenon

Monday, Dec. 2 11:40AM - 11:50AM Room: S502AB

Participants
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PURPOSE

Cerebrovascular reactivity is a physiological characteristic of the brain that is related to the intrinsic ability of arteries to alter their diameters in response to a vasoactive stimulus, and this parameter is important in cerebrovascular disease. Steal is one of the impairment of CVR which refers a paradoxic flow reduction in response to a vasodilatory stress. In the present study, we evaluated the arterial transit time (ATT) in addition to the time corrected CBF (TCF) from the multiple post-labeling delay ASL as compared with basal/acetazolamide stress Technetium99-hexamethylpropylene amineoxime (99mTc-HMPAO) SPECT in prediction of the cerebrovascular reactivity, especially in steal phenomenon.

METHOD AND MATERIALS

TCF maps and ATT maps were acquired in 30 consecutive patients with unilateral ICA or MCA steno-occlusive disease (severe stenosis or occlusion). Internal carotid artery territory-based ROIs were applied to both perfusion maps. Additionally, impairments in the CVR were evaluated according to both qualitative and quantitative analyses of the ROIs on basal/acetazolamide stress 99mTc-HMPAO SPECT using a previously described method. The ROIs were divided into four groups; group A included normal basal CBF and normal reactivity on acetazolamide challenge, group B included decreased CBF and impaired reactivity on acetazolamide challenge, group C included normal CBF and impaired reactivity on acetazolamide challenge and group D included decreased CBF in baseline and further decreased CBF in Diamox challenge (Figure 1). ANOVA test was performed to compare the ATT and TCF among four groups. Diagnostic decision tree was developed to differentiate among four groups.

RESULTS

ATT is significantly prolonged in group C (1848.0 [1644.0; 1980.0] [ms], compared with other groups (Figure.2). In the diagnostic tree, a cut off value of ATT as 1816 [ms] and TCF as 26 [ml/100 g/min], the four groups were differentiated 83.82% of accuracy (Figure 3).

CONCLUSION

Our results demonstrate that the ATT with TCF based on multiple postlabeling delay ASL perfusion MRI can be useful in prediction of the cerebrovascular reactivity, especially in steal phenomenon.

CLINICAL RELEVANCE/APPLICATION

ATT and TCF from multiple postlabeling delay ASL is useful in detecting cerebrovascular reactivity (CVR), especially in steal phenomenon, and is recommended in evaluation of CVR, instead of acetazolamide stress test.

SSC10-09 Predicting PET Cerebrovascular Reserve with Deep Learning from Baseline MRI: Towards a "Drug-Free" Brain Stress Test

Monday, Dec. 2 11:50AM - 12:00PM Room: S502AB

Participants
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PURPOSE

To predict the cerebrovascular reserve (CVR) in Moyamoya patients using deep learning on PET/MRI images without the need for pharmacological vasodilation.

METHOD AND MATERIALS

Simultaneous [15O]-water PET/MRI including arterial spin labeling (ASL) MRI was acquired to assess cerebral blood flow (CBF) in 20 Moyamoya patients and 10 healthy controls before and after a vasodilator (acetazolamide, ACZ) injection. A deep convolutional neural network (dCNN) was used to predict the absolute change in perfusion (ΔCBF) due to vasodilation from only baseline MRI. The dCNN structure was a U-Net, with multiple baseline MR inputs, including perfusion images (CBF, arterial transit time on ASL), structural scans (T2 FLAIR, T1) and brain template coordinate, to predict the voxelwise synthesized ΔCBF (syn-ΔCBF). The dCNN was trained on the ground truth (PET-ΔCBF) and tested on the 30 studies with 5-fold cross-validation. Image quality was evaluated with peak signal-to-noise ratio (PSNR) and normalized root mean squared error (NRMSE). Mean ΔCBF was calculated in ASPECTS ROIs. Syn-ΔCBF and ASL-ΔCBF were compared to the PET reference with correlation and Bland-Altman analyses. The accuracy for identifying vascular territories with impaired PET-ΔCBF (<75% ΔCBF in cerebellum) was evaluated.

RESULTS

Syn-ΔCBF had significantly higher PSNR (20.4±1.2 vs. 14.3±4.7, $p<0.001$) and lower NRMSE (0.36±0.07 vs. 0.87±0.67, $p<0.001$) than ASL-ΔCBF. Quantitatively, syn-ΔCBF yielded similar ROI values compared to PET-ΔCBF (0.90±0.20 vs. 0.91±0.24, $p=0.77$), while ASL-ΔCBF significantly overestimated ΔCBF (0.99±0.52, $p<0.001$). Both syn-ΔCBF and ASL-ΔCBF showed significant correlation with PET-ΔCBF (ß=0.51, r =0.68 vs. ß=1.28, r =0.57). However, on Bland-Altman plots, syn-ΔCBF showed less bias and reduced variance than ASL-ΔCBF, which showed overestimation errors for larger ΔCBF values. The sensitivity/specificity for identifying impaired PET-ΔCBF was 81%/95% for syn-ΔCBF and 76%/85% for ASL-ΔCBF.

CONCLUSION

The dCNN combines multi-contrast from baseline ASL and structural MRI to predict PET-ΔCBF, with higher image quality and quantification accuracy than ASL-ΔCBF. The prediction of PET-based CVR using only MRI and without injecting ACZ enables accurate CVR measurements in routine MRI settings.

CLINICAL RELEVANCE/APPLICATION

The ability to assess PET-CVR without the need for pharmacological vasodilation and radiotracers is of high value to the clinical evaluation in chronic cerebrovascular patients.

Printed on: 10/29/20

SSC11

Neuroradiology (Spine)

Monday, Dec. 2 10:30AM - 12:00PM Room: S504CD

NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Asim Z. Mian, MD, Cambridge, MA (*Moderator*) Stockholder, Boston Imaging Core Lab, LLC Consultant, MEDIAN Technologies

Sub-Events

SSC11-01 Validation of the National Institute of Neurologic Disease and Stroke (NINDS) Spinal Cord Injury MRI Common Data Elements (CDE) Instrument: Is it Ready for Prime Time?

Monday, Dec. 2 10:30AM - 10:40AM Room: S504CD

Participants
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PURPOSE

The NINDS CDE project was designed to harmonize data collection for NIH funded clinical studies in Neurologic disease. The purpose of this investigation was to perform a multi-site, multi-reader validation study of the SCI MRI CDEs to gauge the reliability of this instrument in clinical and research investigations.

METHOD AND MATERIALS

This study specifically focused on a subset of 18 of 52 CDE elements directly related to the injured spinal cord. Features included: length/location of cord edema/hemorrhage, absolute measures of canal/cord and lesion length. Four neuroradiologists and one spine neurosurgeon from five institutions were recruited as independent readers. 35 SCI MRI studies from twelve different centers were pre-selected from a collection of over 120 studies. Anonymized exams were loaded into a cloud-based viewer platform. All 35 exams were scored independently by the five experts at their own pace. The exam order was randomized and then re-scored for a second round. Inter- and intra-rater assessment was performed using intraclass correlation coefficient (ICC) at 95% CI.

RESULTS

Inter-rater agreement for all features in round one evaluations ranged from poor 0.22 (0.06, 0.37) to excellent 0.99 (0.99, 1.00). Highest inter-rater agreement was found for categorical features of edema/hemorrhage length/location relative to anatomic reference (ICC range 0.69 - 0.99) whereas lower inter-rater ICCs were found for absolute measures (ICC range 0.22 - 0.83). Good agreement for measures at the level of injury (ICC range 0.73 - 0.83). Minor differences in agreement were observed overall between the two reading sessions. Intra-rater ICCs overall ranged from good to excellent (ICC range 0.78 to 1.00) with removal of outliers. There was no significant difference in performance between experienced neuroradiologists and spine surgeon.

CONCLUSION

The devised NINDS SCI MRI CDE instrument provides a uniform method for capturing reliable quantitative and categorical data for SCI investigational work and clinical trials. The system is highly reliable and reproducible by radiologists and spine surgeons.

CLINICAL RELEVANCE/APPLICATION

Multi-center investigations and pharmaceutical trials for SCI are highly dependant upon MRI as a surrogate representation of the extent of injury and to monitor therapeutic interventions. Validation of the NINDS SCI MRI CDE instrument was a necessary step to justify its use in clinical research.

SSC11-02 Assessment of Cervical Spinal Stenosis: Can We Assume that Most Compression of the Cord Occurs Along the Midsagittal AP Direction?

Monday, Dec. 2 10:40AM - 10:50AM Room: S504CD

Participants
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PURPOSE

Cervical spinal stenosis (CSS) has been assessed by the midsagittal distance of the spinal canal along the straight anterior-posterior (S-AP) direction. This study aims to investigate the incidence of the maximal compression force (MCF) to the cord that occurs not along the S-AP direction, and to compare the inter-rater consistency of stenotic distance as measured by the CSF space along the S-AP and MCF directions.

METHOD AND MATERIALS

Cervical MRI of 30 consecutive CSS patients were retrospectively reviewed by 2 raters. Axial T2W images were used to determine the point with MCF to the cord. The vector of the MCF (V-MCF) was defined as a line drawn between the point with MCF and the center of the cord. To quantify the deviation of V-MCF away from the S-AP direction, the angle of MCF (A-MCF) was defined as the angle intersected by the S-AP line and line of V-CMF. To assess the severity of CSS along either S-AP or V-MCF direction, the stenotic distance was measured as the CSF distance anterior and posterior to the cord. Consistency between 2 raters was assessed using descriptive statistical analysis with intra-class correlation coefficients (ICC).

RESULTS

Overall, the incidence of A-MCF being within <10 degrees of the S-AP direction was low (n=6; 20%), with the majority of MCF occurring further off of the midsagittal plane (n=24; 80%; maximum A-MCF 48.54° and 42.66°; median A-MCF 18.1°, and 19.2°, respectively from 2 raters). The stenotic distances measured along the V-MCF direction were significantly lower (more severe) than those measured along the S-AP direction (2 raters, p=0.024 and 0.001, paired t-test) with a good ICC agreement (ICC=0.717 for V-MCF, 0.714 for S-AP).

CONCLUSION

Our preliminary data suggest that most CSS occur not in the S-AP direction. The stenotic distance measured along the V-MCF is significantly smaller than that measured along the S-AP direction. The current standard of practice assessing only the S-AP direction may underestimate the severity of CSS. Quantitative evaluation of the CSF distance along the V-MCF can be readily performed in the clinical setting with reliable consistency.

CLINICAL RELEVANCE/APPLICATION

To quantify the severity of cervical spine stenosis, the canal size should be measured along the direction of the maximal compression force to the cord, not along the AP direction as currently used.

SSC11-03 Dual Energy CT (DECT) Collagen Material Decomposition Application for Detection of Lumbar Spine Disc Extrusion and Sequestration

Monday, Dec. 2 10:50AM - 11:00AM Room: S504CD

Participants
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PURPOSE

To assess the value and diagnostic accuracy of DECT Tendon application (collagen material decomposition algorithm) in detection of lumbar spine disc extrusion and sequestration.

METHOD AND MATERIALS

All CT lumbar spine DECT scans with reported diagnosis of disc extrusion and/or sequestration done in the emergency department between March 1st, 2016 and March 1st 2019 with MRI lumbar spine correlation (gold standard) within 60 days were included. Additional age and sex-matched 42 DECT lumbar spine studies (i.e. control) done on the same scanners during the same duration were added to the pool. The added studies have variable degree of disc prolapse or protrusion confirmed by MRI but no extrusion or sequestration.The DECT scans were grouped into 1) Standard CT Lumbar spine alone and 2) Standard CT plus reformatted series with collagen material decomposition application.Two radiologists independently reviewed both sets of scans in two settings (5-week interval) for diagnosis of the disc extrusion and sequestration.

RESULTS

The study included 42 CT lumbar spine with MRI-confirmed extrusion (n= 33) or sequestration (n= 9). The reported sensitivity, specificity, negative predictive value (NPP) and accuracy were higher in the second group in comparison to the first (Standard CT

only) group: 97.6%, 100%. 97.7% and 98.8 % in comparison to 90.5%, 85.7%, 90% and 88% respectively. Two-sample t-test showed statistically significant difference in specificity (p=0.01) and accuracy (p=0.04). No statistical difference was demonstrated for sensitivity and NPP (p > 0.05).Interobserver reliability indicates strong agreement on both, the Force (K= 0.89, P<0.005).

CONCLUSION

The use of DECT collagen material decomposition application increases specificity and accuracy of lumbar spine disc extrusion and sequestration detection.

CLINICAL RELEVANCE/APPLICATION

Recommend use of DECT collagen material decomposition application for all CT lumbar spine scans to confidently and accurately report disc extrusion and/or sequestration (particularly in emergency setting), limiting the need for unnecessary MRIs.

SSC11-04 Utility of Spine MRI in Trauma at a Northern California Level I Trauma Emergency Department

Monday, Dec. 2 11:00AM - 11:10AM Room: S504CD

Participants
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PURPOSE

The purpose of this presentation is to examine the added utility of spine MRI in the setting of trauma in the context of the AOSpine Subaxial Cervical and Thoracolumbar Spine Injury Classification Systems (AOSSC & TLICS). AOSSC & TLICS have been shown useful in characterizing spinal injuries with predictive scoring to suggest instability and need for surgical intervention. However, appropriate indications for MRI to evaluate integrity of the spinal column are poorly defined. Our purpose is to examine the frequency of changed AOSSC & TLICS scoring with additional spine MRI as compared to CT alone and determine the clinical significance of adding MRI for evaluating spinal instability in the trauma setting.

METHOD AND MATERIALS

A retrospective analysis was performed by querying our imaging database for all spine MRIs ordered by the emergency department by CPT code from the dates of January 1, 2017 to August 31, 2018. 458 such scans were identified and reviewed by the authors. Exclusion criteria included atlanto-axial injuries, non-traumatic injuries, and MRI scans without a CT scan within the prior 3 days leaving 260 total patients. Subsequent review characterized AOSSC & TLICS scores for the initial CT scan and the subsequent MRI and compared differences in score.

RESULTS

Of the 260 total patients that were reviewed, 99/260 (38.1%) had a change in AOSSC or TLICS score when assessed by MRI as compared to CT alone. Further, of 86 negative CT scans, subsequent imaging with MR revealed pathology relevant to AOSSC or TLICS scoring in 24 (27.9%). The most common pathology revealed with MRI related to CT-occult ligamentous injury of the posterior ligamentous complex.

CONCLUSION

The AOSSC & TLICS system provide a framework for stratifying patients based on risk of traumatic spinal instability; however, CT has limited ability to evaluate the soft tissues in the spine. In our study, MRI revealed CT-occult findings relevant to AOSSC & TLICS scorring in more than 1/3 of cases where MRI was obtained. CT-occult ligamentous injuries of the PLC were most commonly identified with MRI.

CLINICAL RELEVANCE/APPLICATION

This retrospective study investigated the added benefit of MRI in the acute trauma setting for defining traumatic spinal instability based on AOSpine Subaxial Cervical and TLICS grading.

SSC11-05 Rates of Vertebral Augmentation for the Treatment of Osteoporotic Vertebral Compression Fractures Among the Commercially Insured

Monday, Dec. 2 11:10AM - 11:20AM Room: S504CD

Participants
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PURPOSE

750,000 people/yr in the U.S. sustain osteoporotic vertebral compression fractures (OVCF). Vertebroplasty and kyphoplasty,

collectively termed vertebral augmentation (VA), continue to be utilized as minimally invasive treatments for OVCF. Since 2009 strong evidence has emerged refuting the efficacy of vertebroplasty. Kyphoplasty does not currently have a strong evidence base to support or reject its use. Prior publications have examined the role of VA primarily in adults 65 and older. Notably, there is a knowledge gap regarding VA in younger patients. Our aim was to determine the temporal trends in vertebral augmentation over the past decade in a commercially insured, working-age American population.

METHOD AND MATERIALS

Retrospective cohort analysis of patients with OVCF in the IBM MarketScan® Research Database of Americans with employer-provided health insurance for the 2008-2017 period. 149 million individual patients were screened over this time period with an age range of 18-65. Our cohort included only thoracic and lumbar osteoporotic fractures treated with VA within 6 months of initial fracture identified using ICD-CM 9/10 codes. We excluded patients with confounders such as neoplasm or recent transportation accidents.

RESULTS

We identified 14,581 patients with OVCF with an average age of 55. 2535 (17%) underwent any VA with 522 (3.6%) treated with vertebroplasty, 1912 (13%) received kyphoplasty and 101 (0.7%) had both. As a percentage of VA performed, vertebroplasty decreased from 25.5% in 2009 to a low of 10.6% in 2015 where kyphoplasty increased from 71.7% to 83.3% across the same time period. The overall percentage of fractures treated with VA remained relatively stable over the time period ranging from 14.9% in 2011 to a high if 19.9% in 2016.

CONCLUSION

This work shows VA is used in this younger patient cohort. Vertebroplasty continued to be utilized, although at a decreased rate over time. The rates of kyphoplasty, initially a substantial proportion of total procedures performed, increased in the same period. It appears kyphoplasty is being substituted for vertebroplasty in the treatment of some OVCF. This implies the need for rigorous studies assessing the efficacy of kyphoplasty.

CLINICAL RELEVANCE/APPLICATION

Vertebral augmentation is used in younger patients with osteoporotic fractures and a higher proportion are treated with kyphoplasty. We need rigorous studies evaluating kyphoplasty for efficacy.

SSC11-06 Qualitative and Quantitative Comparison of Compressed SENSE (C-SENSE) accelerated T2, STIR and White Matter Suppressed (WMS) Imaging of Multiple Sclerosis (MS) Lesions in The Cervical Spinal Cord

Monday, Dec. 2 11:20AM - 11:30AM Room: S504CD

Participants
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PURPOSE

To compare subjective conspicuity and contrast ratio in MS lesions on Compressed-SENSE accelerated WMS, T2 and STIR scans.

METHOD AND MATERIALS

Twenty four patients (5 male, 19 female, average age 45±12) underwent cervical spine MRI for MS on a 3T scanner. 2D TSE based sequences were acquired in sagittal plane using compressed SENSE, including T2 (C-SENSE= 1.4, Time =1:54), STIR (C-SENSE=2, Time = 2:30) and WMS (C-SENSE=3, Time =3:32). WMS uses an inversion time to suppress the signal from white matter. Images were reviewed by a radiologist. Definite and uncertain lesions were counted on each series and compared by paired student t-test. Lesion conspicuity was compared using an ordinal five-point Likert scale on side-by-side comparison. Region of Interest based lesion-to-cord contrast ratio (CR) was then calculated for a subset of definite lesions. Image review and measurement was done in Philips Intellispace Discovery system.

RESULTS

There was no significant difference between total lesion counts (total: nWMS=53, nT2=46, nSTIR=48, p=0.17). WMS showed 88.5% ($p<0.001$) and 33.4% ($p<0.002$) more definite lesions and 80% ($p<0.002$) and 63.6% ($p<0.016$) less uncertain lesions compared to T2 and STIR, respectively (definite: nWMS=49, nT2= 26, nSTIR=37; uncertain: nWMS=4, nT2=20, nSTIR=11). The average scores for subjective lesion conspicuity were 4.72/5 for WMS vs. T2 ($p<0.01$) and 3.89/5 for WMS vs. STIR ($p<0.01$). Lesion-to-cord contrast ratio was compared in 41 lesions. CR was higher on WMS (M=0.31, SD=0.2) compared to T2 (M=0.51, SD=0.3, $p<0.01$) and STIR (M=1.57, SD=0.6, $p<0.01$). Combined time reduction with C-SENSE for T2 and STIR acquisitions was 3:03min.

CONCLUSION

On WMS more lesions were classified as definite and fewer were classified as uncertain compared to T2 and STIR. The significantly higher lesion CR on WMS reinforces the findings of the subjective assessment. By applying C-SENSE only 29sec additional time was needed to run the WMS scan. The findings suggest that C-SENSE WMS may be a faster and more sensitive alternative for T2 and STIR in MS.

CLINICAL RELEVANCE/APPLICATION

C-SENSE accelerated WMS may increase diagnostic confidence through better lesion detection and may reduce exam time (when replacing T2 and STIR) and the reading time, thereby improving workflow.

SSC11-07 Cervical Cord Cross-Sectional Area and Progressive Multiple Sclerosis: A Meta-Analysis

Monday, Dec. 2 11:30AM - 11:40AM Room: S504CD

Participants
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PURPOSE

To verify whether MRI had the appropriate sensitivity to distinguish patients with multiple sclerosis (MS) from healthy controls. In particular, the study focused on the identification of a significant threshold area that would discriminate healthy controls' cervical cords from MS patients' cervical cords.

METHOD AND MATERIALS

Two operators separately reviewed the literature published between 2000 and 2018, taking into consideration cervical cord areas measured in patients with MS and in healthy controls, studied by MRI; and built parametric tables based on cervical cord areas. We included 1545 MS patients: [benign MS (BMS): 120; remitting-relapsing MS (RRMS): 669; primary progressive MS (PPMS): 230; secondary progressive MS (SPMS): 428; clinically isolated syndrome (CIS): 64; radiologically isolated syndrome (RIS): 34] and 505 healthy controls, from 17 studies, which included cervical cord areas measured on MRIs, with standard measurement techniques, in patients with MS and in healthy controls. Exclusion criteria ruled out articles that examined the size or changes in size of MS plaques, non-homogeneous patient categories and patients with MS undergoing experimental therapies. Data were analysed using Discipline Biomedical Statistics software. Finally two ROC curves were created, taking into account PMS (progressive multiple sclerosis = PPMS + SPMS) and RRMS patients, respectively.

RESULTS

A significant statistical difference between PMS patients' and healthy controls' cervical cord areas ($p<0.05$) was found. Furthermore, using ROC curves, we hypothesized a threshold area of 71 mm2 to determine MS patients with severe prognosis as PMS from other MS patients and healthy controls (Odds Ratio value $p<0,001$).

CONCLUSION

The detection of a cervical cord area <=71 mm2, measured on MRI scans, in patients with MS, allows physicians to discriminate PMS (progressive multiple sclerosis) forms from less aggressive forms of MS and healthy subjects. This threshold value could be used in clinical practice to determine MS patients' clinical prognoses.

CLINICAL RELEVANCE/APPLICATION

A cervical cord threshold area <=71 mm2 allows physicians to discriminate PMS forms from other forms of MS and healthy controls, and to determine MS patients' clinical prognoses.

SSC11-08 Lateral Decubitus Digital Subtraction Myelography to Identify Spinal CSF-Venous Fistulas in Spontaneous Intracranial Hypotension

Monday, Dec. 2 11:40AM - 11:50AM Room: S504CD

Participants
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PURPOSE

Objective Spontaneous spinal CSF-venous fistulas are a distinct type of spinal CSF leak recently described in patients with spontaneous intracranial hypotension (SIH). Using digital subtraction myelography (DSM) in the prone position we have been able to demonstrate such fistulas in about one-fifth of patients with SIH who had no evidence for a CSF leak on conventional spinal imaging with MRI or CT-myelography. We compared DSM in the lateral decubitus position versus the prone position and now report a significantly increased yield of identifying spinal CSF-venous fistulas with modification of our imaging protocol.

METHOD AND MATERIALS

The patient population consisted of 23 patients with SIH who underwent DSM in the lateral decubitus position and 26 patients with SIH who underwent DSM in the prone position. None of the patients had evidence for a CSF leak on conventional spinal imaging. A Chi-square test was used to evaluate differences in fistula rates between patients who underwent DSM in the prone versus lateral decubit position. A p-value <0.05 was concluded statistically significant. Analysis was performed with SAS software, version 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

A CSF-venous fistula was demonstrated in 17 (74%) of the 23 patients who underwent DSM in the lateral decubitus position

compared to four (15%) of the 26 patients who underwent DSM in the prone position (p<0.0001). The mean age of these 16 women and five man with a spinal CSF-venous fistula was 52.5 years (range, 36 to 66 years). The duration of symptoms ranged from 8 to 105 months (mean, 34 months). CSF-venous fistulas were found in 13 (76%) of 17 women and in four (67%) of six men who underwent the DSM in the lateral decubitus position. .

CONCLUSION

Among SIH patients who have no evidence for a CSF leak on conventional spinal imaging, DSM in the lateral decubitus position demonstrates a CSF-venous fistula in about three-fourths of patients compared to only about 15% of patients when the DSM is performed in a prone position, an approximately five-fold increase in the detection rate.

CLINICAL RELEVANCE/APPLICATION

Among SIH patients who have no evidence for a CSF leak on conventional spinal imaging, DSM in the lateral decubitus position demonstrates a CSF-venous fistula in about three-fourths of patients compared to only about 15% of patients when the DSM is performed in a prone position, an approximately five-fold increase in the detection rate.

SSC11-09 Usefulness of Dual-Layer Spectral Computed Tomography for Cervical and Thoracic Myelography

Monday, Dec. 2 11:50AM - 12:00PM Room: S504CD

Participants
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Kazufumi Kikuchi, MD,PhD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The image quality in cervical and upper thoracic CT myelography is sometimes suboptimal due to insufficient distribution of the intrathecal contrast material. Dual-layer spectral CT has been reported to increase contrast enhancement using low keV virtual monochromatic (MonoE) images. The purpose of this study was to evaluate the usefulness of dual-layer spectral CT for cervical and thoracic myelography.

METHOD AND MATERIALS

This retrospective study included 18 patients (14 males and 4 females; age range 35-82 year-old; median 64.5 year) from 2018 to 2019 with clinical suspicions for spinal stenosis. All patients underwent dual-layer spectral CT (IQon Spectral CT; Philips Healthcare, Best, Netherlands) 30-60 min after intrathecal injection of contrast material (Iotrolan 240; 15-20 ml). The imaging parameters for CT were as follows: 120 kVp, 445 mA, slice collimation = 64 × 0.625 mm, rotation time = 0.5 sec, and CTDIvol = 38.1 mGy. The images were reconstructed at 1-mm thickness. The regions-of-interest (ROIs) were placed on the spinal cord, cerebrospinal fluid and erector spinae muscles at foramen magnum, C4/5, C7/T1, T6/7 and T12/L1. Attenuation and standard deviation (SD) were recorded on 120 kVp and MonoE images (40-70 keV; 10-keV interval) The contrast was defined as follows: (ROICSF - ROIcord). The contrast-to noise ratio (CNR) was calculated as follows: (ROICSF - ROIcord)/SDmuscle. Statistical analysis was performed with Steel-Dwass test.

RESULTS

The contrast (range; 696.7-2456.3 vs. 219.0-1369.4) and CNR (range; 43.3-112.1 vs. 14.0-59.6) were higher on MonoE images using 40-70 keV than on 120 kVp images at all locations. There were statistically significant differences among these values ($P < 0.05$).

CONCLUSION

Dual-layer spectral detector CT could retrospectively increase the contrast and CNR in cervical and thoracic myelography which could help precise evaluation in these regions.

CLINICAL RELEVANCE/APPLICATION

Dual-layer spectral detector CT can retrospectively yield virtual monochromatic images with higher contrast and CNR in cervical and thoracic CT myelography.

SSC12

Physics (CT Radiation Dose)

Monday, Dec. 2 10:30AM - 12:00PM Room: S504AB

CT PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sarah E. McKenney, PhD, Stanford, CA (*Moderator*) Nothing to Disclose
Baojun Li, PhD, Iowa City, IA (*Moderator*) Research Grant, General Electric Company

Sub-Events

SSC12-01 Coronary Calcium Scoring Using Tin Filtration to Dramatically Reduce Radiation Dose

Monday, Dec. 2 10:30AM - 10:40AM Room: S504AB

Participants
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PURPOSE

The purpose of this work is to evaluate the ability of tin (Sn) filtration to dramatically reduce radiation dose for CT calcium (Ca) scoring to dose levels comparable to a few chest x-rays.

METHOD AND MATERIALS

Chest phantoms emulating small/medium/large patients were scanned on a dual-source CT (Definition Force, VB10, Siemens). A piece of pork was placed at the center of the phantoms, which contained three cylindrical hydroxyapatite (HA) inserts (diameter/length = 5 mm, HA concentration = 200/400/800 mg/mL) emulating coronary calcifications. Phantoms were scanned at 100 kV and 600 mAs/rot using a Sn filter to remove low-energy photons that increase patient radiation dose but do not substantially contribute to image quality. The same phantoms were then scanned using a standard Ca scoring protocol at 120 kV, with mAs determined by a clinical technique chart designed for different patient sizes. Images were reconstructed using a specially designed reconstruction kernel (Sa36 kernel), which accounts for the different attenuation of Ca materials due to different x-ray spectra of Sn100 and 120 kV, and generates 120 kV-like images. The CT numbers of pork and a 200 mg/mL HA insert were measured, the Ca scores were calculated using commercial software, and the results compared between 120 kV and Sn100 kV scans.

RESULTS

Radiation dose was reduced from 2.3/6.8/14.3 at 120kV to 1.5/1.5/1.5 mGy at Sn100 kV for the small/medium/large phantoms, yielding a 34%/78%/90% dose reduction. CT numbers of soft tissue and HA measured from Sn100 kV images were consistent with those of the 120 kV images (max differences < 7/15 HU for tissue/Ca, respectively). Ca scores of HA inserts measured from Sn100 kV images were consistent with those of 120 kV images for the small/medium phantoms (max difference < 16). Larger differences (40-140) were observed for the large phantom.

CONCLUSION

Ca scoring using a Sn filtered x-ray beam was found to achieve 34-78% dose reduction compared to the standard 120 kV technique while yielding consistent Ca scores for small/medium patients. However, it may not be suitable for large patients due to considerable score elevation.

CLINICAL RELEVANCE/APPLICATION

The evaluated technique can reduce patient dose from coronary calcium screening to levels comparable to a few chest x-rays.

SSC12-02 Impact of Imaging Conditions on Localizer-Based Water Equivalent Diameter Estimation and on Dose Modulation

Monday, Dec. 2 10:40AM - 10:50AM Room: S504AB

Participants
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Alexander A. Bankier, MD, PhD, Boston, MA (*Abstract Co-Author*) Consultant, DAIICHI SANKYO Group
Matthew R. Palmer, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Water equivalent diameter (WED) is a sound patient-size descriptor, and CTs use localizers to determine WED and to guide dose modulation. Localizer-based WED estimation requires a calibration to relate localizer pixel values to attenuation. We investigated how imaging conditions affect the WED calibration and dose modulation performance.

METHOD AND MATERIALS

We acquired localizer and axial images of ACR and body CTDI phantoms on 11 CT models from GE, Siemens, Philips, and Canon. We estimated calibration parameters (slope and intercept) by associating axial images with the corresponding localizer lines using custom built software. Experiments were conducted under combinations of kV, mA, orientation, and imaging kernel of localizer radiographs, and axial kV. In separate experiments, the ACR phantom and body CTDI phantom (iso-centered) were imaged together on table top. We repeatedly acquired 120kV-helical scans with dose modulation, after taking localizers at varied kV and mA levels, to examine their impact on dose modulation.

RESULTS

Calibration slope and intercept depends on localizer kV on all CTs. E.g., on a Canon A-One CT, slope changed from 1.47 to 1.64 for localizers from 80 to 135 kV. Using calibration of 120kV localizers, we simulated errors in WED estimation caused by using unmatched calibrations: WED from 80kV- ~ 135kV-localizers deviated from the truth by 1-5% for the body CTDI phantom and 1-7% for the ACR phantom. Localizer mA and directions have small impacts on calibrations and WED results. Calibration also depends on localizer kernels for Canon CTs. For the A-One, WED calibration slopes under Sharp- and STD-kernels were identical (diff. < 0.01%) but differed from the Soft-kernel slope by 55%. Using the Sharp-kernel calibration, WED from Soft-kernel localizers deviated from the truth by 35% for the CTDI phantom and 42% for the ACR phantom. Localizer kV affected dose modulation performance. On a GE CT750HD, comparing to the CTDIv (11.65 mGy) of a baseline condition (120kV-localizer), CTDIv from the same helical scans after 80kV-, 100kV-, 140kV-localizers were 12.43 (+7%), 11.98 (+3%), and 11.41 mGy (-2%). Localizer mA did not affect dose modulation.

CONCLUSION

Localizer kV and image kernels have stronger impacts on WED calibration and dose modulation than other factors.

CLINICAL RELEVANCE/APPLICATION

Using the same kV and image kernel for localizers may improve consistency of dose modulation and WED estimation.

SSC12-03 Protocol Optimization of Whole-Body Low-Dose CT in Patients with Multiple Myeloma: How Low is Too Low?

Monday, Dec. 2 10:50AM - 11:00AM Room: S504AB

Participants
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PURPOSE

To investigate the minimum radiation dose needed to perform a whole body low dose CT (WBLDCT) with a latest generation CT scanner while maintaining an optimal diagnostic accuracy for bone lesions detection.

METHOD AND MATERIALS

A preliminary image quality and patient dose assessment was retrospectively performed in 25 patients using a GE Revolution CT scanner, highlighting high subjective ranks and differenti reader's agreement in osteolitic lesions detection, with a median effective dose of 1.9 mSv. Base on the reference protocol (120 kV, noise index 25, slice thickness 1.25 mm, iterative ASIR-V 50%, collimation 80 mm, average CTDIvol of 2.3 mGy), an anthropomorphic whole body phantom (PIXY phantom) was repeatedly scanned varying the acquisition parameters with a relative CTDIvol range of 0.3 - 1.5 mGy. For each slice, a noise analysis was performed with means of an automatic segmentation tool and multiple ROI evaluations. Both noise and tube current profiles were compared along z axis in each acquisition. Some phantom details were identified as potential simulation of pathologic bone and assumed as reference for a subjective evaluation by three radiologists (5-point Likert scale). An optimized protocol was defined and employed primarily on 10 patients.

RESULTS

Individual reader's scores showed stable high values with average of 4.8 up to a CTDIvol of 0.9 mGy. For the lower doses

Individual reader's scores showed stable high values with average of 4.8 up to a CTDIvol of 0.9 mGy. For the lower doses, significant lower average scores were observed (4.2 for CTDIvol of 0.5 mGy and 3.2 for CTDIvol of 0.3 mGy, $p<0.01$). The minimum CTDIvol without loss of diagnostic information was achieved with different combinations of exposure parameters, and among these, a maximum image quality rank was obtained with a scan performed with 140 kV and a percentage of ASIR-V of 80 %. The overall corresponding medians of automatic noise measurements for the phantom were 49 HU (range 22 - 67) with a sharp convolution kernel and 13 HU (range 7 - 21) with a standard kernel. Using the optimized protocol, the median effective dose for ten patients was estimated 0.7 mSv.

CONCLUSION

Routinary submillisievert WBLDCT can be performed on latest generation CT scanner with a proper balance between tube current modulation parameters and iterative reconstruction strength.

CLINICAL RELEVANCE/APPLICATION

Assessing the lowest achievable dose for WBLDCT with phantom studies and image quality metrics can be useful to optimize this imaging modality in accordance with the ALARA principle.

SSC12-06 The Presence of Contrast Agent Increases Absorbed Organ Radiation Dose in Contrast-Enhanced CT

Monday, Dec. 2 11:20AM - 11:30AM Room: S504AB

Participants
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PURPOSE

Although intravenous iodinated contrast agents are being used in 50 to 60 % of all computed tomography (CT) scans, their presence is not considered in patient dosimetry calculations. The aim of this study is to investigate the impact of contrast agent on absorbed radiation dose in the venous phase of abdominal CT scans.

METHOD AND MATERIALS

10 female and 10 male abdominal contrast-enhanced dual energy computed tomography (DECT) scans were retrospectively selected from our patient database. Organ and tissue doses were calculated by an ad-hoc Monte Carlo (MC) simulation model (ImpactMC) that was experimentally validated (accuracy<5.5%) for the scanner geometry (GE Revolution CT) and acquisition parameters including tube current, tube voltage, beam shape filter, and collimation were modeled. MC simulations were performed in the presence and in the absence of contrast agent using the contrast-enhanced and virtual-unenhanced dataset of DECT as patient models. The simulated dose volumes were segmented (3D slicer) to obtain the dose in the liver, liver parenchyma, left kidney, right kidney, aorta, and spleen. We calculated the relative dose increase due to contrast as (DI-D0)/D0 where DI is the dose in the presence of contrast agent and D0 is the dose in the absence of contrast agent. The iodine concentrations in the simulations were estimated using iodine content calculated by DECT.

RESULTS

The average iodine concentrations among 20 patients are 7.16 ± 1.51 mg I/ml for left kidney, 6.98 ± 1.58 mg I/ml for right kidney, 5.62 ±1.04 mg I/ml for aorta, 3.76 ± 1.03 mg I/ml for spleen, 3.22 ± 0.97 mg I/ml for liver, and 2.95 ± 0.87 mg I/ml for liver parenchyma. Compared to a non-contrast scan, the relative doses increase in the liver (21 ± 5 %), liver parenchyma (20± 5 %), aorta (34 ± 6 %), right kidney (37 ± 7 %), left kidney (39 ± 7 %) and spleen (26 ± 3 %).

CONCLUSION

In abdominal CT, organ radiation doses increase due to the presence of contrast agents. On average, doses increase by 29 %. The highest increase is observed in kidneys, then in aorta, spleen, liver, and lowest in liver parenchyma.

CLINICAL RELEVANCE/APPLICATION

The presence of contrast agents should be considered in patient dosimetry calculations.

SSC12-07 Paradoxical Increase in Eye Lens Dose When Using Automatic Exposure Control During Non-Contrast Head CT and Mitigation by Organ-Based Tube-Current Modulation

Monday, Dec. 2 11:30AM - 11:40AM Room: S504AB

Participants
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PURPOSE

In CT scanning, tube current modulation techniques aim to maintain image quality over a variable anatomy. We examined eye lens

dose and image noise when activating a combination of automatic exposure control (AEC, current modulated based on anatomic attenuation measured on localizer) and organ-based tube-current modulation (OBTCM, current decreased over anterior portion of tube arc).

METHOD AND MATERIALS

We performed CT scans of an adult anthropomorphic head phantom on 2 scanners (SOMATOM Force and SOMATOM Definition AS+, Siemens Healthcare) using 4 acquisition modes: 1) fixed mAs; 2) AEC (CARE Dose 4D) only; 3) OBTCM (X-CARE) only; 4) and both AEC and OBTCM active. For both scanners, we used 2 protocols: 'trauma' with 310 and 'follow-up' with 250 effective mAs or quality reference mAs, as applicable. We maintained a constant kV of 120. For each of 6 replicates at each acquisition mode, we placed an optically stimulated luminescence (OSL) dosimeter in each orbit to measure absorbed dose. We averaged OSL doses at each mode to obtain generalized lens dose and characterized image noise (σ) from 4 ROIs placed at the level of the sella on subtraction images derived from consecutive scans with the least interscan motion. We used Student's t-test and distribution to test for significance and to calculate confidence intervals.

RESULTS

For the Force trauma, Force follow-up, AS+ trauma, and AS+ follow-up protocols, respectively, fixed current technique produced average lens doses of 35.8, 28.0, 32.1 and 25.5 mGy. As compared to the benchmark fixed technique, AEC alone paradoxically increased eye lens dose (+11%, +21%, +22%, +21%), while OBTCM decreased lens dose (-33%, -33%, -29%, -35%), and combining both techniques decreased lens dose (-21%, -21%, -21%, -20%). Every acquisition mode produced a significant change from the benchmark ($p<0.05$). Noise measurements revealed a roughly inverse linear relationship between σ and vdose ($R2 = 0.88$ and 0.72 for Force and AS+, respectively).

CONCLUSION

Compared to the standard fixed technique, activating AEC on non-contrast head CT paradoxically causes a significant increase in eye lens dose. Conversely, OBTCM with or without AEC significantly decreases lens dose.

CLINICAL RELEVANCE/APPLICATION

In designing non-contrast CT head protocols, use of AEC requires careful consideration because it may increase eye lens dose despite reducing overall dose. Adding OBTCM to AEC can mitigate this effect.

SSC12-08 kV Independent Coronary Calcium Scoring: A Phantom Evaluation of Score Accuracy and Potential Radiation Dose Reductions

Monday, Dec. 2 11:40AM - 11:50AM Room: S504AB

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PURPOSE

Because of the use of a fixed CT number threshold in the Agatston calcium (Ca) scoring method, and the dependence of CT numbers on photon energy, coronary Ca CT exams are required to be performed at a fixed tube potential (120kV). Here, we determine the accuracy of a kV-independent Ca scoring technique and its potential to reduce radiation dose by using tube potentials below 120kV.

METHOD AND MATERIALS

Three hydroxyapatite (HA) cylinders (5 mm diameter and length; 200, 400, 800 mg HA/mL) were inserted into a piece of pork and placed within anthropomorphic chest phantoms representing small, medium, and large adults. Phantoms were first scanned at 8 tube potentials (70-140kV) to compare CT numbers and Ca scores. Next, phantom scans were performed with automatic exposure control (AEC) and automatic kV selection (CareDose4D QRM=180/150/120/90mAs, CarekV setting = 4) to evaluate potential dose reduction. A dedicated reconstruction kernel (Sa36) was used to create 3-mm-thick 120kV-like images every 1.5 mm, from data acquired at other kVs, by appropriately scaling CT numbers above a soft tissue threshold. Phantoms were also scanned at 120kV using our clinical size-dependent mA chart. CT numbers were measured from images at different kVs, and Agatston scores calculated using commercial software.

RESULTS

Absolute CT number differences at different kVs (relative to 120kV) were small (tissue <4 HU; HA/Ca <5 HU for kV > 80 and < 18 HU for kV <= 80). The differences in Ca scores for kV >= 90 (relative to 120kV) were < 13.8 (8%) for 200/400 mg HA/mL, and < 22 (7%) for 800 mg HA/mL cylinders. The use of AEC and lower tube potentials reduced CTDIvol from 4.1/10.0/20.8 mGy (120kV, small/medium/large phantoms) to 2.1/4.4/5.6 mGy (for QRM=90mAs), yielding 48/56/73% reduction in CTDIvol and Ca score difference (for 400 mg HA/mL insert) < 13 (8%) in relative to 120 kV.

CONCLUSION

kV independent Ca scoring methods, coupled with AEC and lower tube potentials, provide a 48-73% reduction in CTDIvol and Ca scores that are consistent with those at 120 kV.

CLINICAL RELEVANCE/APPLICATION

The reported technique benefits patients undergoing coronary Ca scoring CT by considerably reducing radiation dose while maintaining accurate Ca scores.

SSC12-09 Exploring the Limits of Size-Specific Dose Estimates (SSDE) as an Estimate of Organ Dose from Routine Chest and Abdomen/Pelvis CT Examinations

Monday, Dec. 2 11:50AM - 12:00PM Room: S504AB

Participants
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PURPOSE

Size-Specific Dose Estimate (SSDE) adjusts scanner-reported CTDIvol to account for patient size and should be widely available on future scanners. While not intended to represent organ doses, the purpose of this work was to explore the ability of SSDE to provide a reasonable estimate of organ doses in routine chest and abdomen/pelvis exams across a wide range of patient sizes.

METHOD AND MATERIALS

Raw projection data and patient protocol pages for 133 routine chest (71 women, 62 men) and 82 routine abdomen/pelvis (40 women, 42 women) CT exams performed with tube current modulation (TCM) were gathered from two Siemens MDCT scanners (Sensation 64 and Definition AS64, Siemens Healthineers, Forchheim, Germany). Image data were reconstructed and were semi-automatically segmented to identify lung and glandular breast tissues in chest exams and liver, spleen, and kidneys in abdomen/pelvis exams. Segmented image data were used to create voxelized models of chest and abdomen/pelvis anatomy. TCM data was extracted from the raw projection data to describe the tube current values as a function of gantry angle and table location. Voxelized patient models and TCM data were incorporated into a validated Monte Carlo (MC) simulation engine to estimate absolute lung, breast, liver, spleen, and kidney dose using MDCT source models. Normalized lung (nDlung), breast (nDbreast), liver (nDliver), spleen (nDspleen), and kidney (nDkidney) doses were obtained by dividing respective absolute doses by the CTDIvol values from the patient protocol pages. SSDE values were acquired using AAPM Report 204 and the water equivalent diameter (Dw) from the image data. Normalized doses were then compared to SSDE f-factors.

RESULTS

The relative bias of nDlung, nDbreast, nDliver, nDspleen, and nDkidney to the SSDE f-factors was observed to be 17.4%, 35.4%, 16.2%, 17.9%, and 17.1%, respectively. SSDE overestimates organ dose in small and large patients.

CONCLUSION

SSDE may serve as a reasonable estimate lung, liver, spleen, and kidney dose across patient size within 20%, but may overestimate dose in small and large patients. For breast, SSDE may serve as a reasonable estimate within 36%.

CLINICAL RELEVANCE/APPLICATION

SSDE may provide reasonable estimates of organ dose for routine chest and abdomen/pelvis CT exams for most organs; however, estimates of breast dose may require wider tolerances.

SSC13

Physics (Breast X-Ray Imaging)

Monday, Dec. 2 10:30AM - 12:00PM Room: S503AB

BR PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSC13-01 Sensitivity of the New ACR QC Phantom for Detecting Degradations in DBT Systems

Monday, Dec. 2 10:30AM - 10:40AM Room: S503AB

Participants
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PURPOSE

Recently the FDA approved the use of the new ACR phantom for QC and to accredit DBT systems. Being new, the extent to which it can capture deficiencies in a 3D system is not well known. In this work we investigate how sensitive the new ACR phantom is to various DBT system degradations.

METHOD AND MATERIALS

Degradations were added to assess the impact on image quality: 1. Focal spot (FS) positioning error, and 2. Dose levels corresponding to 100%, 50%, and 25% of the AEC dose. For error in the FS positions, prior to reconstruction the x-ray angular position for each projection was perturbed by a Gaussian random value. Four levels of error were modeled: σ = 0.1°, 0.3°, 0.5°, and 1.0°. For each σ, five trials with different sets of projection data were created and reconstructed. Acquisitions were taken with both narrow- and wide-angle DBT geometries. The narrow-angle acquisition used 15 projections, a 15° span, and 700 mm SID. The wide-angle used 25 projections, a 46° span, and 655 mm SID. The system used a W/Rh tube at 29 kVp and an Anrad direct conversion detector with 85 µm pixel pitch. To determine the effects, images were evaluated by reader scoring and FWHM of z-axis resolution, according the new ACR QC Manual. Each fiber received 1 point each if the length was >= 8 mm and ½ point if 5-8 mm. Speck clusters each get 1 point if 4-6 specks were seen and ½ point for 2-3 specks. Masses received 1 point each if ¾ of the border was visible and ½ point if ½ - ¾ was visible. Passing required at least 2 points for fibers, 3 for speck groups, and 2 for masses. Z-resolution failed if the FWHM was greater than 30% of baseline (σ = 0°).

RESULTS

For both geometries, reader-averaged results show fiber scores passed until an angular error of σ = 1.0°, speck scores passed until an angular error of σ = 0.5°, and mass scores passed at all error levels. Scores failed at 50% AEC for the 15° geometry, but only show failure at 25% AEC for the 46° geometry. The z-resolution test was more sensitive and failed after σ = 0.1°, for both geometries.

CONCLUSION

In general the ACR phantom was only mildly sensitive to factors that might degrade clinical performance. In the future, we will investigate the impact of these failures on detectability of signals in an anthropomorphic breast phantom.

CLINICAL RELEVANCE/APPLICATION

To our knowledge, no work has been done to assess the utility of the ACR phantom in evaluating DBT systems.

SSC13-02 Comparison of Digital Mammograms, Breast Tomosynthesis and Synthetic Mammograms for Small Detail Detection: Phantom-Based Observer Performance Studies

Monday, Dec. 2 10:40AM - 10:50AM Room: S503AB

Participants
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PURPOSE

Compare small detail detectability in digital mammography (DM), digital breast tomosynthesis (DBT) and synthetic mammograms (SM) of 5 vendors using 2 phantoms: CDMAM (homogeneous background with gold discs) and L1 (structured background with calcification inserts).

METHOD AND MATERIALS

Phantom images were acquired for DM/DBT on Fujifilm Amulet Innovality ST, GE HC Senographe Pristina, Hologic Selenia Dimensions, IMS Giotto Class and Siemens Mammomat Revelation, with SM calculated from DBT. Automatic exposure control (AEC) dose levels for DM/DBT modes were respectively: 1.37mGy/1.93mGy; 1.33mGy/1.33mGy; 1.55mGy/2.02mGy; 1.20mGy/1.48mGy; 1.08mGy/2.09mGy. Twelve acquisitions were made at AEC/2, AEC and 2xAEC levels. Both phantoms were read manually, with CDMAM also read using CDCOM software, both using a 4-alternative forced choice method. Threshold gold thickness (Ttr) at 0.13 mm diameter for CDMAM and threshold calcification diameter (dtr) for L1 were defined from the 62.5% correct score. One-way analysis of variance was performed to test significant differences among dose levels/modalities.

RESULTS

For human reading of CDMAM at AEC dose, SM was inferior to DM/DBT. Ttr results for DM/DBT/SM were for Fuji: 0.59µm/0.70µm/1.02µm, GE: 0.61µm/1.10µm/1.27µm, Hologic; 0.71µm/1.09µm/1.19µm, Giotto: 1.17µm/1.30µm/1.65µm, and Siemens: 0.86µm/1.01µm/1.34µm. CDCOM results were within error bars of human results, however CDCOM failed for SM. For L1, dtr results for DM/DBT/SM at AEC dose were for Fuji: 0.118mm/0.117mm/0.118mm, GE: 0.108mm/0.114mm/0.136mm, Hologic: 0.109mm/0.112mm/0.129mm, Giotto: 0.131mm/0.121mm/0.141mm and Siemens: 0.114mm/0.122mm/0.149mm. SM was significantly poorer than DM/DBT for all vendors, all modalities, all doses, except for Fuji, where dtr was not significantly different at AEC dose. For Giotto, differences were only significant between SM and DBT/DM at high dose. dtr of DM and DBT was never significantly different. Dose had a significant impact on object detectability for both phantoms.

CONCLUSION

For all 5 vendors, better small detail scores were obtained for DM and DBT than for SM. Detectability improved as dose increased.

CLINICAL RELEVANCE/APPLICATION

SM, in its current stage of development for all 5 vendors, cannot be recommended as a stand-alone modality if the small detail detectability levels achieved in DM or DBT is required.

SSC13-03 Comparison of Digital Mammograms, Breast Tomosynthesis, and Synthetic Mammograms for Detection of Masses: An Observer Performance Study

Monday, Dec. 2 10:50AM - 11:00AM Room: S503AB

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PURPOSE

Compare detectability of masses in digital mammography (DM), digital breast tomosynthesis (DBT) and synthetic mammograms (SM) of 5 vendors with a 3D structured (L1) phantom with embedded mass-like lesions.

METHOD AND MATERIALS

L1 is a hemispherical shaped phantom filled with PMMA spheres and water plus nine 3D-printed lesions: 5 non spiculated (diameter 1.6mm to 6.2mm) and 4 spiculated masses (diameter 3.8mm to 9.7mm). DM, DBT and SM images were acquired on these systems: Fujifilm Amulet Innovality ST, GE HC Senographe Pristina, Hologic Selenia Dimensions, IMS Giotto Class and Siemens Mammomat Revelation. Three dose levels were studied (12 acquisitions at each level): automatic exposure control (AEC) level and manually set at AEC/2 and 2xAEC. A 4-alternative forced choice reading paradigm was used. Threshold diameter to reach a 62.5% correct score was evaluated (dtr). One-way analysis of variance was performed to test for significant differences among dose levels/modalities.

RESULTS

For GE, Giotto and Siemens, DBT performed significantly better than SM, while SM showed no difference with DM. For Fuji and Hologic, there was no significant difference between DBT and SM, while DM was inferior to DBT and SM. The dtr values for non-spiculated masses for DM/DBT/SM at AEC dose, were respectively: Fuji: 4.21mm/2.12mm/2.89mm; GE: 4.87mm/2.15mm/4.21mm; Hologic: 7.21mm/1.87mm/3.28mm; Giotto: 4.96mm/2.37mm/4.30mm; Siemens: 4.44mm/2.22mm/4.64mm and for spiculated masses: Fuji: 6.65mm/2.58mm/3.66mm; GE: 4.27mm/2.04mm/3.55mm; Hologic: 5.04mm/2.54mm/3.68mm; Giotto: 4.97mm/2.37mm/4.30mm; Siemens: 5.6mm/2.99mm/4.67mm. Dose did not impact detection of both mass types for GE and Hologic. For Fuji, Giotto and Siemens DBT, decreasing the dose lead to a significantly inferior dtr for spiculated masses and in the case of Fuji and Siemens also for non-spiculated masses.

CONCLUSION

Detectability of mass-like lesions was higher in DBT compared to DM and SM, except for Fuji and Hologic, where SM was not different from DBT. Increasing dose only influenced mass detection in DBT. The L1 phantom demonstrated the superiority of DBT compared to DM for mass detection, for all 5 systems.

CLINICAL RELEVANCE/APPLICATION

For most vendors, SM, in its current stage of development, cannot be recommended as a stand-alone modality if equal mass

detectability as in DBT is required.

SSC13-04 Accurate Local Estimation of Compressed Breast Thickness in Digital Breast Tomosynthesis Using an Iterative Reconstruction Approach

Monday, Dec. 2 11:00AM - 11:10AM Room: S503AB

Participants
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PURPOSE

Our purpose is to describe invasive breast cancer in terms of lipid, water, and protein content using dual-energy tomosynthesis. Previous work for full-field digital mammography required an in-image calibration phantom adhered to the compression paddle to describe thickness, tilt, and warp. We show these parameters can be estimated by using an iterative reconstruction approach on the sinograms resulting in a model of the breast characteristics including local breast thickness, compression paddle tilt, and warp.

METHOD AND MATERIALS

Virtual breast objects (VBO) of known geometries, defined using only five unique parameters (thickness, width, density, warp, and tilt), were constructed in simulation with MATLAB and their corresponding sinograms generated. Breast thicknesses from 1 to 80 mm and chest wall to nipple distances from 1 to 200 mm were generated to sample the space. Single coronal sinograms for training and validation sets of 9600 and 1920 VBO's, respectively, were constructed. Principal component analysis (PCA) was used to generate a model which explains the relationship between the five parameters and the sinograms. Clinical DICOM header thicknesses in 24 tomosynthesis exams were also compared to the local model estimates.

RESULTS

We found that 25 PCA components explained greater than 99% of model variance. A comparison between iterative reconstructed models and phantom measures is ongoing. A mean thickness difference (DICOM - model) of 24 breasts was found to be 2.80 mm (SD = 2.95 mm, Min/Max=-12/11 mm). The PCA model captured the local thickness decline from the chest wall to the nipple.

CONCLUSION

We demonstrate a method to capture local breast thickness using an iterative reconstruction method in the sinogram space. The model was able to describe paddle warp and tilt. Phantom calibration of the model is ongoing and accurate local breast thicknesses were seen when compared to DICOM values in clinical images. This method can be implemented on commercial tomosynthesis systems without modification. Future studies will utilize these thickness measures with dual-energy tomosynthesis to create voxels lipid, water, and protein contents instead of greyscale values alone.

CLINICAL RELEVANCE/APPLICATION

Accurate and local breast thickness measures enable lesions to be characterized by their lipid, water, and protein content through a dual-energy 3-compartment model while still in situ to better assess malignancy status.

SSC13-05 Deep Learning-Driven Sparse-View Reconstruction for Radiation Dose Reduction in Dedicated Breast CT: Quantitative Evaluation

Monday, Dec. 2 11:10AM - 11:20AM Room: S503AB

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PURPOSE

To objectively quantify and demonstrate the feasibility of deep learning-driven reconstruction for sparse-view dedicated breast CT (BCT) to reduce radiation dose and to identify the best method for reader study.

METHOD AND MATERIALS

Projection datasets (300 views, full-scan; 12.6 mGy MGD) from 137 BIRADS 4/5 women who underwent BCT prior to biopsy were reconstructed using FDK algorithm (0.273 mm isotropic voxels) and served as reference. Sparse-view (100 views, full-scan; 4.2 mGy median MGD) projection data were reconstructed using FDK algorithm (0.273 mm isotropic voxels) and three variants of multiscale CNN (ResNet) architecture (individual 2D slices, "ResNet2D"; 5 contiguous 2D slices, "ResNet2.5D"; and, residual dense network with 5 contiguous 2D slices, "ResDenseNet2.5D") were used to train the network with sparse-view and reference FDK reconstructions as input and label, respectively. Each network used 2000/900/900 slices from 20/5/5 breasts for training/validation/testing. Once trained, 42868 slices from the remaining 107 breasts were used to quantify normalized mean-squared error (NMSE), bias and absolute bias, all with respect to the reference, and the standard deviation for all reconstructions.

RESULTS

All 3 deep learning methods suppressed streak artifacts and showed significantly reduced NMSE, bias and absolute bias compared to FDK reconstruction (p<0.001). The NMSE (mean+/-SD, log scale) was significantly lower for ResDenseNet2.5D (-2.59+/-0.27; p<0.001). The bias was lowest for ResNet2.5D (-3.05E-5+/-3.05E-4; p<0.001). The absolute bias was lowest for ResDenseNet2.5D (9.05E-4+/-3.51E-4; p<0.001). The standard deviation for each deep learning sparse-view reconstruction was lower than the reference 300-view FDK reconstruction as the CNN learns from the ensemble of breasts. The standard deviation in ResNet2.5D was lowest (3.67E-3+/-1.38E-3; p<0.001).

CONCLUSION

Quantitatively, ResNet architectures using multiple contiguous slices performed better than that using individual slices. Deep learning-driven sparse-view reconstruction for radiation dose reduction is feasible and needs to be investigated.

CLINICAL RELEVANCE/APPLICATION

Deep learning-driven sparse-view reconstruction can potentially enable radiation dose reduction in breast CT to a level that may be suitable for breast cancer screening.

SSC13-06 Measurements of Resolution in Digital Breast Tomography (DBT) Using a Tomosynthesis Phantom, Special Emphasis on Detecting Calcified Specks

Monday, Dec. 2 11:20AM - 11:30AM Room: S503AB

Participants
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PURPOSE

Investigate measurements of resolution in DBT using a Tomosynthesis Phantom with emphasis on meaning and interpretation of "MTF". The limitations of calcified speck detection in DBT depending on where the speck might occur.

METHOD AND MATERIALS

Tomosynthesis Phantom is used for testing DBT. Small beads (0.09mm radius) are used as both "point sources" and elements along slice width ramps for slice geometry and scan slice incrementation (z). This study examines the use of this PSF when located at intra and inter slice positions. PSF bead, and the scan slice geometry bead ramps isolate where any given bead is located (intra and inter) within the phantom and the slice. Spatial distribution of the (bead) PSF can be examined at a given position. A summation of data from neighboring beads shows study change in PSF increases the z axis slice width. FWHM of the PSF, and Fourier Transform (FT) of the PSF yielding an "MTF" type function, and corresponding Modulation levels. Nine identical DBT images taken on a DBT Tomosynthesis system and the data analyzed from both individual beads as well as combined beads examining highest resolution and average resolution within the slice. A theoretical model of PSF shows PSF tends to move from a typical function at the isocenter of the slice, annular shapes as one moves off center. Annular shapes simulated by combination of Bessel functions.

RESULTS

PSF and "MTF" results show changes in positioning of the bead (calcified speck). Results may have important implications to understanding resolution limitations to finding small calcified specks depending on where in the slice the spec occurs. Result within the slice is different than the best-case result within the slice. High contrast object extends along the z axis, then the average result will better reflect spatial resolution.

CONCLUSION

It is possible to examine the changes in Point Spread Function and "MTF" by using small bead, point sources. It is shown that understanding the resolution differences of location of such specks will depend on inter and intra slice locations. The "MTF" can be used to study this effect.

CLINICAL RELEVANCE/APPLICATION

DBT phantom using small beads to study resolution in DBT systems results help the clinician understand the process of limited angle tomography degrades the highest resolution of a calcified speck location to the more average resolution a bead/speck at some random position in the slice.

SSC13-07 Contrast-Enhanced Spectral Mammography with a Compact Synchrotron X-Ray Source

Monday, Dec. 2 11:30AM - 11:40AM Room: S503AB

Participants
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PURPOSE

Contrast-enhanced spectral mammography (CESM) based on K-edge subtraction (KES) helps to identify uncertain findings in standard mammography. As CESM requires two acquisitions, dose reduction is a crucial issue. Here, two dual-energy dose-compatible CESM approaches are evaluated with a compact synchrotron X-ray source.

METHOD AND MATERIALS

In this study, the commonly used dual-energy KES imaging technique and a two-material decomposition method were used to implement CESM at a quasi-monochromatic compact synchrotron X-ray source. For a better evaluation of the laboratory results, clinical CESM images were also performed. Low-energy attenuation-based images as well as images only showing the contrast agent iodine were acquired with a mammographic accreditation phantom for both the clinical and the laboratory measurements. The phantom has been modified with a tube filled with iodine in a concentration of 6 mg/ml to mimic the contrast agent.

RESULTS

Confirmed by a higher contrast-to-noise ratio (CNR) and spatial resolution, improved image quality has been accomplished with both aforementioned methods carried out in the laboratory for the iodine images while the spectral approach achieved even better results than the KES imaging technique. Exemplarily, we demonstrate the reduction of the applied dose by up to 66% compared to the clinically applied dose. Additionally, the image quality of the laboratory results of the low-energy images - which are comparable to conventional mammography images - also increases compared to the clinical examinations.

CONCLUSION

Our findings regarding the CNR and the spatial resolution suggest the great potential of novel quasi-monochromatic X-ray sources in combination with a two-material decomposition method as a means to improve the diagnostic quality and to reduce the applied dose in clinical examinations. Our results show a significant increase in image quality at the same radiation dose or a significantly reduced dose level required to obtain the same image quality as in the clinical system.

CLINICAL RELEVANCE/APPLICATION

The reduction of radiation dose in mammography, especially for second-level examinations, is a crucial citeria for the improvement of its clinical diagnostic quality.

SSC13-08 Comparison Between Vendor Reported and Physicist Calculated Doses Within a Quality Control Program for a Tomosynthesis Mammography Screening Trial: Interim Results

Monday, Dec. 2 11:40AM - 11:50AM Room: S503AB

Participants
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PURPOSE

We are overseeing the quality control (QC) for a screening trial comparing tomosynthesis (DBT) and 2D mammography. The QC involves weekly, monthly and annual tests. We also collect doses and technique factors used for patient imaging. To understand the reliability of the doses recorded in the DICOM image headers, we are comparing mean glandular dose (MGD_calc) calculated using physicists' measurements of half value layer (HVL) and tube output with those reported in the headers for scans of phantoms (MGD_hdr).

METHOD AND MATERIALS

A set of phantoms is circulated annually among the participating sites and imaged with the DBT mode used for patients. Slabs of PMMA 2, 4, 6 and 8 cm thick, with 0, 0.5, 1.5 and 2.3 cm spacers are used. mR/mAs and HVL values are obtained from the physicist's surveys and used with the imaging technique factors to estimate the MGD_calc using the Dance et al method. Corrections are made for spectrum, fraction of glandular tissue and DBT geometry, as parameterized by Li et al. The dose percent difference (DPD) is calculated as 100x(MGD_hdr-MGD_calc)/MGD_calc . Comparisons of DPDs were made between DBT systems, dosimeter manufacturers and phantom thicknesses.

RESULTS

To date 45 surveys on 4 models from 2 vendors have been conducted. Dosimeters from 4 different manufacturers were used. The doses match best for the 4.5 cm thickness with a DPD of 2.1% (95% CI -1% to +5%). The mismatch is greatest at 22% for 2 cm (95% CI 12% to 25%). The average DPD is larger for one of the dosimeter manufacturers, suggesting a bias with that technology. Differing trends were noted in the size of the DPD vs phantom thickness when separating out by DBT model. QC testing is ongoing and updated data will be available at RSNA.

CONCLUSION

Systematic discrepancies between displayed and calculated doses at different thickness suggest that different dose calculation models and assumptions may be used by the various DBT systems. Care must be taken in drawing conclusions about dose estimates to a population when relying on the figures reported in the DICOM headers. In addition, different biases may be present in the different meters used to measure entrance exposure and HVL, further confounding the assssment of dose.

CLINICAL RELEVANCE/APPLICATION

Differences in assumptions used to calculate dose existing between tomosynthesis mammography systems and in beam quality values mean care must be taken when comparing reported and calculated doses.

SSC13-09 Automatic Exposure Control Intelligence in Digital Mammography for a Diagnostic and Post-Therapy Patient Population

Monday, Dec. 2 11:50AM - 12:00PM Room: S503AB

Participants
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PURPOSE

Automatic exposure control (AEC) systems are designed to find the most attenuating region and adjust the exposure parameters so this region is imaged at some predefined dose/quality level. This study quantifies the success rate of the AEC in selecting the densest breast tissue in diagnostic and post-therapy patient populations.

METHOD AND MATERIALS

A total of 615 successive mammograms were collected from a GEHC PristinaTM system. The AEC-selected region was placed in one of three categories a) AEC region within the densest breast tissue (considered "optimal") b) region located in pectoral muscle and c) clips present inside the region. Second, the images were divided into 1x1 mm^2 areas and mean volumetric breast density (VBD) estimated for each area using VolparaTM. Third, images where the difference between maximum VBD within the AEC region and other parts of the breast was >15% were retrieved and visually scored for the presence of disturbing noise.

RESULTS

In 84% of all mammograms the AEC selected the optimal region. In 5% of all mammograms the AEC selection missed the densest breast part, but only 3.7% resulted in differences in VBD >15%. Visual inspection of these images did not show excessive noise. In 6% of all mammograms, the AEC region was positioned in the pectoral muscle, where the correct selection should have been in the breast tissue. The mean, minimum and maximum difference in pixel values between the pectoral muscle and the densest breast tissue was 5%, -15% and 29%. In 32% of these cases a larger than targeted dose compared to breast tissue selection was given, being on average 6%. Finally, 179 mammograms (29%) contained clips. In 32 images (5% of all mammograms), the AEC selected a region that included the clips, but in 28 of these images the signal due to the clip was excluded when determining the exposure settings.

CONCLUSION

Automatic exposure control selection within mammograms of breasts with lesions, clips etc. is a challenging task. Region selection by the GEHC PristinaTM AEC is intelligent and overcomes the current challenges via segmentation techniques and local density calculations.

CLINICAL RELEVANCE/APPLICATION

The selection of the automatic exposure control region and subsequent dose level adjustment is a key parameter in the radiation dose/quality balance and should be optimized for all breast types.

SSC14

Science Session with Keynote: Radiation Oncology (CNS Malignancies)

Monday, Dec. 2 10:30AM - 12:00PM Room: E261

NR RO

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Hyunsuk Shim, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SSC14-01 FET-PET Radiomic Feature Correlates with Outcome in Patients with Recurrent Glioblastoma Multiforme

Monday, Dec. 2 10:30AM - 10:40AM Room: E261

Participants
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PURPOSE

Radiotherapy (RT) for primary and recurrent glioblastoma multiforme (GBM) is conventionally planned on anatomical magnetic resonance imaging (MRI), where the target volume is defined as the area of tumor-related gadolinium enhancement on a T1-weighted sequence (Gd-T1-MRI). Recent studies have indicated that O-(2-[18F]fluoroethyl)-L-tyrosine (FET) positron emission tomography (PET) is more specific than MRI and equally sensitive for tumor visualization. However, in recurrent GBM there is yet no clear evidence that the information provided by FET-PET is complementary or superior to MRI in RT target volume delineation and outcome prediction. The aim of this study was to present a comparison of the tumor volumes defined on FET-PET (VFET) and MRI (VMRI) and to analyze the use of FET-PET image features in predicting time to tumor progression (TTP) for patients with recurrent GBM.

METHOD AND MATERIALS

31 previously irradiated patients with recurrent GBM and treated with re-irradiation were prospectively recruited. Gd-T1-MRI and FET-PET were performed before re-irradiation. PET target volumes were defined with a threshold of 1.8 times the standardized-uptake-value (SUV) of the background (BG, 2 volumes manually defined in cerebrum and cerebellum), while MRI volumes were contoured by experienced radiation oncologists. MRI and PET images were co-registered and 135 FET-PET image features (IF) were derived from VFET and VMRI.

RESULTS

Results from the Wilcoxon Rank Test demonstrated that VFET and VMRI were comparable in size ($p>0.05$). However, the low average values for the Dice-Similarity-Coefficient=0.3±0.2, Predictive-Positive-Value=0.4±0.3 and Sensitivity=0.4±0.3 suggested a poor agreement in localization. 117 IF (87%) showed statistically significant differences between VFET and VMRI. 74% of the IF were significantly different between VFET and BG, including all SUV-related features (min, max, peak and mean). Small-Zone-Low-Gray-Level-Emphasis (SZLGE) showed statistically significant predictive value for TTP ($p=0.00027$, Log-Rank test between TTP curves for patients with SZLGE< SZLGEmedian and patients with SZLGE> SZLGEmedian).

CONCLUSION

Our findings suggest that FET-PET provides complementary information with respect to MRI and could contribute to the outcome assessment of patients with recurrent GBM treated with re-irradiation.

CLINICAL RELEVANCE/APPLICATION

FET-PET can contribute to the outcome assessment of patients with recurrent glioblastoma treated with re-irradiation.

SSC14-02 ASL Perfusion MRI Reveals Reduced Cerebral Blood Flow in the Region of the Hippocampus and Auditory Cortex in Patients with Former Childhood Medulloblastoma

Monday, Dec. 2 10:40AM - 10:50AM Room: E261

Participants
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PURPOSE

Long-term survivors of former childhood Medulloblastoma are increasing. Thus, monitoring of sequelae of the applied radiochemotherapy (RCT) such as vascular damage is gaining importance. In this study Arterial Spin Labeling (ASL) perfusion MRI was used to analyze alterations of cerebral blood flow (CBF) in patients who underwent RCT.

METHOD AND MATERIALS

ASL perfusion MRI was performed in 28 patients (mean age: 25.2; range: 10-55 years; mean years after primary RCT 14.9 years, range: 1-45 years) and 24 healthy subjects (mean age: 32; range: 22-63 years). Individual CBF-maps were calculated and brought into MNI-space using SPM12. Mean CBF in grey matter was determined for every group and, based on MNI coordinates, mean CBF was calculated for the hippocampus and auditory cortex and compared on an individual basis by a nonparametric Wilcoxon rank-test.

RESULTS

No significant differences of mean grey matter CBF were found in patients and the healthy control group, respectively of 66.57 (65.24-68.90) vs. 65.88 (65.01-66.88)ml/min/100g. Region based comparison, however, revealed a highly significant reduction of CBF of the hippocampus in patients after RCT (69.23 (66.18-74.51)ml/min/100g) compared to the healthy control group (79.84 (78.19-81.75)ml/min/100g), and 63.01 (60.69-65.03)ml/min/100g for the auditory cortex compared to 70.98 (69.01-71.75)ml/min/100g for the healthy control group

CONCLUSION

ASL perfusion MRI can be used as a noninvasive tool to analyze CBF after RCT in patients with former childhood medulloblastoma. The significant reduction of hippocampal and auditory cortex CBF is in agreement with hearing impairment and deficient memory and cognition frequently observed in these patients. Hence, ASL perfusion might be considered in routine follow-up MRI protocols.

CLINICAL RELEVANCE/APPLICATION

ASL MR perfusion reveals significantly reduced cerebral blood flow in the region of hippocampus and the auditory cortex in patients after RCT with former childhood medulloblastoma.

SSC14-03 Basic Pretreatment RADIOMICS Features to Predict SRS Outcome of Meningiomas and Vestibular Schwannomas

Monday, Dec. 2 10:50AM - 11:00AM Room: E261

Participants
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PURPOSE

The goal of this study was to identify basic RADIOMICS features from conventional Magnetic Resonance imaging (MRI) and from diffusion tensor imaging (DTI) that best predict the volumetric changes in benign meningiomas and vestibular schwannomas (VS) after treatment with Gamma Knife radiosurgery (GKRS).

METHOD AND MATERIALS

In 24 patients with VS routine MRI and in 32 patients with meningioma routine MRI and DTI were measured before GKRS. A total of 78 parameters derived from texture analysis of the pretreatment MRI, including calculation of the mean, standard deviation (SD), percentiles, and kurtosis and skewness of data in histograms on a voxel-wise basis, and additionally 10 different DTI parameters were correlated with lesion volume change after a mean follow-up period of 36 month (range 19.5-63.3m) for meningiomas, and 41.8 months (range 21.9-80.3m) for VS.

RESULTS

In case of meningiomas, several DTI-derived parameters correlated significantly with volume change. The parameter that best predicted the results of GKRS was the 2.5th percentile value of the smallest eigenvalue (L3) of the diffusion tensor (CC=0.739, $p <= 0.001$), whereas among the non-DTI parameters, only the SD of T2-weighted images correlated significantly with a tumor volume change (CC=0.505, $p <= 0.05$, after correction for family-wise errors using false-detection-rate FDR correction). In case of VS, 2 histogram parameters from T2-weighted images reached statistical significance ($p<0.05$, FDR corrected). Kurtosis of T2 signal values turned out to predict progression with a sensitivity and specificity of 86% and 78%.

CONCLUSION

The prediction of volumetric response after radiosurgery can influence therapeutic strategies, such as modifying radiation dose, or

The prediction of volumetric response after radiosurgery can influence therapeutic strategies, such as modifying radiation dose, or strengthen the case for radiosurgery over conventional resection. The results of our texture analysis indicate that DTI-derived parameters have a high correlation to shrinkage of meningioma volume after SRS, while conventional imaging can predict SRS outcome of both meningiomas and VS, though with somewhat less accuracy.

CLINICAL RELEVANCE/APPLICATION

Image based prediction of response after radiosurgery can influence therapeutic strategies, such as modifying radiation dose, or strengthen the case for radiosurgery over conventional resection.

SSC14-04 Hypofractionated SRS versus Single Session SRS for Perioptic Lesions. A Single-Center Study of 245 Patients

Monday, Dec. 2 11:00AM - 11:10AM Room: E261

Participants
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PURPOSE

Hypofractionated radiosurgery (HFSRS) of lesions in the sellar region is still controversially discussed as an alternative to single session SRS.

METHOD AND MATERIALS

According to our protocol, HFSRS is performed when it is technically impossible to limit the maximum point dose to the anterior visual pathway (AVP) to 12 Gy. Between 2011 and 2018 a total of 72 patients with perioptic lesions (mean distance lesion-to-AVP=0.3mm, 69% in direct contact) were treated with HFSRS and 173 with single fraction (mean margin dose was 15.5 Gy, mean distance lesion-to-AVP=2.0mm, 30% in direct contact). In the HFSRS group, 7 treatments were performed with a 5 day course with a mean margin dose of 5x6.93 Gy, 56 treatments with 4x5.32 Gy, and 9 treatments with 3x6.31 Gy. Exact delineation of the optic pathways was performed on high resolution 3D T1 images and additionally since 2016 by applying FGATIR sequences.

RESULTS

After a mean imaging follow-up period (FUP) of 23m [2-72m], local control was achieved in all lesions treated with HFSRS, except for 1 lesion (caused by pituitary apoplexy). An overall mean reduction in volume of 3.05%/m was observed. Mean FUP for ophthalmologic evaluation was 28m [2-79m]. Improved vision was observed in 10 cases; 1 case was confirmed for radiation induced optic neuropathy (RION) after delivery of 4x5.60 Gy as maximum optic point dose. All treatments were well tolerated and concluded satisfactorily. Spatial frame displacement during HFSRS course was measured < 0.3mm using CT images. In the group of single session SRS, after a mean imaging FUP of 27m [4-78m], local control was achieved in all but 7 lesions, with an overall mean reduction of 1.52%/m. Mean FUP for ophthalmologic evaluation was 36m [7-81m]. 1 case was confirmed for RION, after delivery of 10.2 Gy as maximum optic point dose. For all patients dose volume histograms were analyzed for both nerves, both tracts and chiasm.

CONCLUSION

According to our preliminary results, HFSRS can be considered as an efficient and relatively safe alternative to treat lesions even contacting the AVP, benefiting from a low alpha/beta ratio of 1.03 Gy (abstract presented at RSNA 2018) of the visual pathway.

CLINICAL RELEVANCE/APPLICATION

Hypofractionated radiosurgery can be considered as an efficient and relatively safe alternative to SRS in the treatment of lesions adjacent to the optic pathway

SSC14-05 Hyperpolarized Carbon-13 Metabolic MRI for Differentiating between Radiation Necrosis and Brain Tumor

Monday, Dec. 2 11:10AM - 11:20AM Room: E261

Participants
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PURPOSE

The aim of this study was to explore the feasibility of Hyperpolarized (HP) carbon-13 (13C) MRI in differentiating brain tumor from radiation necrosis.

METHOD AND MATERIALS

Radiation necrosis was created by an 80Gy single-dose irradiation of a half cerebrum in mice (n=7). 2 brain tumor models were created by intracranial injections of GL261 cell line (n=6) and Lewis Lung carcinoma (LLC) metastasis cells (n=7). The irradiated and tumor-bearing mice developed contrast enhancement (CE) ~2.5 months and ~14 days after treatment, respectively. 13C 3D MRSI data were acquired with the injection of HP 13C1-pyruvate, pre-polarized using a HyperSense. Lactate and pyruvate were normalized by vascular maximum total carbon signal (nLac and nPyr, respectively) and the ratio of lactate to pyruvate (Lac/Pyr) was evaluated

RESULTS

Conventional MRI exhibited typical radiographic features of radiation necrosis and brain tumor: The irradiated mice developed large CE in post-Gd T1 MRI and were heterogeneous on the T2 MRI. Similarly, the GL261 glioma and LLC metastasis models exhibited CE and T2 hyperintensity. HP 13C data indicated that radiation-induced necrotic tissue and brain tumors had distinct metabolic profiles: Radiation-induced injury exhibited significantly lower Lac/Pyr and nLac than both mouse glioma and LLC metastatic tissue. There was no significant difference in nPyr between the radiation-induced injury and either GL261 glioma or LLC metastasis models, implying that the amount of pyruvate taken up by the three types of tissue were similar. Histological analysis demonstrated distinct characteristics between the radiation-induced necrosis and brain tumors: In contrast to the radiation-induced necrotic tissue, both tumor models showed a high cell density, which is one of the characteristics of cancer. The increased level of cellularity in these tumors was consistent with the high level of lactate observed in HP 13C data.

CONCLUSION

The results from this study suggest that HP 13C metabolic imaging may provide a unique and noninvasive imaging biomarker for distinguishing recurrent brain tumors from radiation necrosis.

CLINICAL RELEVANCE/APPLICATION

The differentiation of recurrent tumor from radiation necrosis after radiation therapy remains often challenging in patients with brain tumor despite various advanced MR imaging techniques. We showed the potential of HP 13C MRI to differentiate brain tumor from radiation necrosis.

SSC14-06 The Value of ADC in the Differential Diagnosis of Benign/Malignant Meningioma and ADC with Ki-67 Proliferation Index in Meningioma

Monday, Dec. 2 11:20AM - 11:30AM Room: E261

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PURPOSE

To investigate the value of the apparent diffusion coefficient (ADC) value of intracranial meningioma in the differential diagnosis of benign/malignant meningiomas and to distinguish different grades of meningioma, and the correlation between ADC value of meningioma and Ki-67 value-added index.

METHOD AND MATERIALS

A retrospective analysis of 125 patients with meningioma who were diagnosed by pathology and preoperative Ki-67 positive rate were divided into two groups according to pathological findings: benign and malignant in 94 cases (malignant in 94 cases, malignant in 31 cases), including 52 cases of WHOI level, WHOII There were 59 cases in grade and 14 cases in grade III. The region of interest (ROI) was manually drawn on the ADC image, and the ADC values of the parenchymal region were averaged 6 times in three consecutive sections. The same method was used to obtain the ADC value of the contralateral normal white matter of the tumor entity, and the tumor entity was obtained. The relative ADC values (rADC) of the peritumoral edema area were compared between different grades of meningiomas and benign/malignant meningiomas. The Ki-67 proliferation index was analyzed in the postoperative immunohistochemistry results, and the correlation between ADC value, rADC value and Ki-67 index was analyzed.

RESULTS

The ADC and rADC values were lower in the benign group than in the benign group (P<0.001). There were differences in ADC and rADC values between different grades of meningiomas, and the high-level group was lower than the low-level group (P<0.001). ADC values (rs=-0.42, P **CONCLUSION**

The data showed that the ADC value can improve the accuracy of benign and malignant identification and preoperative pathological grade of meningioma, and the ADC value is negatively correlated with the Ki-67 index.

CLINICAL RELEVANCE/APPLICATION

Preoperative MRI is important for the evaluation of patients with meningioma and the treatment of later stage.

SSC14-08 Radiation Oncology Keynote Speaker: CNS Malignancies

Monday, Dec. 2 11:40AM - 12:00PM Room: E261

Participants
Ranjit Bindra, MD, PhD, Madison, CT (*Presenter*) Co-founder, Cybrexa, Inc; Consultant, Cybrexa, Inc; Stockholder, Cybrexa, Inc

SSC15

Vascular/Interventional (Spine and Pain Intervention)

Monday, Dec. 2 10:30AM - 12:00PM Room: E263

IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Rex M. Pillai, MD, Sacramento, CA (*Moderator*) Nothing to Disclose
Karunakaravel Karuppasamy, MD,FRCR, Westlake, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSC15-01 Risk of Acute Vertebral Fractures Post-Vertebroplasty Depends on the Distance and Location Relative to the Initial Treatment Level

Monday, Dec. 2 10:30AM - 10:40AM Room: E263

Participants
James Moroney, Grand Rapids, MI (*Presenter*) Nothing to Disclose
Aaron Clark, Grand Rapids, MI (*Abstract Co-Author*) Nothing to Disclose
Albert D. Jiao, BS, Grand Rapids, MI (*Abstract Co-Author*) Nothing to Disclose
Nicholaus Monsma, BS , Grand Rapids, MI (*Abstract Co-Author*) Nothing to Disclose
Charlene B. Ofosu, MD, Grand Rapids, MI (*Abstract Co-Author*) Nothing to Disclose
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James J. Morrison, MD, Grand Rapids, MI (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The risk of developing an acute vertebral fracture following a percutaneous vertebroplasty (PVP) remains unclear in the literature. Some studies suggest an increased risk is placed on adjacent vertebrae while other studies report no additional risk whatsoever.

METHOD AND MATERIALS

Between 2002 and 2017, 1796 patients (mean age 78.9; 70.1% female) received a PVP secondary to an acute vertebral fracture. Medical records were reviewed for new onset vertebral fractures within one-year post-PVP and for evidence of additional PVP. Fractures were categorized as osteoporotic, traumatic and pathologic. New fractures were evaluated for relative location to the initial PVP level. Risk factors including age, gender, chronic steroid use and body mass index were evaluated. Analysis of post-PVP vertebral fractures stratified fracture risk as a measure of distance from the initial treatment level, evaluated specific fracture risk locations (above or below PVP) and identified risk factors for repeat PVP.

RESULTS

Distribution of initial fractures was 56.35% osteoporotic, 41.65% traumatic and 2.00% pathologic. Thoracolumbar junction fractures (T12 or L1) accounted for 34.65% of total initial PVP. 403 patients (22.44%) developed a new fracture with a mean time of 76 days post-PVP. The highest frequency of post-PVP vertebral fractures occurred at adjacent vertebrae (34.2%) with 53.3% of total new fractures occurring within two vertebral levels from the initial PVP. Fractures at adjacent vertebrae were 15.1% more likely than fractures two vertebrae removed. Adjacent fractures located above the PVP level were 1.83 times more likely to occur than adjacent fractures below the PVP level ($p=0.0256$). Chronic steroid users were 1.33 times more likely to develop multi-level fractures ($p=0.034$) and 1.65 times more likely to require multiple PVP compared to non-steroid users ($p<0.01$).

CONCLUSION

Acute vertebral fractures post-PVP occur with greatest frequency at adjacent vertebrae above the PVP level. Chronic steroid use was the most predictive risk factor for multi-level fractures and repeated PVP.

CLINICAL RELEVANCE/APPLICATION

This is the first report to assess post-vertebroplasty fracture risk as a measure of distance and relative location (above or below) to the previously treated vertebral level.

SSC15-02 Clinical Follow-Up of Low-Dose CT Guided Lumbar Foraminal Nerve Blocks: Differential Visual Analogue Scale Score for Pain At 3 Months Can Predict the Need for Spine Surgery

Monday, Dec. 2 10:40AM - 10:50AM Room: E263

Participants
Bharath B. Das, MD, MBBS, Bangalore, India (*Presenter*) Nothing to Disclose
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Puneeth K. K N, MD, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose
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Bhavana Nagabhushana Reddy, MBBS, MD, Bengaluru, India (*Abstract Co-Author*) Nothing to Disclose
Sanjaya Viswamitra, MD, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess the utility of differential VAS in predicting need for surgery at 3months follow up in patients undergoing low dose CT guided lumbar foraminal nerve blocks (LD CTGNB) for radiculopathy. To ascertain cut off differential VAS score to dichotomise patients into groups who will not need surgery.

METHOD AND MATERIALS

A total of 34 patients with lumbar radiculopathy were taken for LD CTGNB. All patients had prior MR LS spine for disc level. Procedure was done in low dose presets in 128 slice CT scanner. Pre procedure VAS score was considered baseline. Differential score obtained from subtracting follow up VAS from pre-VAS, these were obtained immediately after procedure, follow up 1-week and at 3-months. Dixon test for performed to identify outliers. ROC curve and one tailed test was used to find cut off differential VAS score, p Value and accuracy predicting for no surgery.

RESULTS

In 34 patients, 2 outliers were excluded. Average duration of follow up is 5months. With ROC curve analysis and one tailed test, a differential VAC score of 4 was identified to have highest sensitivity and specificity. This cut off was used for accuracy prediction for surgery free group. Thus, with differential VAC 4 or above, in immediate post procedure, we could predict that patient does not need surgery with 81% accuracy, similarly at 1 week with 92% accuracy and at 3 months with 96% accuracy. These were statistically significant with p value <0.001

CONCLUSION

Differential VAC score obtained from follow up showed progressively increasing accuracy in determining surgery free cohort. A differential pain score of 4, at >3 months of follow up (median number of months) would mean that the patient does not have to go into surgery, 97% of the times. This can be said with 95% confidence.

CLINICAL RELEVANCE/APPLICATION

In reference to this study, after CT GNB, if pain is alleviated by differential VAC score of 4 immediately post procedure, patient is likely to have same degree of alleviation of pain for next 3 months and 97% of times he may not need spine surgery. This could be used for patient counselling and follow up.

SSC15-03 The Potential Role of Intervertebral Lumbar Disc FA (Fractional Anisotropy) Map in Diffusion Tensor Imaging (DTI) to Select Patients Suffering from Low Back Pain and Who May Benefit from Intradiscal Oxygen-Ozone Injection

Monday, Dec. 2 10:50AM - 11:00AM Room: E263

Participants
Marco Varrassi, L'Aquila, Italy (*Presenter*) Nothing to Disclose
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Alessandra Splendiani, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Antonio Barile, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Ernesto E. Di Cesare, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To assess annular fibers anisotropy through the use of intervertebral disc FA map to select patients suffering from low back pain of lumbar disc origin and who may benefit from intradiscal oxygen-ozone injection.

METHOD AND MATERIALS

A total of 75 patients suffering from back pain were selected for prospective non-randomized blinded trial approved by the Medical Ethical Committee of our Institution. Before treatment they underwent MRI 3 Tesla exams performed with conventional sequences (T2-FSE-WI, T2 fat-sat and T1 FSE-WI) and additional DTI sequence, respectively for assessing lumbar disc pathology according to the nomenclature and Fractional Anisotropy (FA) map of the involved intervertebral disc. Discography was obtained before treatments under CT guidance of the involved discs in order to confirm MRI reports. Patients were randomly assigned to two groups; control Group (20 men, 16 women; median age 45 years old) underwent intraforaminal injection of steroid and anesthetic. The remaining 39 patients (Study Group composed by 18 men, 21 women; median age 46 years old) underwent the same treatment with the addiction of intradiscal oxygen-ozone (O2-O3) injection. Oswestry Low Back Pain Disability (ODI) Questionnaire was administered before treatment and at intervals, the last at 6-month follow-up. Results were compared with X2, t test and regression analysis.

RESULTS

In cases of annular fissures without herniation or extrusion disc, O2-O3 intradiscal injection therapy was successful in 16 (41%) study group patients compared with 10 control group patients (27,5 %) ($P < 0.01$). ODI questionnaire showed significant improvement of symptoms in both Groups ($P < 0.01$). Similar results were observed in the remaining cases of both groups when the disc was involved with associated radicular pain ($P < 0.01$).

CONCLUSION

An FA disc map congruous with a rupture of annular fibers could be considered as a predictive sign of response to oxygen-ozone lumbar intradiscal injection treatment so it could be added to the routine MR exam.

CLINICAL RELEVANCE/APPLICATION

Preliminary MRI evaluation before Oxygen-Ozone treatment with FA map of lumbar degenerated discs may be helpful in distinguishing annular tear from herniation and ,therefore, planning which patients may benefit of O2-O3 chemiodiscolysis.

SSC15-05 Efficacy of MR-Guided Focused Ultrasound Surgery in Facetal arthropathy: A Study of 21 Patients

Monday, Dec. 2 11:10AM - 11:20AM Room: E263

Participants
Ritu M. Kakkar, MBBS, DMRD, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose
Chandresh O. Karnavat, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose
Shrinivas B. Desai, MD, Mumbai, India (*Presenter*) Nothing to Disclose

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PURPOSE

To evaluate efficacy of MR guided Focused Ultraound Surgery(MRgFUS) in treatment of low backache due to facetal arthropathy by assessing symptomatic improvement in terms of decrease in Numerical rate score (NRS) and Oswestry Disability Index(ODI)

METHOD AND MATERIALS

126 facet joints (L3-4 to L5-S1)in 21 patients in the age group 40 to 80 yrs were selected for study after approval from ethics committee.The inclusion criteria were LBP due to facetal arthropathy without significant Radiculopathy, Facet joint arthropathy without significant spinal canal or neural foraminal stenosis ,Diagnostic facet jt. injection with local anesthetic & steroid causing significant pain reduction (done in 10 patients).All included patients had a NRS of >5 and ODI >50% Treatment was performed on GE 1.5 TESLA HDXT with EXBLATE 2000 in supine position under mild conscious sedation Immediate post treatment evaluation was done by identifying Post Contrast enhancement at the posterior margin of the facets joints.1 week, 1 month, 3 and 6 months follow up of all the patients was done by plotting of Numerical rate scale (NRS)scores, Oswestry Disability (ODI)scores .

RESULTS

Average pre treatment NRS was 9 ,which reduced to 4, 1 month following treatment and to 2 ,6 months following treatment The reduction in NRS score after 1 and 6 months is statistically significant ($p=0.00001$) Average pre treatment ODS 70% ,with reduction to 35% and 22% following 1 and 6 months respectively .By chi square test ,reduction in ODS was significant with p value of 0.0248 after 1 month and 0.0020 after 6 months .

CONCLUSION

MRgFUS is a safe and effective procedure in treatment of facetal arhropathy related pain in selected patients with no adverse effects or complications and can be performed on out patient basis .

CLINICAL RELEVANCE/APPLICATION

MRgFUS is a non invasive modality providing good pain relief in facetal arthropathy ,with results comparable to other more invasive procedures like radiofrequency ablation

SSC15-06 3T- MRI Analysis of Alcohol Distribution and Side Effects after Sympathetic Blocks and Sympathicolysis: Is 1ml Enough for Harm Avoidance?

Monday, Dec. 2 11:20AM - 11:30AM Room: E263

Participants
Benjamin Reichardt, Essen, Germany (*Presenter*) Nothing to Disclose
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Michael Forsting, MD, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Sympathicolyses are optional third line treatments in patient with complex regional pain syndrome (CRPS) and peripheral occlusive disease, whose vascular status does not permit reconstructive surgery. To avoid structure damage CT needle guidance is the most often used procedure when performing an alcohol sympathicolysis. There are reports that alcohol can cause minor and major complications such as ureter strictures, retroperitoneal bleeding and irritation of peripheral nerves. However, the frequency, mechanism, spread and atypical dilution of injected alcohol is unknown. This is the first 3T-MRI based study for visualization the distribution and diffusion behavior of alcohol at the area of injection and affection of the neighboring tissue.

RESULTS

In all cases alcohol demonstrated an effective sympathicolysis and patients reported pain relief. One Patient reported a peripheral

paresthesia caused by a nerve irritation. One Patient had a retroperitoneal bleeding. No-one had detected erythrocytes in urine as a sign of ureter strictures. Despite small volume injection of 1,5ml alcohol and even when needle placement was performed correctly, MRI showed high signal changes caused by edema in soft tissues and vessel- and ureter walls in all patients. Neurolytic sympathetic ganglia showed an increase of size and proton signal in MRI in 4 patients.

CONCLUSION

In all cases the interventions lead to an effective sympathicolysis and pain relief. In most cases all detected changes and injuries had no clinical consequences. A prediction of distribution of applicated alcohol and its performance is not possible or seems to be ambiguous and may be accompanied with an intermediate risk for the patient. Therefor after alcohol sympathicolysis patients must be clinical monitored and with present of clinical signs an MRI should be performed. For risk avoidance throughout alcohol injections we suggest radiofrequency ablations of sympathetic ganglia.

METHODS

14 patients with either CRPS (n=8) or PAOD (n=6) were treated with a diagnostic sympathetic block with an anesthetic at the Level L3 or L4. With positive response a CT guided alcohol sympathicolysis with 1,5ml were performed. Independently all patient received 3 MRI Neurography of the lumbar sympathetic chain prior and after block and following the alcohol injections. MRI-Neurography protocol included T1 sequences in all direction for visualization of the anatomy, an edema and fluid sensitive sequences for detection of tissue changes and structure damage. We calculated fluid volumes and distribution around the injection area anterior to the vertebra, dorsal of Aorta/IVC and around the psoas muscle. Diffuse edema in muscle, fat, nerves and organs were analyzed for each single CT and MRI and were correlated between the different time points.

SSC15-07 Intraarticular Facet Joint Steroid Injection versus Medial Branch Block: Which One Represents the Best Therapeutic Option in the Management of Lumbar Facet Joint Pain?

Monday, Dec. 2 11:30AM - 11:40AM Room: E263

Participants
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Aldo Victor Giordano, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The aim of our study is to compare the clinical outcome of two different techniques used in the management of lumbar facet joint (LFJ) back pain: intraarticular (IA) steroid injection and medial branch block (MBB).

METHOD AND MATERIALS

76 patients with LFJ back pain were selected on the basis of clinical evaluation and MR-findings and randomly assigned to one of two groups: 36 patients (Group A) underwent intraarticular LFJ steroid injection while 40 patients (Group B) carried out MBB. Both procedures were performed under CT-guidance. We injected each patient with 1.5mL of Ropivacaine in addition to 2mL of Triamcinolone. We evaluated the clinical-outcome by means of VAS score and Rolland-Morris Questionnaire (RMQ) for respectively evaluating the level of pain and disability, before treatment and after 1, 3 and 6 months of treatment. Clinical effectiveness was determined as a >50% reduction to the pre-treatment VAS value and a value <9 in the RMQ Score.

RESULTS

Mean values of VAS and RMQ before treatment in Group A were 8.1 and 14.6 respectively. The treatment was effective (VAS reduction >50%, RMQ score <9) in 86.1% of patients after 1month, 72.2% after 3months, 61.1% after 6months. Mean values of VAS and RMQ before treatment in Group B were 7.8 and 14.1. The treatment was effective in 85% of the patients after 1month, 67.5% after 3months and 47.5% after 6months.

CONCLUSION

In our study both IA steroid injection and MBB showed similar effectiveness in the treatment of LFJ back pain at 1 and 3 months after procedure. However IA steroid injection has proved a greater clinical efficacy at 6 months (61.1% vs. 47.5%). Although there are not important differences in pain reduction between the two groups of patients, it seems that patients in Group A show slightly better results. On the basis of our results, both IA steroid injection and MBB are effective and interchangeable techniques in the treatment of LFJ back pain with good results in the short and medium term and moderate results in the long term. Both the techniques can be repeated indefinitely over time, considering that there are roughly no side effects.

CLINICAL RELEVANCE/APPLICATION

Intraarticular steroid injection and medial branch block are valid treatment options in the management of lumbar facet joint pain with positive clinical effects for almost six months.

SSC15-08 Utilization and Outcomes for Vertebral Augmentation in Cancer Patients

Monday, Dec. 2 11:40AM - 11:50AM Room: E263

Participants
William Borror, MD, Houston, TX (*Presenter*) Nothing to Disclose
Joshua D. Kuban, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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Steven Yevich, MD, MPH, Houston, TX (*Abstract Co-Author*) Speakers Bureau, Endocare, Inc
Sunil Sheth, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The spine is the most common site of bone metastasis, and metastasis often lead to pathological vertebral compression fractures. Vertebral augmentation is commonly used for mitigation of pain associated with these pathological fractures. The purpose of this study was to perform a population health analysis of the time course, demographics, and outcomes following spine augmentation procedures in cancer patients.

METHOD AND MATERIALS

Using administrative data from all inpatient and outpatient hospital encounters in California (2005 - 2011) and Florida (2005 - 2014), we identified patients a cancer diagnosis based on the relevant ICD-9 diagnostic codes. Patients who underwent spine augmentation procedure (vertebroplasty or kyphoplasty) were then identified based on the appropriate CPT procedure codes. The influence of spine augmentation on overall survival was determined using Kaplan-Meier statistics

RESULTS

We identified 5,757 cancer patients who underwent 7,105 spine augmentation procedures; this population comprised our study cohort. The median age was 76 years, and 58.7% of the cohort was female. Comorbidities included renal insufficiency (19.2%), heart failure (1.6%), chronic obstructive pulmonary disease (27%), diabetes (11.6%), hypertension (36.5%), and osteoporosis (21.3%). Lung, breast, and prostate cancer were the most common histologies. There was a 2.9-fold increase in the utilization of spine augmentation procedures for cancer patients between 2005 - 2014. The mean annual hospital volume for spine augmentation in cancer patients was 1.9, with a range from 1 to 26.9. When compared to a cohort of patients with bone metastases who did not undergo spine augmentation, patients who underwent spine augmentation were noted to have a significant improvement in overall survival ($P = 0.02$).

CONCLUSION

The utilization of spine augmentation in cancer patients is increasing. In addition to its palliative role, spine augmentation may play an important role in patient survival outcomes.

CLINICAL RELEVANCE/APPLICATION

Understanding the outcomes following spine augmentation can better help with treatment and management of patients with spinal metastasis.

SSC15-09 Lobster Project®: A New Method for the Percutaneous Treatment of Lumbar Central Canal and Foraminal Stenosis. Preliminary Experience in 40 Patients

Monday, Dec. 2 11:50AM - 12:00PM Room: E263

Participants
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Giulia Sadotti, MD, Siena, Italy (*Abstract Co-Author*) Nothing to Disclose
Dario Notaro, MD, Siena, Italy (*Abstract Co-Author*) Nothing to Disclose
Chiara Zini, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the effectiveness and to describe the technique of Lobster® device in a cohort of 40 patients with lumbar central canal and foraminal stenosis (LSS).

METHOD AND MATERIALS

From May 2018 to March 2019, 40 patients (male = age range: 45-92 years, mean: 72,7) with elettromigraphically confirmed for neurogenic intermittent claudication (NIC) , related to mono (N=37) or bi-segmental (N=3) LSS, were enrolled in the present study. We treated 43 levels (n.32 L4-L5, n.8 L3-L4, n.3 L5-S1).Magnetic Resonance (MR), physical exam and VAS scale were performed before the procedure and 3 months later. Technical success was defined as correct placement of Lobser® device demonstrated with computer tomography (CT), performed immediately after treatment. All treatments were performed under fluoroscopic guidance (Innova 3131iq, General Electric Healthcare, CT, USA), using mild sedation plus local anesthesia with standard anti-infectious therapy.

RESULTS

All Lobster® device have been placed with 100% of technical success and in 3 cases the device has been placed at L5-S1 level; in 3 patients the treatment was performed in 2 levels at the same time. No major complications occurred; in our population we did not experience any cases of infection, nerve damage, nor bleeding. Most patients (N=36) showed great improvement in symptoms with relevant post-operative VAS scale reduction ($p< 0,001$) and remain stable at 3-month follow-up.

CONCLUSION

Lobster® is feasible and safe minimally-invasive decompression method for LSS in selected patients with NIC, despite the age.Further studies on same topic would be highly desirable to investigate the long term effectiveness.

CLINICAL RELEVANCE/APPLICATION

Lobster® is implanted under local anesthesia using a small skin incision limiting blood loss and muscle trauma preserving anatomical structures; the device could be removed percutanously, if necessary.

Printed on: 10/29/20

SSE01

Breast Imaging (Risk and Density)

Monday, Dec. 2 3:00PM - 4:00PM Room: E450A

BR SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Ritse M. Mann, MD, PhD, Nijmegen, Netherlands (*Moderator*) Researcher, Siemens AG Researcher, Seno Medical Instruments, Inc Researcher, Identification Solutions, Inc Researcher, Micrima Limited Researcher, Medtronic plc Scientific Advisor, ScreenPoint Medical BV Scientific Advisor, Transonic Imaging, Inc Stockholder, Transonic Imaging, Inc
Despina Kontos, PhD, Philadelphia, PA (*Moderator*) Research Grant, Hologic, Inc

Sub-Events

SSE01-01 Use of Comprehensive Health Records to Improve Breast Cancer Risk Prediction

Monday, Dec. 2 3:00PM - 3:10PM Room: E450A

Participants
Michal Chorev, PhD, Haifa, Israel (*Presenter*) Researcher, IBM Corporation
Adam Spiro, Haifa, Israel (*Abstract Co-Author*) Nothing to Disclose
Michal Guindy, MD, Tel Aviv, Israel (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the efficacy of a machine learning model to predict 1-year risk of breast cancer on the basis of complete electronic health records (EHR).

METHOD AND MATERIALS

We collected EHR data of 68,342 women who underwent a screening mammogram between April 2013 and February 2017, to predict the risk of cancer developing within 1 year of the screening. We developed a gradient boosting machines model based on 17,651 clinical factors. We compared our model against Gail model. Based on sequential factor selection, we have identified the factors most contributing to the prediction. All models were evaluated using area under the ROC curve (AUC) values and DeLong's 95% confidence interval.

RESULTS

The cohort comprised the clinical records of 68,342 women, of which 1,478 (2%) women were diagnosed with breast cancer within 12 months, 5,495 (8%) women had a negative biopsy within 12 months, 1,260 (2%) women had a BI-RADS 3 exam without a follow-up biopsy, and 60,109 (88%) women had at least two years of normal (BI-RADS 1 or 2) exams. We split the women's records to 51,256 (75%) in the train set and 17,086 (25%) in the test set. The model obtained AUC of 0.74 (95% CI, 0.72-0.77) and 0.73 (95% CI, 0.70-0.76) on the test set, based on the 17,651 factors and the top 40 factors, respectively. Gail model obtained AUC of 0.55 (95% CI, 0.51-0.58) on the test set, while a model based on factors from Gail's and other common risk models obtained an AUC of 0.66 (95% CI, 0.63-0.69). In addition to the traditional factors, the model identified factors concerning thyroid function, the immune system, indications of metabolic syndrome, iron deficiency, as well as others.

CONCLUSION

Based on complete EHR data, our model showed an improved 1-year cancer risk assessment in comparison to Gail model. Limiting the model to only the 40 most contributing factors did not significantly affect its performance. We identified additional factors that improve breast cancer prediction.

CLINICAL RELEVANCE/APPLICATION

A machine learning model based on health records for 1-year breast cancer risk outperformed state-of-the art risk assessment models, and shed light on additional risk factors linked to breast cancer.

SSE01-02 The Correlation between the Breast Density, Body Mass Index, and the Risk of Breast Cancer Development in Relation to the Menopausal Status

Monday, Dec. 2 3:10PM - 3:20PM Room: E450A

Participants
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PURPOSE

To evaluate the correlation between the breast density, body mass index and the risk of breast cancer development in relation to the menopausal status.

METHOD AND MATERIALS

The study included 30,443 screened females who were classified into cancer and non-cancer groups and each group was sub-classified into pre- and post-menopausal groups. All patients performed mammography examination. The breast density was classified according to the 2013 ACR BI-RADS breast density classification The weight and height were measured and the BMI was calculated. Independent t test was carried to compare the means of BMI among cancer and non-cancer groups as well as among pre- and post-menopausal groups. The correlation between breast density and breast cancer in the pre and post-menopausal groups was carried using Chi square test and Pearson's correlation. Measures of association were verified by calculating the Odds Ratio (OR) and the independence of each risk factor was verified by performing logistic regression analysis.

RESULTS

According to the BMI, 93.3% of the studied population were classified as over-weight and obese A statistically significant difference was calculated between the mean BMI in the cancer and non-cancer groups (p: 0.027) as well as between the pre- and post-menopausal groups (p <0.001). A positive statistically insignificant correlation was calculated between the breast density and the risk of breast cancer in the pre-menopausal group (OR: 1.062, p: 0.919) and a negative highly significant correlation was calculated in the post-menopausal group (OR: 0.234, p<0.001). A highly statistical negative correlation was found between breast density and BMI (p <0.001) among both pre- and post-menopausal groups.

CONCLUSION

BMI and breast density are inversely associated with each other. This inverse relationship had an impact on the results of this study as the majority of the studied population were obese and overweight. In spite of this, both risk factors still play an independent significant role in increasing the risk of breast cancer development with variations according to the menopausal status.

CLINICAL RELEVANCE/APPLICATION

Identifying the modifiable breast cancer risk factors is essential in breast cancer preventive measures. In view of the results of the current study, strict weight control strategies should be implemented for post-menopausal women to decrease their risk for breast cancer development.

SSE01-03 Changes in Breast Density Awareness, Knowledge, and Attitudes: A National Survey

Monday, Dec. 2 3:20PM - 3:30PM Room: E450A

Participants
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PURPOSE

Recent federal breast density (BD) notification legislation requires standardization of BD communication to women after a mammogram and will supersede BD legislation now active in 37 U.S. states, but little is known about the impact of state BD legislation on women's understanding of BD. We assessed changes in BD awareness, knowledge, and attitudes over a 5-year interval.

METHOD AND MATERIALS

Using a probability-based web panel representative of the U.S. population, we administered an identical survey in 2012 and 2017 to women aged 40 -74 years.

RESULTS

Survey cooperation rate was 55% (1502/2730). Relative to 2012, more U.S. women in 2017 had heard of BD (65.8% vs 57.5%; P=.0002) and had knowledge of BD's relationship to masking (57.9% vs. 48.6%; P<.0001) and breast cancer risk (58.8% vs. 53.2%; P=.01). Of those aware of BD in 2017, 47.3% had discussed BD with their provider (4.2% increase from 2012; P=.13). After multivariable adjustment, factors significantly (p<.01) associated with BD awareness in 2017 included white non-Hispanic race, income, education, and having >5 mammograms. As compared to women residing in state(s) without at least 1 year of legislation, those with legislation in effect were more likely to know the masking effect of BD in 2012 (89.9% vs 71.2%, p<.001) and to know the associated breast cancer risk in 2017 (68.3% vs 58.3%, p<.001); however, BD awareness was not associated with legislation status in 2012 or 2017. Similar to 2012, 62.5% would want to know their BD even in the absence of supplemental screening consensus. Fewer women reported that knowing their BD would make them feel confused in 2017 as compared to 2012 (35.9% vs 43.0%, p=0.002); however there was no change from 2012 in the proportion that would feel anxious or informed to make breast health decisions (44.8% and 89.7%, respectively). The majority (78.8%) felt that the federally mandated letter sent to women after a mammogram should include BD information.

CONCLUSION

Although BD awareness, knowledge, and discussions with providers have increased since 2012, there are few differences by state legislation status. Fewer than half of women acknowledged that knowing their BD would cause anxiety or confusion, while more than three-quarters want to know their BD, would feel empowered to make decisions, and would support federal BD notification legislation.

CLINICAL RELEVANCE/APPLICATION

BD awareness and knowledge is increasing, although the proportion of women who have discussed their BD with a healthcare provider is not. Important disparities in BD awareness remain by race, income, and education. The federal BD notification legislation presents an opportunity to clarify BD information to improve awareness and knowledge and to encourage BD conversations with providers.

SSE01-04 Background Parenchymal Uptake on MBI and Risk of Future Breast Cancer Diagnosis: A Cohort Analysis

Monday, Dec. 2 3:30PM - 3:40PM Room: E450A

Participants
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PURPOSE

Background parenchymal uptake (BPU), which describes the intensity of radiotracer uptake in fibroglandular tissue relative to fat on molecular breast imaging (MBI), was associated with breast cancer (BC) in case-control studies. Here, we performed the first cohort analysis to examine association of BPU and risk of future BC.

METHOD AND MATERIALS

Women undergoing MBI with Tc-99m sestamibi and a dedicated gamma camera from 2004-2015 without BC diagnosis before MBI or <180 days after MBI were analyzed. BPU on baseline MBI exam was assessed as photopenic, minimal, mild, moderate, or marked; mammographic density was assessed according to BIRADS 5th edition categories. Follow up was performed via tumor registry linkage, record review, and patient survey. Multivariable proportional hazards models of time from baseline MBI until BC diagnosis or most recent negative breast imaging exam were employed.

RESULTS

Of 2987 women, 122 (4.1%) had future BC (86 invasive, 34 DCIS, 2 unknown). Mean time from baseline MBI to BC diagnosis was 48 months (range 6-115 months); mean follow-up in women without BC was 75 months (range 6-151 months). There were 66 BC cases in 2143 (3.1%) women with photopenic/minimal BPU, 27 cases in 434 (6.2%) with mild BPU, and 29 cases in 410 (7.1%) with moderate/marked BPU. 102 of 122 (84%) cases and 2300 of 2865 (80%) women without BC had dense breasts (BIRADS c or d). Relative to photopenic/minimal BPU, age and BMI-adjusted hazard ratios (HR) with 95%CI were 2.4 (1.5,3.7) for mild and 3.1 (1.9,4.9) for moderate/marked BPU ($p<0.0001$). Additional adjustment for BI-RADS density and hormone use minimally impacted HRs: 2.6 (1.6,4.2) for mild, 3.2 (2.0,5.2) for moderate/marked ($p<0.0001$). In 1827 postmenopausal women with 84 cases, HR was 3.5 (2.1,6.0) for mild and 5.0 (2.6,9.4) for moderate/marked ($p<0.0001$). In 1160 premenopausal women with 38 cases, HR was 1.3 (0.5,3.3) for mild and 2.0 (1.0,4.2) for moderate/marked ($p=0.18$).

CONCLUSION

BPU on MBI is associated with future BC and this risk remains after adjustment for mammographic density. Postmenopausal women with moderate/marked BPU have 5-fold risk of those with photopenic/minimal BPU and similar age, BMI, breast density, and hormone use.

CLINICAL RELEVANCE/APPLICATION

Postmenopausal women with high BPU on MBI should be informed of this risk association. Future studies are needed to examine the role of supplemental screening and prevention strategies in this group.

SSE01-05 Application of Machine Learning in the Calculation of Breast Density Using Transmission Ultrasound: A Comparison with Automated Mammographic Assessment

Monday, Dec. 2 3:40PM - 3:50PM Room: E450A

Participants
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PURPOSE

Increased mammographic density has been found to be an important input into breast cancer risk models. Current breast density assessments rely upon 2D projections or a 3D model consisting of 2D reconstructed images, which may not fully capture the topologically complex nature of the breast. In this study, we (1) describe and compare threshold- and clustering-based algorithms that use transmission ultrasound (TU) for the calculation of breast density, and (2) compare Quantitative Breast Density (QBD) with

automated mammographic density calculations.

METHOD AND MATERIALS

Retrospective data was used from all women screened at a single breast center between April 2017 and November 2018 for a total of 309 breast scans. Within a 3-month interval, each subject received both a digital screening mammogram with tomosynthesis and TU of the breast. Mammographic breast density values were provided by VolparaDensity 3.1 (Volpara Health Technologies). QBD algorithms (1) segment breast tissue from water using attenuation, and (2) segment fibroglandular tissue by both thresholding based on the speed of sound, and clustering into fibroglandular tissue and fat. The ratio of fibroglandular tissue to total breast volume is calculated as QBD. QBD values were correlated with mammographic breast density scores and BI-RADS breast composition categories using Spearman's correlation coefficient (r), where $p<0.05$ was considered significant. We discuss the variability of QBD as affected by iterative image reconstruction schemes.

RESULTS

We found strong correlations between automated breast density values from TU and mammography (Spearman r=0.93, 95% CI:0.91-0.94, $p<0.01$), and between QBD and BI-RADS breast composition categories (Spearman r=0.88, 95% CI: 0.86-0.91, $p<0.01$). The machine learning-based QBD was less sensitive to variability (by 65%) than the threshold-based QBD.

CONCLUSION

We provide evidence that QBD calculations derived from TU are strongly correlated with automated mammographic breast density assessments. Further, machine learning-based QBD calculation is more robust and repeatable than threshold-based methods.

CLINICAL RELEVANCE/APPLICATION

The presence of dense breast tissue is an independent risk factor for breast cancer. An accurate calculation of breast density is critical for risk stratification in screening for breast cancer.

SSE01-06 Breast Cancer Development During Postoperative Surveillance for Women Treated for Atypical Ductal Hyperplasia (ADH): Analysis Evaluating Predictive Factors Including Clinical and Radiologic Features

Monday, Dec. 2 3:50PM - 4:00PM Room: E450A

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PURPOSE

To evaluate cancer development rates and the clinicopathological factors associated to them during surveillance after surgery for atypical ductal hyperplasia (ADH) in the current era.

METHOD AND MATERIALS

From November 2003 to December 2014, 205 women (mean age: 47.1±11.2 years) diagnosed as ADH via excisional biopsy were included. Preoperative breast images of the proven ADH were analyzed and grouped as follows: 1) negative, lesions not detectable on either mammography or ultrasonography (US), 2) lesions with calcifications detected on either mammography and/or US, 3) lesions without suspicious calcifications. Cox regression analysis was performed to evaluate clinical and radiological factors associated to breast cancer development after excision for ADH.

RESULTS

Of the 205 women, 15 (7.3%) had developed either ductal carcinoma in situ (DCIS) or invasive breast cancer during surveillance (mean follow-up interval: 63.9±40.8 months). Symptomatic ADH was significantly associated to breast cancer during postoperative surveillance, 2.091 (95% confidence interval 0.008, 4.289, P=0.039). None of the other clinicopathologic features were associated to breast cancer development after excision for ADH (all $P>0.05$, respectively). Among the imaging features, the presence of calcifications detected on preoperative mammography/US did not show significant association to breast cancer development (P=0.268).

CONCLUSION

Breast cancer development rate during surveillance after excision for ADH was 7.3%. Presence of symptoms may have association to breast cancer development after excision for ADH.

CLINICAL RELEVANCE/APPLICATION

Breast cancer development rate during surveillance after excision for ADH was 7.3%, in which symptomatic patients diagnosed with ADH may have higher association with breast cancer development after excision for ADH.

SSE02

Breast Imaging (Ultrasound Screening)

Monday, Dec. 2 3:00PM - 4:00PM Room: E451B

BR SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSE02-01 Assessing Real-World Contribution of Ultrasound and Clinical Data to Breast Cancer Screening Accuracy

Monday, Dec. 2 3:00PM - 3:10PM Room: E451B

Participants
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PURPOSE

To evaluate the contribution of supplemental breast ultrasound performed regularly in addition to mammography as part of breast screening regime, as well as to assess machine learning model based on clinical information from electronic health records (EHR) in further optimizing personalized screening.

METHOD AND MATERIALS

We extracted data of 32,058 women who underwent ultrasound examination as part of their regular breast cancer screening procedure between April 2013 and February 2017 (median age of 58 years). We utilized 17,651 clinical factors from the women's EHR and developed a gradient boosting machines model to predict breast cancer within one year based on mammogram BI-RADS, ultrasound BI-RADS, and their combination.

RESULTS

The cohort comprised the clinical records of 32,058 women, of which 1,087 (3%) were diagnosed with breast cancer within 12 months, 12,362 (39%) had high breast density and 19,696 (61%) had low breast density. Adding ultrasound to screening increased sensitivity from 77% to 93% while decreasing biopsy positive predictive value (PPV) from 40% to 24%. For women with dense breasts, ultrasound increased sensitivity from 67% to 92% and decreased biopsy PPV from 34% to 16%. In order to examine whether EHR data can further improve our results by lowering the false positive rate, we developed a machine learning model, trained on 75% of the data and tested on 25%. Using an operation point of 87% sensitivity, the model's true negative rate (TNR) increased from 66% when using only mammogram BI-RADS to 82% when using mammogram BI-RADS combined with EHR data. Using an operation point of 95% sensitivity, the TNR increased from 68% when using mammograms and ultrasound BI-RADS to 78% when adding EHR data. This effect was more prominent in the high-density sub-population, where TNR improved from 43% to 70%.

CONCLUSION

Supplementing ultrasound examination increased sensitivity, while increasing false positives by increasing biopsy rates. Use of clinical data improved specificity and therefore may reduce unnecessary biopsies. Further analysis may elucidate when ultrasound would be beneficial.

CLINICAL RELEVANCE/APPLICATION

In a population that undergo ultrasound examination as part of their breast cancer screening regime, ultrasound increased sensitivity but reduced specificity. Using comprehensive EHR data can compensate for this reduction, and reduce unnecessary biopsies.

SSE02-02 Is There Value to Screening Breast Ultrasound as a Supplement to Mammography in Women at Average Risk in Comparison to Those with Known Risk Factors?

Monday, Dec. 2 3:10PM - 3:20PM Room: E451B

Participants
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PURPOSE

To review the outcomes of screening breast ultrasound performed in women dense breast tissue and no other known risk factors and compare with women with dense breasts and at least one known risk factor.

METHOD AND MATERIALS

Retrospective review of 24778 screening ultrasound (US) exams performed during period of 2013-2017 revealed 8415 (34%) exams in patients with no known risk factors (average risk), and 16364 (66%) with one or more known risk factors. All patients undergoing screening US also had screening mammography either on the same day, or within 1 year of the screening US exam. Cases given a BI-RADS 4 or 5 are the focus of further analysis.

RESULTS

There were 550 findings in patients with known risk factor(s) of which 395 were BIRADS 4 or 5 (2.4%). 103 findings were seen on both mammography and US (with 41 invasive cancers diagnosed), and 27 were on mammography only (3 invasive cancers diagnosed). Lesions were detected on US only in 265 (67%); 56 positive biopsies resulted from US only findings of which 50 were invasive breast carcinoma; 70% grade 1 or 2, 6 lymph node positive, and average size at excision of 1.4cm. There were 243 findings from exams performed in patients with no known risk factors; 168 were BIRADS 4 or 5 (2.0%). 13 were on mammography only (1 invasive cancer diagnosed) and 45 on both mammography and US (with 19 invasive cancers diagnosed). 109 US only findings resulted in diagnosis of 14 malignancies; 12 were invasive breast carcinoma, 100% grade 1 or 2, all node negative, and an average size at excision of 1.2cm. US only cancer detection was 3.2/1000 in those with known risk factors, and 1.4/1000 for those with no known risk factors.

CONCLUSION

Screening breast US in patients at average risk can identify invasive malignancy missed on screening mammography, though at a lower rate compared with those with one or more known risk factors (1.4/1000 v. 3.2/1000, respectively). Similar biopsy rates were observed in those with no risk factors compared with those with risk factors (2.0% v. 2.4%). The cancers visualized on US only in the average risk patients were all lower grade, node negative, and averaged 1.2cm, demonstrating there may be value of US in this population.

CLINICAL RELEVANCE/APPLICATION

Determining the optimal screening regimen for women at average risk is an area of continued investigation. Screening US may provide value when used as a supplemental tool with mammography.

SSE02-03 Update on Population Level Supplemental Whole Breast Screening Ultrasound in Women with Dense Breasts

Monday, Dec. 2 3:20PM - 3:30PM Room: E451B

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PURPOSE

Since 2009, we have offered technologist-performed hand-held whole breast screening (WBUS) as supplemental screening for women with dense breasts. With new federal breast density notification legislation recently passed, more women with dense breasts may seek supplemental screening. Understanding the performance outcomes of this adjuvant screening exam is of importance.

METHOD AND MATERIALS

An IRB-approved retrospective search of the breast imaging electronic database (PenRad, MN) was performed for a one-year period (10/1/17 - 9/30/18) for all supplemental WBUS after a normal tomosynthesis screening mammogram. All cases were performed at 3 out-patient satellite offices of a large academic practice by mammography technologists cross-trained in breast sonography using hand-held ultrasound. The final BI-RADS (BR) assessment of WBUS exams was recorded. The lesion size, type and outcome of BR 3 and 4 cases were recorded. Pathology outcomes of all biopsies were reviewed. For malignant cases, cancer size, type and stage was assessed.

RESULTS

A total of 5742 WBUS exams were performed. Final BR assessment was BR1/2 5585 (97.2%), BR3 136 (2.4%), BR4 21 (0.4%). Of 20 biopsies performed (1 cancelled), 2 cases were initially found malignant, PPV 10%. Two BR3 cases showed change on 6 month follow up and were found to be malignant for a total cancer detection 4 (0.7 per 1000). All cancers were 1cm or less, 2 were moderately and 2 were well-differentiated invasive ductal carcinoma. Three were irregular masses and 1 was a 5mm round mass.

Three had negative axillary lymph nodes, but the 5mm round mass had lymphovascular invasion and 2 positive nodes. Reasons for BR3 included: oval mass (58), clustered or complicated cysts (24), likely fibroadenoma (22), multiple masses (9), prominent axillary nodes (6), round mass (5), lobulated mass (4), dilated ducts (4), other (4). All BR3 and BR4 oval masses were all found to be benign on follow up or biopsy.

CONCLUSION

After normal tomosynthesis mammograms, the majority of WBUS cases were found to be normal, with only a small proportion of cases requiring follow up or biopsy. All BR3 and 4 oval masses were found to be benign, suggesting these may be considered BR2. The supplemental cancer detection rate is found to be low.

CLINICAL RELEVANCE/APPLICATION

With experience, the false positive rate of supplemental screening with WBUS over time is low but the supplemental cancer detection is also low.

SSE02-04 BI-RADS 3 on Dense Breast Screening Ultrasound after Digital Mammography versus Digital Breast Tomosynthesis

Monday, Dec. 2 3:30PM - 3:40PM Room: E451B

Participants
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PURPOSE

Compare BI-RADS 3 rate and follow-up of dense breast ultrasound (US) screening following digital mammography (DM) vs digital breast tomosynthesis (DBT)

METHOD AND MATERIALS

For this IRB-approved, HIPAA compliant study, we retrospectively searched databases at two tertiary breast imaging centers and an office practice staffed by the same fellowship-trained breast radiologists for BI-RADS 3 screening US examinations performed 10/1/14-9/30/16. All patients had at least two years of follow-up. Prior DM versus DBT, number and timing of patients lost to follow-up, downgrade rate and timing, upgrade rate and timing, and any pathology results were recorded. Differences between DM and DBT were compared using Chi Square and Fisher's Exact Tests.

RESULTS

3189 screening US examinations were performed, 1434/3189 (45%) after DM and 1674/3189 (52%) after DBT. 81/3189 (2.5%) had no prior mammogram available. 201/1434 (14%) had BI-RADS 3 results after DM and 179/1674 (11%) after DBT (p=0.006). 95% of US screening exams were initial US screening exams. BIRADS 3 rate was 75/624 (12.0%) (42/317 (13%) for DM and 33/307 (11%) for DBT) during the first year of US screening and 75/624 (12.0%) (159/1117 (14%) for DM and 146/1367 (11%) for DBT) during the second year, a small but significant increase (p= 0.0162). Median follow-up time after DBT was 13 months (IQR 9, 24) versus 12 after DM (IQR 6, 23), p=0.0027 (Figure 1). 73/375 (19.5%) of patients were lost to follow-up (38/198 (19%) after DM (26/38 (68.4%) no follow-up after initial exam) and 35/177 (20%) after DBT (19/35 (54.3%) no follow-up after initial exam) 5/375 (1.3%) elected biopsy (3/198 (1.5%) after DM and 2/177 (1.1%) after DBT). 282/375 (75.2%) patients were downgraded (149/198 (74%) after DM and 133/177 (75%) after DBT). 5/198 (2.5%) were upgraded after DM and 1/177 (0.6%) after DBT, p=.6866 Median time to upgrade was 6 months after both DM and DBT. 1/375 (0.3%) patients with BI-RADS 3 results had cancer on follow-up.

CONCLUSION

The BI-RADS 3 rate of screening US was lower after DBT compared to DM. Many patients were lost to follow-up. Median follow-up time was longer after DBT vs DM. The cancer rate of BI-RADS 3 findings was 0.3%.

CLINICAL RELEVANCE/APPLICATION

Patients with prior DBT have the benefit of a lower risk of encountering probably benign findings on screening US that require follow-up imaging, and probably benign findings on screening US have a very low rate of being cancer.

SSE02-05 Added Value of Supplemental Screening Breast Ultrasound Following Digital Breast Tomosynthesis Screening

Monday, Dec. 2 3:40PM - 3:50PM Room: E451B

Participants
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PURPOSE

To evaluate the added value of screening breast ultrasound (US) following digital mammography (DM) combined with digital breast tomosynthesis (DBT) (DM/DBT).

METHOD AND MATERIALS

This institutional review board approved retrospective review included 958 asymptomatic women (mean age, 54 years; range, 33-

81 years) who underwent screening DM/DBT and whole-breast screening US simultaneously at our health care center between March 2016 and October 2017. On the basis of the findings from DM and DBT, supplemental screening US was performed by one of 5 experienced radiologists using a handheld device, and they reported the DM/DBT and US findings separately. The cancer detection rate (CDR), sensitivity, specificity, and positive predictive value (PPV) of DM/DBT and DM/DBT combined with US were compared to those from histological examinations and to 12-month follow-up data, as a reference standard.

RESULTS

Among 958 women, the breast density was almost entirely fatty in 6.5%, scattered areas of fibroglandular density in 23.9%, heterogeneously dense in 46.6%, and extremely dense in 23.1%. Seven cancers (6 invasive ductal cancer [IDC] and 1 ductal carcinoma in situ [DCIS]) were diagnosed, and the mean size of the invasive cancer was 1.6 cm (range, 0.3-3.3 cm). Four cases of cancer were detected on both DM/DBT and DM/DBT combined with US (4 IDCs), and the other three cases of cancer (2 IDCs and 1 DCIS) were detected when US was added to DM/DBT. All three US-detected cancers were node-negative, and the T stages of the 2 IDCs were T1 and T2, respectively. The sensitivities were 57.1% (95% confidence interval [CI]: 0.25-0.84) for DM/DBT and 100% (95% CI: 0.60-1.00) for DM/DBT combined with US (p=0.25). Supplemental screening US detected additional 3.1 cancers per 1000 screens (95% CI: 0.6-9.6). Regarding specificity, DM/DBT had a 99.4% (95% CI: 0.99-1.00) specificity, whereas the specificity on addition of US was 96.4% (95% CI: 0.95-0.97) (P<0.0001). The PPV was 40.0% (95% CI: 0.17-0.69) for DM/DBT, and the addition of US decreased the PPV to 17.5% (95% CI: 0.08-0.32).

CONCLUSION

The addition of screening US resulted in minor increased CDR, however, increased the number of false-positive results.

CLINICAL RELEVANCE/APPLICATION

Supplemental screening US can detect cancers that may not have been detected on DM/DBT screening; however, it increases the number of false-positive results, leading to recall examinations and biopsies.

SSE02-06 Second Reading DBT versus Supplemental Screening US in Dense Breasts: Interim Analysis from the DBTUST

Monday, Dec. 2 3:50PM - 4:00PM Room: E451B

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Uzma Waheed, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Cathy S. Tyma, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Golbahar Houshmand, MD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Bronwyn Nair, MD, Sewickley, PA (*Abstract Co-Author*) Nothing to Disclose
Margarita L. Zuley, MD, Pittsburgh, PA (*Abstract Co-Author*) Investigator, Hologic, Inc

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PURPOSE

To determine the supplemental cancer detection rate from double reading tomosynthesis (DBT) compared to addition of technologist-performed whole breast handheld screening ultrasound (US).

METHOD AND MATERIALS

In an IRB-approved, HIPAA-compliant protocol, 6258 women age 40-75 with heterogeneously dense or extremely dense breasts consented to annual technologist-performed US after DBT for three years at one of three sites in western Pennsylvania. Each modality was independently interpreted in opposing order by two radiologists who were MQSA qualified and met ACRIN 6666 US experience criteria. An interim analysis was performed of 6258 prevalence and 7616 incidence screens through 12/31/18.

RESULTS

Median patient age was 53 years. Among 13,874 analyzable screens, 91 women were diagnosed with cancer (CDR 6.6 per 1000, median invasive size 1.5 cm): 68 (74.7%) detected by reader 1 on DBT; 9 (9.9%) only by reader 2 on DBT (one of which was also visible on US by the primary radiologist, and one of which was dismissed, detected due to symptoms); 12 (12.2%) only on US; 1 (1.1%) by MRI performed for other reasons, and 1 (1.1%) only because of symptoms (interval cancer). Nineteen cancers were DCIS, 18 seen only on DBT (2 only on double reading); 72 were invasive (median size 13 mm), 7 only on DBT double reading (median size 10 mm, 6/7 node negative) and 12 seen only on US (median size 10 mm, 10/12 node negative). Supplemental cancer detection rate of second reading DBT was 0.65/1000 vs. 0.9/1000 for US (p=0.37). Supplemental recall rates were 36.9/1000 for double reading DBT vs. 50.4/1000 for US (p<0.001); PPV1 5.27% vs. 5.33%; NPV 99.89 vs. 99.92%. Of note, 6 cancers detected by reader 1 on DBT in year 1 had been missed on clinical reading of DBT in a subset of 3876 women prior to study entry: if attributed to double reading DBT, yield would be 15/13,874 or 1.1/1000 for double reading.

CONCLUSION

In women with dense breasts, there is a significant yield from supplemental screening with technologist-performed US even after DBT, albeit with sizable increase in recall rate. Double reading DBT increases recall rate less than US. Additional cancers detected by double reading DBT vs. adding US were mostly nonoverlapping and invasive.

CLINICAL RELEVANCE/APPLICATION

The adequacy of screening DBT for women with dense breasts is uncertain. Noninvasive methods to improve cancer detection, including double reading and screening US, merit consideration.

Printed on: 10/29/20

SSE03

Science Session with Keynote: Cardiac (Congenital and Pediatric Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: E350

CA MR PD

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Gautham P. Reddy, MD, Seattle, WA (*Moderator*) Researcher, Koninklijke Philips NV
Jean Jeudy JR, MD, Baltimore, MD (*Moderator*) Nothing to Disclose
Cylen Javidan, MD, Saint Louis, MO (*Moderator*) Nothing to Disclose

Sub-Events

SSE03-01 **Cardiac Keynote Speaker: MRI Evaluation of Function and Physiology in Congenital Heart Disease**

Monday, Dec. 2 3:00PM - 3:20PM Room: E350

Participants
Gautham P. Reddy, MD, Seattle, WA (*Presenter*) Researcher, Koninklijke Philips NV

SSE03-03 **Dual-Venc 4D-Flow MRI For the Follow-Up of Patients with Complex Congenital Heart Disease**

Monday, Dec. 2 3:20PM - 3:30PM Room: E350

Participants
Arshid Azarine, MD, MSc, Paris, France (*Presenter*) Advisory Board, Arterys Inc
Quentin Alias, Paris, France (*Abstract Co-Author*) Nothing to Disclose
Arnaud Fournier, Paris, France (*Abstract Co-Author*) Nothing to Disclose
Veronique Marteau-Marty, MD, Paris, France (*Abstract Co-Author*) Nothing to Disclose
Charles Roux, Paris, France (*Abstract Co-Author*) Nothing to Disclose
Adrien Frison-Roche I, CMD, Clamart, France (*Abstract Co-Author*) Nothing to Disclose
Nadia Canepa, Paris, France (*Abstract Co-Author*) Nothing to Disclose
Daniel Sidi, Paris, France (*Abstract Co-Author*) Nothing to Disclose
Marc Zins, MD, Paris Cedex 14, France (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To test the feasibility of dual-velocity encoding (dual-venc) 4D-flow MRI accelerated by katARC for the follow-up of patients with complex congenital heart disease (CHD), to improve dynamic velocity range of 4D-flow MRI and reduce velocity to noise ratio for low velocities measurements.

METHOD AND MATERIALS

A dual-venc 4D flow MRI sequence accelerated by k- & adaptive-t-ARC, assessed vena cava, pulmonary and aortic flows in 10 young adults followed-up after surgery for various complex CHD. Routine cardiac MRI was performed on a 3T magnet followed by a dual-venc 4D-flow MRI sequence (High-Venc/low-venc were set at 300/100cm/s, temporal/spatial resolution=40-45msec/2×2×2.2mm3) after the injection of gadolinium contrast agent (0.15 mmol/kg). The dataset was anonymized and sent on a cloud-based software. After deep learning based phase offsets correction, both high- and low-venc data were analysed separatly and simultaneously for the feasibility and for assessing arterial and venous hemodynamics (flows) at the great vessels. All patients were informed and signed a consent to test dual-venc 4D flow sequence.

RESULTS

All dual-venc 4D flow MRI scans were acquired successfully with an acquisition time of 12±3 minutes. Dual-venc sequence acquisition time was 1.5 times longer than a single venc sequence, the total acquisition time was reduced by 25% compared to two separate scans. Cloud based data analysis enabled 'real-time' simultaneous analysis of both low-venc and high-venc volumes. Concerning vena cavas velocity measurements, Bland-Altman plot showed good agreement within the 95% limits between high- and low- Venc datasets, noise was noted 25% lower on low-venc vs high-venc dataset. Aliasing occurred on most arterial measurements using low-venc volume.

CONCLUSION

Dual-venc 4D flow MRI used for the follow up of patients with complex CHD reliably incorporates low- and high-velocity fields simultaneously, within a reasonable scan time.

CLINICAL RELEVANCE/APPLICATION

Recently, 4-D flow MRI has shown to bring relevant findings in the follow-up of patients with complex CHD. In these patients,

arterial high velocities and venous lower velocities have to be reliably explored but with always a compromise for the choice of the velocity range to explore. Dual-venc sequences enable a new appraoch enabling reliable measurement of these low and high velocity flows within a reasonable scan time, faster than 2 consecutive single Venc 4D flow sequence.

SSE03-04 Rapid Reconstruction of Highly-Accelerated Real-Time Phase Contrast MRI Using Deep Convolutional Network: A Feasibility Study in Patients with Congenital Heart Disease

Monday, Dec. 2 3:30PM - 3:40PM Room: E350

Participants
Hassan Haji-Valizadeh, Evanston, IL (*Presenter*) Nothing to Disclose
Daming Shen, Evanston, IL (*Abstract Co-Author*) Nothing to Disclose
Joshua D. Robinson, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Cynthia K. Rigsby, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Daniel Kim, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Standard real-time phase-contrast (rt-PC) MRI produces inadequate spatial and temporal resolution, limiting pediatric applications. Compressed sensing (CS) can be used to highly accelerate real-time phase contrast (rt-PC) MRI for achieving high spatial (1.5x1.5x6mm3) and temporal (40ms) resolution. However, it is challenging to clinically translate CS approaches due to the lengthy image reconstruction time (~10 min). We sought to apply a deep learning (DL) framework to rapidly reconstruct rt-PC images and evaluate its performance in patients with CHD.

METHOD AND MATERIALS

We scanned 14 CHD patients (mean age=14.2 ± 7.1yr; 10 males) on a 1.5T scanner (Aera, Siemens) using our 38.4-fold accelerated, rt-PC sequence employing radial k-space sampling with golden angles. Image reconstruction was performed on a GPU workstation equipped with Pytorch. A convolutional neural network was trained with 9860 (29 valve planes x 85 timeframes per plane x 2 complex components x 2 velocity encodings) zero-filled and the corresponding CS reconstructed images obtained from 9 randomly selected patients as input/output pairs. For validation, we reconstructed 6460 zero-filled images from the remaining 5 patients using our trained network, and the resulting images representing a single heartbeat were compared with the corresponding CS reconstructed images. Our proposed DL network was composed of 10 hidden layers with 16 features each, two concatenation connections, and convolution kernel size of 1x1x3 (Figure 1A).

RESULTS

The reconstruction time for DL (5.9±0.5s) was significantly lower ($p<0.05$) than CS (551.4±27.6s). Figure 1B shows representative images reconstructed with CS and DL as well as their corresponding forward flow and peak velocity curves. Compared to CS, DL produced negligible error in valvular velocities (NRMSE = 4.8±1.9%). Flow and velocity curves produced by CS and DL reconstruction were strongly correlated ($R2>0.94$) with small mean differences (<5.9% of means, Figure 1C).

CONCLUSION

This study demonstrates a DL framework to significantly decrease the reconstruction time (93 times) compared with CS for 38.4-fold accelerated rt-PC MRI.

CLINICAL RELEVANCE/APPLICATION

Patients with CHD may benefit from a rapid rt-PC MRI pulse sequence which enables free-breathing imaging.

SSE03-05 Evaluation of Pulmonary Pressure After Glenn Shunts by CT-Based Machine Learning Model

Monday, Dec. 2 3:40PM - 3:50PM Room: E350

Participants
Yuhao Dong, Guangzhou, China (*Presenter*) Nothing to Disclose

PURPOSE

To develop and validate non-invasive machine-learning classifiers for the separation of post-Glenn shunt patients with mean pulmonary arterial pressure (mPAP) >15 mmHg from those <=15 mmHg based on preoperative cardiac computed tomography (CT).

METHOD AND MATERIALS

This retrospective study included 96 patients with functional single ventricle who had undergone a bidirectional Glenn procedure (BDG) between November 1, 2019 and July, 31, 2017. All underwent post-procedure CT examination, followed by cardiac catheterization within six months. In all, 23 morphologic parameters were manually extracted from cardiac CT images for each patient. The Mann-Whitney U test or Chi-square test was applied to select the predictors associated with the outcome of interest. Six machine-learning algorithms including logistic regression (LR), Naive Bayes (NB), Random Forest (RF), Linear Discriminant Analysis (LDA), Support Vector Machine (SVM), and K-Nearest Neighbor (KNN) were used for modeling. The algorithms were independently trained on the 100 train-validation random splits with a 3:1 ratio. The average performance of algorithms were evaluated by area under ROC curve (AUC), accuracy, sensitivity, and specificity.

RESULTS

Seven CT morphologic parameters were selected for modeling. RF method obtained the best predictive performance compared with other methods, with mean AUC of 0.840 (confidence interval [CI]: 0.832-0.850), 0.787 (95%CI: 0.780-0.794) ; sensitivity of 0.815 (95%CI: 0.797-0.833), 0.778 (95%CI: 0.767-0.788), specificity of 0.766 (95%CI: 0.748-0.785), 0.746 (95%CI: 0.735-0.757), accuracy of 0.782 (95%CI: 0.771-0.793), 0.756 (95%CI: 0.748-0.764) in the training and validation cohorts, respectively.

CONCLUSION

The CT-based RF model demonstrates good performance in the classification of PAP

The CT-based RF model demonstrates good performance in the classification of mPAP.

CLINICAL RELEVANCE/APPLICATION

The CT-based RF model may reduce the need for right heart catheterization in post-Glenn shunts patients with suspected mPAP >15 mmHg.

SSE03-06 Dynamic Fetal Cardiac Magnetic Resonance Imaging Using Doppler Ultrasound Gating in the Assessment of the Fetal Aortic Arch: A Feasibility Study and Comparison to Fetal Echocardiography

Monday, Dec. 2 3:50PM - 4:00PM Room: E350

Participants
Bjoern Schoennagel, MD, Hamburg, Germany (*Presenter*) Co-founder and Stakeholder, Northh-Medical GmbH
Jin Yamamura, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
Fabian Kording, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical GmbH
Christian Ruprecht, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical GmbH
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Gerhard B. Adam, MD, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
Manuela Tavares de Sousa, Hamburg, Germany (*Abstract Co-Author*) Co-founder and Stakeholder, Northh Medical GmbH

PURPOSE

To investigate the feasibility of dynamic fetal cardiac MRI using a newly developed MR compatible Doppler Ultrasound (DUS) device for fetal cardiac gating for evaluation of the fetal aortic arch in comparison to fetal echocardiography.

METHOD AND MATERIALS

This was a prospective study including 19 fetuses, with 17 of them having a normal aortic arch and two a suspicion of coarctation of the aorta (CoA) at initial fetal echocardiography. Median fetal age was 33 weeks (range 26-38). Dynamic fetal cardiac MRI was performed using a newly developed DUS device for direct fetal cardiac gating at a 1.5 T scanner. The aortic arch was evaluated in para-sagittal planes using a cine steady state free precision (SSFP) sequence. The visualization of the aortic arch and left subclavian artery was studied. MR image quality was assessed by two observers using a 4-point grading scale (increasing image quality from 1-4). Postnatal fetal echocardiography was considered as the standard of reference.

RESULTS

Direct fetal cardiac gating using the DUS device allowed continuous gating of the fetal heart beat. In four cases the DUS device had to be repositioned during examination due to fetal movement. Examination of one fetus was not possible due to severe fetal movement and loss of the cardiac gating signal. Both, fetal cardiac MRI and echocardiography detected the CoA and enabled visualization of the aortic arch in 16/18 cases (89%). Overall MR image quality according to the 4-point scale grading was high with no or only few artifacts and a resulting mean value of 3.1 (± 1.1). Agreement in overall image quality between the two observers was good (kappa = 0.75 ± 0.13).

CONCLUSION

This study shows that dynamic fetal cardiac MRI using the newly developed DUS device for direct cardiac gating allows reliable evaluation of the fetal aortic arch and in agreement to fetal echocardiography.

CLINICAL RELEVANCE/APPLICATION

Dynamic fetal cardiac MRI may be useful in addition to fetal echocardiography for the evaluation of CoA, especially in cases where echocardiography is inconclusive.

SSE04

Science Session with Keynote: Cardiac (Arrhythmia and Electrophysiology)

Monday, Dec. 2 3:00PM - 4:00PM Room: E353B

CA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jacobo Kirsch, MD, Miami, FL (*Moderator*) Nothing to Disclose
Dharshan R. Vummidi, MD, FRCR, Sale, United Kingdom (*Moderator*) Nothing to Disclose
Benoit Desjardins, MD, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSE04-01 Cardiac Keynote Speaker: The Role of Imaging in Electrophysiology

Monday, Dec. 2 3:00PM - 3:20PM Room: E353B

Participants
Benoit Desjardins, MD, PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose

SSE04-03 Self-Navigated, Free-Breathing 3D Left Atrial Late Gadolinium Enhancement MRI: A Preliminary Study for Evaluation of Image Quality and Quantification of Atrial Fibrosis in Patients with Atrial Fibrillation at 1.5T MRI Scanners

Monday, Dec. 2 3:20PM - 3:30PM Room: E353B

Participants
Suvai Gunasekaran, PhD, Chicago, IL (*Presenter*) Nothing to Disclose
Daniel Lee, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Bradley Knight, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Ryan J. Avery, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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Rod Passman, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Michael Markl, PhD, Chicago, IL (*Abstract Co-Author*) Institutional research support, Siemens AG; Consultant, Circle Cardiovascular Imaging Inc;
Daniel Kim, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Given the thin nature of the left atrial (LA) wall and the need to perform respiratory gating, the clinical translation of LA late gadolinium-enhanced (LGE) MRI has proven difficult, particularly at 1.5T MR scanners. This study describes a self-navigated, free-breathing 3D LA LGE pulse sequence with stack-of-stars k-space sampling and GRASP reconstruction for quantifying atrial fibrosis in patients with atrial fibrillation (AF) at 1.5T.

METHOD AND MATERIALS

8 patients (5 males, 63 ± 6 years) with AF (6 paroxysmal, 2 persistent) were scanned on 1.5 T scanners (Siemens, AERA or AVANTO) using the proposed pulse sequence (1.5 x 1.5 x 2 mm3 spatial resolution, 500 heartbeats). GRASP reconstruction with self-navigation of respiratory motion and temporal total variation as the sparsifying transform was performed with and without adaptive optimized nonlocal means (AONLM) filtering during post-processing. Reconstructed images were analyzed using commercial software (ADAS 3D, Galgo Medical) to quantify LA fibrosis, which was subsequently tested against relevant clinical characteristics. Images were evaluated by two attending readers on a 5-point scale (1=worst, 3=acceptable, 5=best) for each of three categories (conspicuity, noise, artifact), and the overall image quality index was defined as the sum of three scores, where 9 is defined as clinically acceptable. Additionally, LA SNR and edge sharpness were computed.

RESULTS

Use of AONLM significantly ($p < 0.05$) increased SNR (from 21.1 to 28.0), whereas sharpness was not significantly different (from 1.15mm to 1.16mm), representative example shown in Figure 1A-B. The median image quality index was significantly ($p<0.05$) higher with filtering (12.5) than without (9). Figure 1C shows fibrosis quantification of a persistent AF patient with mean atrial fibrosis of 20.41%. The mean LA fibrosis of our patients was 6.5 ± 6.1%. As shown in Figure 1D, unpaired t-tests demonstrated non-significant differences for all variables, except for AF type ($p=0.0058$).

CONCLUSION

This study demonstrates that the proposed 3D LA LGE sequence with post-processing is capable of producing clinically acceptable

This study demonstrates that the proposed 3D LGE sequence with post-processing is capable of producing clinically acceptable image quality (12.5) for quantifying LA fibrosis in patients with AF at 1.5 MRI scanners.

CLINICAL RELEVANCE/APPLICATION

A robust 3D LGE MRI pulse sequence at 1.5T for quantification of LA fibrosis is potentially a useful test for predicting AF recurrence following AF ablation.

SSE04-04 Improvement in Left Ventricular Myocardial Extracellular Volume Fraction Determined with Cardiac MRI after Successful Catheter Ablation for Atrial Fibrillation

Monday, Dec. 2 3:30PM - 3:40PM Room: E353B

Participants
Sang Eun Park, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
Sung Ho Hwang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The effect of catheter ablation of atrial fibrillation (AF) on left ventricular myocardial extracellular volume fraction (LV-ECV) is unknown. We aimed to assess the long-term effects of catheter ablation of AF on the LV-ECV using cardiac magnetic resonance imaging (MRI).

METHOD AND MATERIALS

This retrospective study included 60 patients (mean age, 58 ± 12 years; age range, 32-77 years; 44 men and 16 women) who underwent catheter ablation of AF and cardiac MRI to assess mid LV-ECV at baseline and after 12-months follow-up between March 2016 and March 2018. The study population was divided into 2 groups: 1) sinus rhythm (SR) group and AF group, according to the maintenance of rhythm status during follow-up after catheter ablation. Changes of LV-ECV from baseline to follow-up were evaluated using paired Student t test.

RESULTS

Of all 60 patients, 38 (63%) and 22 (37%) were in SR group and AF group, respectively. No significant difference of baseline LV-ECV was noted between the SR and AF groups (26.2 ± 1.7% vs. 27.0 ± 2.4%, P = 0.09). In the SR group, a significant decrease of LV-ECV from baseline to follow-up was noted (26.2 ± 1.7% vs. 24.4 ± 1.6%, P <0.001). Whereas in the AF group, a significant increase of LV-ECV from baseline to follow-up was noted (27.0 ± 2.4% vs. 28.8 ± 2.0%, P <0.001).

CONCLUSION

After catheter ablation of AF, LV-ECV improves significantly in patients who maintain sinus rhythm. In contrast, an increase of LV-ECV is observed in patients with recurrence of AF.

CLINICAL RELEVANCE/APPLICATION

Catheter ablation may affect the left ventricular myocardium with management of atrial fibrillation. The change of left ventricular myocardium after cathter ablation may be described by extracellular volume fraction determined with cardiac MRI.

SSE04-05 Atrial Remodeling Features in CT to Predict the Recurrence of Atrial Fibrillation After Ablation Therapy

Monday, Dec. 2 3:40PM - 3:50PM Room: E353B

Participants
Christoph Beyer, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose
Lyudmila Tokarska, Wiener Neustadt, Austria (*Abstract Co-Author*) Nothing to Disclose
Gudrun Feuchtner, MD, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose
Markus Stuhlinger, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose
Florian Hintringer, MD, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose
Lukas Fiedler, Wiener Neustadt, Austria (*Abstract Co-Author*) Nothing to Disclose
Robert Schonbauer, Wiener Neustadt, Austria (*Abstract Co-Author*) Nothing to Disclose
Fabian Plank, MD, Innsbruck, Austria (*Presenter*) Nothing to Disclose

PURPOSE

Atrial fibrillation (AF) is the most common arrhythmia and is associated with significant morbidity and mortality. Structural atrial remodeling triggers increased automaticity and is important for AF recurrence and persistence. We evaluated qualitative atrial and epicardial features to predict AF recurrence after ablation therapy.

METHOD AND MATERIALS

812 consecutive patients at two high-volume centers with non-valvular, drug-resistant AF and without significant comorbidities underwent cardiac CT angiography before AF ablation. CT images were evaluated for left and right atrial (RA) diameters and volume, left atrial (LA) wall thickness (LAWT, anterior and posterior), epicardial adipose tissue volume (EAT) and density. Close clinical follow-up for min. 12 months was performed. Interrater variability was assessed.

RESULTS

The final analysis included 732 patients (mean age 56y, 24% female), 321 (43.9%) had a recurrence of AF after a mean of 7 months (mean follow-up period 31 months). CT analysis showed significantly larger LA (47.1 ± 15.5 ml/m² vs. 43.4 ± 15.1 ml/m², p=0.0001) and RA indexed volumes (38.6 ± 12.6 ml/m² vs. 34.2 ± 12.3 ml/m², p=0.0001). Mean anterior LAWT measurements were higher (1.88 ± 0.5 mm vs. 1.64 ± 0.5 mm, p<0.0001), posterior (1.60 ± 0.4 mm vs. 1.36 ± 0.4 mm, p=0.001). Epicardial adipose tissue volume was higher amount in the patients with AF recurrence (141.5 ± 55.1 mm³ vs 129.9 ± 51.3 mm³, p<0.0001) with increased distribution around the left atrium (19.0 ± 8.3 vs. 17.1 ± 7.1, p<0.0001) but not the right atrium (15.6 ± 7.0 vs. 14.7 ± 6.5, p=0.072).

CONCLUSION

Atrial wall thickness as well as epicardial fat volume and attenuation assessed in computed tomography predicts AF recurrence in patients undergoing ablation therapy.

CLINICAL RELEVANCE/APPLICATION

Atrial wall thickness and epicardial adipose tissue are cardiac remodelling factors that help understand the recurrence of atrial fibrillation.

SSE04-06 Early Detection of Left Atrial Dysfunction Assessed by CMR-Feature Tracking in Hypertensive Patients

Monday, Dec. 2 3:50PM - 4:00PM Room: E353B

Participants
Yanyan Song, Beijing, China (*Presenter*) Nothing to Disclose
Xiuyu Chen, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Lu Li, BA, Beijing , China (*Abstract Co-Author*) Nothing to Disclose
Shihua Zhao, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate whether cardiovascular magnetic resonance feature tracking (CMR-FT) can detect early left atrial (LA) dysfunction in hypertensive patients with or without left ventricular hypertrophy (LVH).

METHOD AND MATERIALS

Seventy-three patients with hypertension (HTN) and 29 healthy controls were retrospectively recruited. HTN patients were divided into the LVH (n=29) and non-LVH group (n=44). LA performance was analysed by using CMR-FT in 2- and 4-chamber cine images, including LA reservoir function (LA total ejection fraction [EF], total strain [εs], peak positive strain rate [SRs]), conduit function (LA passive EF, passive strain[εe], peak early negative strain rate[SRe]) and booster pump function (LA booster EF, active strain [εa], late peak negative strain rate [SRa]). The intra- and inter-observer reproducibility was evaluated by the intra-class correlation coefficient (ICC) analysis.

RESULTS

Compared with controls, LA reservoir (LA total EF, εs, SRs) and conduit function (LA passive EF, εe, SRe) were significantly impaired in HTN patients with or without LVH (all $p<0.05$), and these parameters significantly correlated with mitral $E/A<1$ (all $p<0.01$). In contrast, the LA booster pump function was relatively preserved in non-LVH group, representing an intermediate stage between the LVH group and healthy controls. Among LA deformation parameters, εe showed the highest diagnostic value for differentiation of HTN patients with controls (AUC:0.82; sensitivity:80.82%; specificity:72.41%). Observer reproducibility was good-excellent (ICC:0.83-0.97) for all CMR-FT derived parameters.

CONCLUSION

CMR-FT was a promising tool for quantification of LA function. LA reservoir and conduit dysfunction might be detected early by CMR-FT in HTN patients before the presence of LVH.

CLINICAL RELEVANCE/APPLICATION

CMR-FT was a promising tool for early detection of impaired LA reservoir and conduit function in hypertensive patients before the presence of left ventricluar hypertrophy.

SSE05

Chest (Radiomics and Machine Learning)

Monday, Dec. 2 3:00PM - 4:00PM Room: S102CD

AI CH CT

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Brett W. Carter, MD, Houston, TX (*Moderator*) Nothing to Disclose
Archana T. Laroia, MD, Fargo, ND (*Moderator*) Nothing to Disclose

Sub-Events

SSE05-01 Radiomics-Based Prediction of Acute Respiratory Distress Syndrome in Chest Computed Tomography of Polytraumatized Patients at Admission

Monday, Dec. 2 3:00PM - 3:10PM Room: S102CD

Awards
Trainee Research Prize - Resident

Participants
Sebastian Roehrich, MD, Vienna, Austria (*Presenter*) Consultant, contextflow GmbH
Johannes Hofmanninger, Vienna, Austria (*Abstract Co-Author*) Siemens AG Boehringer Ingelheim GmbH
Lukas Negrin, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose
Georg Langs, Vienna, Austria (*Abstract Co-Author*) Co-founder, contextflow GmbH; Shareholder, contextflow GmbH
Helmut Prosch, MD, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The aim of this prospective, internal review board approved study was to investigate the possibility of fully automatic, machine-learning-based prediction of the development of acute respiratory distress syndrome (ARDS) in polytraumatized patients based on the initial computed tomography (CT) scan of the chest.

METHOD AND MATERIALS

Over a timeframe of four years, polytraumatized patients, 18 years or older, with an Injury Severity Score (ISS) greater than 15, were included in the study. Exclusion criteria were: death within 48 hours, burning injury and known oncologic or chronic inflammatory lung disease. All scans were conducted on the same scanner and all scans were conducted within one hour of the accident. ARDS was defined by the Berlin definition. We performed deep-learning-based segmentation of the lungs including pleural effusions. Within the masks we densely sampled 83 radiomics features on locations throughout the lung and learned a spatio-visual vocabulary of radiomics feature expressions. Subsequently, we used the histogram of spatio-visual words of each lung to train a Support Vector Machine (SVM) classifier for prediction of ARDS and compared the algorithm to commonly used scores for prognosis estimation (ISS and abbreviated injury score of the thorax (AIS)). We performed 40-fold stratified cross validation to split training and test sets.

RESULTS

123 patients met the inclusion criteria. 101 of the polytraumatized patients had a thoracic AIS of 3 or greater (indicating severe thoracic injury). 40 out of 123 patients (32,5%) developed ARDS. The machine learning-based ARDS risk-score yielded an AUC of 0.78 (ISS: 0.66; AIS: 0.68). At a cutoff at 0.3, the radiomics risk-score yields a precision of 0.59, recall of 0.73 and an f1-score of 0.65 for ARDS prediction.

CONCLUSION

Machine-learning-based radiomic features of the lung in polytraumatized patients are able to predict ARDS at a higher level than common clinical scores in the same collective.

CLINICAL RELEVANCE/APPLICATION

Clinical decision support regarding the development of ARDS may be supported by extracting and analysing imaging data that is routinely available in polytraumatized patients at their admission to the hospital.

SSE05-02 The Incidental Thyroid Nodule on Chest CT: Application of CT Texture Analysis in the Prediction of Ultrasound Classification

Monday, Dec. 2 3:10PM - 3:20PM Room: S102CD

Participants

Jung In Jo, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jung Im Kim, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
Han Na Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jung Kyu Ryu, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To explore the value of CT texture analysis (CTTA) in predicting subsequent ultrasound (US) classification of incidentally detected thyroid nodule on chest CT.

METHOD AND MATERIALS

A total of 117 incidental thyroid nodules (>=1cm in the longest diameter) on the chest CT scan of 107 patients were enrolled. CCTA parameters (mean value of positive pixels (MPP), kurtosis, entropy, skewness) were extracted using commercial software (TexRAD) with soft, medium and coarse spatial filters. CT texture features were correlated with the Korean Thyroid Imaging Reporting and Data System (K-TIRADS) classification on recent thyroid US within 1 month. All of the single texture features were compared between benign (K-TIRADS 2; n=21) and suspicion (K-TIRADS 3, 4, 5; n=96) nodules by Mann-Whitney U test. Combinations of significant texture features were entered as predictors in logistic regression models for predicting suspicion nodule and the performance of logistic regression model was analyzed by area under receiver operating characteristic curve (AUROC).

RESULTS

The mean values of MPP of benign nodule were significantly lower than suspicion nodule at all filter levels (all, $p<0.05$). Entropy of benign nodule was significantly lower than suspicion nodule at fine and coarse filters ($p=0.018$, 0.040, respectively), besides kurtosis of benign nodule was significantly lower than suspicion nodule at medium filter ($p=0.002$). Skewness of benign nodule were slightly higher than suspicion nodule at medium and coarse filters (both, $p=0.074$). A logistic regression analysis with combination of kurtosis, mpp and skewness at medium filter showed the best performance for the prediction of suspicion nodule with AUROC of 0.841 ($p<0.001$, sensitivity 84.4% and specificity 81.0%). The logistic regression model correctly classified 85.7% benign and 84.3% suspicion nodules.

CONCLUSION

CTTA features of ITN were significantly associated with systematic US classification and can accurately discriminate between benign (K-TIRADS 2) and suspicion (K-TIRADS 3, 4, 5) nodule.

CLINICAL RELEVANCE/APPLICATION

Quantitative CT texture analysis of ITN has the potential to predict benign or suspicion nodule on subsequent ultrasound and can be used to direct further workup of ITN on CT images.

SSE05-04 Deep Learning (DL) Based Interpretation of Frontal Chest Radiographs: Assessing Accuracy of the DL Algorithm

Monday, Dec. 2 3:30PM - 3:40PM Room: S102CD

Participants
Ramandeep Singh, MBBS, Boston, MA (*Presenter*) Nothing to Disclose
Fatemeh Homayounieh, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Jo-Anne O. Shepard, MD, Boston, MA (*Abstract Co-Author*) Editor with royalties, Reed Elsevier
Sebastian Vogt, PhD, Malvern, PA (*Abstract Co-Author*) R&D Director, Siemens AG; Stockholder, Siemens AG;
Eli Gibson, MSc, Princeton, NJ (*Abstract Co-Author*) Employee, Siemens AG

PURPOSE

Deep learning-based algorithm can improve the workflow and turnaround of interpretation of chest radiographs which are one of the most commonly performed imaging exams in hospital settings. The purpose of our study was to assess accuracy of deep learning based algorithm for detection of radiographic findings on frontal chest radiographs (CXR).

METHOD AND MATERIALS

A DL prototype (DNetLoc,Siemens) was trained for detecting and classifying radiographic abnormalities on 112,120 CXRs from the CXR14 data (NIH) and 185,421 CXRs belonging to the PLCO data (Prostate, Lung, Ovarian, and Colon Cancer). Five hundred deidentified CXR (47 PA and 453 AP projection radiographs; 280 males, 220 female; mean age 64 ± 18 years) belonging to the CheXpert data (from Stanford) were processed with the DL prototype. The prototype processed the CXRs and provided prediction statistics and scores for consolidation, pneumonia, atelectasis, pulmonary edema, pleural effusion, and enlarged cardiac silhouette. Statistical analysis was performed with receiver operating characteristics (ROC) to determine the area under the curve (AUC).

RESULTS

Distribution of findings on CXR included 320 pleural effusions, 242 pulmonary edema,183 consolidation, 126 atelectasis, 66 enlarged cardiac silhouette, and 54 pneumonia. Of the included CXR, 183/500 (37%) had multiple radiographic findings, 169/500 (34%) had single radiographic finding per CXR, and 148/500 (30%) CXR had no radiographic abnormality. The estimated sensitivity, specificity, and AUC values for different findings were: pleural effusions (0.88, 0.77, 0.91), pulmonary edema (0.73, 0.80, 0.82),183 consolidation (0.87, 0.76, 0.89), atelectasis (0.87, 0.70, 0.84), enlarged cardiac silhouette (0.70, 0.80, 0.80), and 54 pneumonia (0.78, 0.75, 0.84).

CONCLUSION

DL based prototype can accurately detect radiographic findings such as consolidation, pneumonia, atelectasis, pleural effusion, and

enlarged cardiac silhouette (maximum AUC of 0.91 for pleural effusion). Performance of the prototype may have been limited by the JPEG image format and 8-bit compression of DICOM data.

CLINICAL RELEVANCE/APPLICATION

Deep learning based prototype can accurately detect and classify radiographic findings on frontal chest radiographs.

SSE05-05 Improving Diagnostic Performance of Deep Learning Radiographic Localization by Injecting Expert Knowledge

Monday, Dec. 2 3:40PM - 3:50PM Room: S102CD

Participants
Brian Hurt, MD,MS, San Diego, CA (*Presenter*) Consultant, Arterys Inc; Consultant, IBM Corporation
Andrew Yen, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose
Seth J. Kligerman, MD, Denver, CO (*Abstract Co-Author*) Speakers Bureau, Boehringer Ingelheim GmbH; Author, Reed Elsevier; Consultant, IBM Corporation
Albert Hsiao, MD,PhD, La Jolla, CA (*Abstract Co-Author*) Founder, Arterys, Inc; Consultant, Arterys, Inc; Shareholder, Arterys, Inc; Speaker, Bayer AG; Research Grant, Bayer AG; Speaker, General Electric Company; Research Grant, General Electric Company;

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PURPOSE

We explored a semantic segmentation approach to localize suspected foci of pneumonia and endotracheal tube placement, and tested the hypothesis that additional anatomic contextual information may further improve performance.

METHOD AND MATERIALS

A public data set comprised of 29K frontal chest radiographs was used to train multiple multi-channel U-net neural networks. Foci of pneumonia were represented by bounding box coordinates and converted to probability maps for model training. We developed custom software to draw free-form annotations as a method of injecting expert radiologist knowledge into model training. Pneumonia localization were trained on 25K and tested on 4K frontal radiographs. Two pneumonia models were trained: (a) without and (b) with thoracic cavity annotations. Endotracheal/Tracheostomy tube segmentation models were trained on 771 from the above dataset and tested on 291 private radiographs. Two models for tube tip and carina localization were trained: (a) without and (b) with central airways and tube annotations. Annotations and model training were performed by a physician post-doctoral research fellow. Pneumonia classifications and subsequent ROC/AUC values are derived from predicted heat maps. Points corresponding to the carina and tube tip are extracted from predicted heat-maps, and distance error between prediction and hand-labeled points are calculated.

RESULTS

AUC for detection of pneumonia was 0.861 and improved to 0.906 with concurrent training with the thoracic cavity annotation. Inclusion of central airways and tube entirety improved tube detection AUC from 0.610 to 0.894. Further, mean error in tube tip and carina localization were 19.7 and 13.3 mm, and improved to 10.2 and 6.4 mm with concurrent training with the central airways and the entirety of the tube.

CONCLUSION

Semantic segmentation is a feasible approach to localize anatomy, pathology, and hardware. Injecting concurrent anatomic contextual information using a multi-channel strategy can improve localization performance. This approach may enable radiologists to further improve performance of deep learning algorithms for use in clinical practice.

CLINICAL RELEVANCE/APPLICATION

Multiple deep learning approaches have been proposed to assist interpretation of chest radiographs. Deep learning-based semantic segmentation provides natural model transparency and may enable radiologists to inject expert knowledge.

SSE05-06 The Combination of Deep Learning Based Denoising and Iterative Reconstruction on Ultra-Low-Dose Chest CT: Image Quality and Lung-RADS Evaluation

Monday, Dec. 2 3:50PM - 4:00PM Room: S102CD

Participants
Akinori Hata, MD, Suita, Japan (*Presenter*) Support, Canon Medical Systems Corporation
Masahiro Yanagawa, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose
Tomo Miyata, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose
Yuriko Yoshida, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose
Osamu Honda, MD, PhD, Amagasaki, Japan (*Abstract Co-Author*) Nothing to Disclose
Noriyuki Tomiyama, MD,PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose
Noriko Kikuchi, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose
Mitsuko Tsubamoto, MD, Suita, Japan (*Abstract Co-Author*) Support, Canon Medical Systems Corporation

PURPOSE

To assess the effect of the combination of the deep learning based denoising (DLD) and iterative reconstruction (IR) on the image quality and the Lung-RADS results on ultra-low-dose chest CT.

METHOD AND MATERIALS

Forty-one patients with 252 nodules were evaluated retrospectively. All patients underwent standard-dose CT (SDCT: 6.46 ± 2.28 mSv) and ultra-low-dose CT (ULDCT: 0.19 ± 0.01 mSv). SDCT was reconstructed using hybrid IR. ULDCT was reconstructed using hybrid IR (hIR) and model-based iterative reconstruction (MBIR). Post-processing DLD was performed on ULDCT images (hIR+DLD and MBIR+DLD). Two independent radiologists subjectively evaluated 4 ULDCT image sets (hIR, hIR+DLD, MBIR, and MBIR+DLD) on a

5-point scale (1=worst<2<3<4<5=best) in terms of noise, streak artifact, the visibility of nodule edge, the clarity of small vessels, the homogeneity of normal lung parenchyma, and overall image quality. In addition, two radiologists independently evaluated the nodules according to the LungRADS using the SDCT image set and the two post-processed ULDCT image sets (hIR+DLD, MBIR+DLD). The subjective scores were analyzed using the Wilcoxon signed-rank test with the Bonferroni correction. The intra-observer agreement for the LungRADS category between SDCT and ULDCT was evaluated using weighted kappa coefficients.

RESULTS

In subjective image quality analysis, ULDCT images with DLD showed significantly better scores than those without DLD ($p <= 0.001$) in terms of all items for both readers. MBIR+DLD showed the best scores among the ULDCT images in terms of all items except for the homogeneity ($p < 0.001$). In the LungRADS evaluation, hIR+DLD showed moderate agreement ($\kappa = 0.420$ for reader1 and $\kappa = 0.423$ for reader2) and MBIR+DLD showed moderate or good agreement ($\kappa = 0.591$ for reader1 and $\kappa = 0.663$ for reader2).

CONCLUSION

DLD improved the image quality of both hybrid IR and MBIR images on ULDCT. MBIR was more advantageous than hybrid IR in terms of image quality and LungRADS evaluation even using DLD.

CLINICAL RELEVANCE/APPLICATION

Both deep learning based denoising (DLD) and MBIR may contribute to the clinical practice by the improvement of image quality on ultra-low-dose chest CT.

Printed on: 10/29/20

SSE06

Emergency Radiology (Non-Trauma: Brain, Head and Neck, and Spine)

Monday, Dec. 2 3:00PM - 4:00PM Room: E353A

ER HN NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Suzanne T. Chong, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose
Zachary S. Delproposto, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose

Sub-Events

SSE06-01 Diagnostic Accuracy and Impact on Clinical Patient Management of an Ultrafast 5 Min/5 Sequences Brain MRI Protocol in Acute Neurological Emergencies

Monday, Dec. 2 3:00PM - 3:10PM Room: E353A

Participants
Philipp M. Kazmierczak, MD, Munchen, Germany (*Presenter*) Nothing to Disclose
Max Duhrsen, Munchen, Germany (*Abstract Co-Author*) Nothing to Disclose
Maximilian Patzig, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
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Matthias Klein, Munchen, Germany (*Abstract Co-Author*) Nothing to Disclose
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Andreas Pomschar, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Wolfgang G. Kunz, MD, Munich, Germany (*Abstract Co-Author*) Grant, Medtronic plc
Daniel Puhr-Westerheide, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Sophia Stoecklein, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Olga Solyanik, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate sensitivity, specificity, and impact on clinical patient management of an ultrafast (5 min/5 sequences) brain MRI protocol for the detection of intracranial pathologies in acute neurological emergencies.

METHOD AND MATERIALS

449 consecutive emergency patients with acute non-traumatic neurological symptoms were evaluated for this IRB-approved prospective single center trial. 60 patients (30 female, 30 male, median age 61±19 years) with negative head CT were included and underwent emergency brain MRI at 3 Tesla subsequent to CT. MRI included the ultrafast protocol (Ultrafast-MRI; sag T1 GRE, ax T2 TSE, ax T2 TSE Flair, ax T2* EPI-GRE, ax DWI SS-EPI; TA 5 min) and an equivalent standard-length protocol (TA 15 min), which served as reference standard. Two blinded board-certified neuroradiologists independently analyzed the MRI data sets with regard to image quality (1-non-diagnostic, 2-poor/substantial artifacts, 3-satisfactory, 4-good/minor artifacts, 5-excellent/no artifacts) and intracranial pathologies. Sensitivity and specificity for the detection of intracranial lesions were calculated accordingly.

RESULTS

93 additional intracranial lesions (total: n=125; acute ischemia n=21, intracranial haemorrhage n=27, edema n=2, white matter lesion n=38, chronic infarction n=3, others n=2) were detected by Ultrafast-MRI (CT: n=32 lesions; standard-length protocol: n=133 lesions). Image quality was equivalent to the standard-length protocol (T2; Ultrafast-MRI: 3.95±0.221, standard-length protocol 4.02±0.227, p=0.083). Ultrafast-MRI demonstrated high diagnostic accuracy (sensitivity: 0.939 [0.881;0.972]; specificity 1.000 [0.895;1.000]) for the detection of intracranial pathologies and changed clinical patient management in 10 % (6/59).

CONCLUSION

In 5 min, Ultrafast-MRI including 5 standard sequences allows for the time-optimized diagnostic workup in acute neurological emergencies at high sensitivity and specificity compared to a standard-length protocol, with relevant impact on clinical patient management.

CLINICAL RELEVANCE/APPLICATION

Ultrafast-MRI represents a powerful and fast alternative to head CT for the detection and differential diagnosis of intracranial pathologies in acute neurological emergencies.

SSE06-02 Pitfalls of Automated ASPECTS: Initial Experience in a Tertiary Care Center

Monday, Dec. 2 3:10PM - 3:20PM Room: E353A

Awards
Trainee Research Prize - Fellow

Participants
Shobhit Mathur, MD, Vancouver, BC (*Presenter*) Nothing to Disclose
John P. Walsh, MBChB, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Omar Metwally, MBBCh, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Maria Zhu, MSc, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Nicolas Murray, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

PURPOSE

To compare the performance of automated ASPECTS provided by two software applications in acute stroke

METHOD AND MATERIALS

The non-contrast CT head studies of 91 consecutive patients referred with clinical suspicion of acute stroke were reviewed retrospectively by two observers and ASPECTS readings were made, first in an independent blinded fashion and later in consensus. A blinded consensus reading was also made on follow-up CT or MRI study (available for 67 patients) performed within 7 days. The observers then noted the readings from the software, also noting the possible cause of differences from the consensus readings.

RESULTS

The consensus human readings on the initial studies showed substantial correlation with automated results on the same studies from software package 1 ($r=0.613$, $p<0.001$) and software package 2 ($r=0.663$, $p<0.001$). The consensus human readings on follow up studies showed moderate to poor correlation with automated results on initial studies from software package 1 ($r=0.353$, $p<0.001$) and software package 2 ($r=0.428$, $p<0.001$). Segmentation errors, presence of extra-axial collections, anatomic asymmetry and chronic infarcts were common causes of misreadings by the softwares.

CONCLUSION

In our initial experience, although automated ASPECTS from both the softwares showed good correlation with human readings in acute stroke, they were moderate-poor predictors of final infarct volume.

CLINICAL RELEVANCE/APPLICATION

ASPECTS is a valuable tool in evaluation of acute stoke studies. The suggestions highlighted here would help ongoing improvement in the emerging machine learning based software applications in acute stroke imaging.

SSE06-03 Clinical Utility of Material Decomposition Algorithm on Unenhanced Dual-Energy Computed Tomography in the Detection of Acute Ischemic Infarcts

Monday, Dec. 2 3:20PM - 3:30PM Room: E353A

Participants
Sadia R. Qamar, MBBS, Vancouver, BC (*Presenter*) Nothing to Disclose
Nicolas Murray, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Bonnie Niu, BSC, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Gordon T. Andrews, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

For information about this presentation, contact:

Sadia.Qamar@vch.ca

PURPOSE

To determine the value of Dual-energy unenhanced computed tomography compared to standard unenhanced computed tomography in the detection of acute ischemic stroke.

METHOD AND MATERIALS

We retrospectively studied 70 patients presenting to the emergency department (ED) with clinical signs and symptoms of acute ischemic stroke who underwent an initial dual-energy CT head without intravenous (IV) contrast within the therapeutic window of 4.5 hours followed by a standard CT head without IV contrast within the next 24 hours. Three material decomposition algorithm to exploit the differences in the energy spectra of gray matter and white matter in an attempt to better visualize the cytotoxic edema associated with acute ischemic stroke was used. Alberta Stroke Program Early CT (ASPECT) scores were assigned on both of these initial and follow up CT heads. The studies were reviewed independently by two board-certified radiologists, blinded to the clinical information and patient outcome. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated.

RESULTS

Standard, brain edema and 24-hour ASPECT scores were calculated for 70 patients. Of these patients, 43 (61.4%) had acute infarctions. Three material decomposition algorithm with brain edema reconstructions were superior to predict the infarction volume keeping 24-hour follow-up standard noncontrast CT as a reference with ASPECTS score of 7.57 vs 7.6; p-value 0.05. Standard non-contrast CT head had a 80% sensitivity (95% confidence interval (CI), 51.3-95.7%), 73% specificity (95% CI, 42-94%), 80% PPV (95% CI, 51.3-95.7%), and 72.3% NPV (95% CI 51.7-95.66%). The DECT showed a 94.2% sensitivity (95% CI, 71.4-99.81%), 100% specificity (95% CI, 76.3-100%), 100% PPV (95% CI, 77.1-100%), and 92.3% NPV (95% CI 62.44-99.89%). The overall interobserver agreement was good (0.61-0.80).

CONCLUSION

DECT proves to provide a better estimate of the end-infarct volume when compared to the standard non-contrast CT head in acute ischemic stroke.

CLINICAL RELEVANCE/APPLICATION

Early detection of acute ischemic stroke is critical for the patient outcome. Non-contrast CT head is the initial imaging modality to estimate the infarct volume and assess prognosis. DECT with its three material decomposition application improves the visualization of edema in acute ischemic infarct compared to standard non-contrast CT head, thus improving diagnostic accuracy.

SSE06-04 Capability of a New Model-Based Iterative Reconstruction for Brain CT to Diagnose Acute Ischemic Stroke: Multicenter Study

Monday, Dec. 2 3:30PM - 3:40PM Room: E353A

Participants
Hidenori Mitani, Hiroshima, Japan (*Presenter*) Nothing to Disclose
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PURPOSE

We investigated the clinical capability of a newly developed model-based iterative reconstruction (MBIR) for brain CT to diagnose acute ischemic stroke.

METHOD AND MATERIALS

Of 211 patients admitted with suspected acute ischemic stroke at four participating institutes, 83 who had undergone brain CT within 24 hr post-onset and were diagnosed with acute ischemic stroke by diffusion-weighted MRI or follow up CT were enrolled. CT scanning was on a 320-detector CT instrument [Aquilion Genesis, Canon Medical Systems (CMS)]; 2-mm-thick slices were reconstructed with both hybrid IR [h-IR: AIDR 3D (FCXX), CMS] and newly-developed MBIR (Brain LCD, CMS). Two diagnostic radiologists consensually graded the visualization of ischemic areas (IAs) on all reconstructed images. Grade I = IA not visualized, grade II = IA barely visualized, grade III = IA visualized, and grade IV = IA clearly visualized. The contrast-to-noise ratio (CNR) of the IA vis-à-vis contralateral normal sites was calculated. The visualization grade and the CNR of scans subjected to MBIR and h-IR were compared using the Wilcoxon signed-rank test.

RESULTS

IA visualization grades I, II, III, and IV were assigned to 39-, 8-, 10-, and 26 of the 83 MBIR images, respectively, and to 40-, 16-, 13-, and 14 of the h-IR images. In 61 patients (73.5%) the visualization grade was the same with both reconstructions; in 22 (26.5%) it was higher with MIBR than h-IR. In no cases was h-IR superior to MBIR ($p<0.01$). The median CNR was 5.0 for MBIR [interquartile range (IQR) 2.6-8.5] and 1.2 (IQR 0.8-2.0) for h-IR ($p<0.01$).

CONCLUSION

The new MBIR algorithm was superior to h-IR with respect to IA visualization and the identification of low-density areas in patients with acute ischemic stroke.

CLINICAL RELEVANCE/APPLICATION

MBIR improved the diagnostic ability of brain CT to identify low-density areas in patients with acute ischemic stroke.

SSE06-05 One-Stop-Shop Imaging in Acute Ischemic Stroke: Clinical Application of Simultaneous Acquisition of Cardiac CT in a Potential Cardioembolic Stroke

Monday, Dec. 2 3:40PM - 3:50PM Room: E353A

Participants
Sadia R. Qamar, MBBS, Vancouver, BC (*Presenter*) Nothing to Disclose
Saira Hamid, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Gordon T. Andrews, MD, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
Savvas Nicolaou, MD, Vancouver, BC (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

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PURPOSE

To demonstrate the usefulness of performing simultaneous cardiac CT in patients undergoing CT head/ CTA arch to the vertex for acute ischemic stroke.

METHOD AND MATERIALS

We retrospectively analyzed one-year clinical data for all patients presenting with clinical suspicion of ischemic stroke categorized as hot stroke, per institutional policy. All of these patients underwent non-contrast CT head and multiphasic CT angiography from arch to the vertex as a standard hot stroke imaging protocol. This clinical data was further extracted for simultaneously performed

cardiac-gated coronary CTA during their initial presentation. Potential cardioembolic sources were identified and categorized into high and medium risk categories. Frequency and percentages were calculated. Furthermore, all of these positive stroke patients were evaluated for risk assessment based on (Coronary Artery Disease Reporting and Data System) CAD-RADS scoring system.

RESULTS

A total of 5227 patients underwent hot stroke imaging with 1405 positive patients. Out of these, 110 patients (7.82%) patients had their cardiac-gated coronary CTA performed during their initial presentation. Potential cardioembolic sources were identified in 53/1405 (3.77%) patients. High-risk causes included; myocardial infarction 1(1.88%), left atrial thrombus 1 (1.88%) , infective vegetation 1 (1.88%), non-infective vegetation (marantic) 1 (1.88%), prosthetic cardiac valves 7 (13.2%). Medium-risk causes included; patent foramen ovale 11 (20.75%), atrial septal defect 1 (1.88%), mitral valve prolapse 1(1.88%), valvular calcifications 11 (20.75%), mitral annular calcifications 14 (26.41%), and enlarged left atrium 4 (7.54%) patients. Three patients had both valvular and mitral annular calcifications. CAD-RADS categories were as follows; 0 in 43 (81.15%), 1 in 3(5.66%), 2 in 4(7.54%), 3 in 2(3.77%) and 4 in 1 (1.88%) patients.

CONCLUSION

We conclude that cardiac CT can reliably identify the potential sources in clinically suspected cardioembolic strokes and simultaneously provide the coronary artery risk assessment.

CLINICAL RELEVANCE/APPLICATION

Identification of the potential embolic sources in suspected cardioembolic strokes is vital for reducing patient's morbidity and mortality due to its early and late complications. Simultaneous acquisition of the cardiac CT with stroke imaging can act as a one-stop shop to detect these cardioembolic sources in selected patients.

SSE06-06 Fatal Intracerebral Hemorrhage Complicated With and Without Methamphetamine Poisoning: Can We Tell the Differences on PMCT?

Monday, Dec. 2 3:50PM - 4:00PM Room: E353A

Participants
Maiko Yoshida, MD, Chiba, Japan (*Presenter*) Nothing to Disclose
Yohsuke Makino, MD, Setagaya-ku, Japan (*Abstract Co-Author*) Nothing to Disclose
Masatoshi Kojima, RT, Chibashi, Japan (*Abstract Co-Author*) Nothing to Disclose
Takuro Horikoshi, MD, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose
Hiroki Mukai, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose
Shinya Hattori, MD, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose
Hajime Yokota, MD, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose
Hirotaro Iwase, Chiba, Japan (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The purpose of this study was firstly to assess the incidence of fatal hemorrhage complicated with methamphetamine (MA) poisoning and secondly to assess post-mortem CT (PMCT) feature of fatal intracerebral hemorrhage (ICH) with MA poisoning comparing its findings to those without MA poisoning in order to figure out whether the key findings exist to differentiate those 2 groups.

METHOD AND MATERIALS

Consecutive medico-legal autopsy data from November 2011 through February 2018 (n=3044)were searched, yielding 80 cases with non-traumatic fatal hemorrhage. In all cases, toxicological examination was performed. Among 80 cases, ICHs located on basal ganglia and brain stem were extracted and comparison of findings was performed between 2 groups; ICH with MA poisoning and ICH without MA poisoning. The frequency, age distribution, types of hemorrhage and PMCT findings were compared. Two board-certified radiologists with forensic experiences interpreted PMCT images.

RESULTS

; On MA poisoning group there were 9 ICH cases located on basal ganglia and brain stem (The median age was 51.88years), while there were 14 cases on non-MA poisoning group (The median age was 61.35years). There was statistically significant difference between the ages of those 2 groups (p=0.0094). On PMCT comparison, there were statistically significant differences on mid-line shift distance (mm) (only for basal ganglia) (p=0.0281) and volume of aortic valve calcification (p=0.0182), while there was no statistically significant difference on volume of hematoma, cardiothoracic ratio, circumference of ascending aorta and calcification of aortic wall.

CONCLUSION

Forensic radiologists should be aware the possibility of ICH with MA poisoning if massive hemorrhage on PMCT is detected. Younger age, calcification of aortic valve and remarkable mid-line shift could be the key.

CLINICAL RELEVANCE/APPLICATION

(dealing with Postmortem CT) "Using Postmortem CT with toxicological examination is recommended in the process of death investigation."

SSE07

Gastrointestinal (Hepatobiliary)

Monday, Dec. 2 3:00PM - 4:00PM Room: S404CD

GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Jonathan R. Dillman, MD, MSc, Cincinnati, OH (*Moderator*) Research Grant, Siemens AG; Research Grant, Guerbet SA; Travel support, Koninklijke Philips NV; Research Grant, Canon Medical Systems Corporation; Research Grant, Bracco Group

Sub-Events

SSE07-01 Differential and Prognostic MRI Features of Gallbladder Neuroendocrine Tumors from Adenocarcinomas

Monday, Dec. 2 3:00PM - 3:10PM Room: S404CD

Participants
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PURPOSE

To identify MRI features that are helpful for the differentiation between gallbladder (GB) neuroendocrine tumors (NETs) and adenocarcinomas (ADCs) and to evaluate their prognostic values.

METHOD AND MATERIALS

Between January 2010 and November 2018, we recruited 63 patients with GB NETs (n=21) and ADCs (n=42) who underwent MRI. Two radiologists independently assessed MRI findings and reached a consensus. Univariate and multivariate analyses were performed to identify significant differential MRI features of GB NETs from ADCs. Cox proportional hazard model was used to find prognostic MRI findings for overall survival (OS).

RESULTS

Compared to ADCs, NETs more frequently demonstrated the following MR features: well-defined margin, intact overlying mucosa, targetoid enhancement on contrast-enhanced images, and targetoid appearance on diffusion-weighted imaging (DWI) (Ps<0.001 for all). In addition, liver metastasis was more common (P<0.001) and had more conspicuous border (P=0.045). Lymph node (LN) metastasis tended to show higher N stage (P=0.006) and targetoid appearance on DWI (P=0.001). On quantitative analysis, the sizes of GB mass and metastatic LN in NETs was significantly larger than those of GB ADCs (P=0.003 and P=0.022, respectively). Median and mean follow-up periods were 16.0 months (range, 1-62 months) and 21.6 ± 17.6 months, respectively. GB NETs showed a significantly worse OS compared to ADCs (median OS, 12.0 months versus 44.0 months, P=0.005). Multivariate Cox regression analysis revealed that the presence of liver metastasis (hazard ratio (HR) 10.683, 95% confidence interval [CI]: 1.551-73.587) and a larger size of metastatic LN (HR 2.004, 95% CI: 1.189-3.377) were poor prognostic factors for OS.

CONCLUSION

There are several differential MR features of GB NETs from ADCs. GB NETs showed a significantly worse OS compared to GB ADCs and the presence of liver metastasis and a larger size of metastatic LN were associated with poor OS.

CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced MRI including diffusion-weighted imaging could be helpful for the differentiation of GB NETs from GB ADCs as well as for the prediction of patients' prognosis.

SSE07-02 Spleen and Liver Volumetry in Primary Sclerosing Cholangitis: Comparison to MELD Score in Predicting Liver Function

Monday, Dec. 2 3:10PM - 3:20PM Room: S404CD

Participants
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PURPOSE

To determine if liver and spleen volumes can predict liver dysfunction as defined by encephalopathy, variceal bleeding, Hepatorenal syndrome, and liver-related death in PSC patients and to compare the value of these volumes to MELD in predicting outcome.

METHOD AND MATERIALS

This IRB-approved, retrospective single center study included 166 PSC patients with at least one liver imaging study (MR/CT) between 2000 and 2018. Total liver(T), right(R) and left(L) lobes, caudate(C) and spleen(S) volumes were measured. The volumetric parameters were compared between patients with and without liver dysfunction, which was an adverse outcome, using Mann-Whitney U test. Spearman's test was performed to correlate the volumes to MELD. We used ROC analysis to test the accuracy of volumetric parameters to predict developing an adverse outcome and multiple logistic regression to find its independent predictors. Pvalue<0.05 was considered statistically significant.

RESULTS

Our cohort included 97 (58%) males with mean age of 43, with no significant differences in age between patients with and without liver dysfunction. Among 166 patients,35% didn't have adverse outcome,14% were dead and 37%,26%, and 3%, ended up with variceal bleeding, encephalopathy, and/or Hepatorenal syndrome, respectively. Patients with and without adverse outcome had significantly different absolute and ratio volumetry of S, L, and C ($p<0.05$). S, S/R, and ST/RR (n=155; 11 patients had splenectomy) with AUC of 0.729, 0.744, and 0.738, respectively, to differentiate patients with and without adverse outcome, correlated significantly with MELD with AUC of 0.714 (rho was 0.52, 0.53, and 0.53, respectively; $p<0.001$). S, L, C, L/T, C/T, S/T, S/L, S/R, ST/L2, ST/RR were potential predictors of adverse outcome in unadjusted univariate logistic model ($p<0.05$). In final adjusted model, ST/RR showed superior predictive value (OR=1.56; p=0.041) over MELD (OR=1.10; p=0.003).

CONCLUSION

Liver and spleen volumetric parameters could predict liver dysfunction in PSC. Using the volumes of T, R, and S could potentially improve the predictive value of MELD.

CLINICAL RELEVANCE/APPLICATION

MELD may fluctuate in patients with PSC due to recurrent cholangitis episodes. Increased MELD may result in un-necessary transplant workup, since it could be transient. Liver and spleen volumetry are less susceptible to transient fluctuations and may be better predictors for the need for liver transplantation.

SSE07-03 Balanced Steady-State Free Precession MRCP is a Robust Alternative to Respiration-Navigated 3D Turbo-Spin-Echo MRCP

Monday, Dec. 2 3:20PM - 3:30PM Room: S404CD

Participants
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PURPOSE

Despite synchronization to respiration, respiration-navigated (RN) 3D turbo-spin-echo MRCP is limited by susceptibility to motion artifacts. Aim of this study was to assess the quality of pancreaticobiliary duct visualization of a non-RN MRCP alternative based on balanced steady-state free precession imaging (BSSFP) with overlapping slices compared with RN-MRCP.

METHOD AND MATERIALS

This is a prospective study on 50 consecutive patients receiving MRCP at 1.5T without final diagnosis of pancreaticobiliary duct disease. We performed an intraindividual comparison of coronal RN-MRCP (thickness, 1.5 mm; interval, 1.5 mm) with combined coronal (thickness, 4 mm; interval, 1.6 mm) and transverse (thickness, 6 mm, interval, 2.4 mm) BSSFP-MRCP. Image quality was scored by 3 readers for 6 pancreaticobiliary duct segments (3 pancreatic, 3 biliary) using a 6-point scale (1, not completely depicted, 6, entirely depicted with excellent details). A segment score of 3 or lower as assessed by at least 2 of 3 readers was defined to indicate insufficient segment visualization. Wilcoxon nonparametric tests and assessment of interrater agreement were used for statistical analysis.

RESULTS

Overall duct visualization averaged over all readers was scored with 4.5±1.1 for RN-MRCP (pancreatic, 4.1±0.5; biliary, 5.0±0.4) and 4.9±0.9 for combined coronal and transverse BSSFP-MRCP (pancreatic, 4.6±0.6; biliary, 5.1±0.6), respectively ($p<0.001$). The number of segments visualized insufficiently was 48/300 for RN-MRCP and 11/300 for BSSFP-MRCP ($p<0.001$). Segments visualized insufficiently in RN-MRCP had a mean score of 4.4±0.8 in BSSFP-MRCP. The segment most frequently visualized insufficiently was the pancreatic tail for both RN-MRCP and BSSFP-MRCP. Overall interrater agreement on sufficiency of duct visualization was 0.78 (RN-MRCP, 0.85; BSSFP-MRCP, 0.71). Mean acquisition time was 98% longer for RN-MRCP (198.0±98.7s) than for combined coronal and transverse BSSFP-MRCP (100.2±0.4s).

CONCLUSION

Non-RN BSSFP-MRCP with overlapping slices is a fast alternative to RN-MRCP frequently providing sufficient duct visualization when

RN-MRCP fails.

CLINICAL RELEVANCE/APPLICATION

As an option for patients with poor breathing compliance, pancreaticobiliary duct visualization can be improved with BSSFP-MRCP in 51% of the acquisition time of RN-MRCP.

SSE07-04 MRI in Primary Sclerosing Cholangitis: Retrospective Review in Understanding the Evolution and Related Complications

Monday, Dec. 2 3:30PM - 3:40PM Room: S404CD

Participants
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PURPOSE

To study the incidence of PSC precipitated malignancy. To study the spectrum of MR imaging features in patients with primary sclerosing cholangitis and the incidence of related complications.

METHOD AND MATERIALS

Retrospective analysis of 350 patients with known PSC in whom routine and targeted screening with MRI liver done in our institution in the past 15 years was included in the study. Two abdominal radiologist retrospectively reviewed MR images in consensus. Imaging findings on bile ducts, dominant strictures, pattern of involvement of intra/extra hepatic bile ducts, hepatic fibrosis, changes in liver morphology, varices, gall bladder abnormalities, cholangitis was studied. The incidence of PSC preciptated malignancies was ascertained.

RESULTS

The incidence of dominant stricture was 11.4% (40 cases), in whom the biopsy did not reveal any underlying malignancy. Incidence of overlap syndrome was 0.8 %, while there was background cirrhosis in 8.5% ;hepatic parenchymal fibrosis in 4.2% cases; large varices in 2.8% ; and there was associated infective exacerbation due to cholangitis in 2.2% of cases. The incidence of cholangiocarcinoma was 1.4% (5 cases), non-hodgkins lymphoma was 0.8% (3 cases), gall bladder carcinoma in 0.2% (1 case). The frequency of screening and resource allocation in performing a follow up MRI had an average interval period of 14 months.

CONCLUSION

Understanding spectrum of imaging findings and related complications is important for progressing further clinical management in cases related to PSC. Although there is no sufficient guidelines recommending the time interval of MRI liver follow up that is required, an annual follow up irrespective of clinical or biochemical worsening is useful in ascertaining the temporal evolution of the disease.

CLINICAL RELEVANCE/APPLICATION

(dealing with PSC) ' MRI liver with MRCP is an excellent tool to depict the temporal evolution of PSC and related complications "

SSE07-05 Prediction of Tumor Recurrence and Poor Survival after Surgery of Ampullary Adenocarcinoma Using Preoperative CT Imaging, Clinical, and Histopathological Findings

Monday, Dec. 2 3:40PM - 3:50PM Room: S404CD

Participants
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PURPOSE

To predict tumor recurrence and poor survival in patients who underwent surgery for ampullary adenocarcinoma using preoperative CT imaging, clinical, and histopathological findings.

METHOD AND MATERIALS

In this retrospective study, 230 patients with ampullary adenocarcinoma who underwent preoperative CT and surgery were included. CT findings were assessed by two radiologists. Clinical characteristics and histopathological results such as CA19-9, CEA, T-, N-stage, histologic phenotypes; intestinal or non-intestinal (pancreatobiliary or mixed type), and resection status were investigated. Cox proportional hazard model and Kaplan-Meier method with log-rank test were used to find prognostic factors for recurrence free survival (RFS) and overall survival (OS). Also optimal cutoff value of tumor size was evaluated for oncologic outcomes and validated with internal cross validation

RESULTS

Median OS was 61.8 ± 37.4 and RFS was 54.3 ± 40.7 months. Tumor size on CT (odds ratio (OR) 1.045, 95% CI: 1.015-1.076, p=0.003), N-stage (OR 1.979, 95% CI: 1.271-3.081, p=0.003) and histologic differentiation (OR 2.437, 95% CI: 1.025-2.437 for

well-differentiated compared with moderate differentiation; OR 5.536, 95% CI 2.033-15.078 for moderate differentiation compared with poor differentiation, p<0.05) were important predictors of early recurrence. For poor survival, tumor size (OR 1.030, 95% CI: 1.001-1.061, p=0.042), papillary bulging (OR 0.633, 95% CI: 0.400-0.999, p=0.05), organ invasion (OR 1.855, 95% CI: 1.012-3.401, p=0.046) on CT scans, and N-stage (OR 2.808, 95% CI: 1.771-4.453, p<0.001) were important predictors of poor OS. Especially for tumor size, 2.65cm and 3.15cm were significant cutoff value for poor OS and RFS and it was validated internal cross validation (P<0.001). For tumor exceeding this cutoff value, median survival time were 22.5 months for OS and 8.4 months for RFS.

CONCLUSION

Both preoperative CT findings and histopathological results are useful to predict oncologic outcomes. Especially preoperative CT findings including tumor size, papillary bulging, and organ invasion were important for prediction early recurrence and poor survival.

CLINICAL RELEVANCE/APPLICATION

Combination of preoperative CT findings and histopathological results can be useful to predict patients' prognosis after surgery for ampullary adenocarcinoma. Especially for tumor size on CT, 2.65cm and 3.15cm were significant cutoff value for poor OS and RFS.

SSE07-06 CT Findings and Outcomes of Acute Cholecystitis: Is Additional Imaging Necessary?

Monday, Dec. 2 3:50PM - 4:00PM Room: S404CD

Participants
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PURPOSE

To evaluate the positive predictive value of CT for diagnosing acute cholecystitis when used as a first line imaging evaluation for working up abdominal pain and to assess if additional imaging with ultrasound studies add value to the diagnosis.

METHOD AND MATERIALS

CT imaging studies were evaluated in a retrospective study within a large US health system, which combines multiple academic centers with community centers. Final CT reports over a 25-month period were queried for abnormal gallbladder findings. Other relevant modalities performed within 24 hours of the initial CT were also included. Cases were tracked by chart review, and the clinical outcomes in each case were compiled to establish a final outcome or diagnosis. Surgical pathology or abnormal fluid aspirate analyses were treated as positive. Cases were stratified by the radiologist confidence level of each CT, and the positive and negative predictive values (PPVs and NPVs) were compared between different combinations of each modality.

RESULTS

Of the 468 CT imaging studies meeting criteria, 192 were read as probable or highly probable for acute cholecystitis on CT. The PPV for acute cholecystitis was 48% when no ultrasound was performed, compared to 57% when ultrasound was performed, which amounted to an insignificant gain (P = 0.1936). When subdivided into confidence levels, high confidence positive CTs demonstrated no significant change without ultrasound (67%) compared to ultrasound (65% in 'highly probable' impressions, 71% in 'probable' impressions). CT reads lower than 'highly probable' demonstrated potential gain from ultrasound; in the case of a 'probable' CT impression, PPV increased from 39% without ultrasound to 70% in the setting of a 'highly probable' ultrasound impression. In CT impressions negative for acute cholecystitis, there was no significant additive negative predictive value to ultrasound.

CONCLUSION

Based on current clinical practices within a large health system, CT examinations with either high or low suspicion for acute cholecystitis demonstrated no significant diagnostic gain from additional imaging with ultrasound. However, additional imaging may be of benefit when CT interpretations are less definitive but still suspicious for acute cholecystitis.

CLINICAL RELEVANCE/APPLICATION

This study identifies subclasses of CT interpretations regarding acute cholecystitis that would predict no additional diagnostic benefit from ultrasound imaging.

SSE08

Gastrointestinal (Esophagus and Stomach)

Monday, Dec. 2 3:00PM - 4:00PM Room: S404AB

CT GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Erik Soloff, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company
David J. Disantis, MD, Jacksonville, FL (*Moderator*) Nothing to Disclose

Sub-Events

SSE08-01 Radiogenomics for Epigenomic Data: Estimated Serum MicroRNA-1246 From Contrast-Enhanced CT Can Predict Prognosis of Esophageal Squamous-Cell Carcinoma

Monday, Dec. 2 3:00PM - 3:10PM Room: S404AB

Participants
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PURPOSE

Radiogenomics is a new field that provides clinically useful predictions of prognosis by linking the molecular characteristics such as genetic aberrations of malignant tumors with medical images. On the other hand, abnormal expression of serum microRNA has been reported as a prognostic factor of malignant and is thought to be a new biomarker. Using the technique of radiogenomics, we attempted to infer the degree of expression of microRNA in the serum of esophageal squamous-cell carcinoma (ESCC) patients.

METHOD AND MATERIALS

Serum miR-1246 expressions in 92 ESCC patients were evaluated by qRT-PCR. A radiologist delineated the volume of interest (VOI) within each tumor region on contrast-enhanced CT images. Using morphology, histogram and texture analyses, 45 imaging features (IF) in the VOIs were extracted. Features were selected according to correlation analysis between miR-1246 and each IF. A prediction model for miR-1246 was constructed using linear regression of selected feature with 10-fold cross-validation. A threshold of miR-1246 dividing into high and low expression groups was defined with ROC analysis. Survival analyses were performed using the log-rank test and Cox regression.

RESULTS

SHAPE_Compacity and NGLDM_Coarseness were selected as IF correlated with the expression of miR-1246 (real_miR-1246) ($r = 0.29$ and 0.30; $p = 0.004$ and 0.003) and were used to construct a prediction model. When applying the calculated threshold of Real_miR-1246 (=15.0) for the estimated miR-1246 expression (est_miR-1246), there was a significant difference between high and low expression groups ($p=0.003$) as well as real_miR-1246 ($p=0.001$). Real_miR-1246 was an independent predictor for overall survival on the multivariate test, whereas est_miR-1246 was also the same.

CONCLUSION

The close relation between expression levels of miR-1246 and IF such as SHAPE_Compacity and NGLDM_Coarseness were observed. Est_miR-1246 had similar power to predict prognosis of ESCC.

CLINICAL RELEVANCE/APPLICATION

Radiogenomic can predict genomic/epigenomic data strongly related to prognosis with low cost. This approach might proceed to accomplish precision medicine.

SSE08-02 Esophageal Cancer: Dual-Energy Spectral CT Quantitative Parameters for Preoperative Diagnosis of Metastatic Lymph Nodes

Monday, Dec. 2 3:10PM - 3:20PM Room: S404AB

Participants
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PURPOSE

To evaluate the diagnostic performance of quantitative parameters derived from dual-energy CT for the preoperative diagnosis of metastatic lymph nodes in participants with esophageal cancer.

METHOD AND MATERIALS

For this prospective study, dual-phase contrast agent-enhanced CT was performed in participants with esophageal cancer from June 2016 to May 2018. Quantitative dual-energy CT parameters were compared between metastatic and non-metastatic lymph nodes. The optimal cutoff value of metastatic node was determined using the receiver operating characteristic (ROC) curve analysis.

RESULTS

This study included 99 participants. A total of 51 lymph nodes were diagnosed as metastatic lymph nodes, and 45 lymph nodes were diagnosed as non-metastatic lymph nodes. Quantitative dual-energy CT parameters including iodine concentration (IC), normalized iodine concentration (ICN), slope of the spectral Hounsfield unit curve (λHu), normalized slope of the spectral Hounsfield unit curve (λHu-N) measured at venous phase were higher in metastatic than in non-metastatic lymph nodes ($P < 0.01$). The combined diagnosis was the best predictor of metastatic lymph nodes, with a threshold of 0.558, thus demonstrating 88.2% sensitivity, 93.2% specificity, and 90.5% accuracy ($P < 0.001$), with the area under ROC curve of 0.943.

CONCLUSION

Dual-energy CT is a complementary means for the preoperative identification of lymph nodes metastases in participants with esophageal cancer.

CLINICAL RELEVANCE/APPLICATION

Dual-energy CT could be used for the preoperative identification of lymph nodes metastases in participants with esophageal cancer.

SSE08-03 Real-Time MRI for Assessment of Gastroesophageal Reflux Disease: Comparison to pH-Metry and Impedance

Monday, Dec. 2 3:20PM - 3:30PM Room: S404AB

Participants
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Ulrike Streit, MD, Goettingen, Germany (*Abstract Co-Author*) Nothing to Disclose
Dirk Voit, Goettingen, Germany (*Abstract Co-Author*) Research collaboration, Siemens AG
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Jens Frahm, PhD, Goettingen, Germany (*Abstract Co-Author*) Inventor, Real-Time MRI Method
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PURPOSE

To evaluate the diagnostic potential of real-time MRI for assessment of gastroesophageal reflux disease in patients with GERD-like symptoms compared to pH-metry and impedance.

METHOD AND MATERIALS

Patients who underwent real-time MRI and pH-metry between 2015-2018 were included in this study. Real-time MRI at 3 Tesla was achieved by highly undersampled radial FLASH acquisitions with iterative image reconstruction by regularized nonlinear inversion. Real-time MRI visualized transit of pineapple juice through the gastroesophageal junction at rest and during Valsalva maneuver. MRI results were compared to 24-hour pH-metry to assess acid reflux (following Lyon Consensus guidelines), as well as to impedance to assess non-acid reflux. A standard 2x2 table was chosen to calculate diagnostic performance measures.

RESULTS

Of 93 eligible patients, 91 patients with GERD-like symptoms fulfilled inclusion criteria (male n=49; female n= 42; median age 55y). One patient was excluded due to pH-metry probe defect and one due to diagnosis of achalasia on real-time MRI. All MRI studies were successfully completed without adverse events at a median examination time of 15 minutes. Using real-time MRI, reflux was detected in 60 patients (66%). pH-metry revealed reflux in 41 patients (45%), and impedance in 54 patients (59%). Compared to pH-metry as reference, real-time MRI demonstrated sensitivity 0.82 (0.67, 0.93), specificity 0.47 (0.33, 0.62) and PPV 0.55 (0.42, 0.68). Due to the high number of false positive readings in this setting, a second scenario with assessment of acid as well as non-acid reflux was considered. Here, the reference standard was either positive reflux on pH-metry (indicating acid reflux) or a high number of reflux episodes during impedance (indicating non-acid reflux). In this scenario, real-time MRI sensitivity was 0.78 (0.66, 0.87), specificity 0.67 (0.45, 0.84) and PPV 0.87 (0.75, 0.94).

CONCLUSION

Real-time MRI is a fast and safe imaging method for assessment of gastroesophageal reflux in patients with GERD-like symptoms. Considering its high positive predictive value, real-time MRI can accurately identify patients in which further invasive testing with pH-metry and impedance might be considered.

CLINICAL RELEVANCE/APPLICATION

Real-time MRI is a novel imaging technique that allows for assessment of reflux in patients with GERD-like symptoms, showing a good correlation with established pH-metry and impedance measurement.

SSE08-04 Stratification of Gastrointestinal Stromal Tumors: Evaluation of Data Mining and Radiomics Features

Monday, Dec. 2 3:30PM - 3:40PM Room: S404AB

Participants
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Andrea Laghi, MD, Rome, Italy (*Abstract Co-Author*) Speaker, General Electric Company; Speaker, Guerbet SA; Speaker, Bayer AG; Speaker, Bracco Group; Speaker, Merck & Co, Inc
Federica Landolfi, MD, Rome, Italy (*Presenter*) Nothing to Disclose

PURPOSE

To develop and validate a decision tree model, based on texture features extracted from contrast enhanced multi detector computed tomography (MDCT), to discriminate between high and low risk gastrointestinal stromal tumors (GISTs) according to Miettinen's classification

METHOD AND MATERIALS

A population of 53 patients with proven GIST and subjected to MDCT of the abdomen were selected. All patients underwent surgical resection and histopathology was the gold standard. 30 texture features were extracted from MDCT images and 8 morphological features were identified by two expert radiologists. The population was split in two cohorts, one for training (32 patients) and one for validation (21 patients) of a random forest (RF) classifier. The training model was obtained after 100 iterations. All patients were stratified as higher risk (Miettinen's class moderate and high risk) or lower risk (Miettinen's class no risk, very low risk and low risk).

RESULTS

The model based on RF classifier algorithm correctly classified 16 (80%) patients (validation cohort) with a mean absolute error of 0.34%. The AUC for the identification of higher risk patients was 0.845 while for lower risk was 0.815. True positive rate was 80% while false positive rate was 20% for both classes (Higher and lower risk).

CONCLUSION

The RF model developed using texture and morphological features, obtained from MDCT images, provided a high accuracy (80%) for the identification of higher and lower risk patients according to Miettinen's classification. This approach can be considered as a potential tool for the non invasive staging of GISTs.

CLINICAL RELEVANCE/APPLICATION

Texture analysis and morphological computed tomograpy features can be considered as a potential tools for the non invasive staging of GISTs

SSE08-05 Noninvasive Evaluation of Esophageal Varices with Spleen Hemodynamics in Cirrhotic Patients: A Dual-Energy CT Study

Monday, Dec. 2 3:40PM - 3:50PM Room: S404AB

Participants
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PURPOSE

To evaluate noninvasively the degree of esophageal varices in cirrhotic portal hypertension patients with spleen hemodynamic parameters obtained using dual energy CT.

METHOD AND MATERIALS

Fifty patients with portal hypertension due to cirrhosis were retrospectively selected. These patients all had esophageal varices (EV) confirmed by endoscopy. Fifteen liver transplant donors were selected retrospectively as the control group. All patients underwent contrast-enhanced dual energy CT (DECT) scans. The iodine content in spleen (IC-S) in the portal venous phase, the splenic volume (Vol-S), and the diameters of splenic vein (D-SV) were obtained by two experienced radiologists on a DECT post-processing workstation and the iodine volume of spleen (IV-S) was calculated using the following formula: IV-S=IC-S×Vol-S. EV was classified into three groups according the results of endoscopy. The degree of Spearman correlation analysis was used to analyze the correlation between the EV degree and the above parameters. ANOVA was used to compare the differences of the above parameters among different EV groups. The ROC curve was used to analyze the diagnostic efficiency of the correlated parameters. $P<0.05$ was considered statistically significant.

RESULTS

There were positive correlations between the EV degree and Vol-S, D-SV, and IV-S , with the correlation coefficient between EV degree and IV-S the highest ($R=0.627$, $P<0.05$) among the three spectral CT parameters. The differences of the Vol-S, D-SV and

IV-S among different EV degree groups were statistically significant (all P<0.05). The ROC analysis showed that the area under the curve (AUC) with Vol-S, D-SV and IV-S were large. The diagnostic sensitivity and specificity were high using these parameters. The diagnostic specificity of using Vol-S was 96%.

CONCLUSION

The parameters, Vol-S, D-SV and IV-S, obtained in DECT, could be used to evaluate the severity of EV noninvasively.

CLINICAL RELEVANCE/APPLICATION

DECT parameters can be used to indicate the EV degree, predict the esophageal varices bleeding and learn the visceral hemodynamics.

SSE08-06 Is Surveillance CT or Ultrasound Necessary for the Detection of Extragastric Recurrence After Curative Surgery for Early Gastric Carcinoma?

Monday, Dec. 2 3:50PM - 4:00PM Room: S404AB

Participants
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Joon Koo Han, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the yield of follow-up abdomen CT and ultrasound (US) for the detection of extragastric recurrence after curative surgery for early gastric cancers (EGCs).

METHOD AND MATERIALS

In this single-institutional retrospective study, we enrolled 407 patients who underwent radical surgery for EGCs between January and December 2010 and who underwent post-operative surveillance with CT, US, and/or gastroscopy. All patients were followed up until February 2019. The primary outcome was post-operative CT or US detection of extragastric recurrence (i.e., distant or lymph node metastasis) which was not discovered with endoscopy. The secondary outcome was CT and/or endoscopic detection of gastric recurrence.

RESULTS

Mean and median follow-up periods were 64.1 ± 28.1 months and 66.0 months (range, 0-106 months), respectively. From a total of 3808 post-operative CT (2351 examinations) and US (1457 examinations), extragastric recurrence was detected only in two patients, with an incidence of 0.5% (2/407). One patient had extragastric recurrence at duodenal stump which was detected on CT at 23 months after subtotal gastrectomy for EGC (pT1bN0, poorly differentiated). The other patient had liver metastasis which was detected on CT at 10 months after subtotal gastrectomy for EGC (pT1bN0, moderately differentiated). There was no gastric recurrence detected with post-operative CT or US examinations. From a total of 1901 post-operative endoscopic examinations, two gastric recurrences were detected. These two gastric recurrences were detected at 18 and 61 months after subtotal gastrectomy, respectively. One gastric recurrence developed remote to the anastomosis site and the other recurred tumor was detected around the anastomosis site. Both gastric recurred lesions showed identical histologic types to those of the initial tumors.

CONCLUSION

Extragastric recurrence after curative surgery for EGC was very rare (0.5%, 2/407), but exclusively developed in patients with pT1b cancers. Therefore, post-operative surveillance with CT or US should be selectively performed in patients with a higher risk of recurrence.

CLINICAL RELEVANCE/APPLICATION

Considering a radiation risk and cost-effectiveness, post-operative surveillance with CT or US in patients who received gastrectomy for EGCs should be selectively performed in patients with a higher risk of recurrence.

SSE09

Gastrointestinal (Artificial Intelligence and Machine Learning)

Monday, Dec. 2 3:00PM - 4:00PM Room: N230B

AI CT GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Bhavik N. Patel, MD, Fremont, CA (*Moderator*) Speakers Bureau, General Electric Company; Research Grant, General Electric Company
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Sub-Events

SSE09-01 A Machine Learning Pipeline for Automatic Multi-Site-Vendor Quantitative MRI Analysis of the Liver

Monday, Dec. 2 3:00PM - 3:10PM Room: N230B

Participants
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PURPOSE

Quantitative MRI of the liver based on corrected T1, T2* and PDFF enables characterisation of liver state by providing information about fibro-inflammation, iron, and liver fat. This is often difficult and time-consuming challenge to the Radiologist, not least because heterogeneous disease and artefacts such as motion and field inhomogeneities. With of non-alcoholic fatty liver disease, this is increasingly more important, and in order to achieve a high throughput we have developed a machine learning pipeline to generate and automatically analyse quantitative MRI scans of the liver.

METHOD AND MATERIALS

We acquired 1347 MRI scans from 15 sites world-wide, including all major vendors at both 1.5T and 3T. All of the images were processed manually by trained clinical analysts who both performed manual delineation of the liver and selected regions of interest (ROIs) to quantify liver T1, T2* and PDFF. Using these manually generated segmentation masks, we trained a U-Net based deep learning method to automatically delineate the liver. Regions that exhibited poor model fit and artefacts in the MRI image were automatically identified and excluded. Next, in order to mimic ROI analysis performed manually, the unsupervised mask-SLIC algorithm with a trained classifier was used to define and detect the best regions based on quality metrics. In each case, the automatically calculated T2* value for the liver was used to produce an iron corrected T1 (cT1) map. Finally, a triaging step is used to identify low confidence cases for closer manual review.

RESULTS

The manually-placed ROIs were compared to those placed automatically. The difference between manual and automatic was -0.02+/-4.8 ms (T2*), 0.0+/-63 ms (cT1) and -0.1+/-1.9 % (PDFF). By automatically detecting poorer cases with triaging, the CI is reduced to -0.3+/-3.0 ms (T2*), -5.8+/- 30.1 ms (cT1) and -0.2+/-1.1 % (PDFF). These results were similar to the inter-rater variability measured in a smaller trial (-0.6+/-2.12 ms (T2*), 3.68+/-41.3 ms (cT1) and 0.48+/-1.77 % (PDFF)).

CONCLUSION

The automatic processing pipeline (based on machine learning) yields results that compare closely to those generated by manual processing.

CLINICAL RELEVANCE/APPLICATION

Automated analysis of quantitative maps has the potential to hugely increase the efficiency of evaluating challenging quantitative results, and to increase the viability of quantitative MRI analysis in standard clinical workflows.

SSE09-02 Development and Validation of a Deep Learning-Based Algorithm for Detecting Malignant Hepatic Lesions on Multi-Phase CT in Patients at High Risk for Hepatocellular Carcinoma

Monday, Dec. 2 3:10PM - 3:20PM Room: N230B

Participants
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PURPOSE

To develop and validate a deep-learning model for automatic detection of malignant hepatic lesions on multi-phase CT in patients at high risk for hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

In this retrospective study, 1350 multi-phase CT image series including pre-, arterial-, portal-, and delayed-phases in 1320 patients at high risk for HCC (1054 men and 296 women; mean age, 56.76 years; age range, 20-87 years) obtained between 2007 and 2016 were included. Focal hepatic lesions were labeled and annotated by five board-certified radiologists. Final diagnosis of focal hepatic lesions was confirmed either by pathologic results for suspicious malignant lesions or by follow-up imaging studies for benign lesions. The CT images were randomly split into a development set (761 CT series) and a validation set (589 CT series). The development set was further divided into 568 CT scans for training the deep learning based malignant hepatic lesion detection model and 193 CT scans for finding the operational parameter by using the jackknife alternative free-response receiver-operating characteristic (JAFROC) figure of merit (FOM) for per-lesion-based analysis. Diagnostic performances of the developed model were tested in the validation set as sensitivity and false positive (FP) rate per case.

RESULTS

A total of 1348 focal hepatic lesions (462 benign lesions and 886 malignant nodules including 825 HCCs and 61 non-HCC malignancies) in the development set and 809 focal hepatic lesions (415 benign lesions and 394 malignant nodules including 377 HCCs and 17 non-HCC malignancies) in the validation set were labeled. The operational parameter was selected by the JAFROC FOM and applying less than 3 FPs criteria. The detection performance of malignant hepatic lesions was 89 % of sensitivity and 2.54 FP rate in the validation set.

CONCLUSION

The deep learning-based system showed high diagnostic performance for detecting malignant hepatic lesions.

CLINICAL RELEVANCE/APPLICATION

Deep-learning based detection system has potential to be a promising tool to help radiologists to accurately detect focal hepatic malignancies on multi-phase CT.

SSE09-03 Evaluating Appropriate Role of Artificial Intelligence in Preoperative Abdomen CT Assessment for Living Donor Liver Transplants (LDLT)

Monday, Dec. 2 3:20PM - 3:30PM Room: N230B

Participants
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Bharat Aggarwal, MBBS, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

In LDLT, assuring appropriate graft size via evaluation of liver and segmental volumes is a major predictor of safe, successful outcomes. The analysis comprises of two key steps: 1. Segmentation of liver and hepatic vascular structures, and 2. Liver Resection to calculate graft and remnant volumes. Here we aim to study preoperative LDLT assessment using 3 different approaches: A: Fully Manual (Hepatic anatomy is segmented by manual contouring followed by manual resection), B: AI with Manual Resection (Hepatic anatomy is automatically segmented using AI and a radiologist resects manually), and C: Fully Automated (Hepatic anatomy is automatically segmented and resected by AI with no radiologist intervention).

METHOD AND MATERIALS

Our developed AI system comprised of 3 CNN models trained on 324 triphasic contrast-enhanced CTs and validated on 100 CTs from multiple institutions for liver and veins segmentation and middle hepatic vein (MHV) classification. For automated resection (C), we sample points from the MHV and IVC to draw a resection plane and return the graft and remnant volumes. 100 retrospective abdomen CT scans with preoperative analysis done were extracted from a large tertiary hospital. 6 studies were excluded due to incomplete information. On the remaining 94 CTs, the graft and remnant volumes were generated for A, B, and C. Intraoperative surgical weights were collected for comparison as ground truth.

RESULTS

We measured the variance of graft volume for A, B, and C against intraoperative surgical weight. B has the least overall variance of 9.14%, followed by C (9.32%) and A (10.62%) on 94 cases. A close correlation (variance < 5%) with the weight was seen in 40 cases using C as compared to 39 cases using B and 32 cases using A. Fig 1 shows the boxplot of the variance of A, B, and C.

CONCLUSION

Amongst the 3 approaches for LDLT analysis, AI with Manual Resection (B) and Fully Automated (C) give the best results, with B displaying the least overall variance.

CLINICAL RELEVANCE/APPLICATION

While AI can automate routine mundane tasks such as hepatic structure segmentation, an AI system coupled with expert intervention is poised to deliver better outcomes in Liver Transplant Planning.

SSE09-04 AI For Detecting Serrated Polyps in CT Colonography

Monday, Dec. 2 3:30PM - 3:40PM Room: N230B

Participants
Janne J. Nappi, PhD, Boston, MA (*Presenter*) Royalties, Hologic, Inc Royalties, MEDIAN Technologies
Tomoki Uemura, MS,BA, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the performance of AI in automated detection of serrated polyps in CT colonography (CTC).

METHOD AND MATERIALS

A total of 101 CTC cases with biopsy-confirmed serrated polyps were collected from a prospectively acquired database of patients enrolled in a CTC screening program. The patients were prepared for the CTC examination with saline laxative and fecal tagging by 250 ml barium sulfate and 60 ml of iodine-based diatrizoate. The CTC data were acquired using a section collimation of 1.25 mm with 1-mm reconstruction interval, noise index of 50, 30-150 mA, and 120 kVp. Polyps were detected from the CTC datasets automatically by use of an AI algorithm that was designed to detect the contrast-coating phenomenon of serrated polyps in combination with a 3D-convolutional neural network. For pilot evaluation, the detection accuracy of the AI algorithm was evaluated by use of 10-fold per-patient cross validation.

RESULTS

There were 144 serrated polyps >=6 mm in size: 76 polyps were >=10 mm and 68 polyps were 6-9 mm in size. Sixty-six (46%) of the polyps were flat lesions. Contrast coating was visible on 131 (91%) of the polyps. The average per-polyp detection sensitivity was 93±7% at 0.8±1.8 false-positive (FP) prompts per patient on average. The average per-patient sensitivity for polyps >=10 mm (for polyps 6-9 mm) was 94±9% (96±7%) at 0.1±0.2 (0.6±1.9) FPs per patient on average.

CONCLUSION

The contrast coating of serrated polyps provides an effective biomarker for AI to detect serrated polyps at a high sensitivity in CTC.

CLINICAL RELEVANCE/APPLICATION

Serrated polyps were recently discovered to represent a new pathway into colorectal cancers. Current CADe systems have not been designed to detect serrated polyps.

SSE09-05 Machine Learning-Based Ultrasomics Improved Diagnostic Performance in Differentiating Focal Nodular Hyperplasia and Atypical Hepatocellular Carcinoma

Monday, Dec. 2 3:40PM - 3:50PM Room: N230B

Participants
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PURPOSE

To investigate whether machine learning-based ultrasomics of contrast enhanced ultrasound (CEUS) can improve the diagnostic performance in differentiation of focal nodular hyperplasia (FNH) and atypical hepatocellular carcinoma (aHCC).

METHOD AND MATERIALS

A total of 226 focal liver lesions, including 107 aHCC and 119 FNH underwent CEUS, were reviewed retrospectively. For machine

learning-based ultrasomics, 3,132 features were extracted from images of baseline, arterial and portal phases respectively. An ultrasomics signature was generated by using the least absolute shrinkage and selection operator (LASSO) logistic regression model. Predictive model was developed using the support vector machine trained with following groups: (i) ultrasomics features, (ii) radiologist's score, (iii) combination of ultrasomics and radiologist's score. The area under the curve (AUC) of operating characteristic was used to explore their performances. The clinical usefulness was assessed by decision curve analysis (DCA).

RESULTS

Fourteen ultrasomics features were selected to build an ultrasomics signature, and they presented good performance in the differentiation of FNH and aHCC with an AUC of 0.860, sensitivity of 76.6%, and specificity of 79.0%. The model trained with combination of ultrasomics and radiologist's score had a significantly higher AUC (0.927) than radiologist's score (AUC: 0.840, $P < 0.001$). Adding an ultrasomics signature into radiologist's feature score significantly improves the accuracy of the model in differentiating FNH from aHCC. DCA demonstrated that the combination of ultrasomics and radiologist's score model had the highest net benefit compared with both the other models.

CONCLUSION

The machine learning-based ultrasomics is as good as the staff radiologist in predicting the differential diagnosis of FNH and atypical HCC. Incorporating ultrasomics signature into radiologist's score improves the diagnostic performance in FHN and aHCC.

CLINICAL RELEVANCE/APPLICATION

Adding an ultrasomics signature into radiologist's feature score can significantly improve the accuracy of the model in discrimination of FNH and aHCC.

SSE09-06 Texture Analysis and Machine Learning for Quantification of Liver Fibrosis in MRI: Correlation with MR Elastography and Histopathology

Monday, Dec. 2 3:50PM - 4:00PM Room: N230B

Participants
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PURPOSE

To assess the diagnostic accuracy of texture analysis (TA) derived parameters of T1w in-phase (ip) and T2w fat-saturated (fs) images in comparison to MR elastography (MRE) for the diagnosis of liver fibrosis using a machine learning approach.

METHOD AND MATERIALS

Routine liver MRIs including MR elastography (MRE) of 79 patients (mean age 48 years, range 18 - 71) with suspected or known chronic liver disease, performed between 2015 and 2018, were retrospectively analyzed. Two readers performed TA measurements using an open-source software (MaZda, v. 3.20). Gray-level normalization was performed with the TA software by rescaling the histogram data to fit within μ-gray-level mean ± 3 standard deviations. The regions-of-interest were set manually on axial T1w ip and T2w fs images according to the MRE analysis by two independent readers. Histopathology of liver biopsy (n=78) or resection (n=1) served as reference standard. The patients were categorized into no or low grade fibrosis (0-2) and advanced fibrosis (3-4) groups. The data was split in a 2/3 ratio of model derivation and 1/3 ratio for validation. Machine learning based prediction of liver fibrosis was evaluated by calculating the AUC using a support vector machine (SVM) combined with previously implemented principal component analysis (PCA).

RESULTS

For feature selection, TA features with an intraclass correlation coefficient < 0.8 were excluded from further analysis. For further dimensional reduction PCA with two principal components was implemented. On axial T1w ip, a classification accuracy of 92% and 75% for fibrosis groups 0-2 and 3-4 was achieved, respectively, with K=10 folds using an SVM radial basis function (RBF) kernel. On axial T2w fs, a classification accuracy of 62% for both fibrosis groups (0-2 and 3-4) was achieved. The AUC for TA on T1w ip was similar to MRE (0.82 vs. 0.92, P=0.4066), while the AUC for T2w fs was significantly lower compared to MRE (0.57, p=0.0075).

CONCLUSION

Liver fibrosis levels can be assessed with TA-derived parameters of T1w ip images using a TA and machine learning approach with similar accuracy compared to MRE.

CLINICAL RELEVANCE/APPLICATION

T1w ip images, which are part of routine liver MRI, can serve as an alternative to assess liver fibrosis levels when MRE is not available.

SSE10

Gastrointestinal (Small Bowel, Crohn Disease)

Monday, Dec. 2 3:00PM - 4:00PM Room: N229

GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Joel G. Fletcher, MD, Rochester, MN (*Moderator*) Grant, Siemens AG; Consultant, Medtronic plc; Consultant, Takeda Pharmaceutical Company Limited; Grant, Takeda Pharmaceutical Company Limited; ;

Sub-Events

SSE10-01 Comparison of a Simplified MR Index of Activity With and Without Gadolinium for Assessing Luminal Disease and Therapeutic Response in Patients with Crohn's Disease

Monday, Dec. 2 3:00PM - 3:10PM Room: N229

Participants
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PURPOSE

Recent concerns on repeated use of gadolinium (Gd) increased the interest in determining if it could be avoided to assess inflammation in Crohn's disease (CD). The aim of this study is to compare the accuracy and the reliability of MRE for detecting activity and response to treatment using a simplified MRE index with and without Gd-enhanced sequences.

METHOD AND MATERIALS

We prospectively included patients with CD that presented at least one intestinal segment with active and severe inflammation at endoscopy (segmental CDEIS >8.5 or presence of ulcers). The accuracy of the simplified MaRIA (sMaRIA) and its responsiveness was determined at baseline and after 46 weeks of treatment with biological drugs. Endoscopy (CDEIS) was considered the gold standard. The sMaRIA was read independently by two readers, at first using non-Gd- enhanced sequences (set 1: T2-w and DWI), and after 1 month of washout using the full set of images (set 2: T2-w, DWI and T1-Gd-enhanced images). An adjudicator solved differences between readers.

RESULTS

Data from 50 patients at baseline were available and 270 intestinal segments were explored by both MRE and ileocolonoscopy. Of them, 39 patients had MRE and ileocolonoscopy at week 46. On a segment-by-segment analysis, at baseline, both sets 1 and 2 had similar sensitivity (86% vs. 89%; p=0.6) and specificity for detecting activity (92% vs. 93%; p=0.6) and similar sensitivity (87% vs. 85%; p=0.99) and specificity (95% vs. 94%; p=0.5) for detecting severe inflammation. Both sets were similarly accurate for detecting endoscopic ulcer healing (sMaRIA<2) after 46 weeks of treatment (85% vs. 91% p=0.45). Intraclass-correlation between set 1 and set 2 were similar at baseline (0.82 vs. 0.85 p=0.45) and also after treatment (0.74 vs. 0.67 p=0.13). The correlation of magnitude of changes between CDEIS and sMaRIA was moderate and significant using both sets (r=0.73 [95IC: 63-82]; p<0.001 for set 1; and r=0.69 [95IC: 56-79]; p<0.001 for set 2).

CONCLUSION

The sMaRIA can be applied without the use of gadolinium maintaining high accuracy and reliability for both detection and grading luminal inflammation and therapeutic response.

CLINICAL RELEVANCE/APPLICATION

In patients with Crohn's disease MRE without the use of gadolinium may detect active luminal disease and changes after treatment maintaining high accuracy and reliability.

SSE10-02 Role of Supplementary Anal Imaging in Magnetic Resonance Enterography in Crohn's Patients Not Suspected to Have Perianal Fistula

Monday, Dec. 2 3:10PM - 3:20PM Room: N229

Participants
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Jong Seok Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To prospectively evaluate the role of brief anal scan supplementary to magnetic resonance enterography (MRE) in Crohn's disease (CD) patients not suspected to have perianal fistula.

METHOD AND MATERIALS

Between June 2012 and December 2017, we added a brief anal scan to MRE in 451 consecutive adults who were diagnosed with or suspected of CD and were not suspected to have perianal fistula. Images were examined for the presence of perianal tracts; if present, colorectal surgeons reexamined the patient. Patients were followed-up to determine if and when they underwent surgery for perianal fistula/abscess. The diagnostic yield of anal MR imaging for detecting perianal tracts, associated factors, and natural history of MR-detected asymptomatic perianal tracts were determined. Multivariable analysis was performed.

RESULTS

A total of 440 CD patients (mean age±SD, 29.6±8.9 years; 345 men and 95 women) were analyzed. On anal MR, 12% (53 patients; 95% CI, 9.3-15.4%) showed perianal tracts. Reexamination by the surgeons was unremarkable and required no additional treatments in all patients. The tracts were mostly single unbranched (83%), inter-sphincteric (72%), and showing a linear dark signal at the tract margin (79%). Younger age at MRE, female sex, and higher CD activity index score were independently associated with detection of perianal tracts on anal MR. Presence of MR-detected asymptomatic tracts was an independent risk factor for future surgery for perianal fistula/abscess: 17.8% cumulative incidence at 37 months and an adjusted hazard ratio of 3.457 (95% CI, 1.103-10.836; P=0.033).

CONCLUSION

The diagnostic yield of supplementary anal MR was 12%. The MR-detected asymptomatic tracts did not require additional treatments, mostly showed findings of chronicity or healing, but were an independent risk factor for future anal surgery.

CLINICAL RELEVANCE/APPLICATION

The supplementary anal MR may have a role in the early identification of CD patients who are at risk of perianal complications and may help direct more attention to their management.

SSE10-03 A Novel Diffusion Kurtosis Imaging-Based Nomogram for Assessment of Bowel Fibrosis in Patients with Crohn's Disease

Monday, Dec. 2 3:20PM - 3:30PM Room: N229

Participants
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Yitao Mao, Changsha, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To develop a prediction model based on magnetic resonance imaging (MRI) variables for individualized assessment of bowel fibrosis in patients with Crohn's disease (CD) using surgical histopathology as a reference standard.

METHOD AND MATERIALS

Thirty-one consecutive patients (eighty-one bowel specimens) with CD undergoing conventional MRI and diffusion kurtosis imaging (DKI; b values, 0-2000 s/mm2) preoperatively were recruited as a test set. We observed T2-weighted signal intensity and enhancement pattern on conventional MRI, and measured the apparent diffusion coefficient (ADC) from monoexponential model, apparent diffusional kurtosis (Kapp), and apparent diffusion for non-Gaussian distribution (Dapp) from non-Gaussian DKI model. Histologic fibrosis was graded as non-to-mild and moderate-to-severe. Multivariate logistic regression analysis was performed to identify risk factors to be included into the nomogram to characterize the degree of bowel fibrosis. Its performance was validated on nine new patients (eighteen bowel specimens) with CD.

RESULTS

Significant differences in Kapp (P<0.001), Dapp (P<0.001), and ADC (P<0.001) were found between non-to-mildly and moderately-to-severely fibrotic bowel walls but not in T2WI signal intensity (P=0.210) or enhancement pattern (P=0.748). A strong correlation of histologic fibrosis scores with Kapp (r=0.604, P<0.001) was found, which was followed by Dapp (r=-0.491, P<0.001) and ADC (r=-0.270, P=0.015). Independent factors derived from multivariate logistic regression analysis to assess degree of bowel fibrosis were Kapp, Dapp on DKI. Internal and external validation revealed good performance of the nomogram with concordance index of 0.901 (95% confidence interval 0.824-0.978) and 1.000, respectively, for differentiating non-to-mild from moderate-to-severe fibrosis. The calibration plot reveals a strong agreement between actual and predicted probability of bowel fibrosis.

CONCLUSION

We developed and validated a DKI-based prediction model for the non-invasive assessment of bowel fibrosis in patients with CD. This tool is helpful for individualized treatment decision-making.

CLINICAL RELEVANCE/APPLICATION

The DKI-based prediction model can noninvasively assess bowel fibrosis in patients with CD and is beneficial to individualized treatment decision-making.

SSE10-04 Quantification of Crohn's Disease Activity Using Semiautomated Dual-Energy CT Enterography Derived Iodine Density: Correlation with Crohn's Disease Activity Index (CDAI)

Monday, Dec. 2 3:30PM - 3:40PM Room: N229

Participants
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PURPOSE

To correlate iodine density derived from dual-energy CT enterography (DECTE) with clinical Crohn's disease (CD) activity.

METHOD AND MATERIALS

Twenty patients with CD, imaged with DECTE from 2/2016-5/2018, and available CDAI determinations were retrospectively identified. Using prototype software, 8 manual contours spaced at 45 degree increments were drawn along the mucosa of the entire length of affected bowel segments on curved MPRs created from low kV data (80kV n=17, 90kV n=3). These were then superimposed on the corresponding 150kV data for iodine density calculation at each point along the contours. The software allows the determination of iodine density at specific points, the percentage of iodine density values in specified ranges (1-2mg I/mL, 2-3mg I/mL, etc) and average iodine density along the entire affected segment. Average iodine density across each entire segment was compared to CDAI values. Patient specific iodine density histograms showing percentage of iodine density values within the affected segment were created.

RESULTS

Sixteen patients had clinically active CD (CDAI>150); 4 patients had clinically inactive CD. 13/16 clinically active patients had the greatest percentage of elevated iodine density within the affected segment at least 2-3 mg I/mL with 2 patients in the 3-4 mg I/mL range (average iodine density 2.35±1.0mg/mL). Three clinically active patients had the highest percentage of iodine density only within the 1-2 mg I/mL range, indicating radiologically quiescent disease (average iodine density 1.43±0.49mg/mL, P=0.0016). Two clinically inactive patients had peak iodine density 2-3mg I/mL, indicating radiologically active disease (average iodine density 2.29±0.61mg/mL, compared with 1.84±1.44mg/mL for radiologically inactive disease P=0.18). The average iodine density of active and inactive appearing CD involved bowel were 2.34±0.36mg/mL and 1.60±0.30mg/mL, respectively (P=0.0006). Iodine density maps demonstrated heterogeneous involvement, discriminating between segments with similar average iodine density values. Median effective dose was 4.56±1.68 (2.03-8.12) mSv.

CONCLUSION

Iodine density from DECTE can be used as a biomarker of CD activity. The distribution of iodine density provides additional information about disease activity and complements clinical indices such as CDAI.

CLINICAL RELEVANCE/APPLICATION

Average and regional iodine density from DECTE can be used as a biomarker of CD activity.

SSE10-05 Evaluating the Inflammatory Activity in Crohn's Disease Using Magnetic Resonance Diffusion Kurtosis Imaging

Monday, Dec. 2 3:40PM - 3:50PM Room: N229

Participants
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Ke Wang, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose
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Xiaoyun Leng, Wuhan , China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To explore the feasibility of diffusion kurtosis imaging(DKI) for evaluating inflammatory activity in Crohn' s disease(CD).

METHOD AND MATERIALS

In all, 51 CD patients were included, who were performed with consecutive enteroscopy, MR and DKI(b values = 0 - 2000 mm2/s). The lesions of bowel segments were graded as inactive(0-2), mild(3-6), and moderate-severe group(>6) based on simplified endoscopic activity score for Crohn's disease(SES-CD). To compare the ability of the parameters of DKI and DWI in grading different activity lesions.

RESULTS

127 bowel segments including inactive(15), mild(45) and moderate-severe(67) were analyzed. ADC(r = -0.627, P <0.001), Dapp(r = -0.381, P < 0.001) and Kapp(r = 0.641, P < 0.001) were correlated with SES-CD. These parameters were significantly different among the three groups(all P <0.001). ROC analysis found ADC had the highest accuracy(AUC = 0.884, P < 0.001) to differentiate inactive from active group with the threshold at 0.865×10-3 mm2/s, which was slightly higher than Kapp(AUC = 0.867, P < 0.001) with the threshold at 0.645, and was obviously higher than Dapp(AUC = 0.726, P = 0.005). Similarly, ADC also had the highest accuracy(AUC = 0.846, P < 0.001) to differentiate inactive-mild from moderate-severe group with the threshold at 0.825×10-3 mm2/s, and minimally higher than Kapp(AUC = 0.843, P < 0.001) with the threshold at 0.695, and obviously higher than Dapp(AUC = 0.690, P < 0.001).

CONCLUSION

DKI is feasible and comparable to conventional DWI for the evaluation of inflammatory activity in CD.

CLINICAL RELEVANCE/APPLICATION

DKI, as a method for non-invasive non-invasive assessment of free diffusion of water molecules, is not only applied to grade lesions activity about Crohn's disease, but able to provide more useful information about lesion. What's more, DKI, the same as DWI, can be an alternative to contrast-enhanced for pediatric patients or renal failure patients.

SSE10-06 Interobserver Variation in the Interpretation of Enteric Ultrasound for Crohn's Disease

Monday, Dec. 2 3:50PM - 4:00PM Room: N229

Participants
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PURPOSE

Quantifying interobserver variability is an important part in evaluating medical imaging. To date there has been little research into interobserver variability in enteric ultrasound (US) across multiple observers

METHOD AND MATERIALS

The study utilised patients recruited to a prospective trial comparing the diagnostic accuracy of MRE and US for CD (newly diagnosed or relapsing) across 8 hospitals. A construct reference standard (multidisciplinary panel diagnosis) was used in the trial, incorporating 6 months of patient follow up. 38 patients (11 new diagnosis, 27 relapse) from 2 recruitment sites underwent repeat US examinations on the same day performed by 2 practitioners from a pool of 7. Practitioners were blinded to each other's interpretation, patient's symptoms and previous disease history, and documented the presence and location of small bowel and colonic disease. Data was analysed separately for the new diagnosis and relapse cohorts. Interobserver variability was measured using percentage agreement with the consensus reference standard across the 2 reads, grouped as disease positive or negative. Prevalence adjusted bias adjusted kappa (PABAK) was also reported. Agreement between the radiologists irrespective of agreement with the reference standard was also calculated.

RESULTS

In the new diagnosis cohort, the overall percentage agreement for small bowel disease presence against the consensus reference was 82% (52-95% (95%CI)) with a kappa coefficient (κ) of 0.64, (substantial agreement). Agreement for colonic disease presence was 64%, κ of 0.27 (fair agreement). In the relapse cohort, agreement for small bowel disease presence was 81%, κ of 0.63 (substantial agreement). Agreement for colonic disease presence was 78%,κ of 0.56 (moderate agreement). Simple agreement between practitioners was higher when disregarding correspondence with the consensus reference, (84% and 87% for small bowel and colonic disease presence respectively).

CONCLUSION

Based on data from a multi-reader, multicenter prospective trial, there is substantial agreement between practitioners for the presence of small disease against an independent standard of reference

CLINICAL RELEVANCE/APPLICATION

Compared to an independent standard of reference there is substantial agreement between practitioners for the presence of small bowel disease on US, supporting wider dissemination.

SSE11

Genitourinary (New Techniques in Pelvic Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: S502AB

GU

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Harriet C. Thoeny, MD, Fribourg, Switzerland (*Moderator*) Nothing to Disclose
Claudia P. Huertas, MD, Medellin, Colombia (*Moderator*) Nothing to Disclose

Sub-Events

SSE11-01 CT Virtual Hysterosalpingography: Impact on Radiation Dose and Discomfort Regarding Physicians Experience in Performing the Study

Monday, Dec. 2 3:00PM - 3:10PM Room: S502AB

Participants
Patricia M. Carrascosa, MD, Buenos Aires, Argentina (*Abstract Co-Author*) Research Consultant, General Electric Company
Carlos Capunay, MD, Buenos Aires, Argentina (*Presenter*) Nothing to Disclose
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PURPOSE

CT-Virtual hysterosalpingography (CT-VHSG) is a good non-invasive method to evaluate the complete gynecologist system. It allows to detect intraluminal pathology in the cervix, uterus and fallopian tubes. The image acquisition lasts few seconds and it does not produce discomfort in the majority of the patients. The objective of this paper is to determine the importance of the physicians experience in performing CT-VHSG regarding radiation dose and discomfort.

METHOD AND MATERIALS

A group of women with infertility were studied with 64,128 and 256 Multi-detector CT scanners. Technical parameters were slices 0.6 mm width, mAs: 100-200, kV: 80-120, scan length:10 cm. They were adapted according to patients size . Half of the patients were performed by a 4th year resident (Group A) and the other half by an experienced radiologist (> 10 years) (Group B). Different issues were evaluated: • Level of discomfort classified in 4 grades: no discomfort, mild, moderate or severe discomfort. • Total number of acquisitions to perform an accurate diagnosis. • Total radiation dose received by the patients. • Total duration time since the patient enters until she leaves the CT room • Patients containment during the procedure by the physician: they were asked to answer if they felt emotionally comprehended.

RESULTS

Patients of Group A presented higher number of scans (2,6) to perform an adequate diagnosis giving more radiation dose to the patients (1,3 mSv). Eighty percent presented no or mild discomfort and only 65% replied that they felt a good containment during the procedure. Total time to perform the study: 28+/-11 minutes Contrary patients from Group B ninety one percent had no or mild discomfort during the procedure. A mean of 1,3 acquisitions were performed per patient with a mean radiation dose of 0,52 mSv. Regarding containment during the study 92% considered being emotionally comprehended. Total time to perform the study 22+/- 6 minutes.

CONCLUSION

It is important the physicians experience to perform the CT-VHSG Experienced radiologists performed a better tolerated study (no or mild discomfort in the majority of the patients), gave significant lower radiation dose and carried out a quicker study. Additionally and very important, patients answered in a higher percentage they felt emotional supported during the complete procedure.

CLINICAL RELEVANCE/APPLICATION

CT-Virtual hysterosalpingography as a method to evaluate the gynecologist system.

SSE11-02 Combination Between the Retrograde Urethrogram and the Virtual Urethroscopy as Urethral Structure Screening Profile: An Inexpensive Imaging Diagnostic Tool Compared to the Urological Urethroscopy in the Evaluation of the Male Anterior Urethra

Monday, Dec. 2 3:10PM - 3:20PM Room: S502AB

Participants
Ching Hsien Huang Liu, MD, Santo Domingo, Dominican Republic (*Presenter*) Nothing to Disclose
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PURPOSE

To analyze the feasibility of the combination of the retrograde urethrogram and the virtual urethroscopy (urethral ultrasound) as urethral stricture screening profile due to their inexpensive cost compared to the urological urethroscopy, furthermore, in order to avoid the use of the invasive urethroscope as the initial diagnostic imaging tool.

METHOD AND MATERIALS

A total of 21 patients were included. The correlation of the localization between two methods was carried out. We also analyzed the feasibility of the measurement about the spongiofibrosis's extension and the resulted stenosis percentage.

RESULTS

9 of 21 patients presented findings of urethral stricture with a total of 10 strictures. Significant correlation was found between both modalities regarding the localization of the narrowing in the anterior urethra, there was a correlation in 100% of the cases of the anterior urethra stricture (95% confidence level, p: <0.05). It was evidenced that 100% of the cases of the anterior urethra narrowing detected by conventional retrograde urethrogram, all showed spongiofibrosis with the realization of urethral ultrasound. We realized, that the measured diameter of the permeable portion of the affected lumen can be converted to the French catheter scale in order to avoid the use of the invasive urethroscope for the measurement.

CONCLUSION

The urethral stricture screening profile is useful as the initial approach and follow-up for patients with diagnosis or suspicion of urethral stricture.

CLINICAL RELEVANCE/APPLICATION

The urethral stricture screening profile is a minimally invasive and inexpensive tool compared to the invasive urethroscope as a diagnostic tool. That means, the conventional urethroscope as an invasive diagnostic tool, should not have any major diagnostic role in the anterior urethra narrowing until the patient makes the decision to accept any surgical intervention in order to evaluate the urethral mucosa.

SSE11-03 Clinical Role of Translabial Ultrasound in Midurethral Mesh Complications

Monday, Dec. 2 3:20PM - 3:30PM Room: S502AB

Participants
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PURPOSE

To determine if transperineal or translabial ultrasound assists in clinical management,surgical decision and planning in patients with midurethral sling complications.

METHOD AND MATERIALS

This is a retrospective study enrolling consecutive patients who underwent midurethral sling insertion, presented to urology clinic for urologic symptoms, and received translabial ultrasound. The presenting symptoms, including pain, dysuria, dyspareunia, recurrent urinary tract infection, urinary frequency, urinary urgency and nocturia were documented. This descriptive data also includes the postoperative outcome (pain, incontinence), location of erosion in the operative finding to determine if translabial ulltrasound assisted in clinical management, surgical decision and planning..

RESULTS

48 patients were identified from 2010 - 2018 inclusive with midurethral sling complications. 26 patients had retropubic procedure, 14 patients had transobturator procedure, 2 patient had both and 6 patients were unable to recall their surgical history. More than half of our patients suffered from pain, recurrent urinary infection, urinary urgency, nocturia and urinary incontinence. 36 patients underwent surgery, 23 erosions were found at urethra(11), bladder(6) and vagina(6). 25 patients were pain-free after the surgery. In chart review, 25 ultrasound studies helped with surgical decision, furthermore 17 ultrasound studies were of assistance in identifying the location of the complication

CONCLUSION

Translabial ultrasound is helpful in clinical and surgical planning in patients with midurethral sling related complications.

CLINICAL RELEVANCE/APPLICATION

Translabial ultrasound is important to perform prior to clinical and surgical planning for patients with midurethral sling complications.

SSE11-04 Endometrial Total Choline Levels on 1H MR Spectroscopy Predict High-Risk Group for Nodal Metastasis and Reflect Underlying Tissue Choline Metabolism

Monday, Dec. 2 3:30PM - 3:40PM Room: S502AB

Participants
Gigin Lin, MD, Taoyuan, Taiwan (*Presenter*) Nothing to Disclose
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Chiao-Yun Lin, Taoyuan, Taiwan (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To investigate and characterize the values of endometrial total choline levels on 1H MR spectroscopy in predicting high-risk group for nodal metastasis, with tissue metabolomics and biochemistry corroboration.

METHOD AND MATERIALS

1H MR spectroscopy using external phase array coil was prospectively conducted in 353 consecutive endometrial cancer patients at 3 Tesla (T) to evaluate tumor choline levels in vivo (δ 3.2 ppm), according to their nodal metastasis status (n=10, 11, 236 in stage N2, N1, N0, respectively). Endometrial tumors were further analyzed (n=81) using a 600MHz high-resolution nuclear magnetic resonance (NMR) system to correlate the tissue levels of choline-related metabolites-free choline, phosphocholine (PC) and glycerophosphocholine (GPC). We corroborated the expression of a key enzyme in choline metabolism-endometrial carcinoma differential 3 (EDI3). Statistical methods included Mann-Whitney U test, Kruskal-Wallis H test, logistic regression and Pearson's correlation. A P value < 0.05 was considered a significant statistical difference.

RESULTS

Total choline levels were significantly higher in endometrial cancers with nodal metastasis (N2: 14.93±6.23mM, N1: 6.20±2.42mM, N0: 6.04±0.60mM, mean ± standard error of mean, P = .039), measured using in vivo MR spectroscopy. Elevated choline levels on MR spectroscopy significantly increased the risk of para-aortic lymph node metastasis (odds ratio 1.06; 95% confidence interval 0.99-1.13, P = .046). Changes of choline on MR spectroscopy significantly correlated with the tissue levels of GPC (r = 0.322 P = .002), but not PC (P = .588) nor free choline (P = .697). The key enzyme in choline metabolism EDI3 overexpressed in tumors from endometrial cancer with nodal metastasis (P = .040).

CONCLUSION

Increased endometrial total choline levels on 1H MR spectroscopy depicted high-risk cancer group for nodal metastasis, supported by increased tissue GPC levels and overexpression of EDI3.

CLINICAL RELEVANCE/APPLICATION

MR spectroscopy using external phase array coil has potentials to add dimensions of clinical phenotyping to guide treatment and predicting nodal metastasis for women diagnosed with endometrial cancer.

SSE11-05 Characterization of Brown Adipose Tissue in PCOS Patients by Z-Spectrum Imaging (ZSI)

Monday, Dec. 2 3:40PM - 3:50PM Room: S502AB

Participants
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PURPOSE

Given that the majority of patients with polycystic ovary syndrome (PCOS) demonstrate obesity and chronic insulin resistance and targeting brown fat represents a novel treatment strategy for metabolic diseases, the purpose of the study is to characterize brown adipose tissue (BAT) in PCOS patients in comparison to healthy subjects using MR Z-spectral imaging (ZSI).

METHOD AND MATERIALS

ZSI data were collected on 19 normal control females (NCF, 24-34 years old), 17 males (NCM, 22-35years old), and 13 PCOS patients (female, 20-33 years old) with a CEST saturation pulse of 1 μT, 200 ms long and fast spin echo readout. Z-spectral data were fitted with multiple Lorentzian curves to quantify the direct saturation of water and fat. Fat water fraction (FWF) maps were then computed based on the fitted amplitudes of water and fat direct saturation. FWF thresholds were prescribed for the differentiation and segmentation of white adipose tissue (WAT), BAT, or Muscle (Figure). At last, two parameters were extracted from the analysis: the average FWF value within the segmented BAT (FWF(BAT)) and the fraction of BAT over the total fat depot, defined as BATf=BATarea/ (BATarea+WATarea). The two parameters were compared among the 3 study groups and correlated to subjects' BMI.

RESULTS

FWF(BAT) correlated linearly with BMI in healthy subjects, whereas there was an inverse correlation between BATf and BMI (Figure). The PCOS group had higher FWF(BAT) than the NCF group (P<0.001), while the BATf of the PCOS group was smaller than the controls (P<0.001). The FWF(BAT) of the NCF group was found to be higher than the NCM group (P<0.05), while there was no significant difference between male and female in BATf (Figure).

CONCLUSION

Normal subjects with higher BMI show less BATf and have increased FWF(BAT), indicating relatively higher level of metabolic passive WAT depot and relatively reduced metabolism in their BAT depots. PCOS patients have the least BATf and the highest FWF(BAT), suggesting decreased BAT mass and function in PCOS.

CLINICAL RELEVANCE/APPLICATION

MR Z-spectral imaging has been demonstrated to noninvasively identify and characterize BAT mass and function in PCOS patients,

providing insights on the comorbidities mechanism, diagnosis, and treatment of PCOS.

SSE11-06 Comparative Role of Retrograde Urethrography (RGU) and Sonourethrography (SUG) in Anterior Urethral Structures

Monday, Dec. 2 3:50PM - 4:00PM Room: S502AB

Participants
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Rajul Rastogi, MD, Greater Noida, India (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Sonourethrography (SUG) has starting earning clinical acceptance over Retrograde Urethrography (RGU) recently for evaluation of anterior urethral strictures. Conspicuous delineation of stricture as well as periurethral region is possible with SUG obviating radiation exposure. Urethral management primarily depends upon site & length of stricture, presence or absence of spongiofibrosis and distraction of urethral segments. Hence, this prospective pilot study aims for determining: • Comparative role of RGU & SUG in evaluation of anterior urethral strictures. • Comparative role of RGU & SUG in predicting management of anterior urethral strictures

METHOD AND MATERIALS

Fifteen patients with suspected anterior urethral strictures referred to our department were evaluated by RGU after instilling optimal amounts of non-ionic contrast agent per urethram followed by filming at 45 degrees oblique position with the ipsilateral lower limb flexed at hip & knee joints and penis stretched parallel to leg. SUG was performed with a high-resolution, linear-array transducer through penile & transperineal technique after instillation of sterile gel per urethram followed by soft, penile tip clamp. Data related to site & length of stricture, presence or absence of spongiofibrosis and any other associated abnormality will be recorded in both RGU & SUG.

RESULTS

SUG detected spongiofibrosis in addition to the accurate length of stricture required for management in 5 patients out of fifteen affecting the mode of management

CONCLUSION

SUG is an accurate imaging tool in anterior urethral strictures that not only complements RGU but also affect the mode of management thus affecting the prognosis of the patient, hence should be a routine procedure in all patients with positive findings on RGU

CLINICAL RELEVANCE/APPLICATION

Since SUG is an effective tool for evaluating anterior urethral strictures in males, it should be performed routinely prior to decision making for the mode of managment thus reducing the morbidity associated with the disease

SSE12

Genitourinary (Scrotum and Bladder)

Monday, Dec. 2 3:00PM - 4:00PM Room: S505AB

GU

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sebastian Feuerlein, MD, Tampa, FL (*Moderator*) Nothing to Disclose

Sub-Events

SSE12-01 Qualitative and Quantitative Multiparametric Ultrasound Evaluation of Focal Testicular Lesions

Monday, Dec. 2 3:00PM - 3:10PM Room: S505AB

Participants
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Maria E. Sellars, MD, FRCR, London, United Kingdom (*Abstract Co-Author*) Speaker, Bracco Group; Speaker, Samsung Electronics Co, Ltd
Paul S. Sidhu, MRCP, FRCR, London, United Kingdom (*Abstract Co-Author*) Speaker, Koninklijke Philips NV; Speaker, Bracco Group; Speaker, Hitachi, Ltd; Speaker, Siemens AG; Speaker, Samsung Electronics Co, Ltd; Advisory Board, Samsung Electronics Co, Ltd; Advisory Board, Itreas Ltd

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PURPOSE

To evaluate the diagnostic accuracy of multiparametric ultrasonography (MP-US), consisting of gray-scale US, color Doppler US (CDUS), strain elastography (SE), and contrast-enhanced US (CEUS) in the assessment of focal testicular lesions.

METHOD AND MATERIALS

166 MP-US examinations for testicular focal lesions performed between 2009 and 2017 were analysed. SE was performed to assess tissue elasticity, and hard lesions were defined as malignant. CDUS and CEUS were performed to determine lesion vascularity. Avascular lesions were defined as benign. Qualitative and quantitative CEUS assessments with time-intensity curves analysis were performed for vascular lesions. Histopathologic results or follow-up of a minimum of 6 months served as reference standards. Sensitivity, specificity, and positive and negative predictive values, and accuracy of benign or malignant classification were calculated.

RESULTS

Of the 166 MP-US examinations, 108 revealed benign (lesions size = 10.66 +/- 10.15 mm) and 58 malignant (lesion size = 23.82 +/- 14.01mm) diagnosis. Single-modality sensitivities, specificities, PPV, NPV and classification accuracies were 91.38%, 52.78%, 50.96%, 91.94%, and 66.27% for CDUS; 100%, 42.59%, 48.33% and 100% and 62.65% for CEUS; 86.96%, 35.90%, 44.44%, 82.35% and 54.84% for SE respectively. Used in combination, MP-US improved accuracy of classification to 70.16%. The feature of prolonged hyperenhancement on qualitative CEUS assessment is statistically significant ($p = 0.012$) in differentiating seminoma and Leydig cell tumors (LCT), the two largest histological sub-types of benign and malignant vascular neoplasms. Quantitative CEUS analysis reveals a more rapid inflow rate for LCT when compared to seminoma ($p = 0.002$).

CONCLUSION

We demonstrated that used in combination, advanced US techniques improved accuracy of classification. In addition, the additional features of absence of prolonged enhancement and a more rapid inflow on qualitative and quantitative CEUS further differentiate between benign vascular LCT and malignant seminoma.

CLINICAL RELEVANCE/APPLICATION

Multiparametric US improves accuracy of pre-operative classification of testicular lesions for avoiding unnecessary orchiectomies and for testis-sparing strategies to be implemented.

SSE12-02 The Value of Whole Tumors Volume-Based ADC Histogram Analysis for Differential Diagnosis in Testicular Germ Cell Tumors

Monday, Dec. 2 3:10PM - 3:20PM Room: S505AB

Participants
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PURPOSE

Germ cell tumors are the most common tumors in the testis, which are further divided into seminoma and nonseminogenic germ cell tumors, which are quite different in metastasis, treatment, and prognosis. seminoma is very sensitive to radiotherapy and chemotherapy, most prognosis is good. Nonseminogenic germ cell tumor is more invasive than seminoma, and which has poor response to radiotherapy.Purpose of this study to is explore the value of whole tumors apparent diffusion coefficient (ADC) gray histogram analysis or differential diagnosis in testicular germ cell tumors.

METHOD AND MATERIALS

The date of 43 patients pathologically confirmed of testicular germ cell tumors was analysis retrospectively. Among them, there were 22 cases of seminomas germ cell tumors, 21cases of nonseminomatous germ cell tumors(NSGCTs)(5 cases of mixed germ cell tumors, 6 cases of Embryonal carcinoma, 2 cases of Yolk sac tumors, 8 cases of Mature teratoma). Retrospectively draw the region of interest(ROI)in the ADC maps of two groups on each layer of tumor level by using Mazda software and analyze the gray histogram, including mean, variane, kurtosis, skewness, pere.01%, pere.10%, pere.50%, pere.90%, pere.99%. The statistical analysis was performed on the histogram parameters to find out the different characteristics between the two groups, and the ROC curve was drawn to evaluate its diagnostic efficacy for two groups tumors.

RESULTS

Through histogram analysis of 9 parameters, these 7 parameters were statistically significant (all $p<0.05$), including mean, variane, kurtosis, pere.10%, pere.50%, pere.90%, pere.99%.The largest AUC of the ROC curve to differentiate two groups was pere.10%, the AUC was 0.866, the sensitivity was 81.0%, the specificity was 90.9%.

CONCLUSION

The ADC gray histogram analysis based whole tumors is helpful for the diagnosis to preoperatively differentiate seminomas from NSGCTs.

CLINICAL RELEVANCE/APPLICATION

MRI features has become the primary method for preoperative diagnosis of testicular germ cell tumors. However, testicular seminoma is similar to nonseminogenic germ cell tumor in MRI manifestations. For example, the age of onset, tumor capsules, the characteristics of uniform signal and uneven enhancement. The global histogram analysis can reflect the overall data of each layer of the lesion ROI, which can better reduce the sampling error caused by delineating the local global ROI, which may be more reliable and accurate.

SSE12-03 Value of Dixon-MRI in the Localization of Non Palpable Undescended Testes with Laparoscopic Correlation - A Preliminary Study

Monday, Dec. 2 3:20PM - 3:30PM Room: S505AB

Participants
Mohamed S. Shaaban, Alexandria, Egypt (*Presenter*) Nothing to Disclose
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PURPOSE

To study the potential value of Dixon MRI in localization of the non-palpable undescended testes and correlation with the laparoscopy

METHOD AND MATERIALS

This is a prospective study conducted upon patients with non-palpable undescended testes referred to the MRI unit to localize the undescended testes in the period between August 2018 and April 2019. Each patient was subjected to 3T MRI examination including conventional sequences of T1 TSE, T2 TSE, STIR, and DWI, in addition to T2 DIXON sequence with generated in-phase/out-of-phase, fat only, and water only images. Images were reviewed by two independent radiologists for the location of the undescended testes in Dixon images and conventional MRI each separated. Laparoscopic exploration was done for all patients to determine the site of the testes.

RESULTS

The current study was conducted upon 15 patients. Ages ranged from 2 months to 26 years. Eight patients had clinically non-palpable testes on the left side (47.1%), 6 had non-palpable testes on the right side (35.3%), and 3 patients had non palpable testes bilaterally (17.6%), giving a total of 20 non-palpable undescended testes. Laparoscopy could not localized 4 testes (20%), while 5 testes were found in the pelvis (25%), 5 testes were found in the right inguinal region (25%), 4 testes were found in the left inguinal region (20%) and 2 ectopic testes in the scrotal neck (10%). Conventional MRI was able to correctly localize 11 testes (55%) but failed to localize 9 (45%). The located testes were 4 in the left inguinal region (20%), 4 in the right inguinal region

(20%), 2 in the left scrotal neck (10%), and one intra-pelvic testis (5.0%). On Dixon technique using water-only and fat-only images; 4 were not detected (20 %), the located testes were 5 intra-pelvic (25.0%), 5 right inguinal (25%), 4 left inguinal (20.0%), and 2 in the scrotal neck (10%). Using laparoscopy as gold-standard, conventional MRI had a sensitivity of 68.7%, Specificity of 100%, NPV of 44.4%, PPV 100%, and accuracy of 75%. On the other hand, Dixon technique scored 100% in its sensitivity, specificity, NPV, PPV, and accuracy.

CONCLUSION

Dixon technique is a promising tool for more accurate localization of the non-palpable undescended testes compared to the conventional MRI

CLINICAL RELEVANCE/APPLICATION

Dixon technique offers potential inclrease in the accuracy of MRI in the localization of undescended testes

SSE12-04 Implementation of mpMRI and VI-RADS for High-Risk Non-Muscle Invasive Bladder Cancer (NMIBC) Candidate for Secondary Trans-Urethral Resection (Re-TURBT): Preliminary Results form a Prospective Single-Center Experience

Monday, Dec. 2 3:30PM - 3:40PM Room: S505AB

Participants
Martina Pecoraro, MD, Roma , Italy (*Presenter*) Nothing to Disclose
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PURPOSE

To prospectively evaluate the use of mpMRI with VI-RADS to identify patients with high-risk NMIBC could potentially avoid unnecessary Re-TURBT.

METHOD AND MATERIALS

Two-hundred and twenty-two patients with newly suspected bladder lesions (at ultrasound, CT scan and/or cystoscopy) were prospectively enrolled and underwent mpMRI before Photodynamic Diagnosis (PDD) assisted TURBT. All patients eligible for Re-TURBT with high-risk NMIBC, absence of carcinoma in situ at multiple random intraoperative biopsies and absence of upper urinary tract lesions at preoperative CT scan were included in the study. Exclusion criteria were: diagnosis of muscle-invasive bladder cancer (MIBC) at first TURBT, low-risk NMIBC, absence of detrusor muscle in TURBT specimen, incomplete or doubt about completeness during initial resection, non-urothelial carcinomas. Correlation analysis was performed to compare results of TURB and Re-TURBT with VI-RADS score of pre-operative mpMRI.

RESULTS

Thirty nine (17.4%) patients with MIBC, 67 (30%) with low-risk NMIBC, 16 (7.1%) with no detrusor in the specimen and 6 (2.6) with incomplete or doubtful resection were excluded. A total of 95 high-risk NMIBCs who underwent TURBT and Re-TURBT were included in the final analysis. Median age was 63 (range 45 - 68). At Re-TURBT 84 (88.4%) patients reveled absence of cancer in the specimen and among them 81 (96.4%) were diagnosed with VI-RADS 1-2 lesions. Among the 8 (8.4%) patients diagnosed as MIBC, 7 (87.5%) were diagnosed with preoperative VI-RADS 3-5. Four (4.2%) showed persistent high-risk disease, all of whom presenting at first TURBT with multifocal and large tumor dimensions (i.e. > 3cm). A good correlation was demonstrated (Pearson's r = 0,71, $p<0.05$) between preoperative VIRADS score and re-TURBT histological reports.

CONCLUSION

Implementation of mpMRI in the pre-TURBT setting is reliable in differentiating MIBC from NMIBC. Selected patients with high-risk NMIBC and VI-RADS score 1-2 have a low risk of being understaged and could therefore avoid Re-TURBT.

CLINICAL RELEVANCE/APPLICATION

The use of Multiparametric MRI and the VI-RADS score might further stratify the category of high risk patients with non invasive bladder cancer that should undergo Re-TURBT.

SSE12-05 Radiomics Prediction of Detrusor Muscle Invasion in Bladder Cancer Based on Multiparametric MR Imaging

Monday, Dec. 2 3:40PM - 3:50PM Room: S505AB

Participants
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PURPOSE

To explore a radiomics approach for the preoperative prediction of muscle invasion in bladder cancer (BCa).

METHOD AND MATERIALS

This retrospective study involved 121 BCa patients from two clinical centers with different MR scanners. The datasets from one of the two centers were used for model training and the other for independent testing. A total of 1404 features were extracted from the largest possible tumorous regions of interest (ROIs) by manual delineation in preoperative multiparametric MR images, including T2-weighted (T2W), diffusion-weighted (DW) and apparent diffusion coefficient (ADC) images. Support vector machine-based recursive feature elimination (SVM-RFE) approach was used to determine an optimal feature subset with the training group to construct a model for predicting muscle invasion of BCa. Then the performance of the proposed model was quantitatively evaluated by the testing group.

RESULTS

Of the 1404 features extracted from T2W, DW and ADC images, an optimal subset containing 31 features was selected and confirmed with the best area under the curve (AUC) of receiver operating characteristic, which consists of 11 features from T2W images, 13 features from DW images and 7 features from ADC maps, and used to construct the prediction model. Its averaged accuracy and AUC after 100-round classifications with 10-fold cross-validation were 93.31%, 0.9778 (95% CI: 0.9771, 0.9782) in the training group, and 88.10%, 0.9475 (95% CI: 0.9463, 0.9486) in the validation group, respectively.

CONCLUSION

With the radiomics signature selected from multiparametric MRI features, especially the features from DW images, the proposed prediction model is an effective tool for preoperative prediction of muscle invasion in BCa patients.

CLINICAL RELEVANCE/APPLICATION

Clinical management of bladder cancer is mainly determined on the basis of distinguishing non-muscle invasive (stage T1 or lower) from muscle invasive ones (stage T2 or higher) because the treatment options differ considerably. MRI is the best imaging modality for the noninvasive evaluation before surgery. With the radiomics signature selected from multiparametric MRI features, a prediction model can be established, which can be used as an effective tool for preoperative prediction of muscle invasion in BCa patients.

SSE12-06 MDCT Urography for Prediction of Pathologic Complete Response after Neoadjuvant Chemotherapy in Muscle-Invasive Bladder Cancer: Diagnostic Performance Using 5-Point Grade and Comparison with RECIST Criteria

Monday, Dec. 2 3:50PM - 4:00PM Room: S505AB

Participants
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PURPOSE

The purpose of this study was to investigate imaging criteria based on urothelial phase CT (UP CT) for evaluation of the complete response after neoadjuvant chemotherapy (NACT) in patients with muscle-invasive bladder cancer (MIBC) and to compare its diagnostic performance with the current response evaluation criteria in solid tumors (RECIST).

METHOD AND MATERIALS

A total of 50 patients were included who underwent NACT and subsequent radical cystectomy for MIBC between January 2017 and February 2019. UP CT findings after NACT were divided into five grades [UP grades] as follows: grade 1, no bladder wall thickening or inner layer enhancement; grade 2, thin inner layer enhancement without bladder wall thickening; grade 3, inner layer enhancement with low-attenuated wall thickening; grade 4, enhancing wall thickening; and grade 5, nodular enhancement or enhancing soft tissue. Two radiologists independently evaluated UP grades. An experienced reader separately assessed the treatment response per RECIST criteria. Area under the Receiver-operating-characteristic curve (AUC) was used to evaluate the diagnostic performance of UP grades and RECIST criteria to predict complete pathologic response. To determine the optimal cutoff of the UP grades, sensitivity, specificity, PPV, NPV, and accuracy were assessed. Interreader agreement of UP grades was assessed using a weighted kappa coefficient.

RESULTS

Sixteen patients (32%) were confirmed as pathologic complete response. The AUCs of UP grades were 0.89 (95% CI, 0.77, 0.96) and 0.87 (95% CI, 0.75, 0.95) in both readers, which showed a significant increase over the AUC of RECIST criteria (0.65; 95% CI, 0.50, 0.78). Using grade 1 or 2 as a criterion of clinical complete response, the sensitivity, specificity, PPV, NPV, and accuracy were 75.0%, 85.3-88.2%, 70.6-75.0%, 87.9-88.2%, and 82.0-84.0% in both readers. Interreader agreement for UP grade was substantial (K=0.78).

CONCLUSION

Grading system using UP CT may show better diagnostic performance than the conventional size-based RECIST criteria with high interreader agreement. No or thin inner layer enhancement without bladder wall thickening may indicate pathologically complete response after NACT in MIBC.

CLINICAL RELEVANCE/APPLICATION

A grading system based on urography CT can be useful for assessment of treatment response following neoadjuvant chemotherapy.

SSE13

Health Service, Policy and Research (Trends and Utilization)

Monday, Dec. 2 3:00PM - 4:00PM Room: E261

HP SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Aran M. Toshav, MD, New Orleans, LA (*Moderator*) Speakers Bureau, Koninklijke Philips NV
Kathryn Lowry, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company

Sub-Events

SSE13-01 Medical Radiation Exposure of Patients in the United States

Monday, Dec. 2 3:00PM - 3:10PM Room: E261

Participants
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PURPOSE

This work reports the medical radiation exposure of patients in the United States. The report is an update 10 years after the publication of NCRP report 160 (2009) and is focused on 2016 data for radiation doses to patients from medical exposures.

METHOD AND MATERIALS

Data on the type & number of procedures were obtained from a number of sources including commercial surveys, the US Medicare billing data, & other governmental & regulatory agencies, professional societies & published literature. Data on effective dose (E) per procedure were obtained from UK National Radiation Protection Board, International Commission on Radiological Protection (ICRP), American College of Radiology, State & Federal surveys & peer-reviewed literature. E was used as a dose metric & since E requires use of "tissue weighting factors" (wt) defined by ICRP Publications 60 (1990) and 103 (2007), E was computed using wt based on ICRP 60 & 103 to allow for comparison with previous reports. E-60 was computed for 2006 data & 2016 data & E-103 was computed for 2016 data for various sources of medical radiation. The collective effective dose (S) was estimated using different ICRP wt values, referred to as S-60 & S-103, & represented as percentages of collective doses for various modalities.

RESULTS

The largest contributor of collective dose is CT. In 2016, there were nearly 84 million CT scans (25% higher than the previous report). The US population was 323 million in 2016, so the estimated annual individual effective dose (E-US 60 and E-US 103) from CT was ~1.4 to 1.5 mSv. In 2016, there were nearly 13.5 million nuclear medicine procedures (20% decrease from previous report). The estimated E-US 60 and E-US 103 from nuclear medicine was ~0.41 to 0.32 mSv.Collective effective dose (S) was also computed for radiography & fluoroscopy & for cardiac and non-cardiac interventional fluoroscopy.

CONCLUSION

The 2016 estimates for S & E-US indicate a decline of ~15-20% from 885,000 (2006) to 717,000 & 755,000 person-Sv (S-103 & S-60) and approximately from 3.0 (2006) to 2.3 & 2.2 mSv (E-US 60 & E-US 103) respectively.

CLINICAL RELEVANCE/APPLICATION

This report provides insight into the radiation exposure of patients in the United States and describes changes compared to the previous decade. These changes may be due to radiation dose optimization efforts, technological innovations and education and awareness about patient exposure.

SSE13-02 Trends and Independent Predictors of Imaging Utilization in Stroke: A Nationwide Analysis of

Emergency Department and Inpatient Encounters between 2006 and 2014

Monday, Dec. 2 3:10PM - 3:20PM Room: E261

Awards
Trainee Research Prize - Resident

Participants
Anna Trofimova, MD,PhD, Atlanta, GA (*Presenter*) Nothing to Disclose
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PURPOSE

To assess nationwide trends and independent predictors of neuroimaging utilization in stroke patients during emergency department (ED) and inpatient encounters between 2006 and 2014.

METHOD AND MATERIALS

The largest U.S. all-payer ED and inpatient encounter databases (The Healthcare Cost and Utilization Project Nationwide Emergency Department Sample and National Inpatient Sample) were used to identify ED and inpatient visits with a primary diagnosis of cerebral artery occlusion between 2006 and 2014. Longitudinal trends and independent predictors of neuroimaging utilization were determined using logistic regression.

RESULTS

An estimated total of 3,075,906 ED (mean age 70.4; 52.6% female) and 3,021,099 inpatient (mean age 70.9; 53.5% female) weighted cohorts were identified. Urban settings accounted for 47.3% of ED and 33.1% of inpatient encounters. Neuroimaging tests were performed in 8.5% of ED and 9.4% of inpatient encounters. In the ED setting, the most commonly performed imaging test was a non-contrast CT head (8.2%), followed by brain MRI (1.2%). In the inpatient setting, head CT was performed in 4.7% and brain MRI in 6.7% of encounters. Utilization of neuroimaging tests in the ED increased from 2006 (14,685, 4.5%) to 2014 (53,174, 13.9%). Imaging utilization in the inpatient setting was highest in 2007 (12.6%) and lowest in 2014 (7.3%). Independent predictors of higher ED imaging utilization were year after 2010 (OR 2.2); weekend admission (OR 1.1); private insurance (OR 1.2). Independent predictors of higher inpatient imaging utilization were non-elective admission (OR 1.7) and urban location (OR 1.3). Independent predictors of lower imaging utilization in both groups were: age > 55 (OR 0.8 (ED) and 0.9 (inpatient)) and female gender (OR 0.9 (ED and inpatient). Urban location was an independent predictor of lower ED imaging utilization (OR 0.6). (All $p < 0.05$).

CONCLUSION

In the setting of stroke, patterns of imaging utilization and their predictors differed between the ED and inpatient settings. In 2014, imaging utilization in the ED was highest (13.9%), but lowest in the inpatient setting (7.3%), suggesting that imaging is increasingly being "frontloaded" earlier in stroke care.

CLINICAL RELEVANCE/APPLICATION

Further research is needed to identify drivers of disparities and changing imaging utilization in the setting of stroke.

SSE13-03 National Trends in Modalities of Entry to Colorectal Cancer Screening - What is the Current Application of CT Colonography?

Monday, Dec. 2 3:20PM - 3:30PM Room: E261

Participants
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PURPOSE

Colorectal cancer is the third leading cause of cancer-related deaths in the US population. However, despite effective screening options, nearly one-in-three eligible adults have not undergone screening. Given the potential implications on assessments of policy efficacy and targeted educational initiatives, we aimed to determine the current national trends in first-time colorectal cancer screening in the outpatient setting.

METHOD AND MATERIALS

Using a National Commercial Claims database, we identified the first outpatient visit of commercially insured patients between 50-55 years of age across all US states between 2010 and 2016. These were identified by ICD9 code V76.51 or ICD-10 code Z12.11 (screening for malignant neoplasms of colon). Patients with family history of gastrointestinal neoplasm and/or personal history of colonic polyps were excluded.Logistic regression analysis was used to estimate the annual change in the rate of imaging before and after controlling for covariates.

RESULTS

896,789 individual first time patient encounters met inclusion criteria. Mean age 55, 52% were female. Across the study time period, 616,789 (68%) patients underwent colonoscopy as their screening modality. 277,147 (31%) patients underwent a fecal test, 2,166

(0.24%) underwent sigmoidoscopy, and only 678 (0.08%) underwent CT Colonography. The use of colonoscopy significantly increased over time, whereas the use of fecal testing decreased (p<0.001). The use of CT colonography did not significantly change.

CONCLUSION

We found that the use of colonoscopy as the initial colorectal cancer screening modality represents the majority of screening and significantly increased with time in our national population sample. In contrast, the use of fecal tests decreased. The relative use of CT colonography has remained stable and represents less than 1% of initial screening, likely due to continued challenges for insurance coverage and fear of radiation.

CLINICAL RELEVANCE/APPLICATION

Improving public awareness and commercial insurance coverage of CT colonography is required to increase its use and screening rates for persons who do not wish to undergo an invasive colonoscopy.

SSE13-04 Associations Over Time Between Paid Medical Malpractice Claims and Imaging Utilization in the United States

Monday, Dec. 2 3:30PM - 3:40PM Room: E261

Participants
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PURPOSE

Little research has evaluated the association between medical imaging and the medicolegally unpredictable environment in the United States. This study explores state level relationships over time between the incidence and amount paid for malpractice claims and Medicare imaging utilization and spending in the United States.

METHOD AND MATERIALS

Using claims data from a 5% national sample of Medicare beneficiaries for years 2004-2016, we calculated population-adjusted annual Medicare imaging utilization and spending by state. For each year and state, we calculated a population-adjusted lagged three-year rolling average paid malpractice claims frequency and payout amount using data from the National Practitioner Data Bank. Associations between paid malpractice claims and imaging utilization were assessed using a multivariate regression analysis with a log-log specification controlling for a secular trend and state effects.

RESULTS

Between 2004 and 2016, Medicare fee-for-service imaging utilization and spending declined by 31.1% and 34.1%, respectively (from 418,618 to 288,559 examinations and $27,954,457 to $18,428,151 USD per 100,000 beneficiaries). Overall paid malpractice claims and payouts declined 46.9% and 29.3%, respectively (from 5.37 to 2.85 claims and $1,488,243 to $1,051,537 USD per 100,000 population). After controlling for secular trends, imaging utilization and spending were both positively associated with paid malpractice claims and payouts. Each 1% increase in paid malpractice claims was associated with a 0.14% increase in imaging utilization (p=0.0001) and a 0.10% increase in imaging spending (p=0.0015). Moreover, each 1% increase in malpractice payouts was associated with a 0.07% increase in imaging utilization (p=0.0015) and a 0.07% increase in imaging spending (p=0.0015).

CONCLUSION

In recent years, Medicare imaging utilization and paid medical malpractice claims in the United States have both declined. Imaging utilization and spending are positively correlated with rates of paid malpractice claims and associated payouts.

CLINICAL RELEVANCE/APPLICATION

The use of medical imaging is positively correlated with paid malpractice claims, supporting the contention that physicians utilize medical imaging as a "defensive medicine" strategy in the United States.

SSE13-05 Risk of Anaphylactoid Reactions to Iopromide After Intra-Arterial versus Intra-Venous Administration: A Nested Case-Control Analysis of 133,331 Patients

Monday, Dec. 2 3:40PM - 3:50PM Room: E261

Participants
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PURPOSE

To better understand the pathomechanisms of anaphylactoid reactions: Nested-case control analysis of 133,331 patients comparing intra-arterial (i.a.) with intra-venous (i.v.) to administration.

METHOD AND MATERIALS

Four observational studies were pooled. Almost half of the study population (48.1%) was from Europe, and one quarter each from China (27.6%) and other Asia countries (24.1%). All patients received iopromide either i.a. or i.v. for angiographic procedures

(mostly cardioangiography) or contrast enhanced computed tomography. A nested case-control analysis, including a multivariate logistic regression model, was performed. Cases were defined as patients with typical and unequivocal anaphylactoid reactions, controls were patients without any recorded reactions. The primary target variable was the Odds ratio of having an anaphylactoid reaction after i.a. vs. i.v. administration.

RESULTS

A total of 133,331 patients met the inclusion criteria, 27,871 and 105,460 patients received iopromide i.a. or i.v., respectively. For 822 patients anaphylactoid reactions were recorded, 132,509 patients served as controls. Major risk factors for anaphylactoid reactions were i.v. injection (vs. i.a.), age 18-<50 years (vs. >=65 years), history of allergy or previous contrast media reaction (all p<0.001) and bronchial asthma (p=0.005). A total of 56 patients (0.2%) and 766 patients (0.7%) were recorded with anaphylactoid reactions after i.a. or i.v. administration, respectively (p<0.0001). Adjusted Odds ratio (i.a. vs. i.v.) was 0.23 (95 % C.I. 0.16 - 0.32).

CONCLUSION

Anaphylactoid reactions to iopromide were significantly less frequently recorded after i.a. administrations. This could likely be related to the delayed and diluted arrival of the contrast medium in the lungs.

CLINICAL RELEVANCE/APPLICATION

This study confirmed the hypothetical lower risk of anaphylactoid reactions after i.a. vs. i.v. administration of iodine contrast agents.

SSE13-06 Which Radiology Subfield has the Greatest Amount of Specialization? A Generalizable Method for Quantifying Specialization within Radiology, and Its Results

Monday, Dec. 2 3:50PM - 4:00PM Room: E261

Participants
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PURPOSE

To develop methodology to measure specialization within radiology, and to apply it to Medicare claims data to study specialization.

METHOD AND MATERIALS

The IRB approved this study under exempt review. We accessed the Medicare Physician and Other Supplier Public Use File for 2015, and searched for all diagnostic radiologists. All diagnostic radiology CPT codes were mapped into one or more subfields according to conventional anatomic designations: abdominal and pelvic, breast, chest, musculoskeletal, and neurologic. Within each subfield, a bundle of "advanced imaging" studies was designated, which consisted of those studies that benefit the most from a specialist interpretation. Each radiologists' total work RVU (wRVU) and wRVU within each radiology subfield were calculated, and based on these calculations, radiologists were labeled as either a specialist or a non-specialist for each subfield. The labeling of radiologists as specialists was done by comparing each radiologist's wRVU in a subfield against the average of radiologists who spend about 30% of their wRVU in that subfield. Finally, the percent of "advanced imaging" wRVU interpreted by a specialist versus a non-specialist in each subfield was calculated. Code for querying the database and statistics were performed in Python.

RESULTS

A total of 28,851 radiologists billed Medicare for 48,431,278 wRVU in calendar year 2015. Of this wRVU, 96.67% falls within one of the areas of specialization. The number of specialists within each subfield varied from a high of 9,437 (33% of all radiologists) in abdominal and pelvic to a low of 1,559 (5% of all radiologists) in musculoskeletal. The amount of specialization is greatest within neuroradiology (84% of advanced imaging wRVU read by specialists), followed by abdominal and pelvic (78%), breast (55%), musculoskeletal (37%), and lastly chest (31%).

CONCLUSION

It is possible to measure specialization within radiology with generalizable methodology that can be applied broadly across all subfields in radiology. This methodology demonstrates that specialization within radiology is greatest in neuroradiology and least in chest radiology.

CLINICAL RELEVANCE/APPLICATION

We describe a method for measuring degree of specialization of the radiology marketplace. The methods can be used to assess individual radiology practices, or regional or national samples.

SSE14

Informatics (Artificial Intelligence: Triage, Screening, Quality)

Monday, Dec. 2 3:00PM - 4:00PM Room: S406B

AI IN SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSE14-01 Automated AI Detection and Measurement of Midline Shift on Head CT Scans in an Emergency Teleradiology Set Up: Its Contribution to Critical Value Communication

Monday, Dec. 2 3:00PM - 3:10PM Room: S406B

Participants
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CONCLUSION

The immediate detection and accurate measurement of midline shift on head CT examinations is key to prompt patient triage and management in the emergency setting. An AI algorithm demonstrated promising results in both detection and quantification of midline shift, thereby allowing for prioritization of radiologist review, accelerated critical value communication and enhanced patient care.

Background

To evaluate the efficiency of an artificial intelligence (AI) program using complex neural networks and deep learning algorithms for the detection and measurement of midline shift on non-contrast computed tomography examination of the head. Also, to determine feasibility of deploying such an algorithm in the emergency Teleradiology setup to promote earlier detection and facilitate work flow prioritization.

Evaluation

The retrospective study was HIPAA compliant and performed with the approval of the institutional review board. A representative sample set of curated data comprising 163 non-contrast pre-operated noncontrast computed tomography examination of the head were used for validation constituted by 93 cases positive for midline shift and 70 cases negative for midline shift. AI throughput was processed with convolutional neural network for midline shift detection and measurement.

Discussion

AI tool demonstrated, for the midline shift detection model, accuracy at 95.15% with sensitivity of 92.63%(88 out of 93), (confidence interval CI-85.41%-96.99%) and specificity of 98.57%(69 out of 70)(CI-92.3%-99.96%), with area under the receiver operating characteristic curve(AUC) of 0.956. AI tool demonstrated, for the midline shift measurement model compared to radiologist ground truth reports, accuracy at 91.41% with sensitivity of 91.95%(80 out of 93) (confidence interval CI-84.12%-96.7%) and specificity of 90.79%(69 out of 70)(CI-81.94% to 96.22%), with area under the receiver operating characteristic curve(AUC) of 0.914.

SSE14-02 Utilizing Machine Learning to Improve ED and In-Patient Throughput in Cases of Acute Intracranial Hemorrhage by Non-Contrast Head CT

Monday, Dec. 2 3:10PM - 3:20PM Room: S406B

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CONCLUSION

Increases in patient volume have been accompanied by increases in ED and inpatient imaging volume, which have led to higher demands for shorter report TAT in an effort to streamline throughput and decrease healthcare expenditures. Integrating a ML software tool in the radiologist workflow allows for more rapid diagnosis and reporting of acute pathologies, which can enhance triage of patients to the appropriate level of care.

Background

From order scheduling to report generation, ML is slowly revolutionizing radiology work processes. Demonstrating how algorithms ultimately add value and improve patient outcomes remains of importance. Here, we determine the impact on throughput of a ML platform in cases of acute intracranial hemorrhage (ICH) by non-contrast head CT at a large, busy tertiary care center. We hypothesize that utilization of ML software trained to detect ICH leads to a reduction in report turnaround time (TAT) and length of stay (LOS) in both ED and in-patient populations.

Evaluation

A ML platform based on a convolutional neural network model was incorporated across CT scanners at 2 imaging sites in January 2018. Report TAT and LOS were derived for reports and patients, respectively, between July 2017 and December 2017 (pre-ML) and compared to those between January 2018 and June 2018 (post-ML). 26,249 cases were evaluated in 2017 (pre-ML) and 25,544 cases in 2018 (post-ML). Report TAT decreased from 53 min to 46 min for head CT cases positive for ICH ($p<.001$). In-patient LOS for positive cases decreased from 9950 min to 8870 min ($p>.05$). ED LOS decreased from 567 min to 508 min ($p<.001$).

Discussion

The rapid detection of ICH in patients with acute neurological symptoms is critical and delays in diagnosis are costly. Here, we demonstrate that adoption of a ML software platform was associated with a statistically significant decrease in report TAT for cases positive for ICH as a function of the software prioritizing those scans for radiologist interpretation. The implementation of a ML platform was also associated with a statistically significant decrease in LOS for ED patients, but not for inpatients, presumably as those patients with ICH were expeditiously transferred out of the ED.

SSE14-03 Contemporaneous Use of AI as The Third Eye In a Teleradiology Setup for CT Evaluation of Subtle Intracranial Hemorrhages in An Emergency Teleradiology Setup

Monday, Dec. 2 3:20PM - 3:30PM Room: S406B

Participants
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CONCLUSION

Contemporaneous use of AI as a second reader on critical scans holds promising results towards improvised patient care by increasing the accuracy rates of reading radiologists in a teleradiology setup.

Background

With increasing workloads in radiology, the number of scans reported by teleradiologists is ever increasing. AI as the third eye may enhance accuracy on critical scans in a teleradiology setup to optimize work efficiency. The aim of this study was to evaluate if AI algorithm can help reduce errors in evaluation of subtle critical findings such as intracranial hemorrhages in head CT scans in an emergency teleradiology setup.

Evaluation

Retrospective analysis of 22 cases of intracranial hemorrhages missed by the radiologists from a denominator of 50,782 CT heads read in an emergency teleradiology setup were selectively run through AI models designed specifically for detection of intracranial hemorrhage. We then compared this bleed detection AI model with an enhanced model designed specifically to detect small and subtle hemorrhages for improved accuracy.

Discussion

The AI algorithm was able to pick up intracranial hemorrhages 11 out of 22 missed bleed critical scans with 59.62% sensitivity and 91.07%specificity, and accuracy of 89.8% accuracy with an AUC of 0.753 on slice-wise detection of the routine bleed detection model. The AI algorithm demonstrated higher sensitivity at detection of subtle intracranial hemorrhages at 14 out of 22 critical scans with an AUC of 0.789, 69.23% sensitivity and 88.64% specificity, and slightly decreased accuracy at 87.85%, due to increased false positives as a trade-off on the enhanced bleed detection model. The performance of bleed detection model was also run against a random selection of 367 pre-operated, non-contrast head CTs with accuracy for ICH at 91.55% with sensitivity of 93.16%(150 out of 161) (confidence interval CI-88.10% to 96.64%) and specificity of 90.29%(186 out of 206)(CI-85.40% to 93.97%), with area under the receiver operating characteristic curve(AUC) of 91.55%(88.22% to 94.19%).

SSE14-04 Utility of Artificial Intelligence Tool as a Prospective Radiology Peer Reviewer -Detection of Unreported Intracranial Hemorrhage

Monday, Dec. 2 3:30PM - 3:40PM Room: S406B

Participants

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CONCLUSION

AI solution can serve as a prospective peer review tool for non-contrast head CT scans to identify ICH and thus decrease false negatives.

Background

Misdiagnosis of intracranial hemorrhage (ICH) can adversely impact patient outcome. Increasing workload on the radiologists may increase the chance of error and compromise quality of care provided by the radiologists.

Evaluation

We used a FDA approved artificial intelligence (AI) solution based on convolutional neural network (CNN) to assess the prevalence of ICH in scans which were reported as negative for ICH. We retrospectively applied the AI solution to all consecutive non-contrast computed tomography (CT) head scans performed at 6 imaging sites affiliated to our institution. In the 6565 non-contrast CT head scans, which met the inclusion criteria, 5585 scans were reported to have no ICH ("negative-by-report" cases). We applied AI solution to these "negative-by-report" cases. AI solution suggested there were ICH in 28 of these scans ("negative-by-report" and "positive-by-AI solution"). After consensus review by three neuroradiologists, 16 of these scans were found to have ICH which was not reported (missed diagnosis), with false negative rate of radiologists for ICH detection at 1.6%.

Discussion

Our study demonstrates that AI solution can help radiologists to diagnose ICH and thus decrease error rate.

SSE14-05 Diagnostic Assessment of a Deep Learning System For Detecting Missed Pulmonary Nodules On Computed Tomography

Monday, Dec. 2 3:40PM - 3:50PM Room: S406B

Participants
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CONCLUSION

Use of DLS-assisted automated detection as a second reader for missed pulmonary nodules on computed tomography (CT) may potentially enhance the performance of radiologists.

Background

We aim to evaluate the diagnostic performance of a deep learning system (DLS) for automated detection of missed pulmonary nodules on computed tomography (CT) as a second reader to enhance the performance of radiologists.

Evaluation

This single-center retrospective study screened 21150 consecutive chest CT studies from September 2018 to February 2019. Axial chest CT images were transferred to the DLS for automated detection of pulmonary nodules if the associated report was negative. Pulmonary nodules detected by the DLS but not mentioned in the initial radiology report were flagged. Flagged images were then reviewed by four board-certificated radiologists with five years of experience. All flags were scored according to ACR RADPEER 2016 scoring guidelines. Nodules marked as score 2 ("understandable miss") or 3 ("should not be missed") were then separated as clinically insignificant (2a or 3a) or clinically significant (2b and 3b) in accordance with Fleischner 2017 guideline for pulmonary nodules. The miss rate was defined as the total number of studies receiving score 2 or 3, divided by total screened studies.

Discussion

Among 140 studies flagged by the DLS, 73 (52 %) were confirmed by radiologist review, and further categorized as 2a in 33 studies (24 %), 2b in 13 studies (9 %), 3a in 14 studies (10 %), and 3b in 13 studies (9%). For identifying clinically significant findings (2b/3b), the system's overall specificity was 18%. Missed pulmonary nodules were identified in 0.3% of total chest CT scans, and one-third of these had clinical implications.

SSE14-06 Using Out of Distribution Detection to Fix Nearly All AI Models in Medical Imaging

Monday, Dec. 2 3:50PM - 4:00PM Room: S406B

Participants
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PURPOSE

Nearly all AI models for medical imaging behave unpredictably and fail silently on input data dissimilar from data used to train them, which hampers their safe clinical use. To address this problem, we introduce a simple modification to the standard AI training procedure that teaches AI models to produce confidence estimates along with their original task predictions, which radiologists can use to determine how reliable the AI model believes its task predictions to be.

METHOD AND MATERIALS

Our approach separates the AI model output into task and confidence components. We use the original loss for the task term, but introduce a new loss that encourages the model to ask for hints on inputs for which it has lower confidence. This modification produces models with higher confidence for inputs resembling the training set ('in distribution') and lower confidence otherwise ('out of distribution') at inference time. To evaluate our approach, we trained AI models for two previously studied tasks: chest abnormality detection and bone age estimation. For each task, we reused previous model architectures for the task prediction and introduced our approach to the training procedure for the confidence estimate.

RESULTS

For both tasks, our approach successfully distinguished between unseen 'in distribution' and 'out of distribution' inputs ($p<0.05$). For our classifier that predicts normal or abnormal on AP/PA chest radiographs, our confidence estimate yields AUC of 0.76 for filtering lateral view chest radiographs and 0.86 for filtering out upper extremity radiographs, while maintaining a task AUC of 0.89, which does not differ significantly from the AI model trained without the confidence term ($p=0.38$). For our regressor that predicts bone age from hand radiographs, our confidence estimate yields an AUC of 0.997 for filtering out other upper extremity radiographs, while maintaining a task MAD of 5.6 months, which does not differ significantly from the model trained without the confidence term ($p=0.34$).

CONCLUSION

Our promising results in two clinical tasks suggest that our approach could enable radiologists to determine when AI models for medical imaging are likely to produce correct or incorrect predictions.

CLINICAL RELEVANCE/APPLICATION

Similar to how rads express uncertainty when interpreting outside their specialty, our method permits AI models to express uncertainty on inputs outside of the narrow task for which they were trained.

Printed on: 10/29/20

SSE15

Musculoskeletal (Accelerated Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: N228

MR MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Naveen Subhas, MD, Shaker Heights, OH (*Moderator*) Research support, Siemens AG

Sub-Events

SSE15-01 Acceleration in Knee MRI: Compressed Sensing for 2D and 3D Applications

Monday, Dec. 2 3:00PM - 3:10PM Room: N228

Participants
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PURPOSE

Compressed sensing (CS) allows to accelerate 2D and 3D scans promising higher acceleration factors than previous parallel imaging techniques. This study evaluated potential clinical acceleration factors of SENSE and Compressed SENSE (combination of Compressed Sensing and SENSE) for a fat saturated 2D sagittal and 3D PD sequence in the knee.

METHOD AND MATERIALS

Twenty-one healthy volunteers were scanned with a 3T scanner (Ingenia, Philips, Best, Netherland). All received a standard, commercially available sagittal, fat saturated 2D PD (SENSE 1.4) and three CS (CS2, CS3, CS5) and the time-equivalent SENSE accelerations. The 3D sequence (SENSE 2.0) was acquired with four CS (CS6, CS8, CS10 and CS15) and the equivalent SENSE factors. The images were rated by three independent readers (two radiologists and one orthopedic surgeon) with at least 5 years of experience in MRI imaging regarding diagnostic certainty and overall image impression on a 5-Point-Likert-scale. The non-parametric subjective scoring was analyzed with the Friedmann test for statistical significance and the Dunn´s test for post-hoc analysis.

RESULTS

The standard sequences lasted for 221 seconds (2D) and 384 s (3D). The scan time decreased with increasing CS factor (2D CS2: 145 s, 2D CS3: 95 s, 2D CS5: 57 s, 3D CS6: 293 s, 3D CS8: 220 s, 3D CS10: 176 s, 3D CS15: 119 s). The 2D standard sequence was rated best for diagnostic certainty and overall image impression with an average of 4.95±0.21 and 4.78±0.42, statistical superior in both parameters for all sequences (all $p<0.05$) except for 2D CS2, 2D S2 and 3D standard. The 3D standard performed only better than 3D CS15 rearding the 3D CS sequences but better than all 3D SENSE accelerations except for the lowest (SENSE 2.2). The post-hoc analysis showed only significant differences for the fast 3D accelerations of CS10 vs. S2.9 ($p<0.0001$) and CS15 vs. S3.5 ($p=0.0002$).

CONCLUSION

Compressed Sensing can significantly decrease (34% for 2D and 54% for 3D) the scan time for PD sequences of a knee MRI with unchanged diagnostic certainty and overall image impression compared to the clinical reference. The new technique proved especially valuable for fast 3D accelerations.

CLINICAL RELEVANCE/APPLICATION

The application of Compressed Sensing can increase the patient compliance and can reduce healthcare cost for MR imaging due to significant decreased scan times.

SSE15-02 Next-Generation 5-Min Knee MRI with Combined Simultaneous Multislice and Parallel Imaging Acceleration: Ready for Prime Time?

Monday, Dec. 2 3:10PM - 3:20PM Room: N228

Participants

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Jan Fritz, MD, Baltimore, MD (*Abstract Co-Author*) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

PURPOSE

2-fold parallel imaging (PI) acceleration can realize 5-min 2D FSE MRI of the knee, but the associated signal loss may require compromises in image quality and anatomical coverage. In contrast, 2-fold simultaneous multi-slice (SMS) acceleration is near signal neutral. Advances in pulse sequence design now allow for the combined use of PI and SMS to enable 4-fold-accelerated 2D FSE, which can achieve fast MRI with higher image quality and improved coverage. We compared traditional 2-fold PI- and novel 4-fold SMS-PI-accelerated 2D FSE MRI of the knee for the detection of internal derangement.

METHOD AND MATERIALS

Following IRB approval and informed consent, 25 symptomatic patients [12 women, 13 men; age 44 (18-64) years] prospectively underwent 1.5T MRI of the knee, including a 2-fold PI-accelerated 5-min 2D FSE MRI protocol, and a 4-fold SMS-PI-accelerated 5-min 2D FSE MRI protocol with higher spatial resolution, higher anatomic coverage, smaller inter-slicer gaps, improved suppression of vascular flow artifacts, and stronger and more homogenous fat suppression. Both protocols included sagittal PD, sagittal PDFS, coronal T1, coronal T2FS, axial PDFS sequences. Two MSK radiologists independently assessed image contrast, noise, artifacts, structural visibility, and abnormalities. Non-parametric comparison, kappa agreement, and interchangeability tests were applied.

RESULTS

The inter-reader reliability (kappa=0.681) was good. 5-min SMS-PI MRI of the knee had better image contrast ($p<0.001$), less noise, ($p<0.001$), better structural visibility ($p<0.001$), and no flow or aliasing artifacts ($p=0.657$). There was unidirectional interchangeability in favor of SMS-PI MRI for the diagnosis of meniscal tears and cartilage defects, and bidirectional interchangeability for anterior cruciate and collateral ligament tears, tendon tears, bone marrow edema pattern, and fractures.

CONCLUSION

Combined, 4-fold-accelerated SMS-PI 2D FSE enables artifact-free 5-min MRI of the knee with higher image quality, better visibility of anatomic structures, and possibly better detectability of cartilage defects and meniscal tears than 2-fold PI-accelerated 5-min 2D FSE MRI of the knee.

CLINICAL RELEVANCE/APPLICATION

The validation of short knee MRI protocols without image degradation are essential to increase MR efficiency in clinical practice.

SSE15-03 Comparison of Modulated Flip Angle in Refocused Imaging with Extended Echo Trains with Compressed Sensing (CS-MATRIX) and Conventional Two-Dimensional Sequences on Knee Imaging

Monday, Dec. 2 3:20PM - 3:30PM Room: N228

Participants
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PURPOSE

To evaluate and compare the image quality and diagnostic agreement of an isotropic 3D fast spin echo (FSE) sequence, which employs modulated flip angle technique in refocused imaging with extended echo trains with compressed sensing (CS-MATRIX), to conventional 2D sequences for knee at 3T.

METHOD AND MATERIALS

Forty-four knees from 42 symptomatic patients (mean age: 43.5±14.9 years) were examined on a 3T MR scanner (uMR780, United Imaging Healthcare, Shanghai, China) with 2D T2-weighted fat suppressed (T2-fs) sequence, proton density-weighted (PD) sequence and isotropic 3D CS-MATRIX sequence. A four-point scale (4=Excellent, 3=Good, 2=Acceptable, 1=Poor; based on clarity of anatomical structures, noise and artifacts) was employed to assess image quality subjectively, then the scores of 2D and 3D CS-MATRIX sequences were compared utilizing Wilcoxon signed-rank test. Furthermore, Kappa statistics were used to evaluate diagnostic agreement between 2D and 3D CS-MATRIX sequences for detecting multiple types of knee joint pathologies.

RESULTS

For image quality, no significant difference in scoring was found between 3D CS-MATRIX T2-fs and 2D T2-fs sequences (mean score=3.29±0.63 and 3.34±0.68, $p=0.715$), however, the scores of images obtained from 2D PD was significantly higher than those of 3D CS-MATRIX PD sequence (mean score=3.84±0.37 and 3.57±0.50, $p<0.05$). In diagnostic agreement evaluation, there was a very good agreement between 3D CS-MATRIX and 2D sequences for detecting cartilage lesions ($\kappa=1.000$), and bone marrow edemas ($\kappa=0.955$). Moreover, the diagnostic agreement was good to very good in grading evaluation of medial and lateral menisci tears ($\kappa=0.748$, $\kappa=0.936$), as well as of anterior and posterior cruciate ligaments tears ($\kappa=0.725$, $\kappa=1.000$).

CONCLUSION

The 3D CS-MATRIX sequences allow for faster knee imaging over conventional 2D sequences, while yielding much the same image quality as 2D T2-fs sequences. In addition, 3D CS-MATRIX sequences could present similar diagnostic value in evaluating lesions in cartilage, bone marrow, menisci and cruciate ligaments as 2D sequences.

CLINICAL RELEVANCE/APPLICATION

3D CS-MATRIX sequence has become a non-invasive technique for evaluating knee joint lesions, while providing higher time-efficiency than 2D sequences in magnetic resonance imaging.

SSE15-04 Highly Accelerated 2D Spine Imaging Using Compressed Sensing: Evaluation of Scan Time and Subjective Image Quality

Monday, Dec. 2 3:30PM - 3:40PM Room: N228

Participants
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PURPOSE

Imaging of the spine, with 2D as the clinical standard, is the most common examination for MRI and it´s duration has a large impact on the clinical scan schedule and healthcare costs. Due to susceptibility to field inhomogeneities and motion artifacts of the bowel and aorta acceleration techniques remain challenging for sagittal sequences, resulting in comparable low net acceleration factors. The new acceleration technique Compressed Sensing promises higher acceleration factors. In this study Compressed SENSE (combination of Compressed Sensing and SENSE) was evaluated for accelerated sagittal T2 imaging of the lumbar spine using gradient echo (GE) and turbo spin echo (TSE) based prescans.

METHOD AND MATERIALS

All scans were performed on a 3T scanner (Ingenia, Philips, Best, Netherland). Sixteen patients received the standard spine protocol including a sagittal T2 sequence (SENSE factor 1.4, 266 seconds) and three different CS acceleration factors (CS2: 172s, CS3: 109s and CS4: 78s). An additional TSE prescan (35s) was acquired to compare the reconstructions based on the common GE and the TSE prescan. The images were rated by two independent readers (experts in musculoskeletal and neuroradioloyg) regarding diagnostic certainty and overall image impression on a 5-Point-Likert-scale. The non-parametric subjective scoring was analyzed with the Friedmann test for statistical significance and the Dunn´s test for post-hoc analysis.

RESULTS

The diagnostic certainty (4.75±0.41) and overall image impression (4,63±0.50) were rated highest for the CS2 with a TSE prescan (TSE CS2) although not with a statistically significant difference to the standard T2 (4.72±0.41 and 4.56±0.51). The standard T2 showed significant better overall image impression compared to the CS3 ($p<0.0001$) and CS4 ($p<0.0001$) accelerations with GE prescan while none of the TSE prescan sequences or the CS2 with GE prescan was significant worse.

CONCLUSION

The combination of the standard T2 with the GE prescan (266s) offered unchanged diagnostic certainty and overall image impression than CS2 with the GE prescan (172s) or CS4 with the TSE prescan (112s).

CLINICAL RELEVANCE/APPLICATION

Compressed Sense with the GE prescan (-35%) and especially with a TSE prescan (-58%) drastically reduces the scan time for the sagittal T2 sequence with unchanged subjective scoring. Similar reductions for additional sagittal scans (T1, T2 fat saturated) within the protocol should feasible.

SSE15-05 Compressed Sensing-Sensitivity Encoding (CS-SENSE) Accelerated MR Brachial Plexus Imaging: Reduced Scan Time without Reduced Image Quality

Monday, Dec. 2 3:40PM - 3:50PM Room: N228

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PURPOSE

3D Contrast-enhanced nerve-view Imaging provides has very high clinical value for brachial plexus nerve trauma,tumor etc. However, relatively long acquisition time(above 10min)limits its clinical application. The aim of this study was to reduce the scan time of 3D Nerve-view using Compressed Sensing-Sensitivity Encoding (CS), and evaluate the image quality and capability of diagnosis of accelerated 3D Nerve-view sequences.

METHOD AND MATERIALS

In a consecutive cohort of 15 patients with suspected disease of brachial plexus underwent MR studies. 3D Nerve-view sequences with 6 different CS accelerating factors (4,6,8,10,15,20), and a traditional 3D Nerve-view with 2-fold parallel imaging (sense) as a clinical reference were obtained on a 3T scanner (Ingenia CX, Best, Philips Healthcare). Images were graded by 2 experienced radiologists in MR neurography for image quality (scale of 1 to 5). An Objective quantification analysis of SNR and CNR were also

performed. Beyond that, the similarity between images of the 3D standard sequence and the accelerated sequences was evaluated using the pixelwise root mean square error (RMSE) and structural similarity index (SSIM).The scan time of each sequence were measured. An analysis of variance with repeated measurements and the Friedman test was used to test for potential difference between the sequences.

RESULTS

The mean values of the RMSE ranged from 73.38 ± 15.91 for CS 8 to 234.66 ± 43.56 for CS 10, while SSIM was highest for CS 4 with 95.11% ± 2.23% and lowest for CS 20 with 87.90% ± 5.32%. The scan time using sense2,CS2,4,6,8,10,15,20 is 11min09s,5min50s,3min55s,2min56s,2min23s,1min35s,1min13s respectively. The two radiologists evaluated all images and mean scored 4.1±0.3 with CS factor below 8. There is no statistical difference in the contrast between the brachial plexus and the surrounding tissue between CS factor 4-8, and the lesion display of the brachial plexus has no statistical difference. The images of CS factor above 8 have no diagnosis value.

CONCLUSION

In conclusion, CS-3D Nerve-view with factor 8 offer equilibrium between comparable clinical diagnostic quality with less scan time (2min56s)

CLINICAL RELEVANCE/APPLICATION

CS-3D Nerve-view with factor 8 offer equilibrium between comparable clinical diagnostic quality with less scan time , which potentially increasing the productivity of MR scanners.

SSE15-06 Compressed Sensing SEMAC MRI of Hip and Knee Arthroplasty Implants at 1.5T and 3T Field Strengths: An Intra-Subject Comparison Study

Monday, Dec. 2 3:50PM - 4:00PM Room: N228

Participants
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Jan Fritz, MD, Baltimore, MD (*Abstract Co-Author*) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

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PURPOSE

Metal artifact reduction MRI of metallic arthroplasty implants at 1.5T field strength has inherently lower susceptibility artifacts than at 3T field strength. However, 3T MRI offers higher signal-to-noise and contrast-to-noise ratios, and allows for higher spatial resolution. In this study, we tested the hypothesis that compressed-sensing (CS) accelerated slice-encoding-for-metal-artifact-correction (SEMAC) MRI of hip and knee arthroplasty implants can generate similar image quality and visibility of periprosthetic abnormalities at 1.5 and 3T field strengths.

METHOD AND MATERIALS

Thirty patients with symptomatic hip (15) and knee (15) arthroplasty implants were included in this IRB-approved study after giving informed written consent. Each patient underwent consecutive 1.5 and 3T MRI using previously optimized protocols consisting of PD-weighted and STIR CS-SEMAC turbo spin echo pulse sequences in coronal (hip) or sagittal (knee) planes. The 3T protocols utilized 25 SEMAC encoding steps while the 1.5 T protocols used 19 SEMAC encoding steps. The 3T protocols had higher spatial resolution. Each pulse sequence took 4-5 min. Paired PD-weighted and STIR image datasets were separated, anonymized and randomly reassigned. Two musculoskeletal radiologists qualitatively evaluated image quality and the presence of six periprosthetic abnormalities independently. Wilcoxon test, Kendall W agreement, and substitutability testing were applied.

RESULTS

Image quality of hip and knee studies were over all good with slight non-significant (hip, p=0.21 / knee, p=0.33) dominance of 1.5T over 3T. Reader agreements were moderate to very good (W range, 0.53-0.81). Inter-method agreement was overall good (W, 0.67/0.71). For each joint, substitution analysis demonstrated that the higher resolution but slightly longer 3T CS-SEMAC could replace the lower spatial resolution, but faster 1.5T CS-SEMAC technique (p-value range, 0.41-0.94) in diagnosing the six abnormalities, including periprosthetic osteolysis, synovitis, bone marrow edema, fractures, tendon tears, and extra-capsular collections.

CONCLUSION

With the use of optimized pulse sequence parameters, 3T CS-SEMAC can generate high-resolution MR images with similar degrees of metal artifact reduction and detection of periprosthetic abnormalities compared to 1.5T CS-SEMAC.

CLINICAL RELEVANCE/APPLICATION

3T CS-SEMAC has the potential to generate high-resolution MR images without diagnostic compromise.

SSE16

Musculoskeletal (Arthritis and Cartilage)

Monday, Dec. 2 3:00PM - 4:00PM Room: N227B

MR MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSE16-01 Spondyloarthropathy: Improved Sensitivity by Combining UTE with Conventional MRI

Monday, Dec. 2 3:00PM - 3:10PM Room: N227B

Participants
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PURPOSE

To evaluate whether the combination of ultrashort TE (UTE) sequences and conventional magnetic resonance imaging (MRI) helps to increase diagnostic performance in the diagnosis of spondyloarthropathy compared with those achieved by using each MRI technique alone.

METHOD AND MATERIALS

The study included 22 sacroiliac joint (SIJ) MRI from 11 spondyloarthropathy (SpA) patients and 52 SIJ MRI from 27 patients without SpA. Three sets of images (UTE only, conventional MR only, combined UTE and conventional MRI) were analyzed independently by 3 reviewers (2 musculoskeletal radiologists, 1 unexperienced radiologist) to diagnose SpA based on bone marrow edema (BME), erosion, sclerosis, and ankyloses. For SpA patients, patient grouping was subdivided to those with BME and those without BME. Diagnostic accuracy, sensitivity, specificity, and positive and negative predictive values were calculated. In those 16 patients with CT, the Pearson correlation test was performed.

RESULTS

The overall sensitivity was significantly higher for the combined set (92.3%) in the group without BME than those for the conventional MRI-only (89.5%) or UTE-only (81.7%) sets ($P<0.05$). However, in the group with BME, the UTE-only set showed lower sensitivity (83.8%) compared with the combined (93.3%) and conventional MRI (93.4%) sets ($P=0.62$). All reviewers did not show a significant difference in specificity for the 3 sets in both groups. The Pearson coefficient of correlation between erosion in UTE and erosion in CT was 0.71 ($p<0.001$).

CONCLUSION

UTE provides CT-like images, allowing good depiction of erosion; a combination set of UTE and conventional MRI showed better sensitivity in the diagnosis of SpA, especially in those without BME.

CLINICAL RELEVANCE/APPLICATION

Recently, BME of the SIJ are reported to be nonspecific findings in SIJ MRI, leaving osseous erosion to be important finding. With UTE providing CT-like imaging, this will help detect early erosion, resulting better diagnosis of SpA.

SSE16-02 Are Undifferentiated Arthritis and Pre-Rheumatoid Arthritis Associated with the Longitudinal MRI Features of Knee Osteoarthritis Structural Damage?

Monday, Dec. 2 3:10PM - 3:20PM Room: N227B

Participants
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Frank W. Roemer, MD, Erlangen, Germany (*Abstract Co-Author*) Officer, Boston Imaging Core Lab, LLC; Research Director, Boston

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PURPOSE

Shared inflammatory pathophysiology of osteoarthritis (OA) and inflammatory joint diseases such as Rheumatoid Arthritis (RA) have been suggested previously. Undifferentiated arthritis (UA) and Pre-RA are considered as early stage inflammatory arthropathy before the diagnosis of RA based on clinical criteria; However, UA may persist without ultimate progression to RA. We aimed to investigate the association between knee OA structural damage worsening and clinically defined UA/Pre-RA using 3T-MRI measurements.

METHOD AND MATERIALS

This was an IRB-approved and HIPAA-compliant study of 600 subjects from the FNIH project. At the baseline visit, subjects with physician-diagnosed RA were excluded. Participants with any signs of arthritis, but not diagnosed RA, were assessed by connective tissue disease RA screening questionnaire and knee radiography. After exclusions of possible RA subjects (using questionnaire/radiography), the remaining were regarded as UA. Any of the UA-(control) or UA+ subjects who have developed RA in follow-up visits were categorized as Pre-RA. Baseline and 24-month semi-quantitative MRI OA Knee Score (MOAKS) measures of study groups were extracted and analyzed. Logistic regression model, adjusted for age, sex, BMI, and smoking status was used to assess the association between UA/pre-RA and baseline/worsening of MRI-based OA-related structural damages including cartilage thickness/surface scores, Hoffa-synovitis, and effusion-synovitis.

RESULTS

Presence of UA was associated with nearly significant structural damage in cartilage surface/thickness scores of whole knee (OR (95%CI): 1.73(0.94-3.1) and 1.73(1.0-3.04)), especially in patellofemoral joint (OR: 2.05(1.16-3.62) and 1.76(0.99-3.07)). In longitudinal assessment, presence of UA was significantly associated with 24-month worsening of lateral tibiofemoral cartilage damage (OR: 2.46(1.1-5.07). Pre-RA was not significantly related to cartilage damage after adjustments. There was also no association between UA/pre-RA and knee Hoffa-synovitis/effusion-synovitis.

CONCLUSION

Positive history of UA is associated with the concurrent knee joint cartilage defects at baseline, and its worsening over 24-months.

CLINICAL RELEVANCE/APPLICATION

Knee OA characteristic cartilage defects are probable in UA subjects despite absence of knee effusion/synovitis. This finding warrant further investigations for altered OA outcomes in subjects with UA but not definitive RA diagnosis.

SSE16-03 Diagnostic Performance of Texture Analysis for Differentiation of Inflammation versus Degeneration in the Sacroiliac Joints

Monday, Dec. 2 3:20PM - 3:30PM Room: N227B

Participants
Felix Kepp, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Florian A. Huber, Zurich, Switzerland (*Presenter*) Nothing to Disclose
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PURPOSE

to investigate the performance of texture analysis (TA) for differentiation of inflammation from degeneration in sacroiliac joints (SIJ).

METHOD AND MATERIALS

MR images of SIJ from patients with clinically established ankylosing spondyloarthritis (AS), degenerative changes and healthy individuals (30 patients each) were analyzed retrospectively. Two residents blinded to each other rated typical structural and inflammatory changes on a four-point Likert scale and categorized patients into different groups, using paracoronal sets of TIRM, T1w and T1w fat-sat contrast enhanced (T1wCE) images. Additionally, same-sized regions of interest were placed into pathologic (where applicable) or random healthy spots of SIJ. TA was performed with opensource software (MaZda). Logistic regression with ten-fold cross validation was applied to detect relations with clinical labels. Standard statistical testing was applied for interreader agreements (IA) and regarding distribution of qualitative and TA findings among the clinical categories.

RESULTS

Moderate IA was present for categorization into different groups (k=.40). Qualitative ratings showed weak to moderate IA, but cumulative qualitative scores differed significantly among patient categories (p<.001). TA showed perfect IA (k>.80) for 203, 194 and 210 features in TIRM, T1w & T1wCE, respectively. TA outperformed qualitative evaluation for differentiation between AS vs. non-AS (AUC=.89 vs. .75 for TA vs. qualitative) and between AS vs. degeneration (AUC=.91 vs. .66). MR sets showed different impact on TA based differentiation of AS vs. non-AS with AUCs of .74, .76 and .81 for TIRM, T1w and T1wCE.

CONCLUSION

TA improves accuracy in differentiation of AS from degeneration in the SIJ. Its performance is predominantly determined by T1wCE images.

CLINICAL RELEVANCE/APPLICATION

Determining the aetiology of chronic and acute changes in the sacroiliac joints is an everlasting difficulty in clinical and radiological routine. This work presents a quantitative approach that may help in valid identification of patients with axial spondylarthritis from the remainders, which would imply an impact on further patient management and conservative treatment.

SSE16-04 Quantitative MR Blood Perfusion Patterns of Infrapatellar Fat Pad T2 Hyperintense Lesions on Unenhanced MR in Patients with and without Knee Osteoarthritis

Monday, Dec. 2 3:30PM - 3:40PM Room: N227B

Participants
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PURPOSE

Infrapatellar fat pad (IPFP) T2 hyperintense lesions on unenhanced MR are an important imaging feature of knee osteoarthritis (OA) and are thought to represent inflammation. These lesions are very common, though, also in non-OA subjects, and may not always be linked to inflammation. This leads to the hypothesis that IPFP lesions may have different pathophysiological subtypes. The aim of this study was to evaluate quantitative blood perfusion parameters within T2 hyperintense lesions in patients with knee OA, with patellofemoral pain (PFP) (supposed precursor of OA), and in control subjects.

METHOD AND MATERIALS

43 healthy controls, 35 patients with PFP and 22 patients with knee OA were included. All underwent MRI including T2-mapping and dynamic contrast enhanced (DCE)-MRI. Image registration was used to correct for motion. If present, hyperintense T2 lesions in the IPFP were delineated on T2 maps using Horos software (Horosproject.org, USA). A second region was drawn in an adjacent area without T2 signal intensity alteration. Quantitative perfusion parameters (Ktrans, Ve, Vp) were extracted by fitting the extended Tofts' pharmacokinetic model where Ktrans represents the inflow, Ve the extravascular extracellular space and Vp vascular fraction of the region. A paired Wilcoxon-signed-rank test was used to compare regions with and without T2 lesions within subjects for each subgroup.

RESULTS

IPFP T2 hyperintense lesions were present in 14 controls, 13 PFP patients and 16 knee OA patients. Perfusion parameters were not statistically significantly different between areas with and without a T2 lesion within controls and PFP patients. In knee OA patients, the lesions demonstrated statistically significantly higher values of Ktrans and Ve compared to an area without a lesion. Remarkably, all regions drawn in knee OA demonstrated higher perfusion parameters, including Vp, compared to the other groups.

CONCLUSION

IPFP T2 hyperintense lesions are non-specific. In contrast to morphologically similar lesions in PFP patients and controls in knee OA patients IPFP hyperintense lesions are associated with higher perfusion, suggesting inflammation and neo-angiogenesis.

CLINICAL RELEVANCE/APPLICATION

OA has a tremendous societal burden, but the pathophysiology remains unknown. Quantitative DCE-MRI can serve as a method to unravel certain aspects of the pathophysiology of OA.

SSE16-05 Radiographic Hand Osteoarthritis and Its Association with Worsening of MRI-Based Tibiofemoral Osteoarthritis-Related Structural Damage

Monday, Dec. 2 3:40PM - 3:50PM Room: N227B

Participants
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Shadpour Demehri, MD, Baltimore, MD (*Abstract Co-Author*) Research support, General Electric Company; Research Grant, Carestream Health, Inc; Consultant, Toshiba Corporation

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PURPOSE

To determine whether the presence of hand osteoarthritis (OA) is associated with radiographic knee OA progression (over 48-months) and MRI-based knee OA structural damage worsening (over 24-months).

METHOD AND MATERIALS

600 subjects from the Foundation for the National Institute of Health (FNIH) project which is an IRB approved HIPAA compliant study were included (one index knee and hand in each subject). Baseline hand radiography of all subjects was measured for the presence of hand OA (modified Kellgren and Lawrence (mKL) grade >2 in each hand joints). Baseline and follow-up knee radiographic measurements and MRI OA Knee Score (MOAKS) variables for cartilage damage, bone marrow lesions, osteophytes, effusion, and Hoffa-synovitis as well as MRI-based knee periarticular bone area measurements were extracted. The association between the presence of hand OA (presence vs. absence of hand OA in each hand joint) and 48-months radiographic knee OA progression (>0.7mm reduction in medial tibiofemoral joint space width) as well as 24-months change in knee MOAKS and periarticular bone measurements were analyzed using regression model (adjusted for age and sex).

RESULTS

Presence of any carpometacarpal (CMC) OA (OR 95%CI: 1.58(0.96-2.62)) and overall hand OA (prsence of any mKL>2 in all hand joints) (OR 95%CI: 1.44(0.97-2.07)) was associated with 48-month radiographic knee OA progression (approached but not reached significance). In comparison with controls, subjects with hand OA showed higher odds of worsening tibial/femoral cartilage damage (OR 95%CI: 1.38(0.95-2.01) and 1.79(1.24-2.58)) and femoral periarticular bone area expansion (Beta 95%CI: 10.54(1.40-19.69)) over 24-months. CMC OA and 24-months worsening of MRI-based tibiofemoral cartilage damage and periarticular bone area expansion were also showed approached significant associations.

CONCLUSION

Presence of hand OA, especially in CMC joint, is associated with longitudinal MRI-based knee OA-related structural damage worsening including tibial/femoral cartilage damage and periarticular bone area expansion.

CLINICAL RELEVANCE/APPLICATION

Hand OA (specifically CMC OA), as a marker of generalized OA, may be considered a predictor of more rapid progression of knee OA compared to patients without hand OA, which might be of relevance for inclusion in clinical trials of disease modifying OA drug development.

SSE16-06 Assessment of the Angular Dependence of Multicomponent Driven Equilibrium Single Pulse Observation of T1 and T2 (mcDESPOT) in Patellar Cartilage Samples

Monday, Dec. 2 3:50PM - 4:00PM Room: N227B

Participants
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PURPOSE

To evaluate the magic angle sensitivity of Multicomponent and Single-component parameters of Multicomponent Driven Equilibrium Single Pulse Observation of T1 and T2 (mcDESPOT) in imaging the cadaveric human patellar cartilage samples on a clinical 3T scanner.

METHOD AND MATERIALS

mcDESPOT was prospectively performed on 3 human patellar cartilage samples. Imaging parameters were: FOV=4cm, slice thickness=0.5mm, rBW=125kHz, SPGR TR/TE=11.6ms/3.1ms, IR-SPGR TR/TE=9ms/3.1ms, TI=450ms, SSFP TR/TE=12.2ms/6.1ms, SPGR FA=3,4,5,6,7,9,13,18°, SSFP FA=2,5,10,15,20,30,40,50°; IR-SPGR FA=5°, matrix=160×160×26, and total scan time=~21min. The imaging was performed three times, each with a different orientation (0°, 55°, and 90° relative to B0). Regional analysis (superficial/middle/deep layer and global) was applied. Single-component T1/T2 relaxation time (T1/T2 Single) and the corresponding T1/T2 proton density (T1/T2 PD), multicomponent T1/T2 relaxation times of the fast relaxing water component (T1f/T2f) and of the slow relaxing water component (T1s/T2s), and fraction of the fast relaxing water component (Ff) were measured, and their angular dependence were analyzed.

RESULTS

Figure 1 shows T1 single values which show the smallest magic angle effect with 5.1% decrease from 1644.5 ms at 0° to 1562.3 ms at 55°. Ff values show a decreased magic angle effect with 48.4% decrease from 15.5 % at 0° to 8.0% at 55°. T2f values show the largest magic angle effect with 200.0% increase from 9.5 ms at 0° to 27.3 ms at 55°. Different degrees of magic angle effect were also observed for T1s, T1f, T1PD, T2PD, T2s and T2 single with a decrease of 19.5%, 26.3%, and increased of 38.4%, 42.2%, 79.3%, 181.8% respectively, by rotating the cartilage samples from 0 to 55 degrees relative to the B0 field. The values of Ff decrease from the deep layer to the superficial layer for all angular orientations. T2f and Ff maps show increased T2f and decreased Ff in patellar cartilage by rotating the cartilage samples from 0 to 55 degrees relative to the B0 field, and the changes in T2f are more obvious than those in Ff.

CONCLUSION

T1, T1s, T1f, T1PD, T2PD, and Ff show much reduced magic angle effect as compared to T2, T2s and T2f. Ff provides reduced magic angle sensitivity in the evaluation of cartilages as compared to T2, T2s and T2f.

CLINICAL RELEVANCE/APPLICATION

Ff is less sensitive to the magic angle effect than T2, T2s and T2f, and may provide more accurate diagnosis for early OA.

Printed on: 10/29/20

SSE17

Nuclear Medicine (Cardiovascular PET)

Monday, Dec. 2 3:00PM - 4:00PM Room: S403A

CA NM VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Don C. Yoo, MD, Lexington, MA (*Moderator*) Consultant, inviCRO, LLC

Sub-Events

SSE17-01 To Evaluate the Role of 18F-FDG PET/CT in Prosthetic Vascular Graft Infection

Monday, Dec. 2 3:00PM - 3:10PM Room: S403A

Participants
Sikandar M. Shaikh, DMRD, Hyderabad, India (*Presenter*) Nothing to Disclose

PURPOSE

Graft infection after prosthetic vascular reconstruction is an uncommon nowadays due to utmost psot surgical care however severe complication. The clinical presentation is often subtle and nonspecific and may occur long after surgery. Although defining a prosthetic vascular graft infection can be difficult, early diagnosis and treatment are important because of the relatively high rates of amputation and death. The present study assessed the role of PET/CT using 18F-FDG for the diagnosis of vascular graft infections

METHOD AND MATERIALS

Nineteen patients (15 men and 4 women; age range, 44-71 y) with suspected vascular graft infection underwent 18F-FDG PET/CT. The performance of PET/CT for the diagnosis of an infectious process and its localization to the graft or soft tissues was assessed. The final diagnosis was based on histopathologic findings and microbiologic assays obtained at surgery or on clinical and imaging follow-up.

RESULTS

PET/CT detected foci of increased 18F-FDG uptake suspected as infection in 14 patients and localized these findings to the graft in 8 patients. Vascular graft infection was confirmed in 7 of these patients (88%). PET/CT excluded graft involvement in 5 patients, and in 5 (91%) of these 5, long-term follow-up further confirmed that the infectious process was limited to surrounding soft tissues only. No abnormal 18F-FDG uptake was found in any of the 6 patients with no further evidence of infection. PET/CT had a sensitivity of 93%, specificity of 91%, positive predictive value of 88%, and negative predictive value of 96% for the diagnosis of vascular graft infection.

CONCLUSION

18F-FDG PET/CT is a reliable noninvasive imaging modality for the diagnosis of vascular graft-related infection. The precise anatomic localization of increased 18F-FDG uptake provided by PET/CT enables accurate differentiation between graft and soft-tissue infection.

CLINICAL RELEVANCE/APPLICATION

Thus 18F-FDG PET/CT is a reliable noninvasive imaging modality for the diagnosis of vascular graft-related infection

SSE17-02 Usefulness of ^{11}C-PiB PET/CT for Diagnosing Cardiac Amyloidosis

Monday, Dec. 2 3:10PM - 3:20PM Room: S403A

Participants
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PURPOSE

11C-Pittsburgh compound B (PiB) has been promising PET tracer for evaluating amyloid deposition in myocardium. The purpose of this study was to investigate the usefulness of PiB PET/CT for the detection of cardiac amyloidosis using retention index (RI)

images and standardized uptake value (SUV) images.

METHOD AND MATERIALS

PiB PET/CT studies were performed in 12 patients with cardiac amyloidosis (ATTR: 5, AL: 5, AA: 1 and unknown: 1) and 6 patients without cardiac amyloidosis. A 30-min dynamic emission scan of the heart was obtained immediately after bolus injection of PiB. The RI was calculated as the mean PiB radioactivity concentration between 15 and 25 min after injection divided by the integral of the arterial time-activity curve between 0 and 20 min after injection. The SUV images (at 10-20 min and 20-30 min) were reconstructed. RI and SUV images were visually evaluated. SUV images were also semiquantitatively evaluated using myocardium-to-blood pool ratio (MBR).

RESULTS

PiB uptake was visually evident in all 12 patients with cardiac amyloidosis on RI image, in 11/12 patients on 10-20min SUV image and in 7/12 patients on 20-30min SUV image. Myocardial PiB uptake was not observed in all 6 patients without cardiac amyloidosis on both SUV and RI images. The mean (±SD) value of MBR in cardiac amyloidosis on SUV images at 10-20 min and 20-30 min was significantly higher (2.01±0.78 and 1.70±0.75, respectively) than that of patients without cardiac amyloidosis (1.07±0.13 and 0.92±0.14, respectively) (p=0.010 and 0.024). With a cutoff MBR of 1.5 on 10-20min SUV image, the sensitivity and specificity were 100% and 92%, respectively. The mean (±SD) value of MBR in AL type cardiac amyloidosis patients on SUV images at 10-20 min and 20-30 min was higher (2.36±1.12 and 1.98±1.10, respectively) than that of ATTR type cardiac amyloidosis patients (1.88±0.18 and 1.65±0.20, respectively), however, there were no significant differences between two types of cardiac amyloidosis.

CONCLUSION

These preliminary results indicate that PiB PET/CT using RI images and SUV images were likely to be a useful imaging modality for cardiac amyloidosis.

CLINICAL RELEVANCE/APPLICATION

PiB PET/CT using RI images and SUV images were likely to be a useful imaging modality for diagnosing cardiac amyloidosis.

SSE17-03 Varying Correlation between Inflammation and Microvascularization in Carotid Atherosclerotic Plaques with Hybrid 18^F-FDG PET/MR

Monday, Dec. 2 3:20PM - 3:30PM Room: S403A

Participants
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PURPOSE

Hallmarks of vulnerable atherosclerotic plaques are inflammation that can be quantitatively assessed with 18F-fluorodeoxyglucose positron emission tomography (18F-FDG-PET), and increased neovascularization that can be evaluated by dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI). It remains unclear whether these parameters are correlated or represent independent imaging parameters. This study determines to investigate the correlation between inflammation and neovascularization in atherosclerotic carotid plaques by performing hybrid 18F-FDG PET/MR.

METHOD AND MATERIALS

Twenty-five patients with transient ischemic attack or minor stroke in the carotid territory and ipsilateral carotid artery stenosis of 30% to 69% were included. All patients underwent hybrid PET/MR a median of 180 min after injection of 18F-FDG. 18F-FDG standard uptake values with target/background ratio (TBR) were determined. Neovascularization was quantified by transfer constant (Ktrans). Spearman rank correlation coefficients between TBR and Ktrans were calculated.

RESULTS

Results: The correlation between TBR and Ktrans was only marginal in the whole study sample (r=0.25, p=0.043). The two variables correlated with each other in the symptomatic plaques (r=0.71, p=0.013), but were independent in the asymptomatic plaques (r=0.03, p=0.473). Neither TBR nor Ktrans was significantly higher in the symptomatic plaques, but both showed inverse relationships with time since last cerebrovascular ischemic event (r=-0.92 and -0.74 for TBR and Ktrans, respectively).

CONCLUSION

The correlation between inflammation and microvascularization in carotid atherosclerotic plaques with hybrid 18F-FDG PET/MR varied with clinical conditions, pointing to a complex interplay between macrophages and neovessels under different pathophysiological conditions. The moderate correlation shown only in symptomatic plaques indicates the presence of acute plaque inflammation with increased metabolic activity and cytokine production by inflammatory cells. Hybrid 18F-FDG PET/MR systems can help to evaluate the correlation between inflammation and microvascularization in carotid atherosclerotic plaques.

CLINICAL RELEVANCE/APPLICATION

Hybrid 18F-FDG PET/MR systems can help to evaluate the correlation between inflammation and microvascularization in carotid atherosclerotic plaques and this exam is recommended when the underlying cause of such a lesion is unclear.

SSE17-04 Brown Fat Activation Demonstrated on FDG PET/CT Predicts Favorable Lipid Profile and Reduced Risk of Diabetes

Monday, Dec. 2 3:30PM - 3:40PM Room: S403A

Participants
Sonya Y. Park, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose

PURPOSE

Brown adipose tissue (BAT) plays a key role in energy homeostasis, conferring protection against diet-induced obesity, and has even been suggested as a potential target for the treatment of obesity and metabolic syndrome. The purpose of this study was to compare the metabolic outcomes (lipid profile and diabetes) of patients with and without BAT activity on FDG PET/CT.

METHOD AND MATERIALS

PET/CT exams from 1834 breast cancer patients were retrospectively reviewed for bilateral symmetric elongated FDG activity in the neck and chest, typical of BAT activation. To account for temperature changes in the environment, patients with BAT activity and those who underwent PET/CT exams on the same day (but without BAT activity) were included in the study. Blood glucose, lipid profile and presence of diabetes at baseline and last clinical follow-up (mean follow-up of 57 months) were recorded. Comparison of the groups with and without BAT activity was done using Mann Wwhithney U-test. Development of diabetes was analyzed with respect to the other clinical variables using Cox proportional hazard model.

RESULTS

1.1% (20/1834) of the patients who underwent PET/CT demonstrated BAT activation, and 119 patients were analyzed for comparison as the group without BAT activity. The group with BAT activity showed significantly lower age (mean 41.8 vs. 53.7, p<0.001), BMI (mean 22.0 vs. 23.6, p=0.049), blood glucose (mean 90.3 vs. 109.3, p=0.029) and total cholesterol (mean 169.4 vs. 190.4, p=0.029) than the group without. At last clinical follow-up, the group with BAT activity showed little change in terms of triglyceride and total cholesterol levels, but increased HDL (mean 45.5 to 60.8) and decreased LDL (mean 115.5 to 85.6). Presence of BAT activity was the only statistically significant predictor for diabetes on Cox regression (p=0.014), with a hazard ratio of -9.007.

CONCLUSION

Patients with BAT activity demonstrated the characteristic traits of lower age, BMI, blood glucose and total cholesterol at baseline, and showed a favorable change in lipid profiled on follow-up. The hazard for this group was also lower than for the group without BAT activity in terms of diabetes, further suggesting the role of brown fat in lipoprotein metabolism.

CLINICAL RELEVANCE/APPLICATION

Mention of brown adipose tissue activity is recommended when visualized on FDG PET/CT, due to the added information it offers regarding lipoprotein metabolism.

SSE17-05 Assessment of Aortic Involvement in Takayasu Arteritis with FDG PET during the Immunosuppressive Therapy

Monday, Dec. 2 3:40PM - 3:50PM Room: S403A

Participants
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PURPOSE

F-18 fluorodeoxyglucose (FDG) positron emission tomography (PET) is a promising technique for the diagnosis of Takayasu arteritis (TAK). The severity of FDG uptake in the aortic wall is often evaluated by the comparison with liver uptake; whereas, the FDG uptake in the liver has been discussed to be affected by prednisone (PSL) and tocilizumab (TCZ), which are the common treatment of TAK. Moreover, the optimal evaluation of aortic involvement with FDG PET in TAK during the immunosuppressive therapy (IST) has not been established enough. The aim of this study was to elucidate the influence of PSL and TCZ on liver FDG uptake and to find out the appropriate assessment of FDG uptake in the aortic wall in TAK patients during IST.

METHOD AND MATERIALS

Twenty-five consecutive TAK patients during IST were examined with FDG PET. We excluded 6 patients with a history of total arch replacement. Of 19 patients, 11 patients were treated with only PSL (PSL group) and 8 patients received TCZ with/without PSL (TCZ group). First, the maximum standardized uptake value (SUVmax) of the aortic wall, liver, and lumen blood pool was calculated. Next, the aortic wall to liver FDG uptake ratio [target-to-liver uptake ratio (TLR)] and the aortic wall to lumen ratio [target-to-background ratio (TBR)] were determined. Furthermore, TLR and TBR were compared between the patients remaining symptoms (Active, n=12) and the patients with no clinical complaint (Inactive, n=7).

RESULTS

First, SUVmax in the liver was significantly lower in TCZ group than PSL group (2.36±0.15 vs. 3.08±0.13, p<0.01). Secondly, there was no significant difference in TLR between Active and Inactive; on the other hand, TBR was significantly higher in Active than Inactive (1.45±0.07 vs. 1.14±0.09, p=0.01). Based on ROC curve analysis, the optimal TBR cut-off value for detecting active inflammation in the aortic wall was 1.35 with the sensitivity of 72% and specificity of 100%.

CONCLUSION

Since liver FDG uptake was susceptible to IST, the comparison with the liver uptake might not be recommended for the assessment of persistence or recurrence of aortic involvement with FDG PET. TBR is more appropriate to evaluate the aortic involvement in TAK during IST.

CLINICAL RELEVANCE/APPLICATION

IST for TAK affects the FDG distribution in the liver. For the assessment of aortic involvement in TAK during IST, it is more appropriate to compare the FDG uptake in the aortic wall with the lumen blood pool.

SSE17-06 Vulnerable Plaque Features Can Be Detected in Carotid Plaques with Hybrid 18^F-FDG PET/MR Imaging

Monday, Dec. 2 3:50PM - 4:00PM Room: S403A

Participants
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PURPOSE

To investigate morphological and biological features of vulnerable carotid atherosclerotic plaques in patients with known increased risk of atherosclerosis with hybrid 18F-FDG PET/MR imaging.

METHOD AND MATERIALS

Sixteen patients with known increased risk of atherosclerosis underwent hybrid PET/MR of the carotid arteries after injection of 18F-FDG. PET/MR was performed a median of 180 min after injection. American Heart Association (AHA) lesion type and plaque composition were determined on consecutive MRI axial sections in both carotid arteries. 18F-FDG uptake in carotid arteries was quantified using maximum standardized uptake values (SUVmax) and tissue to background ratio (TBR) on corresponding PET sections.

RESULTS

The prevalence of complicated atherosclerotic plaques (AHA lesion type VI) detected with high-resolution MRI was significantly higher in the carotid artery ipsilateral to the ischemic stroke as compared to the contralateral side (31 vs 0 %; p=0.006). Atherosclerotic plaques classified as vulnerable with MRI (AHA lesion type VI) were associated with higher 18F-FDG uptake in comparison with other AHA lesions (SUVmax=3.31±1.13 vs 1.61±0.68 and 0.91±0.37; TBR=3.21±1.04 vs 1.56±0.53 and 0.88±0.26, respectively; p<0.001).

CONCLUSION

Morphological and biological features of vulnerable plaques can be detected with 18F-FDG PET/MR in patients with known increased risk of atherosclerosis. Hybrid 18F-FDG PET/MR systems might help in the evaluation of patients with vulnerable carotid atherosclerotic plaques.

CLINICAL RELEVANCE/APPLICATION

Hybrid 18F-FDG PET/MRI systems can help in the evaluation of patients with vulnerable carotid atherosclerotic plaques.

SSE18

Neuroradiology (Epilepsy/Metabolism/Infection)

Monday, Dec. 2 3:00PM - 4:00PM Room: S401CD

MR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSE18-01 Functional Brain Connectivity in Periventricular Nodular Heterotopia

Monday, Dec. 2 3:00PM - 3:10PM Room: S401CD

Participants
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PURPOSE

Periventricular nodular heterotopia (PNH) consists of ectopic grey matter nodules accumulation, corresponding to small epileptogenic foci. Network analysis have been widely used to characterize brain network organization and changes in epileptic brains. Our objectives were to analyse network alterations in PNH.

METHOD AND MATERIALS

16 PNH patients and 32 healthy controls matched to age and gender underwent a resting-state functional 3T-MRI. We first assessed the relevance of heterotopic nodules' signal by computing the amplitudes of low-frequency fluctuations (ALFF). Then, we analysed the nodular-cortical connectivity with respect to cortico-cortical connectivity. We analysed the relationships between nodular connectivity and geodesic distance to nodule as well as resting-state networks. Finally, from cortico-cortical functional connectivity matrices, network features such as clustering coefficient (CC) and path length (PL) were computed and compared between PNH patients and controls, based on graph theory.

RESULTS

In heterotopic nodules, ALFF was significantly higher than in white matter: 0.30 vs 0.01 ($p<0.001$), and lower than in grey matter: 0.30 vs 0.54 ($p<0.001$). Functional connectivity between heterotopic nodules and grey matter was significantly lower with respect to cortico-cortical connectivity. Nodular-cortical connectivity was significantly anti-correlated to geodesic distance to nodule ($p=0.01$), and heterotopic nodules were mostly connected to the visual, the dorsal attention and the ventral attention networks. When comparing to controls, functional connectivity was significantly decreased in PNH patients ($p=0.02$), with a decreased small-world organization: decrease in CC ($p=0,03$) and increase in PL ($p=0,01$).

CONCLUSION

We found for the first time whole-brain network changes in PNH, such as decrease in small-world organization, which could explain decrease in information processing speed encountered in those patients. We also analysed functional connectivity between heterotopic nodules and neocortex, that could explain the functional impact of nodules' surgical resection. Our results are consistent with studies in other focal seizures etiologies, and allow a better understanding of epileptogenicity in PNH.

CLINICAL RELEVANCE/APPLICATION

Resting-state functional MRI and graph theory are useful to explain epileptogenicity and should be more widely used to understand pathophysiological mechanisms in focal epilepsy.

SSE18-02 Cortical Thickness Changes in Newly Diagnosed MRI Negative Pediatric Generalized Epilepsy Patients

Monday, Dec. 2 3:10PM - 3:20PM Room: S401CD

Participants
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PURPOSE

Patients with generalized epilepsy undergo neuroanatomical changes along their disease course. Previous studies have shown cortical thickness changes in this disease population but with a longer disease duration. The goal of our study was to detect cortical thickness changes in newly-diagnosed pediatric generalized epilepsy patients.

METHOD AND MATERIALS

Generalized epilepsy patients (N=14) and controls (N=14) were studied. Our patient population included: 14 magnetic resonance (MR) negative patients diagnosed with generalized epilepsy and a mean duration of 1 year. The mean age was 16.5 years and the mean age of seizure onset was 15.5 years. EEG was collected and showed generalized pattern with clear background in most of our patient population. FreeSurfer was used to analyze cortical thickness in both patients and age-matched controls.

RESULTS

Pediatric generalized epilepsy patients showed decreased cortical thickness in both hemispheres in the anterior cingulate cortex and medial superior frontal regions.

CONCLUSION

Morphometric analysis in epileptic patients with negative MR showed thinner cortices in both hemispheres in the anterior cingulate cortex and medial superior frontal regions when compared to control group. To the best of our knowledge, this is the first study reporting that a decrease in cortical thickness decreases can be detected within about one year of seizure onset.

CLINICAL RELEVANCE/APPLICATION

Understanding the early changes in generalized epilepsy may prove useful in drug selection, improvement of clinical outcome and in the prediction of long-term cognitive impairments. The role of anterior cingulate cortex and medial superior frontal regions in the pathogenesis of generalized epilepsy or in resulting neurological disturbances remains to be investigated.

SSE18-03 Comparison of the Diagnostic Accuracy of FDG-PET/MR to that of FDG-PET/CT for Epileptogenic Zone Detection

Monday, Dec. 2 3:20PM - 3:30PM Room: S401CD

Participants
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PURPOSE

To compare the diagnostic accuracy of FDG-PET/MR and that of FDG-PET/CT with respect to identifying epileptogenic zone (EZ) in patients with localization-related epilepsy

METHOD AND MATERIALS

This prospective study was approved by our institutional review boards, and written informed consent was obtained from each participant. Between November 2014 and April 2018, thirty-one patients (17 males, 14 females; 8-58 years; median 31 years) were evaluated. All patients were firstly scanned by FDG-PET/CT system for a diagnosis of localization-related epilepsy, then followed by FDG-PET/MR system immediately after. Two series of FDG-PET images acquired using PET/CT and PET/MR were interpreted independently by five board-certified radiologists. All readers were blinded to clinical data including the laterality of seizure as well as electroencephalogram. A Likert scale scoring system was used to assess image quality. The epileptogenic zone was histopathologically proven after surgery. Diagnostic sensitivities and Likert scale scores derived from both PET/MR and PET/CT were compared using the paired t-test. A $P < 0.05$ was considered significant.

RESULTS

Diagnostic sensitivity derived from PET/MR was higher than that from PET/CT (83.2±5.3% vs. 61.9±2.7%, $P = 0.0006$). Image quality score derived from PET/MR was higher than that from PET/CT (2.66±1.45 vs. 1.66±1.49, $P < 0.0001$).

CONCLUSION

The diagnostic accuracy of FDG-PET/MR was superior to that of PET/CT for detection of EZ in patients with localization-related epilepsy.

CLINICAL RELEVANCE/APPLICATION

FDG-PET/MR provides the accurate information of epileptogenic zone, which improves outcome of patient with localization-related epilepsy.

SSE18-04 Metabolic Connectivity Can Help Predict Seizure Outcomes in Temporal Lobe Epilepsy Surgery

Monday, Dec. 2 3:30PM - 3:40PM Room: S401CD

Participants
Mohamed Tantawi, MBBCh, Philadelphia, PA (*Presenter*) Nothing to Disclose
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PURPOSE

The understanding of epilepsy as a network disorder introduced the idea of using the brain connectome as a prognostic indicator. The objective of this study is to assess the potential of metabolic connectivity as a predictive factor of outcome in epilepsy surgery by examining preoperative metabolic connectivity in patients who underwent Laser interstitial Thermal Therapy (LiTT) for medically resistant temporal lobe epilepsy (TLE).

METHOD AND MATERIALS

In this study, we collected positron emission tomography (PET) scans from 24 TLE patients who had unilateral mesial temporal sclerosis. At 1 year follow up after surgery 13 patients were seizure free (Engel class IA), but 11 patients had recurrent seizures and were classified as not seizure free (non-IA class). Initially, PET scans were preprocessed using SPM12. Next, connectivity matrices were constructed based on the correlation of interregional glucose metabolic values within subjects. Finally, graph theoretical analysis was performed using Brain Analysis using Graph Theory (BRAPH) software.

RESULTS

Metabolic network organization in the seizure free group differed substantially compared with the not seizure-free group. Compared with seizure free patients, the temporal pole and cingulate regions had higher connectivity with the surrounding areas in the not seizure free group, while multiple regions including cingulate, precentral gyri, postcentral gyri, and superior parietal gyrus were highly clustered with surrounding nodes indicating greater functional segregation.

CONCLUSION

Our study demonstrated a relationship between presurgical metabolic connectivity and post-surgical seizure outcome of the patients who had LiTT surgery and the potential role as an imaging biomarker to predict surgical outcomes in this patient cohort. Extension of the disease to extratemporal networks, specifically the limbic network, plays a role in seizure recurrence after surgery. Although MTS typically involves sclerosis of the hippocampus, we can conclude that this pathology will involve other medial structures in the temporal lobes of the brain as well as neuronal connections projecting to other structures involving the limbic system, such as the temporal pole and cingulate.

CLINICAL RELEVANCE/APPLICATION

Combined with the current tests used in clinical practice, metabolic connectivity may be used as an additional prognostic/diagnostic factor during pre-surgical evaluation for refractory TLE patients.

SSE18-05 Resting-State Functional Network Topology Correlates with Surgical Outcome in Temporal Lobe Epilepsy

Monday, Dec. 2 3:40PM - 3:50PM Room: S401CD

Participants
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PURPOSE

To correlate resting-state functional network topology and surgical outcome in patients with medically refractory temporal lobe epilepsy (TLE).

METHOD AND MATERIALS

Data from forty patients with medically intractable temporal lobe epilepsy were retrospectively analyzed. All (40/40) patients underwent pre-operative resting-state functional magnetic resonance imaging (fMRI) and subsequent unilateral anterior temporal lobectomy. Postoperative seizure-free status was categorized using the Engel Epilepsy Surgery Outcome Scale. Resting-state functional connectivity networks were analyzed for each subject using a minimum spanning tree (MST) approach, and global and regional network properties were calculated and statistically compared between subjects who experienced complete postoperative seizure freedom (Engel IA) and all others (Engel IB-IV).

RESULTS

Global network properties related to network integration were statistically significantly ($p<0.05$) different between subjects who had Engel IA surgical outcomes and all others, with 9% decreased leaf fraction and 10% decreased tree hierarchy in subjects with ongoing seizures. The regional properties of a cluster of anatomic regions in the contralateral temporoinsular region were statistically significantly ($p<0.05$) different between subjects in these two groups. Specifically, the group-level leaf proportion was 59% decreased in the contralateral entorhinal cortex, 73% decreased in the contralateral inferior temporal gyrus, 43% decreased in the contralateral temporal pole, and 69% decreased in the contralateral insula in subjects with ongoing seizures.

CONCLUSION

Resting-state network topology correlates with surgical outcome in temporal lobe epilepsy, with decreased network integration globally and involving the contralateral temporoinsular region associated with ongoing postoperative seizures.

CLINICAL RELEVANCE/APPLICATION

Resting-state fMRI may be a useful non-invasive tool to determine whether patients being evaluated for resective epilepsy surgery are more likely to experience postoperative seizure freedom.

SSE18-06 Evaluation of Integrity of White Matter Fibers in Patients with Anti-NMDAR Encephalitis Based on Automated Fiber Quantification

Monday, Dec. 2 3:50PM - 4:00PM Room: S401CD

Participants
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PURPOSE

To show the changes in integrity of white matters in patients with anti-NMDAR encephalitis based on automated fiber quantification (AFQ).

METHOD AND MATERIALS

Forty-eight patients with anti-NMDA receptor encephalitis diagnosed in our hospital and 40 matching gender, age and education level healthy controls were recruited in this study. All subjects underwent conventional head MRI, diffusion tensor imaging (DTI) scanning, mRS and mini-mental state examination (MMSE) scores. Fractional anisotropy (FA) and mean diffusivity (MD) quantitative analyses were conducted on 100 nodes of 20 white matter fibers in all subjects' brains using AFQ to compare whether there were statistical differences, and to analysis correlations between these two parameters and mRS and MMSE scores, respectively.

RESULTS

(1) Conventional MRI showed that lesions in bilateral corticospinal tracts (CST) and hippocampi in one patients and in left frontal cortex in another patients. (2) Diffuse increase of FA values and reduction of MD values were measured on the bilateral CST, cingulum cingulate, cingulum hippocampus, and arcuat, showing significantly statistical differences from the healthy controls ($P < 0.01$). Diffusion indexes of the other fibers showed segmental changes, and there was no statistical difference between the two groups ($P > 0.05$). (3) FA values of the bilateral CST, cingulum cingulate, cingulum hippocampus, and arcuat were negatively correlated with mRS score ($r = -0.81, -0.77, -0.86, -0.85$, respectively; $P < 0.01$), and positively correlated with MMSE score ($r = 0.90, 0.83, 0.92, 0.89$, respectively; $P < 0.01$). MD values of the bilateral CST, cingulum cingulate, cingulum hippocampus, and arcuatand were positively correlated with mRS score ($r = 0.84, 0.77, 0.88, 0.77$, respectively; $P < 0.01$), and negatively correlated with MMSE score ($r = -0.92, -0.86, -0.92, -0.89$, respectively; $P < 0.01$).

CONCLUSION

In patients with anti-NMDA receptor encephalitis, extensive microstructural damage is found in the fiberes dominated by CST, cingulum cingulate, cingulum hippocampus, and arcuat, which is closely related to the mRS scores and MMSE scores of patients and is helpful for the diagnosis of occult lesions and explanation of the clinical symptoms.

CLINICAL RELEVANCE/APPLICATION

(Dealing with AFQ and white matter) "Automated fiber quantification can demonstrated white matter changes and this exam is recommended when the underlying cause of such a lesion is unclear"

SSE19

Neuroradiology (Neurointerventional Techniques)

Monday, Dec. 2 3:00PM - 4:00PM Room: S504AB

IR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSE19-01 Functional Flow in Cranial Rotational Angiography: Optimization of Injection Rate to Preserve Cardiac Pulsation Information

Monday, Dec. 2 3:00PM - 3:10PM Room: S504AB

Participants
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PURPOSE

Complex flow patterns in cranial anatomy could lead to new insight in disease staging and treatment. An injection protocol which optimizes identification of temporal information from rhythmic variations in density of the contrast bolus during systole and diastole in 4D-DSA studies has not been defined. Our purpose was to determine the injection protocol most likely to result in optimal contrast pulsatility (CP).

METHOD AND MATERIALS

Two 3D printed patient specific cerebrovascular models consisting of the ICA, MCA, and ACA were connected to a closed-loop flow system driven by a positive displacement pulsatile pump (5.5 L/min, 60 beats/min). The system was configured to deliver 250-260 mL/min of the total flow to the model. A mixture of 60% glycerol and 40% distilled water was used as the working fluid. Contrast (Isovue 370mg I/cc, 75% dilution) was injected through a 6F catheter positioned upstream from the ICA using a power injector. 4D-DSA acquisitions (11.5 second/304 projections) were done for the following injection rates: 1.5, 2.0, 2.5, 3.0 and 3.5 cc/sec for 8 seconds. The CP present in the time concentration curves (TCCs) was analyzed using a previously described numerical metric, the side band ratio (SBR), to determine the signal strength.

RESULTS

CP was present in the TCCs throughout the model in all of the 4D-DSAs acquired. In the inlets of both models, the strongest CP signal (highest SBR) was found with the 2.5 ml/s injection rate. At this injection rate, CP was identifiable throughout the entire vasculature in both models. As compared to previously determined ground truth (micro CT) geometrical measurements, the accuracy of a 3D reconstruction was preserved.

CONCLUSION

An injection rate of 2.5 ml/s provided the strongest CP in a 4D-DSA reconstruction while also maintaining geometric accuracy of a 3D reconstruction. Use of this injection rate provided the best temporal data for use in 4D-DSA velocity and flow calculations.

CLINICAL RELEVANCE/APPLICATION

Quantifying blood flow in the angiography suite would enhance decision making. This would be enabled by an injection protocol which optimizes contrast pulsatiltiy while maintaining geometric accuracy.

SSE19-02 Simultaneous Acquisition of High Speed Angiography (HSA) at 1000 Frames Per Second during Digital Subtraction Angiography (DSA) and Digital Angiography (DA)

Monday, Dec. 2 3:10PM - 3:20PM Room: S504AB

Participants
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Daniel Bednarek, PhD, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation

Stephen Rudin, PhD, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation

PURPOSE

DSA and DA sequences acquired during neuro-endovascular image-guided interventions provide visualization of vascular morphology to interventionalists, but detailed blood flow information is blurred due to movement of contrast during the exposure pulse times. A method is proposed for acquiring this flow information simultaneously during each x-ray pulse using a high frame-rate imager.

METHOD AND MATERIALS

A new single photon-counting detector (Actaeon from XCounter) is a direct-conversion, high-resolution 100 µm pixel, small field-of-view x-ray detector capable of imaging at frame rates of 1000 fps. The Actaeon was used with a mobile c-arm angiography unit to image blood flow details in a 3D-printed, patient-specific aneurysm phantom. The c-arm was operated at 6 pulses per second with technique parameters of 70 kVp, 100 mA, 32 ms pulse width. Ten ml iodine-based contrast was autoinjected into the vessel to enable visualization of flow dynamics in the phantom. One millisecond frames were acquired at 1000 fps during each pulse. 32 HSA frames were integrated to create single region-of-interest DSA/DA images in the sequence. Individual HSA runs of 32 frames are viewed post-acquisition.

RESULTS

The integrated frames demonstrated standard low quantum noise DSA/DA images; however, the flow of the injected contrast is blurred, only showing the shape of the vessels. At no additional dose, the images acquired at 1000 fps were simultaneously recorded. These high-speed images preserve detailed flow information showing the movement of contrast throughout the vessel and pathology.

CONCLUSION

It was demonstrated that the new Actaeon detector can provide DSA/DA quality images and simultaneously is capable of providing images containing detailed flow information at no additional cost in exposure. The additional flow information comes at no added risk to the patient and could become a useful tool for clinicians to use during a procedure in assessing flow dependent tasks, such as the effectiveness of interventional devices in diverting blood flow away from the aneurysm.

CLINICAL RELEVANCE/APPLICATION

Simultaneous 1000 fps acquisition during DSA can provide detailed flow images for assessing treatment at no additional cost in radiation exposure to patients.

SSE19-03 In Vitro Testing of a Funnel-Shaped Tip for Mechanical Thrombectomy: A Novel Approach to Decrease Clot Migration

Monday, Dec. 2 3:20PM - 3:30PM Room: S504AB

Participants
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PURPOSE

One limitation of mechanical thrombectomy (MT) is clot migration during procedure. This might be caused by abruption of the trapped thrombus at the distal access catheter (DAC) tip during stent retriever retraction, due to the cylindrical shape of the catheter tip. New DACs solving this problem needed to be developed. Therefore a cylindrical- shaped tip was modified to a funnel-shaped tip. The study at hand evaluates the proof-of-concept in an experimental in vitro setting

METHOD AND MATERIALS

In order to detect the superiority of a funnel-shaped tip vs. a cylindrical-shaped tip, both models (made of modified introducer sheaths) were tested in an experimental setup. A silicon vessel model and thrombi generated from pig's blood were used for MT. MT was performed 20 times for each device using two different stent retrievers, 10 times respectively.

RESULTS

For the funnel-shaped model, for both stent retrievers (Trevo XP ProVue 3/20 mm; Trevo XP ProVue 4/20 mm) MT was successful at first pass in 9 out of 10 times (90 %), respectively. For the cylindrical-shaped model, 5 out of 10 (50%) MTs were successful at first pass with the smaller stent retriever and 6 out of 10 (60 %) for the larger stent retriever

CONCLUSION

Our first in vitro experiments show a better recanalization rate for the funnel-shaped tip, in comparison to the cylindrical-shaped tip. Further in vitro and in vivo studies are needed to verify the safety and the efficiency of the proposed funnel-shaped tip

CLINICAL RELEVANCE/APPLICATION

Clot migration during mechanical thrombectomy can be decreased by modifying the catheter tip from cylindrical to funnel-shaped.

SSE19-04 Spin Echo T2 signal Intensity the Day After Flow Diverter Insertion is Associated with Early Total Regression

Monday, Dec. 2 3:30PM - 3:40PM Room: S504AB

Participants
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PURPOSE

The purpose of this study was to predict early total regression of flow-diverted sac through MR finding of Spin Echo T2-weighted images the day after pipeline insertion.

METHOD AND MATERIALS

Thirty consecutive patients whose cerebral aneurysms were treated with pipeline embolization device between Feb 2014 and Oct 2018 were included in this study. The procedures consisted of installation of pipeline embolization device (PED; Medtronic, Minneapolis, Minnesota, USA) and any other procedures such as additional coil embolization were not performed. All the procedures were successful except one incomplete apposition due to stent kinking. Angiographic evaluation 3 month after the procedure showed total or near total regression of aneurysmal sac (n=20); and partial regression (n=10). Percent area of stagnated iodine contrast agent was measured by a neurosurgeon on anterior-to-posterior and lateral view of angiography just after installation of pipeline device. Geometric and signal intensity-based analysis was performed by a neuroradiologist using in-house software to demonstrate voxel based histogram analysis. Volume of interest (VOI) was set along the whole volume of treated aneurysmal sac. All the signal intensity was normalized by that of normal appearing white matter.

RESULTS

Demographic data comparison between two groups (total or near total regression vs. partial regression) showed no significant difference. Volume of treated aneurysmal sac was not different (2559.28 mm3±3021.45, 2551.76 mm3±6550.58, p=0.455). Total or near total regression group showed larger area of percent iodine stagnation than partial regression did (52.26%, 23.35%, p=0.002). Median signal intensity and 10-percentile signal intensity of VOI were higher in total or near total regression group (1.29, 0.93, p=0.025; 0.57, 0.24, p=0.005).

CONCLUSION

Percentage area of iodine stagnation on lateral angiography, median and 10-percentile signal intensity of VOI of treated aneurysmal sac on T2 weighted image can be used to predict total regression of aneurysmal sac.

CLINICAL RELEVANCE/APPLICATION

MR finding of Spin Echo T2-weighted images the day after pipeline insertion can be used to predict early total regression of flow-diverted sac and to reduce invasive angiographic procedures.

SSE19-05 Incidence of Post-Lumbar Puncture Headaches Requiring Epidural Blood Patch After Fluoroscopic Guided Lumbar Puncture

Monday, Dec. 2 3:40PM - 3:50PM Room: S504AB

Participants
Daniel W. O'Neal, MD, Norfolk, VA (*Presenter*) Nothing to Disclose
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PURPOSE

The aim of this study was to determine the incidence of post-lumbar puncture headaches severe enough to warrant an epidural blood patch following fluoroscopic guided lumbar puncture.

METHOD AND MATERIALS

Retrospective analysis was performed on 388 fluoroscopic guided lumbar punctures in adults at a tertiary care teaching hospital from 7/1/2018 to 3/31/2019. Patient inclusion criteria included age between 18 and 90 years old; male or female; and both outpatients and inpatients. All lumbar punctures were performed in the prone position utilizing fluoroscopic guidance by attending radiologists or diagnostic radiology residents under direct supervision. Lumbar punctures were performed for diagnostic, therapeutic, myelographic, and nuclear medicine purposes. Medical chart review for each patient to identify lumbar puncture related complications, specifically the need to perform an epidural blood patch, extended up to 30 days post-procedure.

RESULTS

Of the 388 fluoroscopic guided lumbar punctures performed during the study period, 10 also required an epidural blood patch in the post-procedure course. This calculates to a 2.6% incidence of post-lumbar puncture headaches that are severe enough to warrant the intervention of a blood patch.

CONCLUSION

This single center retrospective analysis shows that following fluoroscopic guided lumbar puncture performed in the prone position there is a 2.6% incidence of post-lumbar puncture headaches requiring the intervention of an epidural blood patch over a nine-

month period.

CLINICAL RELEVANCE/APPLICATION

Knowing the incidence of post-lumbar puncture headaches requiring epidural blood patch after fluoroscopic guided lumbar puncture allows the radiologist to provide accurate informed consent.

SSE19-06 Battery-Powered Drill Biopsy Systems Demonstrate Similar Efficacy but Decreased Radiation Dose Compared to Manual Bone Biopsy Systems in CT-Guided Sampling of the Vertebral Column

Monday, Dec. 2 3:50PM - 4:00PM Room: S504AB

Participants
Shingo Kihira, MD, New York, NY (*Presenter*) Nothing to Disclose
Clara Koo, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To investigate differences in efficacy and radiation dose between battery powered and manual bone biopsy systems in CT-guided biopsy of lytic, mixed, sclerotic, and suspected discitis/osteomyelitis

METHOD AND MATERIALS

This was a retrospective single center IRB approved study. A total of 351 CT-guided core needle biopsies were performed at one institution from May of 2010 to February of 2019. Classification of vertebral body lesions, bone biopsy system, diagnostic yield, crush artifact, radiation dose, and procedure times were collected. The bone biopsy systems used for the procedure were OnControl (VidaCare) for the powered drill, and Bonopty (AprioMed) and Murphy (Cook) for the manual systems. Comparison within lytic, sclerotic, mixed (both lytic and sclerotic), and suspected discitis/osteomyelitis were made by Fisher exact test. One-way ANOVA was used for subgroup analysis of the drill systems for procedure time and radiation dose.

RESULTS

Our patient cohorts consisted of a total of 351 patients with 194 lytic, 29 mixed, 74 sclerotic, and 54 infectious vertebral body lesions. The mean ± standard deviation of age (years) was 62 ± 11 with M/F of 160/191. No statistical difference was found when comparing diagnostic yields of the battery powered drill to the manual systems for lytic, mixed, sclerotic, suspected discitis/osteomyelitis, and all lesions. However, in a subgroup analysis, radiation dose was significantly lower for battery powered drill in lytic ($p=0.003$) and all lesions ($p=0.0001$). Procedure time was on average shorter for powered drills than manuals systems, especially in sclerotic lesions, however the difference was not statistically significant ($p=0.07$).

CONCLUSION

Our findings demonstrate that there was no significant difference in diagnostic yield when comparing battery-powered and manual bone biopsy systems for CT guided vertebral column bone biopsies. However, the use of a power-drill system may result in a reduction in radiation dose compared to manual bone biopsy systems.

CLINICAL RELEVANCE/APPLICATION

The battery powered drill may be a preferable bone biopsy system compared to manual systems for vertebral body lesions regardless of lesion type given non-inferior diagnostic yield, significantly lower radiation dose, and potentially shorter procedure time.

SSE20

Neuroradiology (Structural Imaging)

Monday, Dec. 2 3:00PM - 4:00PM Room: S504CD

MR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
James M. Provenzale, MD, Durham, NC (*Moderator*) Research Grant, Bayer AG; Research funded, sanofi-aventis Group; ;
Elizabeth Tong, MD, Stanford, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSE20-01 Substantial Dose Reduction for Sinus CT with Maintenance of High Resolution: A Prospective Clinical Reader Study Utilizing Photon-Counting-Detector CT Substantial Dose Reduction for Sinus CT with Maintenance of High Resolution: A Prospective Clinic

Monday, Dec. 2 3:00PM - 3:10PM Room: S504CD

Participants
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PURPOSE

To examine the ability of photon-counting detector (PCD) CT to improve spatial resolution and reduce radiation dose for sinus CT compared to routine energy-integrating detector (EID) CT.

METHOD AND MATERIALS

After informed consent, twenty-eight patients underwent sinus imaging on a PCD CT system following a clinically indicated scan on the same day. EID images were reconstructed using 512 & 1024 matrices (CTDIvol = 13.5-14.5 mGy). Ultra high resolution PCD exams (Sn100kV) acquired at 10, 8, 7 & 6 CTDIvol, corresponding to 28%, 43%, 50%, and 57% dose reduction, were reconstructed using a 1024 matrix (7 patients/dose level). Images were anonymized, randomized and reviewed by a neuroradiologist. Visualization of key anatomic structures [sphenoid ostia (SO), lesser palatine foramen (LPF), nasomaxillary sutures (NS), anterior ethmoid artery canal (AEA)] was rated for each panel on a Likert scale (1=worse visualization and confidence than routine; 2=worse, no confidence change, 3=similar/routine, 4=preferred, no confidence change, 5=Improved detection & confidence). Image quality scores were provided (noise, sharpness, artifacts, overall quality). Wilcoxon signed-rank ($p < 0.05$) was used to test significance.

RESULTS

At 10 and 8 mGy, PCD was significantly superior to EID 512 for all critical anatomy (SO p=0.016, mean difference (MD) 0.56; LPF p=0.0007,MD 1.5; NS p=0.0002,MD 1.2; AEA p=0.0005,MD 1.4). At these dose levels, PCD was also significantly superior to EID 1024 for visualizing the LPF (p<0.05;MD 0.64), the NS(p=0.008; MD 0.64), and the AEA (p=0.009;MD 0.86). At 7 and 6 mGy, PCD was superior to EID 512 for LPF (p=0.03) and AEA (p=0.02), but not significantly different for any anatomic structure compared to EID 1024. Noise, sharpness, and overall image quality was similar between PCD and EID 1024 across dose levels.

CONCLUSION

PCD CT imaging of the sinus demonstrates superior visualization of anatomy with no significant noise increase even at dose reductions of up to 57% when compared to routine imaging, enabling a significant dose reduction in a frequently imaged population.

CLINICAL RELEVANCE/APPLICATION

PCD CT shows potential to improve routine imaging in a variety of clinical scenarios where spatial resolution and image fidelity improve confidence and accuracy while offering lower dose acquisition.

SSE20-02 Spiral T1-SE for Routine Post-Contrast Brain MRI: Multi-Center/Reader Study Results

Monday, Dec. 2 3:10PM - 3:20PM Room: S504CD

Participants
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PURPOSE

Spiral MRI provides several advantages over routine (Cartesian) MRI, including scan efficiency, and robustness to flow, aliasing, and geometric distortions. Nevertheless, spiral MRI has not gained widespread clinical adoption due to its greater demand on system fidelity. We present here the results of a multi-center clinical study to investigate spiral MRI as an added value alternative to routine post-contrast brain MRI.

METHOD AND MATERIALS

A spiral consortium of 7 clinical sites acquired 88 patient cases on Philips 3.0/1.5T Ingenia scanners with standard hardware configurations. For each patient, two post-contrast scans were acquired: a spiral 2DT1SE, and a routine Cartesian 2DT1SE/fast-SE. The spiral was matched to each Cartesian for scan time, FOV/resolution, and a/TR. The spiral-out readout is fully sampled ~10/20 ms for 3.0/1.5T. Crusher gradients around the 180°-pulse provide added flow signal suppression and black blood contrast. Online reconstruction (~1 sec/slice) uses a B0 prescan in a conjugate-gradient algorithm for joint off-resonance deblurring and Dixon water/fat separation. Nine neuroradiologists reviewed all 88 patient cases. For each patient, the matching pair of spiral vs. Cartesian scans were compared side-by-side, and scored on 10 image quality (IQ) metrics using a 5-point Likert scale.

RESULTS

Summary statistics over all patient cases for the 10 metrics (Wilcoxon signed-rank test, $p < 0.01$) show: Spiral performs better than Cartesian in 7/10 metrics: flow artifact reduction, SNR, GM/WM contrast, image sharpness, lesion conspicuity, preference for diagnosing abnormal enhancement, and overall intracranial IQ. Spirals perform poorer than Cartesian in 2/10 metrics related to magnetic susceptibility: susceptibility artifact, and overall extracranial IQ. Spirals are comparable to Cartesian in 1/10 metrics: motion artifact.

CONCLUSION

Spiral 2DT1SE was superior or comparable to standard-of-care Cartesian 2DT1SE/FSE in 8 of 10 assessed metrics, and was preferred by neuroradiologists for post-contrast intracranial evaluation. Future work to improve IQ in areas of magnetic susceptibility will explore advanced B0 mapping, deblurring, and system characterization methods.

CLINICAL RELEVANCE/APPLICATION

Spiral MRI enables increased scan efficiency (higher SNR, faster scans) and robustness to certain artifacts, providing a compelling alternative to Cartesian MRI that is the current clinical workhorse.

SSE20-03 Neuropathologic Correlates of Enlarged Perivascular Spaces and Contribution to Cognitive Decline in a Community Cohort of Older Adults

Monday, Dec. 2 3:20PM - 3:30PM Room: S504CD

Participants
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PURPOSE

Enlarged perivascular spaces (EPVS) have been associated with aging, increased stroke risk, decreased cognitive function and vascular dementia. However, the relationship of EPVS with age-related neuropathologies is not well understood. Therefore, the purpose of this study was two-fold: to assess the neuropathologic correlates of EPVS, and to determine the contribution of EPVS burden to cognitive decline by combining ex-vivo brain magnetic resonance images (MRI) and pathology in a community cohort of older adults.

METHOD AND MATERIALS

Cerebral hemispheres were obtained from 662 participants of two longitudinal, epidemiologic clinical-pathologic cohort studies of aging. Experienced observers blinded to all pathologic and clinical data rated EPVS burden using a semiquantitative four-level scale (See Figure). Neuropathologic assessment was performed by a board-certified neuropathologist blinded to all clinical and imaging findings. Univariate and multivariate logistic regression was used to investigate the association of EPVS burden with the following age-related neuropathologies: gross and microscopic infarcts, atherosclerosis, arteriolosclerosis, cerebral amyloid angiopathy, amyloid plaques, neurofibrillary tangles, hippocampal sclerosis, Lewy bodies, and TDP-43. Finally, mixed-effects models were used to evaluate EPVS burden contribution to cognitive decline in 6 domains: global, episodic, semantic, working, perceptual, and visuospatial.

RESULTS

Univariate analyses showed significant association of EPVS burden with gross (OR=1.59, p-value=0.002) and microscopic infarcts (OR=1.40, p-value=0.025). Multivariate logistic regression showed a significant association of EPVS burden with gross infarcts (OR=1.60, p=0.004). EPVS burden was significantly contributing to cognitive decline for all cognitive domains except working memory; and the interaction between EPVS burden and time also showed significant for global, episodic and visuospatial cognitive domains.

CONCLUSION

The results suggest: that EPVS and gross infarcts may share similar neurobiological pathways, which is in fair agreement with the literature and proposed etiologies driving these two processes, and that EPVS burden significantly contributes to cognitive decline independently from demographics and neuropathologies.

CLINICAL RELEVANCE/APPLICATION

This is the biggest clinical-pathologic study up to date, and the only one to include cognitive decline in combination with EPVS.

SSE20-04 Visualization of the Morphology and Pathology of the Peripheral Branches of the Cranial Nerves Using 3-Dimensional High Contrast Magnetic Resonance Neurography

Monday, Dec. 2 3:30PM - 3:40PM Room: S504CD

Participants
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PURPOSE

Aims to assess the feasibility and advantages of a contrast-enhanced three-dimensional (3D) flip-angle evolution (SPACE) short-tau inversion (STIR) T2-weighted (T2W) magnetic resonance neurography (MRN) sequence (ceMRN) for visualizing the morphology and pathology of peripheral branches of the cranial nerves.

METHOD AND MATERIALS

35 volunteers with no relevant cranial nerve symptoms and 12 patients with maxillofacial tumors were enrolled. Conventional MRN (cMRN) and ceMRN were performed with 3T MRI system. The continuity of 10 major branches of the cranial nerves on ceMRN was evaluated based on the 5-score evaluation of 3 readers and their interobserver variability was tested. The image quality was compared between cMRN and ceMRN. The relationship between maxillofacial tumors and adjacent peripheral nerves was classified and analyzed in ceMRN of these patients.

RESULTS

The interobserver consistency of all nerves across the 3 readers was excellent, with an average κ value > 0.83. Visualization of the inferior alveolar nerve, hypoglossal nerve and lingual nerve were excellent, with scores of 3.95, 3.77, and 3.63 respectively. Detection of the facial nerve, infraorbital nerve, masseteric nerve, and glossopharyngeal/vagus nerve were relatively good, with scores of 3.25, 3.15, 3.04 and 3.04 respectively. Depiction of the supraorbital nerve and auriculotemporal nerve were moderate, with scores of 2.87 and 2.79 respectively. Delineation of the buccal nerve was fair, with a score of 1.88. The contrast signal-to-noise ratios of nerve to bone marrow, nerve to muscle and nerve to fat on ceMRN were significantly lower than those on cMRN, and the contrast ratios of nerve to bone marrow, nerve to muscle, and nerve to gland on ceMRN were significantly higher than those on cMRN (all $P < 0.05$). The relationship between the extracranial branches of the cranial nerves and tumors were classified as isolated, compressed, embodied, invaded or spread perineurally based on the imaging features on ceMRN.

CONCLUSION

The ceMRN demonstrates excellent visualization the peripheral branches of cranial nerves in a 3D pattern and appears to be a promising method for diagnosis and pretreatment assessment of the pathologies of cranial nerves.

CLINICAL RELEVANCE/APPLICATION

(dealing with 3D ceMRN) 'ceMRN can be used as a preoperative method to evaluate the relationship between peripheral branches of the cranial nerves and maxillofacial tumor.'

SSE20-05 Simultaneous Multi-Angular-Relaxometry of Tissue (SMART) MRI Identifies Myelin-Related Tissue Damage in Multiple Sclerosis

Monday, Dec. 2 3:40PM - 3:50PM Room: S504CD

Participants
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Jie Wen, PhD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose
Anne H. Cross, Saint Louis, MO (*Abstract Co-Author*) Consultant, Biogen Idec Inc; Consultant, Celgene Corporation; Consultant, Novartis AG; Consultant, Merck KGaA; Consultant, F. Hoffmann-La Roche Ltd; Consultant, TG Therapeutics
Dmitriy A. Yablonskiy, PhD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Rapid, pathologically specific and quantitative MRI techniques are needed to assess tissue damage in multiple sclerosis (MS), particularly in progressive MS. The purpose of this study was to demonstrate that SMART MRI metrics can distinguish non-relapsing progressive MS from relapsing-remitting MS (RRMS) and to examine correlations with clinical assessments.

METHOD AND MATERIALS

22 non-relapsing progressive MS and 11 RRMS subjects were scanned at 3T. SMART data with isotropic 1 mm3 resolution were acquired using a three dimensional multi-gradient-echo sequence with five flip angles a (5°, 10°, 20°, 40°, 60°) and three gradient echoes (TE: 2.3, 6.2, 10.1ms) for each a. A phase-based technique was implemented for a-mapping. MS tissue damage, assessed by SMART metrics of macromolecule proton fraction (MPF) and R1 (1/T1) in normal-appearing cortical gray matter (NAGM) and subcortical normal-appearing white matter (NAWM), were correlated with Expanded Disability Status Scale (EDSS), 25-foot timed walk, nine-hole peg test (9HPT), paced auditory serial addition test (PASAT) and Symbol Digit Modality tests. Spearman rank test was used to compute rho values.

RESULTS

MPF was higher in NAWM than in NAGM, consistent with the high macromolecular content in myelin (Fig. 1). MPF measurement demonstrated relatively stronger correlations with the motor related clinical assessments EDSS and 9HPT ($p<0.001$), while a higher quantitative R1 metric showed significant correlations with better cognitive related PASAT scores ($p=0.004$). Interestingly, the left hemisphere showed stronger correlations than right hemisphere when assessing correlations between MPF and motor related clinical tests. Additionally, MPF in NAWM had significantly stronger correlation with clinical assessments than MPF of cortical NAGM. Higher MPF measurements in both GM and WM readily differentiated the relapsing-remitting group from the group with non-relapsing progressive MS ($p<0.01$).

CONCLUSION

Results from this study suggest that SMART MRI has high potential for assessing myelin content and MS-related damage.

CLINICAL RELEVANCE/APPLICATION

Without applying either MT or 180° radiofrequency pulses, SMART MRI generates high resolution quantitative images and is safe for high-field MRI, making it a useful outcome measure in clinical trials.

SSE20-06 Magnetic Resonance Elastography of Brain: Tumor Adherence and Stiffness

Monday, Dec. 2 3:50PM - 4:00PM Room: S504CD

Participants
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Arunark Kolipaka, PhD, Columbus, OH (*Abstract Co-Author*) Benzer Pharmacy; Tenet Healthcare Corporation; Lonwin Healthcare

PURPOSE

To determine brain tumor adherence as well as stiffness in patients using magnetic resonance elastography (MRE) and compare to histopathology.

METHOD AND MATERIALS

In vivo brain MRE was performed on 7 patients using a 3T MRI scanner (Skyra, Siemens Healthcare, Germany). Mechanical waves were introduced into the brain using a pneumatic driver system with a pillow driver at 60Hz and a SE EPI-MRE sequence was used to acquire all axial slices of the brain. Imaging parameters included: TR=3333ms, TE=44ms, slice thickness=3, matrix=128x64, FOV=260cm, GRAPPA acceleration factor R=2; mechanical vibration frequency=60Hz; 4 MRE time offsets; and motion-encoding gradient of 16.67ms duration (60Hz) to encode in-plane and through-plane motion of propagating waves in the brain. Wave images were processed using an in-house local frequency estimation algorithm with curl processing to obtain stiffness as well as octahedral shear strain (OSS) to determine mechanical and adherence properties of the brain tumor respectively. Mean stiffness of the tumor and normal brain are reported along with the OSS values around the tumor boundary. Furthermore, the histopathology measurements obtained post surgery were also recorded for comparison.

RESULTS

Figure shows a T2- weighted magnitude image (a), snap shot of wave propagation (b) and the corresponding stiffness map (c) with a mean stiffness value of 1.2kPa in the tumor region (green contour) and 2.3kPa non-tumor (red contour); OSS map (d) also confirms soft tumor and non-adherent along with histopathology (e) confirming soft tumor glioma grade 4 and easily resectable. The stiffness measurements of other tumors ranged from 0.8 to 1.9kPa for meningioma or gliomas or metastasis. Similarly, histopathology results in other patients with varying tumors also confirmed the findings of MRE.

CONCLUSION

This study has demonstrated that stiffness and adherence patterns of different brain tumors can be quantitated using MRE. This study for the first time compared material properties of the brain tumors noninvasively to histopathology observations. However, more studies are further warranted.

CLINICAL RELEVANCE/APPLICATION

Brain MRE is a noninvasive technique, which can potentially differentiate benign vs malignant tumors and provide information on tumor adherence that can enable better guidance for surgical resection.

Printed on: 10/29/20

SSE21

Pediatrics (Interventional Radiology)

Monday, Dec. 2 3:00PM - 4:00PM Room: S403B

IR PD

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSE21-01 Comparison of DVT Risk Factors and Indications for Pharmacomechanical Thrombolysis in Children Less than 13 Years Old versus Adolescents

Monday, Dec. 2 3:00PM - 3:10PM Room: S403B

Participants
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Paul J. Rochon, MD, Aurora, CO (*Abstract Co-Author*) Speaker, Penumbra, Inc; Speakers Bureau, C. R. Bard, Inc; Speaker, Cook Group Incorporated; Advisory Board, Medtronic plc ; Speaker, Medtronic plc
Marilyn Manco-Johnson, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Pharmacomechanical thrombolysis (PMT) is often performed for iliofemoral DVT in adolescents in order to prevent or minimize the impact of post-thrombotic syndrome (PTS). This study aims to evaluate children less than 13 years old with iliofemoral DVT for their DVT risk factors, incidence of PTS and indications for PMT as compared to adolescents.

METHOD AND MATERIALS

This is a prospective cohort observational study of patients 0-12 years of age presenting with first time, imaging documented DVT within the IVC or the iliac vessels. This was compared to a separate cohort of adolescents, age 13-20 years using chi-square and Fisher's exact tests. Outcomes included imaging-documented recurrent DVT or post thrombotic syndrome (PTS) using a modified Villalta scale. Subgroup analyses of DVT risk factors, including genetic thrombophilia, acquired thrombophilia or anatomic variant (May-Thurner or Atretic IVC) as well as initial treatment were also performed.

RESULTS

38 children (25 males, 13 females) ages 0-12 years and 61 adolescents (20 males, 41 females) ages 13-20 were enrolled. 7 children were initially treated with PMT (2 minor bleeding complications and no major bleeding complictions). 33 adolescents were first treated with PMT (4 minor bleeding complications and 3 major bleeding complications). Children vs adolescent risk factors for DVT included: infection 8 (21%) vs 5 (8%) (P=0.07), catheter related 6 (42%) vs 1 (2%) (P=<0.001), trauma 9 (21%) vs 12 (20%) (P=0.64), congenital heart disease 2 (5%) vs 1 (2%) (P=0.56), chronic disease 2 (5%) vs 2 (3%) (P=0.63), acquired thrombophilia (13 (34%) vs 34 (56%) (P=0.02), anatomic variant 4 (11%) vs 21 (34%) (P=0.009). Only 2 children (6.3%) were found to have PTS and both were related to infection. 16 adolescents developed PTS which was related to obesity, estrogen use and anatomic variants.

CONCLUSION

The greatest DVT risk factors in the 0-12 year old age group was the presence of a catheter. Vascular variants were not found to be risk factors for DVT development in younger patients. Given the overall low incidence of PTS in children 0-12 years, PMT is not indicated to prevent/decrease severity of PTS in this age group but may be beneficial to maintenance of future vascular access.

CLINICAL RELEVANCE/APPLICATION

Understanding the risk factors affecting DVT development and the subsequent progression in different age groups can help tailor treatment and set the goals of therapy.

SSE21-02 A Cross-Sectional Review of Pediatric Gastrojejunostomy Use Amongst US Tertiary Children Hospital

Monday, Dec. 2 3:10PM - 3:20PM Room: S403B

Participants
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PURPOSE

Gastrostomy tubes (GT) are commonly converted to gastrojejunostomy tubes (GJT) in children with gastric feeding difficulties. Conversion can be resource intensive for hospitals and interventional radiologists. The aim of this study is to describe baseline practice variation among US freestanding children's hospitals related to utilization of GJT. Furthermore, we aim to better describe the frequency GJT exchange by calculating the number of average annual exchanges (AAE) for pediatric GJT patients.

METHOD AND MATERIALS

Using data from 2010-2018, a retrospective analysis was performed on 49 tertiary children hospital using the Pediatric Health Information System. Patients were captured by International Classification Disease codes for GT and GJT placement. All initial encounters for patients receiving a GT were captured and conversion dates were used in this analysis. Each patient was then stratified by number of annual average exchanges (AAE).

RESULTS

Of 85,254 patients who received a GT during the study period, 14,732 (18%) were subsequently converted to GJT. Of those converted to GJT, 60% were white and were 5 years at conversion. No significant change was found in rate of GT to GJT conversions during the study period. However, over the study period, there was a significant decrease in mean days from GT to GJT conversion, 636 days in 2010 to 234 days in 2018 (P-value <0.001). After conversion to GJT, the median AAE for a GJT patient was found to be 4 exchanges per year (IQR 1- 19 exchanges), at an average adjusted estimated cost of $1,168.10.

CONCLUSION

Approximately one-fifth of children with a GT will be later converted to a GJT. GT converted to GJT will require numerous future exchanges and hospital visits, creating a significant burden on patients, families, and providers. More work is needed to clarify the optimal approach to patients with feeding intolerance.

CLINICAL RELEVANCE/APPLICATION

Gastrostomy Tubes converted to Gastrojejunstomy feeds are becoming more frequent at children hospitals. Thus, creating a significant burden on patients and families with continuous need for routine changes and additional cost. Further work is needed to find optimal feeding approach for children gastric feeding intolerant.

SSE21-03 Biodegradable Stents Placement in Biliary Strictures after Liver Transplant in Children: A Single Center Experience

Monday, Dec. 2 3:20PM - 3:30PM Room: S403B

Awards
Trainee Research Prize - Resident

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PURPOSE

To evaluate the feasibility and safety of the use of biodegradable SX-Ella biliary stents as part of the treatment of post-liver transplant biliary strictures in pediatric patients. To compare the evolution between pediatric patients treated with and without SX-ELLA

METHOD AND MATERIALS

We conducted a retrospective observational study including pediatric patients with symptomatic benign biliary stricture as a complication of liver transplant diagnosed by US or MR, and treated percutaneously by our interventional team between 2008 and 2019. A descriptive comparison of the clinical evolution and stricture recurrence between patients with and without SX-ELLA placement using clinical, analytical and radiological parameters, was performed.

RESULTS

A total of 25 children were included in the study, divided in two groups: group A (19 children) treated with SX-ELLA biodegradable stent placement and group B (6 children) treated with bilioplasty, drainage catheters and metallic stents. Group A: average number of bilioplasties prior to SX-ELLA placement=1.2. Average time with a biliary tutor=45days. Average stricture recurrence after SX-ELLA placement=0.1 (only 2 patients, one treated with another biodegradable stent, the other patient underwent surgery). After SX-ELLA placement no bilioplasty or biliary drainage was needed. The average number of cholangitis episodes= 0.4. Current clinical and radiological resolution is 68% and 63% respectively. Group B: presented an average number of bilioplasties=2.5, average number of permanent stents= 0.5. Average time with a biliary tutor=225.2 days (7.4 months). Average stricture recurrence= 1.8. Two patients underwent surgery. Average of cholangitis episodes=2. Current clinical and radiological resolution is 50% and 33.3%

respectively.

CONCLUSION

Biodegradable stents placement by a transhepatic approach is a feasible, safe, and effective tool providing a good alternative in the therapeutic algorithm for the treatment of biliary strictures after liver transplant in children improving clinical and radiological outcome. However, the present results should be confirmed with further randomized controlled trials.

CLINICAL RELEVANCE/APPLICATION

The use of biodegradable stents reduces stricture recurrence, repetitive cholangitis episodes as well as the average time with a biliary tutor and its complications, improving clinical and radiological outcome.

SSE21-04 Hemodialysis Catheter Placement in Children Under One Year - Technical Challenges and Outcomes

Monday, Dec. 2 3:30PM - 3:40PM Room: S403B

Participants
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PURPOSE

To evaluate the feasibility, technical aspects, challenges, and outcomes of hemodialysis (HD) central venous catheter (CVC) insertion and maintenance in patients under one year of age.

METHOD AND MATERIALS

Single center retrospective study of all patients under one year who underwent HD-CVC insertions between January 2002 and December 2016. Demographic data, intra-procedural and post-procedural details, including catheter maintenance procedures, technical modifications, complications and long-term outcomes were evaluated.

RESULTS

29 consecutive patients who underwent 49 HD-CVC insertions were included. Mean patient age and weight at the time of insertion was 117 days (median: 113 days; range: 2-342 days) and 4.9 kg (median: 4.6 kg; range: 2.6 - 6.9 kg), respectively. 15/49 (31%) were non-tunneled temporary HD-CVCs; 34/49 (69%) were tunneled permanent HD-CVCs. All insertions were successful. Comparing temporary to permanent catheters respectively: 0/15 (0%) vs 23/34 (68%) required modifications at insertion; 1/15 (7%) vs 25/34 (74%) required catheter maintenance procedures; 25.4 vs 0.84 catheter related blood stream infections/1000 catheter days occurred; and 25.4 vs 1.9 catheter associated thrombosis/1000 catheter days occurred. 11/29 patients (38%) died at <1 year of age from their underlying disease. The remaining 18 patients (62%) survived beyond 1 year: 9/18 (50%) underwent subsequent renal transplantation, 5/18 (27%) remained on dialysis, 1/18 (6%) transitioned to palliative care, 1/18 (6%) completely recovered and 2/18 (11%) were transferred to another institution for management.

CONCLUSION

HD-CVC placement is feasible in children under 1 year of age. Insertion modifications and maintenance procedures are required to maintain function.

CLINICAL RELEVANCE/APPLICATION

Hemodialysis central venous catheter placement is feasible in children under 1 year of age, however insertion modifications and maintenance procedures are often required to maintain function.

SSE21-05 Hepatic Vein Interventions in Pediatric Liver Transplant Patients: Single Center Experience

Monday, Dec. 2 3:40PM - 3:50PM Room: S403B

Participants
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PURPOSE

To evaluate the results of hepatic vein related complications in pediatric liver transplantation patients in our center and related diagnostic and therapeutic interventions.

METHOD AND MATERIALS

A total of 452 pediatric patients who underwent liver transplantation between March 2002 and April 2019 were retrospectively reviewed. Patients with hepatic vein stenosis and thrombosis were evaluated. Sedation and analgesia were used in every patient. Femoral, jugular and percutaneous routes were used. After the pressure-gradient measurements, angioplasty and/or stent implantations were performed. In cases with thrombosis thromboaspirations were done.

RESULTS

A total of 452 pediatric patients 244 male (54%) and 208 female (46%) underwent liver transplantation during study period. The mean ages were 6.3 and 5.9 years for male and females respectively. Of the patients, 327 (72%) were transplanted from the live donor and 125 (28%) from the cadaver. Fulminant liver failure (40%) was the most common indication. A total of 43 patients (23 female and 20 male) underwent hepatic venography-cavography. Jugular vein access (n:42) was the most frequently used route. In 4 patients through and through access was used. In 33 patients a total of 65 balloon angioplasty (mean 1.97), 14 stent implantation (in 10 patients), and 2 thromboaspirations were performed. The hepatic vein complication rate was 7.3% in our pediatric patient group and the average number of hepatic venography procedure was 2,7. Twenty-four of the 33 patients (72.7%) who were intervened is still alive.

CONCLUSION

The risk and incidence of vascular complications in pediatric patients after liver transplantation are higher than in adults. Among these complications, the incidence of hepatic venous outflow obstruction or thrombosis has been reported between 1-13% in the literature. Our 7.3% rate is consistent with the literature data. Angioplasty is the first choice in stenoses and repetitive sessions may be required. In our group, the rate of recurrent angioplasty was found to be 42%. Stent implantation should generally be the last choice in patients who do not respond to recurrent balloon angioplasties or respond poorly. Endovascular interventions for hepatic vein related problems in pediatric liver transplantation cases are safe and effective, and should be the first choice of treatment.

CLINICAL RELEVANCE/APPLICATION

Pediatric liver transplant patients, hepatic vein problems

SSE21-06 Intraabdominal Lymphatic Malformation in Children: Treatments and Outcomes

Monday, Dec. 2 3:50PM - 4:00PM Room: S403B

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PURPOSE

Intra-abdominal lymphatic malformations (LM) pose unique challenges and risks. This study evaluates possible treatment options for intra-abdominal LM and their long-term outcomes.

METHOD AND MATERIALS

Retrospective review of children (<18 years) with an intra-abdominal LM diagnosed on imaging between January 2001 to September 2018. Treatment options were expectant management with a course of antibiotics, sclerotherapy and/or surgical resection. All patients were followed up for at least 1 year after their initial diagnosis. Sclerotherapy consisted of doxycycline with or without 3% sodium tetradecyl sulphate. One or more drains were inserted in all sclerotherapy patients.

RESULTS

15 patients (average age at diagnosis: 6.5 years, range: 1 day to 17 years) were included, all of which had macrocystic LM. Treatment consisted of: sclerotherapy alone (n=9), surgical resection alone (n=2), both sclerotherapy and surgical resection (n=1) and expectant management (n=2). The average number of days of sclerotherapy performed was 2.2 days (range: 1 to 6 days). None of the patients had intra- or post-operative complications related to their sclerotherapy or surgery. Of the two patients who were treated expectantly, both presented with infection of their LM. The LM decreased in size in all patients with 10/15 (66.7%) patients having no residual lesion on follow-up ultrasound. Of the 10 patients, 8 had undergone sclerotherapy, 1 had surgical excision and 1 was managed expectantly. Of the remaining 5/15 (33.3%) patients with residual LM, 3 were less than 2cm at the time of their last follow-up imaging. The two remaining patients had persistent but asymptomatic intra-abdominal LM despite sclerotherapy alone and both sclerotherapy and surgical excision. All patients had complete resolution of their symptoms on follow-up.

CONCLUSION

Sclerotherapy is a less invasive and effective treatment option for intra-abdominal macrocystic LM. In patients presenting with infection, sclerotherapy or surgical resection may not be needed as the acute event may lead to decrease in size of the lesion and resolution of symptoms. Both sclerotherapy and expectant management of infected LM lead no recurrent symptoms for at least one year following initial diagnosis.

CLINICAL RELEVANCE/APPLICATION

Sclerotherapy is an effective treatment for intra-abdominal macrocystic lymphatic malformations. When infected, only expectant management may be needed.

SSE22

Physics (Ultrasound)

Monday, Dec. 2 3:00PM - 4:00PM Room: E352

PH US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSE22-01 Photoacoustic Imaging for Assessing Sonoporation of Pancreatic Cancer in a Pre-Clinical Model

Monday, Dec. 2 3:00PM - 3:10PM Room: E352

Participants
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PURPOSE

To evaluate the disruption of different US contrast agents (UCAs) for augmenting chemotherapy treatment (i.e., sonoporation) in a murine model of pancreatic cancer.

METHOD AND MATERIALS

Athymic, nude mice (n=140) were injected with MIA PaCa-2 cells in the right flank and randomized into 2 control groups (untreated or chemotherapy only) and 8 treatment groups. The latter consisted of chemotherapy and one of 4 UCAs: Definity® (Lantheus Medical Imaging, N Billerica, MA), Lumason® (Bracco, Milan, Italy), Optison™ (GE Healthcare, Princeton, NJ) or Sonazoid™ (GE Healthcare, Oslo, Norway) imaged with a Logiq E9 (GE Healthcare, Waukesha, WI) in a high or low acoustic power cohort (ISPTA of 200 or 60mW/cm2). Groups were treated once a week for 3 weeks. Hemoglobin and oxygenation measurements were obtained weekly (at baseline, during treatment and 1 week post treatment) using photoacoustic imaging with a Vevo 2100 LAZR scanner (Fujifilm Visualsonics, Toronto, Canada). Mice were followed for tumor growth and survival and compared with two-way ANOVAs.

RESULTS

All tumor volumes in the 8 treatment groups and in the chemotherapy only group were statistically smaller than those from the untreated group ($p<0.02$). When comparing tumor volumes from the treatment groups in the high acoustic power cohort to the group receiving chemotherapy alone, all 4 UCA treated groups had significantly smaller tumors ($p<0.006$) with Optison achieving the greatest reduction ($p=0.001$). In the low acoustic power cohort, only mice receiving Definity showed a significant tumor volume reduction ($p=0.003$), while all other comparison were not significant ($p>0.07$). Total hemoglobin and oxygenation values across tumors as well as within areas of detected blood flow were greater in the high acoustic power cohort ($p<0.001$), while the impact of UCAs was statistically significant for oxygenation (Definity and Sonazoid; $p<0.05$) and for hemoglobin within areas of detected blood flow (Optison; $p=0.014$).

CONCLUSION

Preliminary results indicate that chemotherapy treatment of pancreatic xenografts can be augmented with high acoustic power sonoporation, and optimal acoustic parameters may be UCA-dependent.

CLINICAL RELEVANCE/APPLICATION

Sonoporation of pancreatic cancer was successful in a pre-clinical model and the best imaging parameters studied will form the basis for a Phase II clinical trial.

SSE22-02 Ultrasound Monitoring of Myofascial Pain Syndrome Treatment and Response: Assessing Botulinum Toxin Propagation without Contrast Media with a Novel B-Flow Sequence and Bite Force Stiffness with Shear-Wave Elastography

Monday, Dec. 2 3:10PM - 3:20PM Room: E352

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PURPOSE

Idiopathic masticatory myalgia (IMM) is related to multifocal tissue stiffening. Botulinum Toxin (BT) can alleviate synthoms, yet the procedure (number, amount) is empirical. Our goal is to use ultrasound imaging (US) to quantify both IMM treatment and response.

METHOD AND MATERIALS

Porcine ex-vivo masseter was used to compare US BT imaging with optic assessment of excised tissue specimens (dyed with Indigocarmin). A novel B-flow sequence based on 2D-digital image correlation (2D-DIC) was used to compensate for tissue deformation during injection, allowing high sensitive detection of B-mode changes due to BT propagation without contrast medium. Then 50 units of BT toxin type A dissolved in 1 ml normal saline (0.9% NaCL) were injected in both left and right masseters of an female IMM patient. A 3D printed setup was used to co-register BT injection with US imaging. Shear wave velocity (SWV) values of the left masseter muscle were prospectively assessed in a volunteer with alternating relaxed states and biting states of varying force using a Logiq E9 (GE Healthcare) US. Bite force was measured of the right and left second molar teeth, respectively, using the Occlusal Force-Meter GM10 (Nagano Keiko).

RESULTS

2D-DIC allowed visualization of the injected fluid without a contrast medium. In ex-vivo tests, rs = 0.95 with optic tissue area, and Dice Coefficient = 0.85. In vivo, BT propagated along the fiber structure of the muscle, with threefold larger axial compared to lateral expansion. A compressive strain was observed both above and below the needle. SWV ranged between 1.52 and 3.98 m/s for bite force between 0 and 450 N. For bite force and SWV, we found a correlation of rs = 0.908 with the force-meter placed on the contralateral (right) side.

CONCLUSION

Due to greater axial compared to lateral propagation, multiple injections of smaller amounts of BT in masseter instead of a single injection with larger amount are recommended. SWE provides imaging modality of bite force through correlating activation of the masseter muscle when the force-meter is placed on the contralateral side with respect to the ultrasound probe.

CLINICAL RELEVANCE/APPLICATION

The presented B-flow method is promising for a wide range of applications, where Contrast-Enhanced US is not feasible. SWE could have diagnostic properties for differentiating idiopathic masticatory myalgia from other diseases affecting the masticatory muscles.

SSE22-03 US-Triggered Bulk Antibiotic Release from Novel Hardware in a Rabbit Spinal Infection Model

Monday, Dec. 2 3:20PM - 3:30PM Room: E352

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PURPOSE

This study evaluated the efficacy of ultrasound (US)-triggered drug delivery devices to combat bacterial infection in an *ex vivo* cadaveric rabbit spine model.

METHOD AND MATERIALS

Polylactic acid (PLA)-coated, vancomycin (VAN)-loaded polyether ether ketone (PEEK) devices (1 cm3) with a drug-loading reservoir (0.785 cm3) were 3D printed. Two device designs were evaluated: 1 large hole for drug release vs 2 smaller holes. Clips were implanted medial to the spinal midline in mature (~6 months, 3 kg) female White New Zealand cadaveric rabbits (n = 4) under an IACUC-approved protocol. To simulate infection, 104 cfu of *Staphylococcus aureus* were added to 2 of the 4 sites; the other 2 sites were left clean. Two of the 4 sites (1 inoculated, 1 clean) were insonated for 20 minutes with a Logiq E9 ultrasound scanner (GE Healthcare, Waukesha, WI) equipped with a C1-6 curvilinear probe, using power Doppler imaging (1.7 MHz frequency, 6.4 kHz PRF, 100% acoustic output power) to induce rupture of the PLA coating for VAN release. In parallel, positive and negative bacterial controls were evaluated. All implanted devices were incubated for 2 hours post-insonation, then retrieved for analysis. Results were collected in duplicate (n = 16 total) and compared with a two-way ANOVA.

RESULTS

Infected sites showed marked reduction in bacterial colonization following US-triggered VAN release, while uninsonated sites exhibited little reduction in bacterial colonization. At 48 hours, there was significantly greater VAN release from the insonated clips compared to the uninsonated clips ($p < 0.04$). There was significantly greater US-triggered total VAN release from the 1-hole device design than from the 2-hole design (7420 ± 2992 µg vs. 3500 ± 954 µg, $p < 0.0001$). These levels are sufficient to prevent adhesion of *S. aureus* to implant materials.

CONCLUSION

This study demonstrated the feasibility of an US-mediated antibiotic delivery device, which could become a potent weapon against spinal surgical site infections.

CLINICAL RELEVANCE/APPLICATION

This system will aggressively combat post-surgical bacterial infection with great versatility in applications for wide clinical impact.

SSE22-04 Development of Dedicated Anatomical Breast Ultrasound Phantoms for Ultrasound System Performance Evaluation and Image Optimization Training Tools

Monday, Dec. 2 3:30PM - 3:40PM Room: E352

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PURPOSE

In this study, a range of novel anatomical breast ultrasound phantoms were developed for ultrasound system performance evaluation and image optimization tools. The anatomical phantoms had moderate technical complexity associated with them and simulated the sonographic characteristics of the different breast tissues and contained a range of lesion pathology such as cysts, Mondor's disease, fibroadenoma and angular, spiculated lesions representing malignant findings. Both a system performance evaluation plan and a pedagogical plan were developed for use with these novel phantoms.

METHOD AND MATERIALS

Design specifications for the anatomical breast phantom were developed through consultation between Radiologists, breast US sonographers as well as taking into consideration the typical profile of patients presenting to a large Radiology Department. The phantoms were scanned using General Electric Logiq 9, Logiq e and Philips Epic ultrasound systems using the breast pre-set; the individual lesions were scanned using a focused optimization approach. The images were evaluated by breast radiologists and sonographers to determine the performance of each ultrasound system. The image images were scored using a 5-point Likert scale (1=poor to 5=excellent). A pedagogical plan was developed to augment the function of these phantoms as training tools; it included the elements outlined in Fig1b.

RESULTS

No one system consistently performed the best at imaging all types of lesions; however system 3 had the overall best performance (Fig 1c). In particular, it had excellent performance for imaging cystic structures. It was found that the cystic structures provided information about the systems noise level, lesion detectability performance and spatial resolution of the different systems. While, the fibroadenoma and malignant lesions provided information about the system's dynamic range, contrast and spatial resolution performance.

CONCLUSION

The anatomical breast phantoms were able to effectively demonstrate differences between ultrasound systems identifying differences between individual lesion features, such as reduction of haze and noise in cystic structures as well as demonstrate the impact of different image optimization controls.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates the utility of "life-like" ultrasound breast phantoms in the performance evaluation of systems as well as the demonstration of different image optimization controls.

SSE22-05 Photoacoustic Lymphangiography: The Promising Imaging Modality for Lymphatic Vessels

Monday, Dec. 2 3:40PM - 3:50PM Room: E352

Participants
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PURPOSE

Photoacoustic lymphangiography (PAL) is a new optical imaging technique based on photoacoustic technology, which visualizes small blood vessels and lymphatic vessels in the extremities by high-resolution three-dimensional images. In this report, we introduce the still images and videos obtained with PAL in healthy subjects and lymphedema patients.

METHOD AND MATERIALS

We used the PAI-05 system with semi-spherical ultrasonic detector array. Twenty healthy volunteers and 30 lymphedema patients were recruited. To image the lymphatic structures of the limbs, 0.5 mL of indocyanine green (5 mg/mL) was administered subcutaneously to the dorsal aspect of each foot or hand. PA images were acquired by irradiating the tissue using a laser at wavelengths of near-infrared region. We first obtained the lower leg or forearm of the subjects with a wide-field still images, and then recorded the videos of the targeted vessels with the scope of 20 mm in diameter.

RESULTS

In the still images, the lymphatic vessels up to the diameter of 0.2 millimeters could be observed three-dimensionally with the venules around them in the still images. We could distinguish between blood vessels and lymphatic vessels by colors using the difference of molar extinction coefficient. PAL also revealed the depth of each vessel from the skin surface. In the patient-group, dermal backflow patterns were often observed as dense interconnecting three-dimensional structures of lymphatic vessels. Extended or twisting collecting vessels passing below the fine complex network of dermal lymphatics were also observed. In the videos, lymphatic pump was observed intermittently with various intervals. It was difficult to detect the lymphatic flow in the patients because the lymphatic fluids in the channels are stagnated.

CONCLUSION

In this study, three-dimensional high spatial and temporal resolution images were obtained using the PAI-05 system, allowing the visualization of fine lymphatic vasculature and its pumping movement. The morphologic and dynamic characteristics of the vessels were significantly different in the volunteers and patients.

CLINICAL RELEVANCE/APPLICATION

The actual anatomical course of each lymphatic vessel and venul visualized by PAL is useful in both planning of lymphatico-venous bypassing surgery for lymphedema and locating them during the surgery.

SSE22-06 Tissue Viscoelastic Estimates Using a Reverberant Shear Wave Field in Tissues Exhibiting a Power Law Behavior: Generation of 2-D Shear Wave Dispersion Images

Monday, Dec. 2 3:50PM - 4:00PM Room: E352

Participants
Juvenal Ormachea, Rochester, NY (*Presenter*) IP disclosures, Reverberant shear wave elastography; Commercial agreement, Elastance Imaging LLC
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CONCLUSION

Dispersion images are shown to have contrast between tissue types and with quantitative values that align with previous studies. Further study is required to define the practical upper limits of SW frequencies, and the range of normal dispersions expected within a healthy population.

Background

We analyze the case of shear waves (SW) established as a fully reverberant field, in which the waves propagate in all directions. The application of reverberant shear wave (R-SW) fields can be accomplished by applying external sources that can be excited by multiple frequencies within a bandwidth. This enables the analysis of the dispersion of shear wave speed (SWS) as it increases with frequency, indicating the viscoelastic nature of the tissue under study. Furthermore, dispersion images can be created alongside the SWS images. We report preliminary studies on breast and liver tissues using the multi-frequency R-SW technique.

Evaluation

A custom-made portable trifold futon with multiple embedded vibration sources was mounted to a clinical bed to generate the R-SW field. Vibration frequency ranges between 40-400 Hz were used for both CIRS phantoms and liver experiments and 117-702 Hz was used for breast experiments. A Verasonics ultrasound system (Vantage-128TM, WA, USA), was used to track the induced displacements. The wavenumber was estimated by evaluating the autocorrelation function of the R-SW signal. The relationship between SWS and frequency was evaluated over the vibration frequency range. Our multi-frequency data was analyzed for both the traditional linear dispersion slope (LDS) and for power law coefficient (PLC) dispersion.

Discussion

In liver, mean LDS of 0.35±0.06, 0.52±0.11 (m/s/100Hz) and PLC of 0.25±0.04, 0.40±0.10 were obtained for a thin and an obese patient, respectively. In breast, LDS of 0.13±0.06, 0.49±0.09 (m/s/100Hz) and PLC of 0.24±0.11, 0.69±0.10 were obtained for a fibroadenoma and dense tissue, respectively. This work shows that R-SW fields can be produced in deep tissues using external sources, up to 400 Hz in obese patients' livers and over 700 Hz in breast tissue. The dispersion can be analyzed as LDS or as a PLC consistent with a more advanced framework of tissue rheology.

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SSE23

Physics (Nuclear Medicine)

Monday, Dec. 2 3:00PM - 4:00PM Room: E351

NM PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Srinivas C. Kappadath, PhD, Houston, TX (*Moderator*) Research Grant, General Electric Company; Research Grant, BTG International Ltd; Consultant, BTG International Ltd; Consultant, ABK Biomedical Inc; Consultant, Terumo Corporation

Sub-Events

SSE23-01 Comparison of Post-Therapy Y-90 PET/CT Dosimetry Methods in Liver Therapy with Y-90 Microspheres

Monday, Dec. 2 3:00PM - 3:10PM Room: E351

Participants
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CONCLUSION

The MIM and Planet Dose DPK dosimetry values were practically interchangeable. Y-90 disimetry values obtained by all methods were similar, but LDMwS tended to produce slightly higher values.

Background

The aim of our study was to compare dosimetry methods for Y-90 PET/CT, using commercially available software packages.

Evaluation

As a part of continuing study, 25 patients were taken to a PET/CT suite (mCT, Siemens Medical) following therapy with Y-90 microspheres. The low mA, non-diagnostic CT images were used for attenuation correction and localization of the Y-90 microspheres in PET/CT studies. The acquisition time was 15 min, the reconstruction matrix size was 200x200x75 mm and voxel size 4.07x4.07x3.00 mm. Two commercially available software packages, MIM 6.8 (MIM software Inc., Cleveland, Ohio) and Planet Dose (DOSIsoft SA, Cachan, France) were utilized to calculate Y-90 dosimetry from PET images. Three methods were used for voxel-based dosimetry calcualtions; the Local Deposition Method (LDM), LDM with scaling (LDMwS) for known injected activity, and a Dose Point Kernel (DPK) method using the MIRD kernel. Only the DPK approach was applied to the Planet Dose software and these walues were comapred with MIM DPK dosimetry values. LDM and LDMwS were only applied to the MIM software. The average total liver dosimetry values (mean±SD) were 53.59±23.47 Gy, 60.93±28.62 Gy, 55.33±24.80 Gy and 54.25±23.70 Gy, for LDM, LDMwS, DPK with MIM and DPK with Planet Dose (DOSI), respectively. In most cases the LDMwS method produsd slightly higher values than the other methods. The MIM and Planet Dose DPK dosimetry values (i.e., DPK vs. DOSI) were higly comparable. Bland-Altman analysis calculated a mean difference of 1.1 ± 1.6 Gy. The repeatability coefficient was 3.1(5.7% of the mean).

Discussion

The slightly higher values produced by LDMwS compared to the other methods is due to the difference between dose calibrator scaling, and the quantitative accuracy of the Y-90 PET imaging. Although, the differences are not great, they should be diminished by better quantifiable Y-90 PET imaging and improved dose calibrator quality control.

SSE23-02 Accuracy Dose Evaluation in Radioembolization Procedures Using 99mTc-SPECT/CT and 90Y-PET/CT

Monday, Dec. 2 3:10PM - 3:20PM Room: E351

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CONCLUSION

In this paper it is emphasized that, in radioembolization procedures, 99mTc-SPECT/CT images can be used to predict directly the final dose distribution for 90Y microspheres with accuracy. In particular, pixel's intensity uniformity, noise and sensitivity in 99mTc-SPECT/CT images are obviously much better than those observed in 90Y-PET/CT scans. The 90Y-PET/CT dosimetric accuracy, in comparison to 99mTc-SPECT/CT dosimetric accuracy, is still acceptable for dosimetric purpose and it remains a necessary tool for theranostic analysis with therapeutic and diagnostic capabilities.

Background

Radioembolization with 90Y-microspheres is increasingly used in HCC treatment. In terms of the impact of tumoral dose, many studies confirmed a tumor dose response relationship. For pre-therapeutic dosimetry, 99mTc-MAA is used as a surrogate of microsphere distribution to assess tumoral targeting and dosimetry. In the same way, 90Y-PET/CT following radioembolization has been established as a viable diagnostic tool for tumoral targeting and dosimetry. The aim of this study is to evaluate dosimetry accuracy both in 99mTc-SPECT/CT and in 90Y-PET/CT.

Evaluation

iDVH and dDVH obtained from 99mTc SPECT-CT and 90Y PET-CT were evaluated to analyze mean and voxel dose accuracy in tumor and liver dose evaluation, as implemented in MIM software vs. 6.8, with three different dosimetric approach both in a torso phantom and patients. Images were acquired in a Siemens Biograph mCT PET/CT and in a Siemens Intevo 2 SPECT/CT. Figure 1 shows dose distribution in the phantom liver compartment for 99mTc SPECT-CT and 90Y PET-CT. iDVH and dDVH for all the dose calculation methods, both for 99mTc and 90Y, are reported in Figure 2 and 3, respectively. Figure 4, 5 and 6 show same results in patient study with 99mTc SPECT-CT.

Discussion

Mean doses, standard deviation and coefficient of variation obtained from iDVH, for 99mTc SPECT-CT and 90Y PET-CT, shows deviations from MIRD dose between -9% and -4% while deviations between -27% and -9% are reported for 90Y PET-CT. Finally, the CoV dispersion index 1 confirm the better dose distribution estimation obtained in the 3D dosimetry for 99mTc SPECT-CT with respect to those obtained for 90Y PET-CT.

SSE23-03 Development of Wearable Technology to Enable Therapy Personalization of 177Lu DOTATATE for Neuroendocrine Tumors

Monday, Dec. 2 3:20PM - 3:30PM Room: E351

Participants
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Larry Pierce, PhD, Seattle, WA (*Abstract Co-Author*) Co-founder, Precision Sensing LLC
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PURPOSE

The goal of this work is to enable patient specific 177Lu-DOTATATE organ dosimetry without requiring serial imaging sessions at a medical facility. This will be accomplished by developing wearable monitoring technology to allow quantitative measurements to be made through at home usage. This will support accurate estimation of the washout from individual organs at risk (OAR) enabling physicians to tailor the number of treatments based upon personalized organ dosimetry information .

METHOD AND MATERIALS

The enabling technologies are the development of a precision sensing belt (PSB) and software methods that can determine the optimal placement of a sparse set (e.g., 8-15) of small radiation detectors around the mid-section of the patient. A CT image will be used to register the PSB with a patient's internal organs. Based upon the patient specific CT image, Monte Carlo simulations and optimization methods are used to select the optimum positioning of a small set of detectors around the patient. Measurements from the PSB are then correlated with a quantitative SPECT/CT image acquired 24 hours after dose administration. After being sent home, the patient will wear the PSB for 2 minutes per day for 7-21 days. The basic methodology was tested using Monte Carlo simulation. The testing phantom consisted of anthropomorphic objects representing the liver, spleen, right and left kidneys and two tumors. Activity ratios for the liver, spleen, right and left kidneys, 2.5 cm and 1.5 cm tumors to background were 2, 10, 10, 8, 48 and 60. The washout half-lives were 74, 66, 40, 46, 92, 96, and 95 hours, respectively. One hundred simulations were run and the root mean squared error (RSME) was determined for the estimated and actual decay constants for the OAR, background and tumors .

RESULTS

Using only 4 PSB measurements at 4 hrs and 1, 3 and 7 days, the RSME between the estimated and actual washout constants for the OAR and background were all <5%. The 2.5 cm tumor had the worst RMSE of ~12%. However, when 21 daily PSB measurements were made all OAR, background and tumors had a RSME of <4% .

CONCLUSION

The initial results based upon simulation studies indicate that the precision sensing belt is able to estimate washout from OAR and tumors to within ±5%. Use of the PSB could significantly lower the cost of any clinical trial to investigate personalized 177Lu DOTATATE therapy and lead to FDA approval for personalized therapy.

CLINICAL RELEVANCE/APPLICATION

The goal of the precision sensing belt is to enable low cost, patient friendly methods for the personalization of 177Lu DOTATATE therapy.

SSE23-04 Quantitative Impact of Iterative Reconstruction Settings for Next-Generation Digital Photon Counting PET/CT

Monday, Dec. 2 3:30PM - 3:40PM Room: E351

Participants
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PURPOSE

The introduction of next generation, digital PET/CT enables high definition reconstruction with decreased voxel volumes, improving image quality, lesion detectability, and quantitative accuracy. However, using a larger reconstruction matrix without changing reconstruction parameters leads to increases in image noise. We assessed the impact of iterative reconstruction settings on PET quantification in order to overcome the perceived limitations of image noise.

METHOD AND MATERIALS

80 patients injected with 13 mCi 18F-FDG were imaged 90sec/bed on a digital photon counting PET/CT system (Philips Vereos, dPET). PET listmode data were reconstructed with 4 and 2mm3 isometric voxel volumes, initially using 3 iterations with 29 subsets. Secondary reconstructions then completed using 13, 15, and 17 subsets for the 4mm standard definition (SD) images, and 11, 13, and 15 for the 2mm high definition (HD) images. We evaluated visual quality and quantitative precision in target tumors and background tissues, using the 29 subset images as a reference.

RESULTS

Visual review revealed that the lower subset images were more preferable than the reference 29 subset images, particularly for the HD reconstructions where image noise is more apparent. Quantitative evaluation was revealed to be quite stable over a range of reconstruction settings. On average, quantification of physiologic uptake varied less than 2% and 3% for SD and HD reconstructions. In target lesions, the SUVmax decreased on average 4.4%, 4.1%, and 4.2% for SD images with 13, 15, and 17 subsets. In the HD images, the average decrease was 8.7%, 7.2%, and 6.4% for 11, 13, and 15 subsets.

CONCLUSION

The improved sensitivity and time of flight timing resolution of the dPET system allow for more accurate lesion detection and quantification, enhanced by the use of HD reconstructions. Here we have shown that when modifying the reconstruction settings to optimize visual quality of the images, quantitative parameters remain stable. Thus the optimization can be tailored to chosen voxel volumes and expected count densities in order to best leverage the capabilities of new digital photon counting PET.

CLINICAL RELEVANCE/APPLICATION

Higher definition PET imaging is readily achieved after optimization of iterative reconstruction parameters to account for increased noise in the now more count sparse voxels.

SSE23-05 A Study of Pseudo CT Generation for PET/MR Attenuation Correction Using Deep Learning

Monday, Dec. 2 3:40PM - 3:50PM Room: E351

Participants
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PURPOSE

Accurate attenuation correction (AC) remains a challenging problem in today's PET/MR systems. Specialized UTE MR images have been used for generating AC map in conventional scanners. However, the UTE acquisitions are time-consuming and provide little information for clinical diagnostic purpose. In this study, we investigated the feasibility of a deep learning approach using conditional generative adversarial network (cGAN) (Isola et. al., arXiv:1611.07004) to synthesize pseudo CT images from T1-weighted MR images for AC map generation in brain PET/MRI imaging.

METHOD AND MATERIALS

The cGAN network was trained to provide continuously valued CT images. The network structure was adopted from the original paper, which consists of a U-Net generator and a PatchGAN discriminator. Both MR and CT images were acquired at the head position for 100 patients. The T1-GRE-FSP-ISO images, which were included in the clinical scanning protocol, were chosen as the input MR images. The MR and CT images were registered and transformed into 2D axial images with 1mm*1mm pixel size and 2mm slice thickness. Images of 80 patients were used in the training procedure and those of

the other 20 patients were used for validation. The performance of the trained model was evaluated by comparing the generated pseudo-CT to the acquired CT images using structural similarity index (SSIM). Dice coefficients were also calculated via segmenting the images into air (<-500 HU), bone (>500 HU), and soft tissue regions.

RESULTS

For the validation image set of 20 patients, the SSIM between the pseudo-CT images generated by the trained model and acquired CT images is 0.894±0.049. The Dice coefficients are 0.987±0.008 for air, 0.736±0.094 for bone, and 0.938±0.028 for soft tissues.

CONCLUSION

The initial results show that this deep learning approach based on cGAN technique has the potential to synthesize continuously-valued pseudo-CT images from T1-weighted MR brain images, which can then be further used to generate AC map for PET/MR imaging. Future work may include training of 2.5D or fully 3D models as well as employing additional MR sequences as the model input.

CLINICAL RELEVANCE/APPLICATION

This study provides an alternative approach for attenuation correction in PET/MR systems, which may potentially improve the current PER/MR imaging procedure and quality.

SSE23-06 Total-body Parametric Imaging on EXPLORER

Monday, Dec. 2 3:50PM - 4:00PM Room: E351

Participants
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PURPOSE

Dynamic PET can estimate physiologically relevant parameters. Current PET scanners offer whole-body dynamic imaging but require a multi-pass scan protocol, which results in low signal-to-noise and misses temporal information at each bed position. To overcome these limitations, a 2-meter long PET/CT (EXPLORER) has been developed. In this work, we perform total-body parametric imaging and demonstrate its potential benefit for clinical imaging.

METHOD AND MATERIALS

We conducted the first human dynamic total-body PET study using the EXPLORER scanner in a healthy female subject. A 60min dynamic scan was performed immediately after an intravenous injection of 256 MBq of 18F-FDG. We divided the one-hour dynamic dataset into 187 frames and reconstructed it using a 3D TOF list-mode OSEM algorithm with all quantitative corrections (normalization, attenuation, scatter and random corrections) incorporated in the forward model. The linear Patlak model was implemented to analyze total-body FDG metabolism. The Patlak slope Ki image was estimated from the reconstructed 30-60min frames and was compared with the standard uptake value of the static scans at different times post-injection. The input function was obtained from the aorta time activity curve.

RESULTS

First, the reconstructed dynamic images show good image quality with low noise and demonstrate the high sensitivity of the EXPLORER and the benefit of total-body coverage. Second, the Patlak Ki image show good contrast and high signal-to-noise ratio for detecting abnormally high FDG uptake which may potentially increase lesion detectability using FDG PET. In this volunteer study, a hot spot in the right collarbone, possibly representing bone healing processes, can be clearly seen in the Patlak Ki image using the 30-60min data. The hot spot is confirmed in the delayed scan acquired at 4-hr post injection. This result suggests that we may be able to use dynamic scans to obtain improved lesion conspicuity without the inconvenience of late time-point scanning.

CONCLUSION

In this study we performed a total-body parametric imaging study using the EXPLORER and demonstrated its high image quality for clinical imaging.

CLINICAL RELEVANCE/APPLICATION

FDG PET images glucose metabolism and has been widely used in cancer detection and staging. Total-body parametric imaging can potentially improve lesion detection over existing static scans.

Printed on: 10/29/20

SSE24

Physics (Deep Learning - X-Ray Scatter Correction and Denoising)

Monday, Dec. 2 3:00PM - 4:00PM Room: S104A

AI CT PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Timothy P. Szczykutowicz, PhD, Madison, WI (*Moderator*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC; Medical Advisory Board, medInt Holdings, LLC; Consultant, General Electric Company; Consultant, Takeda Pharmaceutical Company Limited

Sub-Events

SSE24-01 Low-Contrast Detectability of Image-Based Denoising Algorithm using Deep Learning in CT: A 12-Reader Study Comparing with Advanced Modeled Iterative Reconstruction and Filtered Back Projection

Monday, Dec. 2 3:00PM - 3:10PM Room: S104A

Participants
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PURPOSE

To compare the low-contrast detectability of deep learning-based denoising algorithm (DLA) with those of advanced modeled iterative reconstruction (ADMIRE) and filtered back projection (FBP).

METHOD AND MATERIALS

Using abdomen and pelvis CT images of 100 patients reconstructed with both ADMIRE and FBP, we trained DLA while feeding FBP images as input and ADMIRE images as the ground truth. To compare the low-contrast detectability of the DLA with those of ADMIRE and FBP, randomized repeat scans of Catphan® low-contrast phantom module (CTP 515) were performed under various conditions of radiation exposures (100 kVp; 200, 100, 50, 25 mAs). All images were reconstructed or denoised using each algorithm. We used 9 mm and 5 mm supra-slice targets with +10 HU difference to the background in measuring the low-contrast detectability. Twelve radiologists reviewed 960 images and evaluated target presence on a five-point confidence scale. Task transfer function (TTF) and noise power spectrum (NPS) of each algorithm were evaluated using American College of Radiology CT accreditation phantom module 1 under the condition of 100 kVp and 200 mAs. To compare the low contrast detectability, multireader multicase area under the receiver operating characteristic curve (AUC) was calculated and noninferiority tests were performed. To compare the TTF and NPS across the algorithms, TTF50, area under the NPS (AUNPS), and NPS peak frequency were compared using paired t-test.

RESULTS

AUC of DLA in detecting low contrast targets was noninferior to that of ADMIRE (AUC difference [95% confidence interval], -0.013 [-0.038-0.012]; $P < 0.001$) and superior to that of FBP (0.039 [0.017-0.060], $P < 0.001$). TTF50 of DLA was significantly higher than those of FBP and ADMIRE ($P < 0.001$), except comparing with that of ADMIRE in the disc simulating hypothetical bone. AUNPS of DLA was significantly lower than those of ADMIRE and FBP ($P < 0.001$, respectively). The NPS peak frequency of DLA was not different from that of ADMIRE ($P > 0.99$) and was significantly lower than that of FBP ($P < 0.001$).

CONCLUSION

The low-contrast detectability of the deep learning-based denoising algorithm was noninferior to that of ADMIRE and was superior to that of FBP.

CLINICAL RELEVANCE/APPLICATION

The deep learning-based denoising algorithm can potentially imitate and substitute the advanced modeled iterative reconstruction, as the image quality of the deep learning-based denoising algorithm was comparable to that of ADMIRE and was superior to that of FBP.

SSE24-02 Patient-Specific Noise Reduction Using a Deep Convolutional Neural Network

Monday, Dec. 2 3:10PM - 3:20PM Room: S104A

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PURPOSE

To develop and evaluate patient-specific training to improve performance for convolutional neural network (CNN)-based CT denoising.

METHOD AND MATERIALS

Two training methods were investigated for CNN-based denoising of CT images: one using abdominal CT data from multiple patient cases to perform generic CNN training, and the other using patient-specific data to fine-tune the generic CNN for use with images from that same patient. A deep residual CNN was trained with routine dose (RD) abdominal CT images from 10 patients, and the corresponding low-dose (LD) images, which use noise insertion into the projection data to simulate data acquired at 25% of RD. The mean squared error (MSE) between LD and RD images was used as the loss function. After training for 300 epochs, the model was referred to as CNN-General. The model was then fine-tuned for 300 epochs using RD images from a new patient (Patient A) and 19 additional LD image realizations achieved through repeated insertion of random noise. After fine-tuning, the model was referred to as CNN-A, since it was tuned to the anatomy of Patient A. Simulated LD (25, 50, and 75%) data from 3 patients (A,B,C) not included in the original 10-patient training cohort were used for validation data; the LD data for Patient A that was used for validation was a different LD realization than the 19 simulated exams used for Patient-A-specific training. Performance was assessed by comparing the minimum MSE values achieved during training and various anatomic features in the original RD images of Patient A after denoising with both methods.

RESULTS

After the first 50 epochs of fine-tuning, CNN-A converged to a lower MSE than CNN-General when applied to Patient A for 25%, 50%, and 75% of RD by factors of 12%, 22%, and 22% respectively. When applied to the original RD images for Patient A, we found that CNN-A improves the visibility of subtle anatomic features compared to CNN-General.

CONCLUSION

A CNN-based denoising algorithm trained using a random patient cohort can be fine-tuned for a specific patient to improve denoising performance using a single CT exam with multiple random noise realizations.

CLINICAL RELEVANCE/APPLICATION

Patient-specific fine-tuning of a CNN-based denoising algorithm can improve performance compared to one that was only trained on a general patient cohort.

SSE24-03 Deep Learning Based Adaptive Filtering for Projection Data Noise Reduction in X-Ray Computed Tomography

Monday, Dec. 2 3:20PM - 3:30PM Room: S104A

Participants
Tzu-Cheng E. Lee, PhD, Vernon Hills, IL (*Presenter*) Nothing to Disclose
Jian Zhou, PhD, Vernon Hills, IL (*Abstract Co-Author*) Principal Scientist, Canon Medical Systems Corporation
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PURPOSE

Raw data noise reduction is often applied in CT before reconstruction in order to improve the quality of reconstructed images. Adaptive data filtering methods have been widely used for this purpose. However, most of adaptive filtering methods choose the kernel parameter based on empirical knowledge which may lack robustness depending on data conditions. In this research, we leverage the deep learning technique to mitigate this limitation. We propose a parametric kernel prediction network (PKPN) which can automatically generate kernel parameters that are adaptive to various data statistics.

METHOD AND MATERIALS

We develop a deep neural network, PKPN, which can automatically predict the spatially variant kernel parameter based on various input data statistics. PKPN includes two major components: a linear sequence network and a spatial variant filtering module (see figure 1). The network is to generate parameters for every data pixel required by the filtering module. Note that when training the network, we still compute the loss between the predicted projection and the reference projection. This ensures that the data after adaptive filtering can still be optimal in terms of training criteria.

RESULTS

We calculated the RMSE and the SSIM with the high-dose reference. For low-dose abdominal (120 kVp, simulated 35 mAs) and thoracic (120 kVp, simulated 45 mAs) projection data, PKPN shows both better RMSE and SSIM on the reconstructed images compared to conventional filtering method (Relative Noise Level) processed data (see figure 2). Anatomical detail is also clearer at the PKPN set compares to the RNL set.

CONCLUSION

PKPN can learned through the training process with a relatively simple three-layer neural network. For both simulated and clinical

low-dose cases, PKPN shows very competitive performance in terms of both image accuracy and resolution compared to the conventional approach. Moreover, the proposed method can be readily extended to kernel functions other than the simple 2-D isotropic Gaussian function.

CLINICAL RELEVANCE/APPLICATION

PKPN for sinogram/projection denoising improves the overall reconstructed CT image quality compared to the conventional approach especially for the low-dose acquisitions.

SSE24-04 Deep Learning based Material Image Denoising for Dual Energy CT with Only Noisy Training Images

Monday, Dec. 2 3:30PM - 3:40PM Room: S104A

Participants
Dufan Wu, PhD, Boston, MA (*Presenter*) Research Grant, General Electric Company
Kyungsang Kim, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Kuang Gong, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Basis material images such as iodine map are noisy in dual energy computed tomography (DECT) due to ill-posed decomposition matrix. This study aimed to reduce noise level of basis material images with deep neural networks which could be trained without noiseless data.

METHOD AND MATERIALS

Most existing deep learning methods for image denoising require noiseless images as ground truth during training, which are not available for real basis material images in DECT. In this work we proposed a novel deep learning based denoising method for DECT which required only noisy data for training. The projections were split to odd and even sets and each set was reconstructed by filtered backprojection (FBP) separately to acquire xi1 and xi2 with nearly independent noise from each other. Two networks (UNet) were trained to map xi1 to material decomposition of xi2 and vice versa. The final denoised material images were the averaged results from the two networks. The method was validated on chest DECT scans from 45 patients for iodine map denoising. 30 patients were randomly selected as training images and the rest 15 were used for testing.

RESULTS

The method was compared against direct inversion and non-local mean based guided filtering (HYPR-NLM) on the 15 testing subjects. 5 ROIs were drawn on aortas for each subject to study bias and noise level of the basis material images. Bias was calculated by subtracting mean of direct inversion's ROIs from mean of the other two methods' ROIs. The proposed method achieved bias of -0.0015 ± 0.0055, which was small enough to be considered unbiased. The proposed method achieved standard deviation of 0.026 ± 0.009 on ROIs and was consistently reduced compared to direct inversion (0.123 ± 0.019) and HYPR-NLM (0.030 ± 0.010), both with $p < 0.01$ under dependent t-test. The images of iodine maps decomposed by the proposed method demonstrated significantly reduced noise level compared to direct inversion. It also showed less structural bias and block / spiky artifacts compared to HYPR-NLM.

CONCLUSION

The proposed deep learning method which required only noisy images to train could significantly reduce noise in basis material images of DECT without introducing bias.

CLINICAL RELEVANCE/APPLICATION

The proposed method could greatly reduce the noise in material decomposition images of DECT and improve image quality in relevant applications such as pulmonary embolism, renal mass, gout, etc.

SSE24-05 Scatter Correction for Contrast-Enhanced Digital Breast Tomosynthesis (CEDBT) Using Deep Learning Approach

Monday, Dec. 2 3:40PM - 3:50PM Room: S104A

Participants
Xiaoyu Duan, Stony Brook, NY (*Presenter*) Nothing to Disclose
Hailiang Huang, MS, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose
Pranjal Sahu, Stony Brook, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Contrast enhanced digital breast tomosynthesis (CEDBT) utilizes weighted subtraction of high energy (HE) and low energy (LE) DBT to generate a 3D iodinated contrast enhancement map of the breast, and potentially improve breast lesion detection and characterization. However, the increased scattered radiation at HE exacerbates the cupping artifact. Monte Carlo (MC) based scatter correction (SC) method suffers from long computation time, and kernel-based method is less accurate, especially near the breast edge due to thickness roll-off. This work is aimed at developing fast and accurate SC using Convolutional Neural Network (CNN).

METHOD AND MATERIALS

The FDA open-source VICTRE tool was used to create digital breast phantoms with various shapes, sizes, and breast densities. HE DBT projection images with and without scatter were generated from MC simulation based on the acquisition geometry of Siemens Mammomat Inspiration DBT system. A U-Net CNN was trained to obtain scattered radiation map from projection images with scatter. To minimize the effect of quantum noise on scatter estimate, a gaussian filter was applied to smooth the scatter maps in the training dataset. The segmented breast region, compressed breast thickness, and projection angle were provided to the CNN as separate channels. Mean absolute percentage error (MAPE) was used as the loss function. The number of projections used for training, validation, and testing was 526, 125, and 150 respectively. The accuracy of the CNN-based SC was compared with the accuracy of kernel-based SC using projection images without scatter from MC simulation as ground truth. The proposed SC method was tested on the HE projection images and DBT volume acquired from an IRB-approved clinical study investigating CEDBT.

RESULTS

After training, the CNN performed SC in real-time. CNN-based SC shows higher accuracy in scatter estimate for HE projections compared to kernel-based SC in the breast peripheral region. The cupping artifact in HE DBT is suppressed post SC.

CONCLUSION

The proposed CNN-based SC provides a fast and accurate scatter correction for CEDBT.

CLINICAL RELEVANCE/APPLICATION

The scatter removal in HE DBT improves the image quality of CEDBT, which can potentially make high clinical impact on breast cancer detection and 3D assessment of contrast-enhanced lesions.

SSE24-06 Monte-Carlo-Free Deep Scatter Estimation (DSE) for X-Ray CT and CBCT

Monday, Dec. 2 3:50PM - 4:00PM Room: S104A

Participants
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Eric Fournie, Forchheim, Germany (*Abstract Co-Author*) Siemens AG
Karl Stierstorfer, PhD, Forchheim, Germany (*Abstract Co-Author*) Employee, Siemens AG
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PURPOSE

To provide an accurate real-time scatter correction algorithm that uses CT measurements of a few simple-to-manufacture phantoms for calibration.

METHOD AND MATERIALS

DSE is a neural network that maps measured CT data onto scatter-free data. To train DSE a Monte Carlo (MC) simulation of scatter had been used [J. Nondest. Eval. 37:57, 2018] [Med. Phys. 46(1):238-249, 2019]. While being very accurate, this simulation-based approach (sbDSE) highly relies on the quality of the MC simulation which needs to be tailored to the CT scanner. To avoid the need for MC we define a limited set of geometric phantoms in several arrangements to provide a training set for the DSE. The advantage of geometric phantoms is that on the one hand they can be measured in a physical setup, providing the sum of primary and scattered radiation. On the other hand the primary radiation can accurately be determined in a polychromatic simulation of the objects. Thus, the scatter intensity can be estimated by subtracting the simulated primary intensity from the measured intensity. The DSE network is trained to map the measured intensity onto the difference of the measured intensity minus the forward projected intensity. This measurement-based DSE (mbDSE) is evaluated using simulations of the calibration procedure (Siemens Somatom Force system, without anti scatter grid). We apply mbDSE to simulations of semi-anthropomorphic phantoms of different sizes.

RESULTS

The mean absolute relative error of the mbDSE scatter estimate is between 2 and 3%. Without scatter correction the CT values of the thorax phantom deviated from the scatter-free ground truth by 102 HU (mean of heart ROI), 140 HU (mean of soft tissue ROI close to vertebra), and 15 HU (mean of lung ROI). DSE is able to correct these values to 2 HU, 1 HU, and 0 HU. An MC-based scatter correction did not perform better. Visually the artifacts introduced due to the scatter are completely removed.

CONCLUSION

The proposed mbDSE may outperform sbDSE and the conventional MC-based scatter estimation since it does not require modeling the scanner's x-ray and scattering properties in detail. Instead it can extract the features relevant for scatter from a set of phantom measurements.

CLINICAL RELEVANCE/APPLICATION

Accurate scatter estimation allows for accurate correction of scatter artifacts and is thus crucial for providing good image quality.

SSE25

Science Session with Keynote: Radiation Oncology (Gynecologic Cancers)

Monday, Dec. 2 3:00PM - 4:00PM Room: E263

GU RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: .50

Participants
Eric Leung, MD, FRCPC, Toronto, ON (*Moderator*) Nothing to Disclose
Tracy M. Sherertz, MD, Seattle, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSE25-01 Optimization and Evaluation the Random Forest Model in Prediction the Efficacy of Chemoradiotherapy for Advanced Cervical Cancer Based on Radiomics Signature Coming from High-Resolution T2WI Images

Monday, Dec. 2 3:00PM - 3:10PM Room: E263

Participants
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Xiaohang Zhang, MS, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Qinglei Shi, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Juan Du, Qinhuangdao , China (*Abstract Co-Author*) Nothing to Disclose
Yongji Wang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Lanxiang Liu, Qinhuangdao, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To establish and optimize a random forest model, and to evaluate the predictive ability of it in prediction the treatment effect of advanced cervical cancer (>IIb) treated with neoadjuvant chemotherapy-radiation therapy based on radiomics signatures coming from high resolution T2WI images.

METHOD AND MATERIALS

This retrospective study included 82 patients with locally ACC (squamous carcinoma 74, adenocarcinoma 8; pathological stage: IIb 40, IIIa 23, IIIb 10, Iva 4, IVb 5) scanned from March 2013 to May 2018. All these patients received concurrent chemoradiotherapy, and all MR examinations were performed before treatment within one month at a 1.5 T scanner (MAGNETOM Avanto, Siemens Healthcare, Erlangen , Germany). According to curative effect, patients were divided into complete remission and partial remission group. Radiomics signatures were extracted using an open source tool named Pyradiomics (https://pyradiomics.readthedocs.io/en/latest/index.html). The model of RF was established and optimized based on the open source toolkit scikit-learn (https://scikit-learn.org/stable/). Through optimization the number of decision trees, the criteria for selecting final partition index, the minimum number of samples partitioned by each node, the performance of RF was evaluated.

RESULTS

The number of decision trees in random forests demonstrated important impact on the performance of the model. When the number of decision trees was set to 10, 25, 40, 55, 70, 85 and 100 respectively, the performance of random forest model shows a trend of rising firstly and then declining. Criteria in selecting final partition index have significant effects on the generation of decision tree. In this study, Gini index demonstrated a better effect compared with information gain index. After optimization, when the number of decision tree is set to 55 and the selection criterion of optimal partition index is set to Gini, the AUC value can reach 0.917.

CONCLUSION

After optimization, the random forest model seems can provide valuable information and showed potential in prediction treatment effect for advanced cervical cancer (>IIb) treated with neoadjuvant chemotherapy-radiation therapy based on a high resolution T2WI images.

CLINICAL RELEVANCE/APPLICATION

The optimized RF model seems can provide valuable information and showed potential in prediction treatment effect for advanced cervical cancer (>IIb) treated with neoadjuvant chemotherapy-radiation therapy.

SSE25-02 Survival Outcomes in Cervical Cancer Patients Who Undergo Radiotherapy Followed by Hysterectomy or Exenteration

Monday, Dec. 2 3:10PM - 3:20PM Room: E263

Participants
Andrew Huang, MD, Madison, WI (*Presenter*) Nothing to Disclose
Karen E. Huang, MS, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
John K. Chan, San Francisco, CA (*Abstract Co-Author*) Speaker, F. Hoffmann-La Roche Ltd

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PURPOSE

While definitive radiotherapy regimens have been shown to be an excellent upfront alternative to surgery for cervical cancer, a small proportion of women still undergo a hysterectomy or exenteration either as an adjuvant or salvage therapy. We wished to determine the outcomes of these women compared to other women in the same cancer stage.

METHOD AND MATERIALS

We queried a custom Surveillance, Epidemiology, and End Results Program (SEER) database that included chemotherapy and radiotherapy treatment variables. Patients staged between 2004-2010 were included in the analysis and stratified by AJCC 6th edition stage. The primary endpoint was 5-year overall survival. We selected for patients who first underwent both external radiotherapy and brachytherapy who then later underwent hysterectomy or pelvic exenteration. We then compared these patients against all-comers within each stage using the Fischer-Exact test. We excluded patients with stage IA, IIIA, and IV disease as there were <20 patients who met our selection criteria in each of these cohorts.

RESULTS

There were 32,028 patients that met our initial selection criteria of having cervical cancer, a specific AJCC stage, and 5-year survival data available. Of these, 311 received both external beam radiotherapy and brachytherapy, followed by either a hysterectomy or pelvic exenteration. Five-year survival stratified by initial stage was 69% (IB1, n=24), 90% (1B2, n=95), 68% (IIA, n=30), 69% (IIB, n=66), and 63% (IIIB, n=62). Compared to all-comers, patients with IB1 disease who underwent surgery had a lower 5-year survival (69 vs 90%, p=0.006) while patients with IB2 disease who underwent surgery had a higher 5-year survival (90 vs 74%, p<0.001, Table 1). No statistical differences in survival were seen in IIA (68 vs 62%, p=.705), IIB (69 vs 64%, p=.366), and IIIB (63 vs 51%, p=.056) patients.

CONCLUSION

Surgical resection after both external beam radiotherapy and brachytherapy in the treatment of cervical cancer is associated with decreased overall survival in Stage IB1 patients but increased overall survival in IB2 patients.

CLINICAL RELEVANCE/APPLICATION

There is still controversy whether adjuvant hysterectomy after definitive radiotherapy for cervical cancer improves outcomes in cervical cancer; our study hopes to contribute to the body of evidence related to this question.

SSE25-03 Bone Fragility After Pelvic Chemoradiotherapy for Cervix Cancer

Monday, Dec. 2 3:20PM - 3:30PM Room: E263

Participants
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PURPOSE

Bone insufficiency fractures after pelvic radiotherapy are reported to have a low incidence and delayed onset when assessed on CT scans. Our aim was to determine the prevalence of pelvic insufficiency fractures (PIFs) after chemoradiotherapy (CRT) for cervical cancer (CxCa) on MRI follow-up, noting time of onset, symptoms, interval to healing and ADC values on diffusion MRI scans.

METHOD AND MATERIALS

In our institution, locally advanced CxCa patients undergo external beam RT (45-50Gy, 25#) including the sacral alar, cervix brachytherapy (24-28Gy, 4#) and weekly Cisplatin. They are followed up with serial MRI pelvis at 3, 12 and 24 months post-treatment. 20 consecutive women were retrospectively reviewed by an oncologic radiologist for the presence of PIFs, defined by linear low T1W and high STIR signal intensity. Features were graded for severity according to displacement, multiplicity, extent of bone oedema. ADC values were measured at the sites of fracture; when no fracture was seen, ADC was measured in the sacral alar. Correlations with symptoms was performed.

RESULTS

15 patients had 55 MRI scans (7 pre- and 48 post-treatment), average follow-up 22 months. 12/15 patients were aged over 50. 13/15 were staged as 2B. 9/15 patients had PIFs, majority diagnosed at 3 months (8/9 patients), 1 at 12 months. PIFs were graded as mild-1, moderate-5 or severe-3. 25 fracture sites were identified (18 sacral, 3 pubic, 1 iliac, 1 acetabular, 2 L4-5). Mean ADC values were 731 um2/s (204-1482) for all visible sacral fractures and 177 um2/s (33-499) for non-fractured sites (MW Test: p<0.001). Healing occurred at 5/25 fracture sites (in 6-23 months), with only 1 patient showing healing of all affected sites. 2 patients had related bone pain. 2 patients with PIFs sustained displaced pelvic fractures after falls. Only 1 patient had pelvic tumour recurrence at 12 months (no PIF).

CONCLUSION

PIFs on MRI are common after CRT for locally advanced CxCa, with an early onset post-treatment. Majority of patients are asymptomatic, but might have increased risk of displacement after trauma. Further research will be done into radiation dose distribution/techniques and any correlation with bone changes.

CLINICAL RELEVANCE/APPLICATION

PIFs are common on MRI follow-up after CRT for CxCa. Although mostly asymptomatic, only 20% healed during follow-up, with 2/15 patients suffering displaced pelvic fractures after minor trauma.

SSE25-04 Vaginal Recurrence of Endometrial Cancer Treated with Image-Guided Brachytherapy: Prognostic Value of MRI Characteristics

Monday, Dec. 2 3:30PM - 3:40PM Room: E263

Participants
Aida K. Kiviniemi, MD, Brookline, MA (*Presenter*) Nothing to Disclose
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PURPOSE

Imaging characteristics and related prognostic determinants for vaginal recurrence of endometrial cancer (EC) are poorly understood. This study evaluates the prognostic significance of MRI appearance, tumor location, and volume in patients treated with salvage radiotherapy.

METHOD AND MATERIALS

Patients with available pelvic MRI at vaginal recurrence of EC treated from 2004-2017 with external beam radiotherapy (EBRT) and image-guided brachytherapy (BT) were retrospectively identified. Extracted qualitative MRI features included tumor location, morphology, T2 signal intensity, enhancement, necrosis, and diffusion appearance. Recurrent tumor volumes were segmented at baseline and pre-BT MRI when available. The association of recurrence location and primary EC characteristics was evaluated by Fisher's exact test. Rates of recurrence-free survival (RFS) and overall survival (OS) were compared by logrank or univariate Cox regression.

RESULTS

In total, 36 patients with baseline pelvic MRI (1.5T or 3T) were included. Pre-BT MRI was available in 67% (24/36). Vaginal recurrence of EC was most commonly located in the vaginal cuff (72%) and showed nodular irregular morphology (82%), restricted diffusion (100%), hypoenhancement (88%), and an enhancing peripheral rim (73%). Tumor involvement of the lower third vagina was associated with lymphovascular invasion (17% without LVI, 63% with LVI) in the hysterectomy specimen ($p<0.05$) and prior adjuvant RT ($p<0.05$). The median tumor volumes at baseline and pre-BT MRI were 9.1 cm3 and 2.5 cm3, respectively, with a median tumor shrinkage of 69% after EBRT. Tumor volume both at baseline and pre-BT predicted OS (HR 1.04, 95% CI 1.01-1.06, $p<0.05$ and HR 1.06, 95% CI 1.00-1.12, $p<0.05$) whereas % shrinkage and BT dose were not prognostic. Diffuse growth pattern along the vaginal wall and the lack of an enhancing rim were associated with worse RFS ($p<0.001$ and $p<0.05$). Tumor T2 heterogeneity and necrosis were not prognostic.

CONCLUSION

Tumor volume at baseline and pre-BT MRI, and the absence of rim enhancement were prognostic for survival. This study represents the first systematic evaluation and prognostication of MRI features in vaginal recurrence of EC treated with salvage BT.

CLINICAL RELEVANCE/APPLICATION

The study provides valuable diagnostic and clinical information for salvage radiation treatment of vaginal recurrence of EC.

SSE25-05 Radiation Oncology Keynote Speaker: Gynecology

Monday, Dec. 2 3:40PM - 4:00PM Room: E263

Participants
Bryan J. Traughber, MD, Cleveland, OH (*Presenter*) Research Grant, Koninklijke Philips NV; Research Grant, Elekta AB

SSE26

Vascular/Interventional (Education and Safety)

Monday, Dec. 2 3:00PM - 4:00PM Room: E260

IR SQ VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Lisa H. Kang, MD, Sacramento, CA (*Moderator*) Nothing to Disclose
Gloria M. Salazar, MD, Boston, MA (*Moderator*) Consultant, Medtronic plc

Sub-Events

SSE26-01 Endovascular Simulation Training: A Tool to Increase Enthusiasm for Interventional Radiology Among Medical Students

Monday, Dec. 2 3:00PM - 3:10PM Room: E260

Participants
Roman Kloeckner, MD, Mainz, Germany (*Presenter*) Advisory Board, Guerbet SA; Advisory Board, Bristol-Myers Squibb Company; Advisory Board, Sirtex Medical Ltd; Speaker, Guerbet SA; Speaker, Sirtex Medical Ltd; Speaker, BTG International Ltd
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Christoph Dueber, MD, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Interventional radiology (IR) is a growing field. However, in most medical schools it is underrepresented in the curriculum. Therefore, we aimed to test whether endovascular simulator training improves the attitude towards IR among medical students.

METHOD AND MATERIALS

This prospective study is conducted at two university medical centers. In both, a dedicated 90-minute course on IR is given to 4th year medical students; in center A in two weeks in February 2019 on a daily basis, in center B once per week between March and May 2019. The course is split into two halves: One theoretical 45-minute part about IR and one practical 45-minute part using endovascular simulators. Questionnaires are completed before the course, after the theoretical part, and after the practical part using smartphones/tablets. Students are asked to rate their knowledge of IR, their interest in IR, the attractiveness of IR, and their willingness to potentially work in IR in the future on a 7-point Likert scale. To prevent position effect-bias, the study was conducted in a crossover design, i.e. 50% of the students heard the theoretical part first followed by the practical training, the other 50% vice versa.

RESULTS

As of the abstract deadline, 211 students completed all three questionnaires. Seminar and simulator led to an increase in knowledge about IR (pretest: 2.7 vs. post-seminar/post-simulator: 5.11/5.36), interest in IR (5.16 vs. 5.54/5.69), attractiveness of IR (4.55 vs. 4.76/4.85), and the likelihood to choose IR in the future (3.33 vs. 3.75/3.9) (all $p<0.05$). Although both parts led a significant improvement, the effect was significantly stronger for the simulator part compared to the theoretical part regarding all items (all $p<0.05$).

CONCLUSION

Endovascular simulator training in medical school significantly increases the knowledge about IR and the willingness to potentially choose IR in the future. In May 2019 the second part will be completed in center B, hopefully confirming these initially positive results.

CLINICAL RELEVANCE/APPLICATION

Implementing dedicated IR-courses in medical school can help to fight recruitment problems in IR; a practical simulator training further increases students' motivation.

SSE26-02 Burnout and Moral Injury Among Interventional Radiologists

Monday, Dec. 2 3:10PM - 3:20PM Room: E260

Participants
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Eunjee Lee, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose
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Travis L. Healey, MD, Indianapolis, IN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To characterize burnout among Interventional Radiologists.

METHOD AND MATERIALS

An anonymous, Institutional Review Board-exempt, 34-question online survey was distributed to practicing Interventional Radiologists through the Society of Interventional Radiology Open Forum, Twitter, Facebook, and LinkedIn. The survey consisted of demographic and practice environment questions, and the 22-item Maslach Burnout Inventory (MBI). Interventional radiologists with high scores on EE (>= 27) or DP (>= 10) MBI subscales were considered to have at least one manifestation of physician burnout. STROBE reporting guidelines were followed.

RESULTS

339 surveys were completed over ten days starting on January 7, 2019. 263 (77.6%) respondents identified as men, 75 (22.1%) as women, and 1 (0.3%) as trans-male. The respondents were Interventional Radiologists practicing at academic (136; 40.1%), private (145; 42.8%), and hybrid (58; 17.1%) centers. Respondents worked an estimated >40 hours (15; 4.4%), 40-60 hours (225; 66.4%), 60-80 hours (81; 23.9%), and >80 hours (18; 5.3%) per week. 307 (90.6%) reported taking call, with most respondents taking 1-5 (116; 34.2%) or 6-10 (158; 46.6%) calls per month. Mean MBI scores for EE, DP, and personal achievement were 29.7 ± 12.9, 10.7 ± 7.0, and 39.7 ± 6.8. Burnout among respondents was 72.0% (244 Interventional Radiologists). Identifying as a woman was significantly associated with burnout (odds ratio 2.4; P=0.009). Compared to respondents who worked <80 hours per week, working >80 hours per week was significantly associated with burnout (odd ratio 7.0; P=0.030). Practice level (P=0.553), practice setting (P=0.557), diagnostic radiology duties (P=0.588), practice size (P=0.232), years' post-graduate (P=0.373), age (P=0.856), and amount of call taken (P=0.110) were not significantly associated with burnout.

CONCLUSION

Burnout is prevalent among Interventional Radiologists. Identifying as a woman and working more than 80 hours per week were strongly associated with burnout. Strategies to reduce burnout within interventional radiology should consider improving gender equity and work hours among Interventional Radiologists.

CLINICAL RELEVANCE/APPLICATION

Strategies to reduce burnout within interventional radiology should consider improving gender equity and work hours among Interventional Radiologists.

SSE26-03 Hand Motion Analysis of Radiologists Performing Simulated Radial Arterial Access: Discerning Differences in Operator Experience Using Kinematic Analysis

Monday, Dec. 2 3:20PM - 3:30PM Room: E260

Participants
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PURPOSE

To perform a pilot evaluation of the ability of electromagnetic hand motion sensor technology to determine differences in the kinematic profile of operators based on their practice experience with radial artery access.

METHOD AND MATERIALS

Six fellowship-trained, right-handed attending interventional radiologists with 1-13 years of experience performed simulated arterial access on a commercial phantom. Two of the attendings reported limited radial arterial access experience (<50 cases), two reported significant experience obtaining palpatory radial artery access (>100 cases), and two had experience with radial artery access under ultrasound (US) guidance (>100 cases). The task involved placing a 21-gauge needle into the phantom radial artery and threading a wire into the artery. The phantom had tubing with red fluid and a squeeze-bulb to simulate a radial artery with blood and arterial pulsations. Each operator performed the task 5 times with an electromagnetic sensor affixed to the dorsum of each hand between the second and third metacarpals. Total time and total distance the sensors traveled (path length) were measured. Statistical analysis was performed using paired T-tests.

RESULTS

The radiologists with significant palpatory radial artery access experience had both a shorter time to complete the task and path

length compared to those who had limited radial artery experience (91 ± 13s vs. 143 ± 32s, p<0.01 and 141 ± 18 cm vs. 239 ± 100 cm, p=0.012). Those with ultrasound experience had a shorter time to complete the task than those with limited radial access experience (105±11s vs. 143±32s, p=0.012) but their path length was not significantly shorter (168±35cm vs. 239±100cm, p=0.063). When comparing only the palpatory and US groups, the time to complete the task was not significantly different (91±13s vs. 105±11s, p= 0.079) but the path length was shorter for the palpatory group (141±18 cm vs 168±35cm, p=0.042).

CONCLUSION

Kinematic analysis of hand motion using electromagnetic motion tracking was successful in distinguishing variability of operator experience with radial artery access. Further exploration of this technology may determine if the kinematic profile correlates with proficiency in completing a procedural task.

CLINICAL RELEVANCE/APPLICATION

Electromagnetic motion sensor technology can determine subtle differences in experience between trained operators for a given manual task and help determine areas for further development.

SSE26-04 Comparison of a New Material-Specific Contrast-to-Noise Ratio-Based Exposure Control with a Regular-Dose Dependent Exposure Control in a Clinical Angiographic System

Monday, Dec. 2 3:30PM - 3:40PM Room: E260

Participants
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PURPOSE

The purpose of this phantom study was to evaluate the skin-dose reduction potential of a material specific contrast-to-noise ratio based exposure control (CEC) in comparison to a regular detector based exposure control (DEC) in a clinical angiographic system.

METHOD AND MATERIALS

A standardized 3D-printed phantom with an iron, tantalum and platinum foil and cavities for contrast material (iodine, barium, carbon dioxide) was developed in order to investigate the dependency of a spatial frequency dependent CNR on image acquisition settings. This phantom was placed into a stack of polymethylmethacrylate and aluminum plates, simulating a patient equivalent thickness (PET) of 2.5cm-40cm. Fluoroscopic (FL) and diagnostic radiograph (DR) images were acquired using a clinical angiographic system with material-specific CEC (iron, tantalum, platinum, carbon dioxide, iodine barium) and regular DEC protocols implemented. The CNR of the CEC protocols were adjusted to the CNR of the DEC protocols in order to allow for a comparison. The possible skin radiation dose reduction for material specific CEC protocols compared to DEC protocols was estimated while the CNR was maintained.

RESULTS

Material specific CEC demonstrated a substantial skin dose reduction potential compared to DEC protocols. For platinum and tantalum the possible mean skin radiation dose reduction while maintaining CNR was 59 ±21% (max. 91% at 30cm) and 65 ±18% (max. 92% at 30cm) for DR and 58 ± 23% (max. 84% at 30cm) and 58 ± 23% (max. 87% at 27.5cm) for FL, respectively. For carbon dioxide imaging the possible mean skin radiation dose reduction was 52 ± 19% (max. 87% at 30cm). For barium, iodine and iron the mean skin radiation dose reduction while maintaining CNR was 32 ±19%, 33 ±17%, 34 ±17% for DR and 18 ±12%, 19 ±18% and 18 ±11% for FL. For these materials highest skin dose reduction of approx. 40% for FL and 50% for DR at 27.5-30cm.

CONCLUSION

The use of a material specific contrast-to-noise ratio based exposure control bears a substantial skin dose reduction potential compared to the regular detector dose dependent exposure control.

CLINICAL RELEVANCE/APPLICATION

Material specific CEC allows for a substantial radiation dose reduction without loss of image quality as compared to DEC. In particular, the dedicated imaging of tantalum and platinum might help to considerable reduce the radiation exposure of the patient and staff.

SSE26-05 Demonstration of a Real-Time Scattered Radiation Display for Staff Dose Management during Fluoroscopic Interventional Procedures

Monday, Dec. 2 3:40PM - 3:50PM Room: E260

Participants
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PURPOSE

To facilitate staff dose management during long fluoroscopic interventional procedures, our group has developed a real-time, virtual reality (VR) scattered radiation display system (SDS). A demonstration of how the SDS works using data from clinical procedures is presented.

METHOD AND MATERIALS

The SDS provides a VR representation of a patient graphic, the c-arm gantry, patient table, and a color-coded overlay that displays the spatial distribution of scattered radiation in the room as well as the scatter dose rate at a staff member's location using a circular indicator. Update of the staff indicator position occurs in real-time via body tracking using a Microsoft Kinect V2 depth camera. To demonstrate its use, cardiovascular interventional cases were retrospectively analyzed under IRB approval using log files of all exposure events obtained from Canon's Dose Tracking System (DTS). The log file data for each clinical case was read into the SDS for selection of the appropriate pre-calculated scatter distributions during playback for each procedure. The real-time SDS has been developed in Matlab using the Python controller area network (CAN) interface module to facilitate inflow of geometric and exposure messages from a Canon Biplane Angiography system. A virtual CAN bus using the Python interface was utilized to play back the clinical log files for this demonstration.

RESULTS

For each cardiovascular case, VR scatter distribution displays were generated showing variations with changes in each of the geometric and exposure parameters read in from the system. A staff member indicator was placed on-screen to display the changing dose-rates during the intervention. The magnitude of the change in scatter is shown as the procedures progressed. Simultaneously, patient skin dose distributions and entrance dose rates were displayed with the DTS.

CONCLUSION

A real-time scattered radiation display can enable staff members to make informed decisions throughout the procedure on where to stand in the room and thus maintain staff dose as low as reasonably achievable. The SDS can be implemented in the procedure room with the DTS for a comprehensive approach to radiation safety and dose reduction.

CLINICAL RELEVANCE/APPLICATION

A real-time scattered radiation display system can facilitate staff dose management and with Canon's real-time patient skin dose mapping system would offer a comprehensive approach to dose reduction.

SSE26-06 A Systematic Review of 639 Patients with Biopsy-Confirmed Nephrogenic Systemic Fibrosis

Monday, Dec. 2 3:50PM - 4:00PM Room: E260

Participants
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PURPOSE

To perform a systematic review of nephrogenic systemic fibrosis (NSF).

METHOD AND MATERIALS

PubMed database was searched using 'nephrogenic systemic fibrosis' from January 2000 to February 2019 for studies in which patients with biopsy-confirmed NSF were reported. Data were pooled and authors were contacted for clarification. We used GraphPad software for statistical analysis of the data.

RESULTS

639 biopsy-confirmed patients with NSF from 173 articles are included. Among 542 with data 292 were female and 250 were male. Age at symptom onset was available for 174 patients [mean=49, (range=6-87)] with no reports in neonates or toddlers and few reports (n=7) in the very old (>80 years). 532 patients had documented exposure to GBCA including Group I (gadodiamide=315, gadopentetate dimeglumine=49, gadoversetamide=6), Group II (gadobutrol=1, gadobenate dimeglumine=1), multiple (n=49) and unknown (n=111). All but 3 patients with GBCA exposure, received gadolinium prior to 2008. 14 patients had no prior GBCA exposure in spite of searching. For 413 patients with clinical severity data, different degrees of motion limitation were present in 291/413(70%) indicating a more severe form of the disease in contrast to 122/413(30%) with only dermatological manifestations. Having a more severe debilitating disease was significantly correlated with being on dialysis at the time of GBCA exposure (P=0.005), chronic renal failure (P=0.04), and receiving a higher cumulative GBCA dose (P=0.0004). NSF was also associated with pro-inflammatory conditions, hyperphosphatemia, beta blockers and epoetin. 48%(70/146) of patients with autoimmune data, had autoimmune disease. Face was always spared except for 3 patients. For 341 patients with follow-up, 12 were cured and 72 partially improved including one during pregnancy. In 34 of these patients, improvement of symptoms occurred following renal function restoration. 4 deaths were attributed to NSF.

CONCLUSION

Although 639 patients with biopsy-confirmed NSF were reported, only 3 followed GBCA exposure after 2008 indicating that regulatory actions and practice changes have been effective preventive measures. Improvement and sometimes cure with renal function restoration is now possible.

CLINICAL RELEVANCE/APPLICATION

This systematic review shows that NSF has been nearly eliminated, is no longer incurable and supports the preference for group II GBCAs in at risk patients.

SSG01

Breast Imaging (CESM, DBT)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S102CD

BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSG01-01 Weakly Supervised Deep Learning Modeling on Sub-Volumes for Pre Assessment of Digital Breast Tomosynthesis

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S102CD

Participants
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PURPOSE

Digital breast tomosynthesis (DBT) is a quasi-3D imaging modality which can increase cancer detection and reduce false recalls. It, however, entails a much larger volume of imaging data to read, decreasing the time-efficiency of radiologists. In this study, we leverage a weakly supervised approach to build deep learning models to improve radiologists' reading, where the model performs a pre-reading to DBTs to identify potential examinations that are more likely to have malignancy or be breast cancer free.

METHOD AND MATERIALS

This retrospective study includes 546 patients (205 malignant and 341 benign cases, all confirmed by pathology), each having a DBT acquired between 2017-2018 at the same institution. Considering the 3D nature of DBT and the varying length of slice numbers (ranging 31 to 111) per breast across the patients, we proposed a sub-volume (i.e., 11 consecutive slices)-based scheme for 3D-based classification. A total of 1005 and 1753 sub-volumes were generated from the malignant and benign cases, respectively, for multi-sub-volume-based analysis. No lesion segmentation/labeling was performed in any slices; instead, only a weak label of 'malignancy' or 'benign' was given to each sub-volume. We constructed 3D convolutional neural network models using the shallow VGG-19 to perform three binary-classification tasks: (1) malignant vs. all benign, (2) malignant vs. BI-RADS 2&3 benign (109 cases), and (3) malignant vs. BI-RADS 4a&4b&4c benign (168 cases). Patient-wise 10-fold validation was performed, using AUC and sensitivity/specificity to measure model performance.

RESULTS

Average AUC was 0.72 (range 0.70-0.74) when using all benign cases in task 1. For the sub-group analysis, we observe an increased AUC of 0.74 (range 0.72-0.77) in task 2 and a decreased AUC of 0.60 (range 0.50-0.69) in task 3. In particular, a high specificity (0.89) is observed for task 1 and high sensitivity (0.91) is observed for task 2. The ROC curves are given in the attached figure.

CONCLUSION

Without the need of lesion segmentation and labeling, our deep learning method can effectively identify potential concerning DBT scans of reader's interests (more likely to have malignancy or be normal).

CLINICAL RELEVANCE/APPLICATION

Volumetric deep learning models can be a helpful tool to pre-read DBT scans for radiologists, with the promise to optimize reading priority, shorten reading time, and reduce unnecessary biopsy.

SSG01-02 Contrast-Enhanced Spectral Mammography (CESM) for Diagnostic Work-Up of MR-BI-RADS 4 Lesions Detected on Contrast-Enhanced Breast MRI

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S102CD

Participants

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PURPOSE

CESM has been proposed as an alternate to MRI for screening as well as staging of breast cancer. Recent studies suggest that CESM offers a similar sensitivity, yet a significantly higher specificity and PPV compared with MRI. Therefore, we investigated whether one can exploit the superior diagnostic accuracy of CESM for work-up of suspicious findings made on breast MRI.

METHOD AND MATERIALS

This prospective bi-center study included 53 asymptomatic patients with 53 contrast-enhancing lesions detected on breast MRI, and categorized as MR-BIRADS-4. All women underwent standard CESM (Selenia 3D Dimensions). MRI and CESM studies were read independently from each other by four breast radiologists. Thereafter, MR and CESM images were read in consensus side-by-side in order to correlate respective imaging findings. All findings were clarified by MR-guided vacuum biopsy.

RESULTS

Of the 53 findings suspicious on MRI, 25 (47.2%) were finally proven to be malignant (11 DCIS, 14 invasive cancers), and 28 (52.8%) benign. CESM suggested presence of breast cancer in 45/53 patients, and absence in 8/53. Of the 25 patients with final diagnosis of a malignant lesion, CESM was positive in 19, and negative in 6. Of the 28 women with final diagnosis of a benign lesion, CESM was positive in 26, and negative in 2. Accordingly, CESM would have caused a correct down-categorization in 2/28 false-positive (benign) MR-BIRADS-4 lesions (7%), but would have caused an incorrect down-categorization of 6/25 true-positive (malignant) MR-BIRADS-4 lesions (24%). No additional breast cancers were found by CESM, but 5 (9%; 5/53) additional false-positive findings. PPV of CESM was lower than that of MRI (47.2% [25/53] vs. 42.2% [19/45]).

CONCLUSION

CESM is not suitable for the non-invasive work up of MR-BI-RADS-4 lesions, because false-positive findings on MRI do mostly also enhance on CESM, with only a minimal reduction of false-positive diagnoses (-7%). Yet even this (low) rate of down-categorization cannot be exploited in clinical practice because it would be associated with cancers going undiagnosed in one out of four cases (24%).

CLINICAL RELEVANCE/APPLICATION

This study does not confirm the reported high sensitivity and superior specificity of CESM. CESM is not suitable for non-invasive work up of MR-BRADS-4 findings.

SSG01-04 Wide versus Narrow Angle Tomosynthesis: What's the Difference?

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S102CD

Participants
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PURPOSE

Today, digital breast tomosynthesis (DBT) is quickly becoming the standard of care for practices across the US and worldwide. While benefits of tomosynthesis are widely known - e.g., increased cancer detection rate and fewer callbacks - performance differences in DBT systems are unclear. Since the inception of DBT, discussion of optimal angular range and reconstruction algorithms has been at the forefront of the evolving 'ideal tomosynthesis' package. To our knowledge, this pilot study is the first to compare two clinical DBT units of differing angular ranges (AR) side by side.

METHOD AND MATERIALS

In this prospective study, patients coming to diagnostic follow-up (BIRADS 0) were recruited and imaged with both narrow-angle (Hologic Selenia Dimensions, AR = 15°) and wide-angle (Siemens MAMMOMAT Inspiration, AR = 50°) DBT. A total of 60 patients were included to yield 39 mass, 23 asymmetry/focal asymmetry, 4 architectural distortion, and 19 calcification comparison pairs for evaluation. Each abnormality was rated on a five-point scale for conspicuity (-2: lesion much better seen on narrow-angle DBT, to +2: lesion much better seen on wide-angle DBT).

RESULTS

Mass conspicuity was superior on wide-angle DBT compared to narrow-angle (mean score 0.97; 95% confidence interval (CI): 0.68, 1.27), as with asymmetry/focal asymmetry (0.96; CI: 0.56, 1.36). Architectural distortion was equivocal (0.50; CI: -0.42, 1.42), while narrow-angle showed calcifications better (-0.79; CI: -1.23, -0.35). Six cases were excluded from comparison because an asymmetry or mass was only seen on narrow-angle DBT, with that area demonstrating overlapping tissue on wide-angle (final work-up confirmatory). In one case, an asymmetry was a single view finding on narrow-angle DBT (CC view), while it was identified on both wide-angle views.

CONCLUSION

Wide-angle DBT makes it easier to identify masses and asymmetries when compared to narrow-angle DBT. The former can be used to reduce callbacks, reduce false positives, and perhaps identify a true finding faster with less imaging. Narrow-angle DBT performs better for calcifications and remains an Achilles heel for wide-angle DBT. Future endeavors include improving visualization of

calcifications through reconstruction techniques.

CLINICAL RELEVANCE/APPLICATION

Wide-Angle DBT can be used to reduce callbacks, reduce false positives, and potentially identify a true finding faster with less imaging.

SSG01-05 Evaluation of Response to Neoadjuvant Chemotherapy by Contrast-Enhanced Mammography in Different Biological Subtypes of Breast Cancer

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S102CD

Participants
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PURPOSE

To assess how the molecular biomarker status of breast cancer affects the accuracy of Contrast Enhanced Spectral Mammography (CESM) in the assessment of residual disease extent after Neoadjuvant Chemotherapy (NAC).

METHOD AND MATERIALS

This study was approved by the institutional review board. 81 patients (age range, 27-77 years) receiving NAC were monitored with CESM. All patients had 2 CESM examinations; prior to and post NAC (maximum 10 days prior to surgery). The longest dimension of the residual cancer was measured at the post-NAC CESM and correlated with the post-operative pathologic findings. Patients were further divided into subgroups on the basis of HER2, hormone receptor, and Ki-67 status. The Pearson correlation was used to correlate CESM and pathologic tumor size, and the unpaired t test was used to compare CESM-pathologic size discrepancies.

RESULTS

Of the 81 patients; 41 had Luminal A tumors, 18 had triple-negative tumors, 16 had HER2-enriched tumors and 6 patients had Luminal B tumors. A strong correlation was found between the size of residual lesions on CESM and histopathology specimens in the total 81 patients ($r=0.921$, $P<0.001$). The overall mean size discrepancy was 0.85 cm +/- 1.04 SD. The HER2-enriched tumors showed the highest correlation with the histologic diameter ($r=0.988$, $P<0.001$), followed by the triple negative tumors ($r=0.932$, $P<0.001$) and then the Luminal A tumors ($r=0.834$, $P<0.001$), while the Luminal B tumors had the weakest correlation with histologic size ($r=0.840$, $P=0.036$). The mean CESM-pathologic size discrepancy was the smallest in the triple negative tumors and HER2-enriched tumors; 0.44 cm +/- 0.5 SD and 0.56 cm +/- 0.7 SD respectively, while the greatest mean size discrepancy was seen with the Luminal A and B tumors; 1.13 cm +/- 1.2 SD and 1.17 cm +/- 0.8 SD respectively.

CONCLUSION

CESM showed overall high diagnostic accuracy in the assessment of residual disease extent, achieving better correlation with pathologic size and smaller size discrepancy with the triple-negative and HER2-enriched tumors.

CLINICAL RELEVANCE/APPLICATION

Accurate assessment of residual disease extent after NAC is crucial for optimum surgical planning. Understanding the impact of the biological subtype of breast cancer on the diagnostic accuracy of a certain imaging modality leads to making sound decisions when it comes to surgical planning, eventually leading to better surgical outcome with tumor free margin.

SSG01-06 Use of Contrast-Enhanced Digital Mammography (CEDM) for Monitoring the Effects of Neoadjuvant Chemotherapy: Results from the "NEO-CEDM Trento Trial"

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S102CD

Participants
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PURPOSE

To report the results of a trial on the comparison between CEDM and Magnetic Resonance (MR) for assessing the size of the residual tumor during and after neoadjuvant chemotherapy (NAC) and estimating the response to therapy

METHOD AND MATERIALS

Between May 2015 and April 2018, 63 women who underwent NAC for breast cancer, were enrolled in this propective study approved by institutional review board. Exclusion criteria were: pregnancy, breastfeeding and contraindications to CEDM and/or MR. Women had contrast examinations before starting (PRE), during (MID) and at the end of NAC (POST). Two experienced radiologists blindly looked at MR, two others looked at CEDM and then reported, for each exam and NAC step, the largest diameter of the target lesion. The response to therapy was finally classified using RECIST criteria comparing first PRE- and MID-NAC, then MID- and POST-

NAC lesion size. Pathological results were collected and used as reference standard for comparison with last CEDM and MR controls. Statystical analysis: Pearson correlation and Bland Altman plot to test, for each NAC step, the agreement between CEDM, MR and pathological measurements; Chi-square test to evaluate the agreement in assessing RECIST criteria

RESULTS

Consistent correlation was found between CEDM and MR measurements both in PRE (0.94, IC 0.90-0.96), MID (0.92, IC 0.86- 0.95) and POST-NAC (0.92, IC 0.86-0.95); when POST-NAC CEDM and MR measurements were individually compared with pathological findings, the correlation found was lower for both methods and with similar results (respectively 0.64, 95% CI 0.44-0.77 and 0.63, IC 95% 0.44-0.77). Classifying the response to therapy according to RECIST criteria, there was significative agreement between CEDM and MR at MID-NAC (88.2%, p <0.0001) and at POST-NAC (84.6%, p <0.0001). Comparing the POST-NAC controls with the pathologist's response, the agreement was higher for MR (84.6%, p <0.0001) compared to CEDM (77%, p <0.0001). MR showed significant higher sensitivity (79% vs 69%) and specificity (100% vs 91%) than CEDM for assessment of complete response (CR) category

CONCLUSION

CEDM seems to be equivalent to MR for assessing tumor size and evaluating the response to NAC although in this study it has shown some limitations compared to MR in estimating the final entity of response

CLINICAL RELEVANCE/APPLICATION

CEDM may represent a reliable alternative in case of contraindications to MR or when MR is not available

SSG01-07 Computerized Scheme for Distinguishing Sentinel Lymph Nodes with and Without Cancer Metastasis Using Computed Tomography Lymphography before Breast Cancer Surgery

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S102CD

Participants
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PURPOSE

Sentinel lymph node (SLN) biopsy for evaluating cancer metastasis during breast cancer surgery can cause the consequent increase in operation time or the abrupt changes in the treatment plan during the operation. Although it is desirable to distinguish SLNs with and without metastasis before surgery, there is no established examination for this purpose. The purpose of this study was to develop a computerized scheme for evaluating metastasis in SLNs by analyzing computed tomography lymphography (CTLG) images.

METHOD AND MATERIALS

Our database consisted of CTLG images obtained from 100 patients with breast cancer who underwent surgery. The number of patients with SLN metastasis was 45, whereas that without SLN metastasis was 55. In our computerized scheme, nine objective features were assessed for SLN and lymphoduct. Support vector machine (SVM) was employed to evaluate cancer metastasis in SLNs. The hyper-parameters of the SVM were determined with a Bayesian optimization. The objective features used as inputs for the SVM were selected from the nine features according to a stepwise method based on Wilks's lambda. A leave-one-out testing method was used for the training and testing of the SVM.

RESULTS

The six objective features used for the SVM were selected from the nine features using the stepwise method. These features were as follows: 1) the shape of the lymphoduct, 2) degree of enhancement of the SLN, 3) long axis of the SLN, 4) area of the SLN, 5) standard deviation of CT values of the SLN, and 6) mean CT value of the SLN. With the computerized scheme, the classification accuracy, sensitivity, and specificity were 98.0% (98/100), 97.8% (44/45), and 98.2% (54/55), respectively. The positive and negative predictive values were 97.8% (44/45) and 98.2% (54/55), respectively. In the receiver operating characteristic analysis, the area under the curve was 0.972.

CONCLUSION

The computerized scheme for distinguishing between SLNs with and without metastasis can provide high classification accuracy by analyzing CTLG images before breast surgery.

CLINICAL RELEVANCE/APPLICATION

The computerized scheme for analyzing CTLG images exhibited high classification accuracy and would be useful in planning surgical procedures for determining whether to implement lymph node dissection.

SSG01-08 Prospective Study: Added Value of Contrast-Enhanced Spectral Mammography (CESM) in the Clinical Management of Indeterminate to High-Risk Lesions

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S102CD

Participants
Amanda Ling Fung Liew, Singapore, Singapore (*Presenter*) Nothing to Disclose
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PURPOSE

To assess the added value of CESM in clinical management of BIRADS 4/5 lesions.

METHOD AND MATERIALS

BIRADS 4/5 lesions detected on conventional imaging (mammogram and/or ultrasound) between July 2016 and Sep 2018 were selected for adjunct dual energy CESM. Histopathology correlation was obtained on all lesions. Additional suspicious lesions that were detected by CESM were also included for histopathological correlation. All images were evaluated independently by two breast-trained radiologists using BIRADS classification.

RESULTS

A total of 105 lesions (63 patients) were included- 30 BIRADS 4A, 21 BIRADS 4B, 34 BIRADS 4C and 20 BIRADS 5 lesions- of which 22 did not enhance. These 22 non-enhancing lesions were all BIRADS 4A and were all found to be benign. Out of the remaining 83 enhancing lesions, 54 (65.1%) were malignant and 29 (34.9%) were benign (p value< 0.05). CESM alone detected 6 additional lesions, which were all later identified on second look ultrasound and were included for biopsy. Out of these 6, 4 were proven malignant and resulted in clinical upstaging.

CONCLUSION

There is evidence that absence of enhancement in CESM strongly favours benignity (almost 100% negative predictive value in our study). Along with conventional imaging, it may lend sufficient confidence to the reporting radiologist to downgrade some cases to BIRADS 3. This can reduce unnecessary biopsies and improve the diagnostic yield of future biopsies. CESM also increases the detection rate for potentially malignant lesions, thereby changing treatment strategy.

CLINICAL RELEVANCE/APPLICATION

BIRADS 4 comprises 4A-4C lesions, all of which need biopsy. Adding CESM may help avoid up to 1/2 of benign biopsies, reduce patient's physical and mental stress and allow better resource utilization.

SSG01-09 Prediction of Invasive Component Using Contrast-Enhanced Spectral Mammography in Patients Diagnosed as Ductal Carcinoma in Situ on Preoperative Core Biopsy: Prospective Observational Study

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S102CD

Participants
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PURPOSE

To evaluate the role of contrast-enhanced spectral mammography (CESM) for the prediction of invasive component in patients diagnosed as ductal carcinoma in situ (DCIS) on preoperative core biopsy.

METHOD AND MATERIALS

A total of 113 tumors in 108 patients diagnosed as DCIS on preoperative core biopsy were prospectively included in this study. Digital mammography (DM), CESM, and breast MRI were performed. Detection rate, lesion type, size on imaging and pathologic features on core biopsy were recorded. CESM grey value of combined image were also evaluated. Intraclass correlation coefficient (ICC), chi-square test, and student t-test were used for statistical analysis. Multivariate logistic regression analysis was used to find independent factors for the prediction of an invasive component.

RESULTS

On final pathology, 50 (44%) were pure DCIS, and 63 (56%) were microinvasive or invasive carcinomas. Detection rate of pure DCIS was 74% for DM, 90% for CESM, 100% for breast MRI, while that of microinvasive or invasive carcinoma 76% for DM, 98% for CESM, and 98% for breast MRI. ICC of tumor size between imaging and final pathology 0.773 for DM, 0.904 for CESM, and 0.832 for breast MRI. A total of 113 lesions, 25% (28/113) was not detected on DM, 5% (6/113) in CESM, and 1% (1/113) in breast MRI. When lesions were divided into calcified and noncalcified lesions, calcified lesions were 59 (52%) and noncalcified lesions were 54 (48%). Detection rate of calcified DCIS was 100% for DM, 98% for CESM, and 98% for breast MRI, while that of noncalcified DCIS was 48% for DM, 91% for CESM, and 100% for breast MRI. On multivariate analysis, nuclear grade on core biopsy, tumor extent on CESM and breast MRI, maximum CGV and maximum-to-minimum difference on CC view of CESM were independent factors for the prediction of invasive components, and AUC of combined feature was 0.84.

CONCLUSION

This study showed that CESM for the detection of DCIS, especially noncalcified DCIS showed similar performance to breast MRI, and significantly higher than DM. Tumor extent and CGV on CESM were independent factors for the prediction of invasive component on final pathology, and AUC was 0.84 when adding the nuclear grade on core biopsy.

CLINICAL RELEVANCE/APPLICATION

As for the detection of DCIS and prediction of invasive component on final pathology, CESM could show a similar diagnostic performance to breast MRI,

SSG02

Cardiac (CT, MRI, and Nuclear Medicine: General Topics)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S104A

CA CT MR NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Tarun Pandey, MD, FRCR, Little Rock, AR (*Moderator*) Nothing to Disclose
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Sub-Events

SSG02-02 Imaging Findings after Aortic Valve Implantation on 18F-Fluorodeoxyglucose Positron Emission Tomography with Computed Tomography

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S104A

Participants
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PURPOSE

Although 18F-Fluorodeoxyglucose (18F-FDG) Positron Emission Tomography (PET) with computed tomography (CT) is an essential tool in diagnosing prosthetic heart valve (PHV) endocarditis, the normal uptake patterns after PHV implantation have not been studied prospectively. We prospectively assessed perivalvular FDG uptake at different time points after aortic PHV implantation.

METHOD AND MATERIALS

Patients who had undergone uncomplicated aortic PHV implantation were included and underwent 18F-FDG PET/CT at 5(±1) weeks (group 1), 12(±2) weeks (group 2) or 52(±8) weeks (group 3) after implantation. After a preparatory diet to suppress normal myocardial glucose uptake, FDG uptake in the myocardium as well as around the PHV was scored using the Qualification Visual Score for Hypermetabolism (QVSH) as 'none' (< mediastinum), 'mild' (> mediastinum but < liver), 'moderate' (> liver), or 'severe' (intense uptake) and quantitative analysis was performed with maximum Standardized Uptake Value (SUVmax) and target to background ratio (SUVratio) on standardized European Association of Nuclear Medicine Research Ltd. (EARL) reconstructions by an experienced nuclear medicine physician.

RESULTS

In total 37 patients (group 1: n=12, group 2: n=12, group 3: n=13) (age 66±8 years) were included. Myocardial FDG uptake was moderate or less in 29/37 scans (78%). QVSH around the PHV was in 8/12 (67%) mild and 4/12 (33%) moderate in group 1, 7/12 (58%) mild and 5/12 (42%) moderate in group 2 and 8/13 (62%) mild and 5/13 (38%) moderate in group 3 (p=0.91). No scan was scored as 'none' or 'severe'. EARL SUVmax was 3.48±0.57, 3.50±0.59 and 3.34±0.55 (mean±SD, p=0.77) and EARL SUVratio was 2.00±0.29, 1.96±0.41 and 1.71±0.26 (mean±SD, p=0.07) for groups 1, 2 and 3, respectively.

CONCLUSION

Baseline FDG uptake around aortic PHV at 5, 12 and 52 weeks after implantation is similar and mild in the majority of cases with an overall mean SUVmax and SUVratio of 3.44±0.56 and 1.89±0.34 respectively.

CLINICAL RELEVANCE/APPLICATION

Knowing the normal baseline FDG uptake around prosthetic heart valves on 18F-FDG-PET-CT is essential to discriminate between normal and infected valves in patients suspected of endocarditis.

SSG02-03 Accuracy of Absolute Myocardial Blood Flow Quantification with Dual-Source CT: Validation in Human Using 15O-Water PET

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S104A

Participants
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PURPOSE

15O-water PET is the most accurate method in quantifying myocardial blood flow (MBF). Model-based analysis of perfusion CT with correction of flow-dependent alteration in extraction fraction(E) of iodine contrast medium may permit quantification of absolute MBF. The purpose of this study was to determine the accuracy of CT measurements of stress MBF by CT using 15O-water PET as a reference.

METHOD AND MATERIALS

Thirty-four patients (70±8 years, 27 male) with known or suspected coronary artery disease(CAD) underwent dynamic stress CT perfusion and stress 15O-water PET. Perfusion index (PI) was quantified in 16 myocardial segments with a dual-source CT and its dedicated software (Force/VPCT body, Siemens) based on maximal upslope method. Since PI is mathematically equivalent to unidirectional influx constant in compartment model analysis, PI can be expressed as a product of MBF and E. For the quantification of stress MBF using 15O-water PET, non-commercial software (Carimas) was used. The E of iopamidol was determined using CT-derived PI and PET-derived MBF (PET-MBF) in 17 subjects (pilot group). For validation, CT-derived MBF (CT-MBF) was calculated using the relation between E and CT-derived PI for the remaining 17 patients (validation group) and compared with PET-MBF. The segments with myocardial infarction were excluded from the analysis.

RESULTS

In the pilot group, CT-derived PI was 1.33±0.27ml/min/g and PET-MBF value was 2.80±0.84 ml/min/g, respectively. From these data, the relationship between E and MBF was $E = 1-\exp[-(0.11\times MBF+1.58)/MBF]$. In the validation group, CT-MBF was 2.40±2.03ml/min/g, while PET-MBF was 2.54±2.03ml/min/g. CT-MBF showed a good linear correlation with PET-MBF (r= 0.93, P<000.1). The measurement bias in measuring MBF between CT and PET was 0.14±0.73ml/min/g.

CONCLUSION

The relationship between E of iodine contrast medium and MBF was determined in this study. By using the relationship, stress MBF can be accurately quantified from the perfusion index obtained from dual-source CT and its dedicated analysis software.

CLINICAL RELEVANCE/APPLICATION

CT-MBF quantification has potential to provide detection of perfusion abnormality and risk stratification in patients with known or suspected CAD with high accuracy comparable to 15O-water PET.

SSG02-04 Development of an Automated Software for 3D Quantification of Extracellular Volume in Cardiac CT: Comparison with Cardiac MRI

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S104A

Participants
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PURPOSE

The objective of our study is to develop and validate a software for automatic three-dimensional (3D) measurement of myocardial extracellular volume (ECV) in cardiac CT compared to CMR in patients with cardiac amyloidosis (CA)

METHOD AND MATERIALS

Twenty patients with a proven diagnosis of CA and 20 control patients free of cardiac pathology were included. Unenhanced and late enhanced (5 minutes) cardiac CT images were analyzed automatically by the software. Duration of processing was recorded. Manual measurements of myocardial attenuation were performed on both sets of images by one operator within the interventricular septum (IVS) as usually performed in clinical practice. Automatic and manual values of ECV were calculated using biological hematocrit and synthetic hematocrit (derived from blood pool attenuation values). Measurements were correlated together and with MR measurements for all patients.

RESULTS

3D automatic segmentation of unenhanced and late enhanced cardiac CT images was successfully performed by the software for all patients. The duration of myocardial segmentation was 20 +/- 5 seconds. The software was able to provide 3D ECV values for all patients. Automated (30+/-20%) and manual (32+/-18%) measurements of ECV were well correlated each other (r2=0.8; p<0.005), and significantly correlated (r2>0.7; p<0.05) with the ECV measured by CMR (34+/-21%). Automatic and manual ECV values calculated with synthetic hematocrit did not significantly differ from biological ones.

CONCLUSION

Automated 3D measurement of ECV in cardiac CT is feasible and well correlated with manual measurements and CMR values. These

results have to be confirmed on a wider range of patients (work in progress)

CLINICAL RELEVANCE/APPLICATION

Myocardial extracellular volume (ECV) is a good diagnostic and prognostic marker in cardiac diseases. ECV measurement is traditionally performed with cardiac magnetic resonance (CMR). Assessment of ECV in cardiac CT may help to use it more often in clinical practice.

SSG02-05 Assessment of Myocardial Extracellular Volume on Routine Body Computed Tomography in Breast Cancer Patients Treated with Anthracyclines

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S104A

Participants
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PURPOSE

To evaluate the feasibility of estimating myocardial extracellular volume (ECV) on routine thoracic contrast-enhanced CT in breast cancer patients, and, if feasible, to assess if a rise in ECV is associated with anthracyclines administration even in absence of clinical symptoms or echocardiographic changes.

METHOD AND MATERIALS

After Ethics Committee approval, female patients with breast cancer who had undergone routine CT examinations at our institution before and shortly after the end of chemotherapy including anthracyclines were retrospectively evaluated. Patients without available haematocrit, with CT images with artefacts, or who had undergone radiation therapy of the left breast were excluded. Follow-up CT examinations were also analysed, when available. ECV was calculated on scans obtained at about 1, 3, and 7 min after contrast injection.

RESULTS

Thirty-two female patients (aged 57±13 years, mean±standard deviation) with pre-treatment haematocrit 38±4%, and ejection fraction 64±6% were analysed. Pre-treatment ECV was 27.0±2.9% at 1 min, 27.4±3.8% at 3 min, and 26.4±3.8% at 7 min, similar to normal values reported for normal subjects in the literature. Post-treatment ECV (median interval: 89 days after treatment) was 31.1±4.9%, 32.5±5.0%, and 30.0±5.1%, respectively, values significantly higher than pre-treatment values at all times ($p < 0.005$). *ECV at follow-up (median interval: 135 days after post-treatment CT) was 31.0±4.5%, 30.0±3.4%, and 27.7±3.7%, respectively, without significant differences ($p > 0.548$) when compared to post-treatment values.*

CONCLUSION

After anthracyclines treatment, ECV was significantly higher than pre-treatment values. In the follow-up ECV remains higher than pre-treatment values.

CLINICAL RELEVANCE/APPLICATION

Myocardial ECV values from routine contrast-enhanced CT scans could play a role in the assessment of myocardial condition in breast cancer patients undergoing anthracycline-based chemotherapy.

SSG02-06 *Cardiac Energetics Alteration in Chronic Hypoxia Rat Model: A Non-Invasive In Vivo 31P Magnetic Resonance Spectroscopy Experimental Study*

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S104A

Participants
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PURPOSE

Energetics alteration plays a key role in the process of myocardial injury in chronic hypoxic diseases (CHD).31P magnetic resonance spectroscopy (MRS) can investigate alterations in cardiac energetic in vivo. This study was aimed to characterize the potential of 31P MRS in evaluating cardiac energetics alteration of chronic hypoxia rats (CHR).

METHOD AND MATERIALS

Thirty CHR were induced by SU5416 combined with hypoxia. 31P MRS (Bruker BioSpec 7.0T) was performed weekly (0-5 week) to follow-up the ratio of concentrations of phosphocreatine (PCr) to adenosine triphosphate (ATP) (PCr/ATP). The index of myocardial structure and systolic function, including the left ventricular function (LVEF) and the right ventricular function (RVEF), were also measured by magnetic resonance imaging (MRI) in each rat. The myocardial injury was shown based on hematoxylin and eosin (H&E) staining and Masson's trichrome staining.

RESULTS

Along weeks, the resting cardiac PCr/ATP ratio decreased from 0 to 5 weeks of modeling. The ratio dropped more markedly after injection of isoproterenol and recovered slowly thereafter. The declension of resting cardiac PCr/ATP ratio in CHR can be observed at the first week, compared with the healthy ones((3.92±0.43vs.4.48±0.56, P<0.05). While the LVEF and RVEF in CHR was similar to healthy rats. Also, the myocardial injury cannot be observed in the first week.

CONCLUSION

31P MRS can sensitivily reveal the cardiac energetics alteration in CHD before the onset of myocardial injury and ventricular dysfunction.

CLINICAL RELEVANCE/APPLICATION

31P MRS at 7.0 T can investigate cardiac energetics alteration in chronic hypoxia rat. Of note, defects in energy regulation were present before detectable myocardial injury and ventricular dysfunction.

SSG02-07 Complete Free-Breathing Adenosine Stress Cardiac MRI Using Compressed Sensing and Motion Correction: Comparison of Functional Parameters, Perfusion and Late Enhancement with the Standard Examination in Breathhold

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S104A

Participants
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PURPOSE

Stress cardiac MRI (CMR) is a demanding examination with multiple breathholds (BH) and long scan times. Aim of this study was to compare free breathing (FB) examinations with the gold standard acquired in BH.

METHOD AND MATERIALS

40 consecutive patients were enrolled prospectively and examined on a 3T MRI. Functional imaging, perfusion and late gadolinium enhancement (LGE) were performed in BH and in FB using compressed sensing and inline motion correction. Left (LV) and right ventricle (RV) functional parameters in BH and FB were compared using Bland-Altman plots and subjective image quality was assessed on a 5-point scale (1=non diagnostic to 5=very good). For perfusion and LGE imaging diagnostic confidence was rated on a 3-point scale (1=low up to 3=high) and image quality on a 5-point scale (1=non diagnostic to 5=very good). Wilcoxon test was used to compare image quality and diagnostic confidence.

RESULTS

Bland-Altman plots showed good agreement for LV and RV functional parameters in BH and FB. Subjective image quality was significantly better with BH for LV (p<0.01) but comparable for RV (p=1.0). Scan time for cine BH was 218s (range 130s-385s), for cine FB 16s (range 11-27s). Extent of perfusion defects, LGE and diagnostic confidence was comparable between both groups. Scan time for LGE BH was 371s (range 239-502s), for LGE FB 189s (range 122-286s).

CONCLUSION

FB adenosine stress CMR examination delivers diagnostic image quality and could represent an alternative for patients who are unable to meet the demands of multiple BH and long examination times.

CLINICAL RELEVANCE/APPLICATION

Free breathing stress cardiac MRI can be performed in significantly shorter time than the gold standard in breathhold.

SSG02-08 Image Quality and Reliability of a Novel Dark Blood Late Gadolinium Enhancement Sequence in Ischemic Cardiomyopathy

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S104A

Participants
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PURPOSE

To assess the reliability of a novel dark-blood LGE (DBLGE) technique compared to standard bright-blood LGE (SBBLGE) sequence in patients with ischemic cardiomyopathy

METHOD AND MATERIALS

This prospective study included 78 patients (63.1 ± 12.6 years, 62 males) with clinical history of ischemic cardiomyopathy who underwent CMR at 1.5T (Discovery MR450w, GE Healthcare, Waukesha, WI) with postcontrast SBBLGE and DBLGE acquisition. Two observers performed the imaging analysis in a double blinded fashion. The endpoints were: a) qualitative and quantitative analysis of signal intensity ratio (SIR) b) n° segments involved; c) transmurality index (i.e. 0-25%;25-50%,50-75%and75-100%) d) papillary muscle enhancement e) microvascular occlusion (MVO). Statistical analysis was performed with non-parametric test.

RESULTS

There were no interobserver variability (all p >0.05). Subjective image quality in DBLGE compared to SBBLGE was higher for the discrimination between LGE and blood signal (p<0.001), inferior (p<0.001) between LGE and myocardium and similar between blood and myocardium (p=0.56). DBLGE provided higher SIR between LGE and blood signal (1.18±1.15vs0.18±0.42;p<0.001), lower SIR between LGE and myocardium (0.91±4.95vs1.96±1.64;p<0.001) and between blood and myocardium (-0.26±0.71vs1.57±1.26;p<0.001). The n° segments involved was similar (p = 0.08). The transmurality index was inferior for DBLGE (3.09±1.02vs3.30±1.11;p=0.007). DBLGE was superior in identifying papillary muscle hyperenhancement (25vs17 cases;p<0.001) and inferior in MVO detection (7vs12 cases;p<0.001).

CONCLUSION

The DBLGE sequences when compared to SBBLGE provided better contrast between LGE and blood-pool, seemed to be superior in identifying papillary muscle hyperenancement, whereas underestimated the trasmurality extension of LGE and the presence of MVO.

CLINICAL RELEVANCE/APPLICATION

Black blood LGE can be extremely useful for evaluation of patients with ischemic cardiomyopathy, however it would be carefully evaluated in patients with acute myocardial infarction.

SSG02-09 Transfer Learning has Potential to Produce Better Reconstruction of Highly-Accelerated, Single-Shot LGE Images than Conventional Deep Learning

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S104A

Participants
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PURPOSE

Compressed sensing (CS) is capable of highly accelerating single-shot late gadolinium enhanced (LGE) MRI for achieving relatively high spatial resolution (1.6mmx1.6mm), but the lengthy image reconstruction time (~50s per image) and inconsistent performance hinder its clinical translation. Given limited training data, we propose a transfer learning (TL) approach to leverage our access to a large database of real-time cine images having similar image content as single-shot LGE, for developing a rapid image reconstruction framework for single-shot LGE.

METHOD AND MATERIALS

Image reconstruction was performed on a GPU workstation equipped with Pytorch. As shown in Figure 1, we pre-trained two deep learning (DL) networks (one for real and another for imaginary data, layer depth = 3, 64 features on the first layer) using existing 5811 (42 rays per frame) zero-filled and the corresponding CS reconstructed (total variation as constraint) real-time cine images from 19 patients (mean age = 66.1 ± 12.0 years; 8 females) as input/output pairs. For TL, we prospectively obtained 2-shot (42 radial spokes per shot), breath-held LGE data sets from 12 patients (mean age = 51.1 ± 20.3 years; 6 females) on 1.5T scanners (Aera and Avanto, Siemens), retrospectively undersampled the 2-shot data (101 images) by a factor of 2 (42 rays per image), and trained the U-Nets using single-shot, zero-filled (input) and the corresponding 2-shot, CS reconstructed images (output). For validation, we obtained 1-shot LGE (42 rays per image) data sets from 10 other patients (mean age = 56.5 ± 16.2 years; 6 females) and compared TL to CS and DL reconstructed images.

RESULTS

As shown in Figure 1, TL produced sharper images and fewer residual artifacts than DL and CS. Both edge sharpness (1.8 ±0.4mm) and CNR for TL (33.5 ± 18.8) were significantly (p<0.05) different from DL (2.3 ±0.4 mm and 27.0 ± 15.7) and CS (1.9 ± 0.4mm and 15.9 ± 7.6). The reconstruction time for DL and TL (0.7 ± 0.0s) was significantly (p <0.05) lower than CS (49.6 ± 1.1s).

CONCLUSION

This study demonstrates a TL approach to rapidly reconstruct 1-shot LGE with better image quality than a conventional DL approach.

CLINICAL RELEVANCE/APPLICATION

While CS is capable of highly accelerating data acquisition, the lengthy image reconstruction hinders its clinical translation.

While CS is capable of highly accelerating data acquisition, the lengthy image reconstruction hinders its clinical translation. Transfer learning enables rapid image reconstruction without requiring a large database of training data.

Printed on: 10/29/20

SSG03

Science Session with Keynote: Chest (Pulmonary Vasculature and Angiography/Dual Energy CT)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S404CD

AI CH CT VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Ioannis Vlahos, MRCP,FRCR, Houston, TX (*Moderator*) Director, Grayscale Ltd; Co-owner, Grayscale Ltd
Carole A. Ridge, MD, London, United Kingdom (*Moderator*) Nothing to Disclose

Sub-Events

SSG03-01 Chest Keynote Speaker: Issues and Techniques in Imaging of Pulmonary Vasculature

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S404CD

Participants
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SSG03-02 CT Pulmonary Angiography in Pregnancy Specific Conversion Factors to Estimate Effective Radiation Dose from Dose-Length Product

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S404CD

Participants
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PURPOSE

Effective dose (ED) is used to understand radiation related malignancy risk of CT scans. Currently, ED for computed tomography pulmonary angiography (CTPA) in pregnancy is estimated by multiplying the CT reported dose length product (DLP) by a DLP-to-ED conversion factor (k-factor) for general chest CT. The purpose of this study is to determine the specific k-factor for CTPA in pregnant patients and its predictive factors.

METHOD AND MATERIALS

This retrospective study evaluates consecutive CTPA in pregnant women across a large health system from January 2012 to April 2017. Patient and CT-related data were obtained from the radiology information system, the picture archiving and communication system, and a radiation dose index monitoring system. Each patient's ED (mSv) was determined by patient specific Monte-Carlo simulation using Cristy phantoms and divided by study DLP to determine k-factor. K-factor was compared to the standard k factor for chest CT of 0.014 with one sample t-test. Patient size was determined by the CT scanner in water equivalent diameter. Bivariate and multivariable analysis were performed for k-factor based on patient and CT factors.

RESULTS

534 patients were included in this study. The mean k-factor for all patients was 0.0249 (mSv·mGy-1·cm-1), 78% greater than 0.014 ($p<0.001$). Multivariable analysis demonstrated lower k-factor was observed with decreasing pitch ($p=0.0002$), patient size ($p<0.001$), and scan length ($p<0.0001$). 120 kVp ($p< 0.001$) and 140 kVp ($p=0.0028$) studies showed a larger k-factor than 80 and 100 kVp studies combined.

CONCLUSION

The k-factor for CPTA for pregnant patients higher than the previously used value for chest CT, which statically increased with decreasing pitch, patient size, and scan length, and was higher for larger kVp values.

CLINICAL RELEVANCE/APPLICATION

The specific k-factor for CTPA in pregnancy should be used to estimate effective radiation dose in that population.

SSG03-03 Patterns of Failure of an AI-Based Software: A Report on False Positive Findings of an Algorithm Detecting Pulmonary Embolism on CT Pulmonary Angiograms

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S404CD

Participants
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PURPOSE

To detect patterns of false positive (FP) findings of an algorithm trained for the detection of pulmonary embolism (PE) in CT pulmonary angiograms (CTPAs) and derive future directions for software development.

METHOD AND MATERIALS

We identified all CTPAs with the clinical question of PE performed at our institution in 2017 (n=1465). The 1-mm slices in soft-tissue kernel were processed by an AI-based software for the detection of PE trained on more than 28,000 CTPAs from other institutions. It was based on a deep convolutional neural network with a residual neural network architecture. Findings suspected of presenting a pulmonary embolus were marked by an arrow on the output series. Findings were reviewed by two radiologists and classified as true positive or FP. Frequency and reasons of FP findings were noted. Ratio of FP findings per case was calculated.

RESULTS

In total, we found 178 FP findings (0.12 FP/case). The six most frequent causes of FP findings were contrast agent related flow artifacts in the pulmonary arteries (n=46), detection of pulmonary veins (n=32), lymph nodes (n=29), pulmonary infiltrates, (n=20), beam hardening artifacts (n=12) and pulmonary metastases (n=10). For all but three FP findings, there was an anatomical correlate (175 of 178; 98.3%). Most FP findings were caused by structures outside the pulmonary tree (120 of 178; 67.4%). A large portion of FP findings was due to non-tubular structures (79 of 178; 44.4%).

CONCLUSION

Most FP findings can be attributed to a limited number of categories comprising clearly visually definable structures. These are often located outside the pulmonary artery tree and/or non-tubular. Therefore, both segmentation of the artery tree and the integration of algorithms detecting nodular structures may be measures to further reduce FP findings.

CLINICAL RELEVANCE/APPLICATION

Irrespective of the performance level of an AI-based algorithm, it is recommended to identify patterns underlying failure to further improve accuracy.

SSG03-04 Machine Learning Assisted Risk Stratification of Acute Pulmonary Embolism on Computer Tomography Pulmonary Angiography Images

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S404CD

Participants
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PURPOSE

This study aims to investigate the value of a machine-learning prediction model based on radiomics features derived from computer tomography pulmonary angiography (CTPA) images in risk stratification of acute pulmonary embolism (APE) patients.

METHOD AND MATERIALS

30 APE patients confirmed by CTPA were divided into high-risk (n = 15) and non-high-risk (n = 15) groups according to 2014 European Society of Cardiology guidelines. Radiomics features were extracted from the manually segmented region of interest (ROI), and independent *t* test and least absolute shrinkage and selection operator (LASSO) were used for feature selection. A step-forward Multiple Linear Regression was used to build a risk stratification model with the selected features.

RESULTS

Among 1746 radiomics features, 7 features were eventually selected as the most discriminative features, including 0 short low gray level, 5-7 Correlation, 2Gauss Area, Hist Area, Convenx Hull Volume, Energy and Skewness. In the step-forward-linear-regression, only 5-7 Correlation, Convenx Hull Volume and Energy were included, R square of the equation is 0.899.

CONCLUSION

The radiomics-based machine learning is useful strategy of risk stratification of CTPA images of APE patients.

CLINICAL RELEVANCE/APPLICATION

The radiomics-based machine learning provides a useful strategy of risk stratification of CTPA images of APE patients.

SSG03-05 Comparison of a New Deep Learning-Based Image Reconstruction (DLIR) with Conventional Image Reconstruction for CT Pulmonary Angiography (CTPA)

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S404CD

Participants
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PURPOSE

A recently introduced deep learning based image reconstruction (DLIR) algorithm (TrueFidelityTM, GE Healthcare) aims to emulate very high dose FBP image texture, with low noise and high-resolution by employing deep CNN-based models, including millions of trained parameters. This study aims to compare image quality of the DLIR algorithm with standard image reconstruction in CTPA.

METHOD AND MATERIALS

52 CTPA studies scanned during routine clinical use (Revolution CT Apex edition, GE Healthcare) were retrospectively reconstructed at 1.25mm slice thickness using FBP, ASIRv50, and 3 levels of a prototype DLIR (low (L), medium (M), and high(H)). Quantitative measurements of noise (standard deviation), signal to noise ratio (SNR) and contrast to noise ratio (CNR vs. liver parenchyma) in Main PA were obtained for all recons. Two radiologists independently rated subjective image noise, nose texture, artifacts, and diagnostic quality of the ASIRv50 and DLIR-M on a 1-5 scale.

RESULTS

The noise (std dev) was 40.55, 29.32, 25.34, 20.42, 15.22 HU, the SNR was 9.81, 13.58, 15.82, 19.81, 27.44, and the CNR was 10.39, 16.22, 16.51, 21.06, and 30.39 in the FBP, ASIRv50, DLIR-L, DLIR-M, and DLIR-H images respectively. All comparisons were significant ($p<0.001$) except for CNR between ASIRv50 and DLIR-L ($p=0.175$). Qualitative scores for ASIRv50 and DLIR-M were 3.86 +/- 0.26 and 4.89 +/- 0.25 (mean +/- std dev) respectively for image noise ($p<0.001$), 3.24 +/- 0.27 and 4.26 +/- 0.27 respectively for noise texture ($p < 0.001$), 3.92 +/- 0.25 and 3.93 +/- 0.25 for artifacts ($p=0.322$), and 4.94 +/- 0.31 and 3.94 +/- 0.31 for diagnostic image quality (p = n.s.).

CONCLUSION

DLIR shows decreased image noise with increased CNR and SNR compared to FBP and ASIRv. DLIR medium strength show decreased image noise with improved image texture qualitatively as compared to ASIRv50. There was no significant difference in subjective assessment of diagnostic quality or artifacts.

CLINICAL RELEVANCE/APPLICATION

The use of AI based image recon to lower noise and improve image texture is an emerging technology. Further study is needed to evaluate translation into dose savings or clinical performance in CT.

SSG03-06 Vascular and Parenchymal Enhancement Assessment by Dual-Phase Dual Energy CT in the Diagnostic Investigation of Pulmonary Hypertension

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S404CD

Participants
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PURPOSE

To prospectively evaluate the non-invasive identification of pulmonary hypertension (PH) by dual-phase dual-energy CT pulmonary angiography (DE-CTPA) vascular enhancement and perfused pulmonary blood volume quantification (PBV) to assess mean pulmonary artery pressure (mPAP) and pulmonary vascular resistance (PVR), corroborated by right heart catheterization (RHC).

METHOD AND MATERIALS

102 patients were recruited to undergo RHC and standard DE-CTPA protocol (series 1) with a second 10 cm central DE-CTPA acquisition after 7 second delay (series 2). In both series, enhancement in the main pulmonary artery (PAenh) and descending aorta (DAenh) were calculated from DE-CTPA iodine images, and volumetric enhancement of each whole lung (WLenh) was analysed using PBV.

RESULTS

65 patients had PH defined by mPAP>=25 mmHg and 51 patients PH defined by PVR >3WU. In series 1, PH patients had significantly higher PAenh/WLenh ratio and lower WLenh and DAenh compared to no PH. By series 2, PH patients had significantly higher PAenh and WLenh than no PH. Change in WLenh (series 1 to 2) offered the best diagnostic accuracy to define disease by mPAP (AUC 0.78) and PVR (AUC 0.79) and the best correlation with mPAP (r=0.62). PAenh series 2 correlated best with PVR (r=0.49). Metrics incorporating series 2 were superior in multivariate linear regression analysis (mPAP, r=0.62; PVR, r=0.56). Utilizing DE-CTPA metrics improved the correlation achieved by conventional CT metrics (mPAP, r=0.61 to r=0.71; PVR, r=0.53 to r=0.64). The presence of

moderate or markedly prominent bronchial collaterals was not more common in patients with increasing WLenh in series 2 compared to those with decreasing WLenh in series 2 (p=0.71).

CONCLUSION

This large prospective RHC corroborated study determined that dual-phase DE-CTPA vascular and parenchymal enhancement assessment appear complimentary to conventional CT metrics and improve the ability to predict mPAP and PVR. This is predominantly by the incorporation of change in whole lung enhancement over time to diagnose PH and by the use of this parameter and delayed pulmonary arterial enhancement to characterize disease severity.

CLINICAL RELEVANCE/APPLICATION

This study has identified a reader independent method to improve the non-invasive diagnosis of PH. These novel techniques have the potential to monitor disease severity and to help identify PH patients where early identification improves poor prognosis.

SSG03-07 Dual Energy Derived Pulmonary Blood Volume Histogram Parameters as Biomarkers of Pulmonary Dysfunction in Acute and Chronic Pulmonary Thromboembolic Disease

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S404CD

Participants
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PURPOSE

To use dual energy computed tomography (DECT) histogram parameters as biomarkers to characterize the degree of pulmonary dysfunction in patients with acute and chronic pulmonary embolism (PE).

METHOD AND MATERIALS

Retrospective analysis of 95 DECT pulmonary angiography scans was performed from 2015-2019 for patients with suspected acute or chronic PE. 0.8mm thick whole lung PBV maps were reconstructed using material decomposition analysis and normalized with a 1cm2 circular region of interest within the main pulmonary artery. 0.8mm thick axial CT images were used to generate a lung mask to limit the PBV map analysis area. Histograms were generated from voxels falling within the label map and fitted with parametric models to generate parameters for analysis.

RESULTS

Of 95 patients, 36 were identified with acute PE, 30 with chronic PE (18 with chronic thromboembolic pulmonary hypertension (CTEPH); 12 with chronic thromboembolic disease without pulmonary hypertension (CTED)), and 29 normal patients without PE. Ages ranged from 21-95 years (average of 61 years). 49 patients were female and 46 were male. Mean voxel values were 109±33 in normal patients, 99±63 in acute PE patients, 83±24 in CTED patients, and 80±31 in CTEPH patients. Statistically significant differences ($p<0.05$) were observed in patients with CTED and CTEPH compared to normal patients. Statistically significant differences ($p<0.05$) were observed when comparing the kurtosis (curve pointedness) and skewness (curve symmetry) in acute PE, CTED, and CTEPH patients to normal patients. Right heart catheterization (RHC) data within 1 month of the DECT were available for review in 11/18 CTEPH patients. RHC-derived mean pulmonary artery pressure (mPAP) and pulmonary vascular resistance (PVR) correlated with mean voxel values with linear regression coefficients of determination (R2) of 0.64 and 0.74 respectively.

CONCLUSION

Preliminary data suggests DECT histogram parameters can characterize pulmonary dysfunction in patients with acute and chronic PE. Mean voxel value is a potential imaging biomarker for quantifying RHC-derived mPAP and PVR.

CLINICAL RELEVANCE/APPLICATION

DECT histogram parameters are a promising surrogate biomarker for pulmonary hemodynamic assessment. Additional studies are warranted to define the role of DECT in evaluating acute and chronic PE and the potential to supplant invasive RHC and echocardiography as the surveillance imaging modality of choice.

SSG03-08 Comparison of Lung Volumes and Perfusion Defects on DECT-Perfusion Blood Volume Images with Clinical Outcomes for Patients with Pulmonary Embolism

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S404CD

Participants
Riddhi M. Borse, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

To determine whether presence and/or extent of perfusion defects on dual energy CT pulmonary angiogram (DECT-PA) of patients with pulmonary embolism (PE) affected their clinical outcomes in terms of morbidity and mortality.

METHOD AND MATERIALS

With IRB Approval, we identified 164 adult patients (86 males, 78 females, mean age- 62±17 years) from the institutional pulmonary embolism response team (PERT) registry. All patients underwent DECT-PA for suspected PE on 384-slice, dual-source CT (SOMATOM Force, Siemens). Deidentified DICOM images were processed with a Lung Lobe Segmentation prototype (eXamine, Siemens). The prototype performed automated lobar segmentation and provided lung volumes, and several perfusion parameters for each lung and each lobe. Two radiologists assessed all DECT-PA for presence/absence of PE, location, occlusive/non-occlusive, and presence and location of pulmonary infarcts and perfusion defects (matched and mismatched). The medical records were reviewed to record any adverse clinical outcome within 3 days of DECT-PA (need for ventilation/mechanical respiration, uncontrolled hypertension, or death). Data were analyzed with multivariable analysis of variance (MANOVA) with SPSS statistical software.

RESULTS

Of the 164 patients, 139 had PE and 25 had no PE. Of the 20 patients (group 1: 20/139 PE+) with adverse clinical outcomes, 60% had perfusion defects on DECT-PA (12/20) as opposed to 29% rate of perfusion defects in patients with stable or improved clinical outcomes (group 2: 35/119 PE+). All quantitative perfusion parameters (iodine concentration, uptake, skewness, kurtosis) in group 1 patients were significantly different from group 2 patients ($p=0.0001$). There was a higher frequency of central and multiple PE in patients with adverse clinical outcomes compared to those with stable or favorable outcomes. The right, left, and whole lung volumes between group 1 (mean 1701±674, 1487±620, 3181±1202 ml) and group 2 (mean 1954±885, 1506±697, 3461±1553 ml) were significantly different as well ($p<0.008$).

CONCLUSION

Qualitative and quantitative perfusion abnormalities, and lung volumes are independent prognostic predictors of adverse clinical outcome in patients with pulmonary embolism on DECT-PA.

CLINICAL RELEVANCE/APPLICATION

Patients with perfusion defects and decreased quantitative perfusion on DECT-PA have high incidence of adverse clinical outcomes.

SSG03-09 The Deep Learning Model in Evaluation of Acute Pulmonary Embolism on Computed Tomographic Pulmonary Angiography

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S404CD

Participants
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PURPOSE

Our goal is to use the deep learning method to calculate clot volume of acute PE on computed tomographic pulmonary angiography (CTPA) and explore its relationship with other imaging parameters.

METHOD AND MATERIALS

The method is on a fully convolutional network called U-Net model to segment acute PE. Two datasets were used to train the deep learning(DL) model. Dataset 1 contains 230 samples of acute PE on CTPA labeled by radiologists and Dataset 2 consists of 65 samples without PE on CTPA. We set the values to 0.1, 0.3, 0.5, 0.7 and 0.99 for the measurement of the clot volume. The test dataset included 144 patients with suspected acute PE admitted to our hospital from Jan 2016 to Oct 2018. The images of CTPA in the test dataset were transferred to the trained model to detect the clot while the clot volume of acute PE were automatically calculated. We evaluated diagnosing time, accuracy, sensitivity and specificity of the proposed model in detecting clot. Meanwhile, clot burden of acute PE patients were assessed with obstruction scores and other imaging parameters by the radiologists.

RESULTS

The test dataset included 51 patients without PE and 93 patients with clinically confirmed acute PE. The average measurement time of DL model was 12.9±3.8 seconds approximately, while the second-year residents needed 10±4 minutes. When the critical value of the model is set as 0.1, the sensitivity and specificity are the highest, 94.6% and 76.5% respectively, and the consistency between measurements two was 100%. The AUC was 0.926 (95% CI:0.884-0.968), which indicates good discriminative power. Clot burden measured with DL model at setting value of 0.1 was significantly correlated with Qanadli score ($r=0.819$, $p<0.001$) and Mastora score ($r=0.874$, $P<0.001$). And it is moderately correlated with parameters related to function of right heart.

CONCLUSION

Detection of acute PE with DL model could greatly improve the diagnosing efficiency and reduce the workload of the radiologists

Detection of acute PE with DL model could greatly improve the diagnosing efficiency and reduce the workload of the radiologists. The DL model had high degree of sensitivity and reproducibility.The clot volume was highly correlated with obstruction scores, while it is moderately correlated with parameters related to function of the right heart.

CLINICAL RELEVANCE/APPLICATION

The deep learning model has high degree of sensitivity and reproducibility in the detection of clot, which is recommended for the detection of clot in patients with pulmonary embolism.

Printed on: 10/29/20

SSG04

Gastrointestinal (Liver Fibrosis)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: E353A

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Aoife Kilcoyne, MBBCh, Boston, MA (*Moderator*) Author, Wolters Kluwer nv

Sub-Events

SSG04-01 Assessing Liver Tumor Stiffness by Diffusion-Weighted MR Imaging-Based Virtual Elastography

Tuesday, Dec. 3 10:30AM - 10:40AM Room: E353A

Participants
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PURPOSE

Recent study showed that there was a significant strong correlation between MR elastographic shear modulus (μMRE) and a shifted apparent diffusion coefficient (sADC200-1500) calculated from diffusion MR signals acquired with *b* values of 200 and 1500 sec/mm2 in the liver parenchyma. The purpose of our study was to retrospectively estimate the liver tumor stiffness by calculating sADC200-1500, comparing with MR elastography (MRE). We also compared tumor standard ADC values (ADC0-800: *b* values of 0 and 800 sec/mm2) with MRE.

METHOD AND MATERIALS

Eighty-seven patients with hepatic tumors underwent liver MR imaging at 3T (hepatocellular carcinoma [HCC], 32; metastasis, 26; hemangioma, 29). Of these, forty-five patients underwent diffusion-weighted imaging (*b* values of 200, 1500 and *b* values of 0, 800 sec/mm2) and MRE. Of forty-five patients, we measured tumor stiffness in fifteen patients (HCC, 9; metastasis, 6) who had tumors larger than 3cm by calculating μMRE, sADC200-1500 and ADC0-800 values. We also measured liver stiffness in forty-five patients by calculating μMRE, sADC200-1500 and ADC0-800 values. Finally, we measured sADC200-1500 values of hepatic tumors in eighty-seven patients. The correlation between μMRE and ADC values was evaluated using Pearson's correlation test. Receiver operating characteristic (ROC) analysis was used to evaluate the diagnostic performance of sADC200-1500 values for differentiating between benign and malignant tumors.

RESULTS

μMRE and sADC200-1500 exhibited strong correlations both for liver tumor (r=0.80; p<.001), and for liver parenchyma (r=0.87; p<.001). Meanwhile, μMRE and ADC0-800 exhibited no correlation for liver tumor (r=0.32; p=.24), and weak correlation for liver parenchyma (r=0.45; p=.002). The mean sADC200-1500 value of hemangioma was significantly higher than that of HCC and metastasis (1.69, 0.88, and 0.92×10-3mm2/sec; p<.001). A cut-off value of 1.27×10-3mm2/sec for sADC200-1500 detected with ROC analysis yielded 96.6% sensitivity and 89.5% specificity for the differentiation between benign and malignant tumors.

CONCLUSION

There was a significant strong correlation in the liver tumor between μMRE and sADC200-1500. Mean sADC200-1500 value of benign tumors was significantly higher than that of malignant tumors.

CLINICAL RELEVANCE/APPLICATION

Liver tumor stiffness estimation could be performed with DWI, and liver tumor stiffness assessment by virtual elastography facilitates the differentiation of malignant and benign liver tumors.

SSG04-02 Intravoxel Incoherent Motion Diffusion-Weighted MRI for Characterization of Diffuse Liver Disease

Tuesday, Dec. 3 10:40AM - 10:50AM Room: E353A

Participants
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PURPOSE

To evaluate the diagnostic performance of diffusion-weighted imaging (DWI) intravoxel incoherent motion (IVIM) parameters and stretched exponential model parameters for assessing histological features in patients with chronic liver disease (CLD).

METHOD AND MATERIALS

This prospective, cross-sectional multi-center study was approved by the Institutional Review Board of the two participating institutions. Ninety patients with suspected or known CLD who underwent clinically indicated liver biopsies were recruited between January 2014 and July 2018. IVIM parameters (perfusion fraction *f*, diffusion coefficient *D*, and pseudo-diffusion coefficient *D**) and stretched exponential model parameters (intravoxel water diffusion heterogeneity *a* and distributed diffusion coefficient *DDC*) were estimated using a least-squares, non-linear regression on DWI series (10 *b* values up to 800 s/mm2). Inflammation, fibrosis, and steatosis were scored by an expert liver pathologist. Spearman's rho, Kruskal-Wallis test, Mann-Whitney U test, and receiver operating characteristic (ROC) analyses were performed. Multiple regression analysis was used to assess the effects of histological features on diffusion parameters.

RESULTS

Among all parameters and histological features, *f* and *a* showed the strongest correlation with inflammation grades (ρ = -0.57 and ρ = 0.40, respectively; $P < 0.001$). Both *f* and *a* were significantly different between all inflammation grades ($P < 0.001$) and between pairs of inflammation grades <= A1 vs >= A2 ($P < 0.001$ and $P = 0.007$, respectively). Areas under the ROC curve for distinguishing <= A1 vs >= A2 were 0.84 (95% confidence interval: 0.74-0.91) with *f* and 0.72 (0.60-0.81) with *a*. In multiple regression analysis, fibrosis had a significant impact on *f* ($P = 0.03$), but not on *a* ($P = 0.18$), while steatosis had a significant impact on *a* ($P = 0.01$), but not on *f* ($P = 0.08$). Association between inflammation and parameters *f* and *a* remained significant when including fibrosis and steatosis in the regression model ($P < 0.001$ and $P < 0.05$, respectively).

CONCLUSION

Perfusion fraction and intravoxel water diffusion heterogeneity show promise as surrogate biomarkers of liver inflammation using IVIM-DWI.

CLINICAL RELEVANCE/APPLICATION

DWI sequence with multiple b values should be performed on abdominal MR examination in patients with chronic liver disease as it could provide supplemental information on inflammatory activity within the liver.

SSG04-03 Can Single-Section, Machine Learning-Based Radiomics Differentiate Normal Liver from Diffuse Liver Diseases?

Tuesday, Dec. 3 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

We hypothesized that machine learning (ML)-based segmentation and radiomic features of liver from a single section of dual-energy CT can differentiate between normal, fatty and cirrhotic liver.

METHOD AND MATERIALS

Our IRB-approved study included 75 patients (mean age 54 ± 16 years; 44 females, 31 males) who underwent clinically-indicated, contrast-enhanced, portal venous phase, dual-energy abdomen-pelvis CT (SOMATOM Flash, Siemens). Low and high tube potential

(80 and 140 kV) image datasets were de-identified and exported to a DECT segmentation and radiomic features analyses prototype (Radiomics, Siemens). The prototype enabled automatic segmentation of liver on a single CT section at the level of the porta hepatis. DECT iodine quantification and radiomics features were derived for the segmented portion of the liver in XML file format. The XML files were imported into a separate ML-based statistical analysis prototype (Radiomics, Siemens) for univariate and multivariate logistic regression and random forest classification.

RESULTS

Both iodine quantification (best AUC 0.95) and radiomic features (best AUC 0.95) differ significantly between normal, fatty and cirrhotic livers ($p<0.0001$). Normalized iodine concentration was superior than the iodine concentration and mean iodine uptake ($p<0.0004$) for differentiating the normal from fatty and cirrhotic liver. Amongst the radiomic features, the first order statistics demonstrated the highest accuracy (AUC 0.90-0.95, $P< 0.0001$). Machine learning based random forest classification yielded an AUC of 0.91 for differentiating normal from cirrhotic liver, 0.95 (AUC) for differentiating fatty and normal liver and 0.93 (AUC) for differentiating fatty and cirrhotic liver.

CONCLUSION

Single-section, DECT iodine quantification and radiomics features enable near-perfect differentiation (AUC up to 0.954) of normal, fatty, and cirrhotic liver from single-section analyses. The most accurate features were iodine concentration and first order statistics from radiomic analyses.

CLINICAL RELEVANCE/APPLICATION

Machine learning-enabled radiomics from single-section DECT can enable automatic distinction of normal liver from fatty and cirrhotic liver.

SSG04-04 Assessment of Liver Fibrosis with Quantitative Analysis of Tc-99m Diethylenetriamine-pentaacetic Acid-galactosyl Human Serum Albumin (GSA) SPECT/CT: Comparison with Histopathological Fibrosis in Hepatectomy Specimen

Tuesday, Dec. 3 11:00AM - 11:10AM Room: E353A

Participants
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PURPOSE

Assessment of liver fibrosis severity is essential in optimizing treatment in patients with chronic liver disease. Tc-99m GSA scintigraphy has been shown to be useful in assessing regional liver functional reserve, because its liver uptake and blood clearance have strong association with several hepatic function tests such as ICG15. However, the relationship between liver fibrosis and quantitative indices by Tc-99m GSA imaging has not been fully elucidated. The purpose of this study was to evaluate the value of quantitative assessment of Tc-99m GSA SPECT/CT to estimate the extent of liver fibrosis determined by hepatectomy specimen.

METHOD AND MATERIALS

Fifty-five patients who underwent Tc-99m GSA imaging before hepatectomy were studied. Following bolus injection of 185MBq Tc-99m GSA, planar dynamic scintigraphy was performed for 20 minutes. Immediately after the planar acquisition, SPECT data was acquired for 8 minutes (60 steps of 6 s/step and 128x128 matrix). SPECT images were reconstructed with CT attenuation correction and scatter correction. Liver uptake ratio (LUR) defined as radioactivity in whole liver divided by injected radioactivity was calculated. LHL15, a conventional index used for Tc-99m GSA planar scintigram, was also measured. LUR and LHL15 measurements were compared with the histopathological grade of liver fibrosis (F0-F4: F0, absence of fibrosis; F4, severe fibrosis).

RESULTS

LUR measured by SPECT/CT had significant negative correlation with the liver fibrosis stage ($p<0.0001$, $r=-0.60$). LUR in patients with severe liver fibrosis (F4) (30.7±12.8%) were significantly lower than those with absence/mild liver fibrosis (F0-1) (49.8±6.6%, $p<0.0001$) and intermediate liver fibrosis (F2-3) (46.0±9.3%, $p=0.017$) (Figure 1A). The areas under ROC curve of LUR for the prediction of severe liver fibrosis (F4) was 0.90 (Figure 1B). With an optimal LUR threshold of 40.4%, the sensitivity and specificity of LUR in detecting severe liver fibrosis was 90.9%(10/11) and 90.9%(40/44). The sensitivity and specificity of LHL15 to diagnose severe liver fibrosis was 72.7%(8/11) and 81.8%(36/44), respectively.

CONCLUSION

Quantitative assessment of Tc-99m GSA SPECT permits accurate prediction of severe liver fibrosis with the sensitivity and specificity of > 90%.

CLINICAL RELEVANCE/APPLICATION

Liver uptake ratio quantified with Tc-99m GSA SPECT/CT is a promising biomarker to estimate the severity of liver fibrosis.

SSG04-06 Breath-Hold Look-Locker Inversion Recovery T1 Map on Gd-EOB-DTPA-Enhanced Liver MRI to Estimate Liver Function: Calibration, Reproducibility, and Diagnostic Value

Tuesday, Dec. 3 11:20AM - 11:30AM Room: E353A

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PURPOSE

To validate Look-Locker T1 map on EOB-MRI for the calibration performance, reproducibility, and diagnostic value to estimate liver function.

METHOD AND MATERIALS

Look-Locker T1 map was established to scan a slice in 13 seconds. For calibration, a quantitative T1-phantom was generated using Gd-EOB-DTPA solutions of various concentrations and was scanned to evaluate T1 linearity. In total 466 consecutive patients with chronic liver disease or liver cirrhosis, MRIs were scanned with a T1-phantom attached. In the liver, T1 values on precontrast and 20-min postcontrast T1 maps were measured and its difference (ΔT1 = T1post - T1pre) and relative change (%ΔT1 = ΔT1 / T1pre) were calculated. Relative liver enhancement at 20-min postcontrast T1-WI was calculated [%RLE = (SIpost - SIpre)/SIpre]. Correlation between MRI indices and Child-Pugh score was calculated. Accuracy of ΔT1, %ΔT1, and RLE to diagnose decompensated cirrhosis was evaluated by receiver-operating-characteristics (ROC) analysis. Reproducibility of T1 value of attached phantom across all patients (n=466) and test-retest repeatability of T1 map of the liver in the same patients (n=52) were evaluated using repeatability coefficient (RC).

RESULTS

Phantom study showed excellent T1 linearity (coefficient of determination R2, 0.9737). In patients, the correlation coefficients between MRI indices and Child-Pugh score was high in %ΔT1 (r=0.584), but low in ΔT1 (r=0.339) and %RLE (r=0.241). Accuracy to diagnose Child-Pugh class B and C differentiating from class A was high in both %ΔT1 and RLE (AUC 0.798 and 0.838, respectively), but low in ΔT1 (AUC 0.683). Accuracy to diagnose Child-Pugh class C differentiating from class A and B was excellent in both %ΔT1, RLE and ΔT1 (AUC 0.993, 0.976, and 0.976, respectively). Reproducibility across all patients (RC 68.16) and test-retest repeatability in the same patients (RCs, 74.7 in T1pre and 79.4 in T1post) were good.

CONCLUSION

T1 map using Look-Locker sequence on EOB-MRI showed promise for evaluating liver function in patients, especially diagnosing decompensated liver cirrhosis. Of MRI indices, %ΔT1 might be the best index for liver function assessment.

CLINICAL RELEVANCE/APPLICATION

Breath-hold Look-Locker T1 map on EOB-MRI can overcome the conventional T1 map's limitation, a long scan time, thus can be easily incorporated in the routine liver MRI for chronic liver disease.

SSG04-07 Diuretic Use Associated with Discordant Estimation of Liver Fibrosis between Magnetic Resonance Elastography (MRE) and Transient Elastography (TE)

Tuesday, Dec. 3 11:30AM - 11:40AM Room: E353A

Participants
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Patrick Chang, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Magnetic resonance elastography (MRE) and transient elastography (TE) are preferred surveillance tools for low-risk individuals with liver disease. However, the estimated METAVIR fibrosis stage of these two studies are frequently discordant, obfuscating clinical decision-making. This study aims to identify factors that may contribute to this discordance.

METHOD AND MATERIALS

The radiology database was queried for patients with a TE within 18 months of MRE study from January 1, 2015 to September 30, 2018. Relevant clinical data were collected and analyzed from identified subjects.

RESULTS

The subjects (N=35) had a mean age of 57.6 years and 51.4% were obese (BMI >= 30 kg/m2). The most represented liver disease was nonalcoholic fatty liver disease (62.9%). The most represented comorbidities were hypertension (40.0%) and diabetes (34.3%). A Pearson's chi-square test identified factors associated with discordance in estimated METAVIR fibrosis stage, defined as difference in estimated stage (F0 to F4) greater than 1. Even with the small number of patients on diuretic therapy (n=14), there was a statistically significant discordance associated with diuretic use (p=0.02). There was no significant discordance in individuals with hypertension (p=0.62), or elevated serum creatinine (p=0.79).

CONCLUSION

This small, retrospective cohort study demonstrates a statistically significant discordance in estimated METAVIR fibrosis stage between TE and MRE in patients on diuretic therapy (p=0.02).

CLINICAL RELEVANCE/APPLICATION

Prior studies have demonstrated that venous congestion affects MRE and TE estimation of liver fibrosis. It has also been shown that hepatic venous congestion preferentially accumulates in peripheral liver tissue. As MRE evaluates a larger proportion of the patient's liver, prior research in heart failure patients suggest that MRE more completely characterizes the liver parenchyma. Because TE primary evaluates peripheral tissue, its estimation of liver fibrosis may be more sensitive to changes in volume status. Thus, our observed discordance between MRE and TE in patients on diuretics may be a result of the location of liver tissue assessed. This suggests that MRE may be the preferred initial study for patients on diuretics as its fibrosis estimation may be less affected by fluctuations in volume status. Further study on variability of estimated fibrosis by TE and MRE with concomittant diuretic use is warranted.

SSG04-08 Estimation of Minimal Liver Fibrosis Using Gadoxetic Acid-Enhanced Liver MRI and Machine Learning

Tuesday, Dec. 3 11:40AM - 11:50AM Room: E353A

Participants
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PURPOSE

The prognosis of patients with chronic hepatitis depends on fibrotic progression. As the transition from minimal to intermediate fibrosis is a major deleterious step, the accurate diagnosis of minimal fibrosis is of clinical importance. Liver biopsy, the reference standard for diagnosing and staging liver fibrosis, is invasive. As MR elastography, an imaging method for diagnosing liver fibrosis, may not be available in many hospitals, we developed a new method for its estimation on gadoxetic acid-enhanced liver MR images using support vector machines (SVM), a traditional application of machine learning. We assessed the diagnostic ability of our SVM analysis using parameters derived from gadoxetic acid-enhanced MR images for identifying minimal liver fibrosis.

METHOD AND MATERIALS

We included 182 patients with pathologically-diagnosed fibrosis stages. The parameters were based on texture analysis of hepatobiliary-phase images. To investigate the significant parameters for the staging of liver fibrosis we performed univariate logistic regression analysis. Parameters with statistical significance were subjected to analysis using multi-class SVMs, and their ability to identify minimal liver fibrosis (F-score >= 2) was determined. The FIB4 index which considers the patient age, the aspartate aminotransferase- and alanine aminotransferase level, and the platelet count was also calculated because it is correlated with the severity of liver fibrosis.

RESULTS

Univariate logistic regression analysis revealed that mean, standard deviation, skewness, kurtosis, the angular second moment, contrast, and entropy were important for the staging of liver fibrosis. The FIB4 index was also significant. The sensitivity, specificity, and accuracy for staging minimal liver fibrosis were 91.5, 55.8, and 81.3% for SVM analysis and 85.4, 60.4, and 78.7% for the FIB4 index based on an optimal cutoff value of 1.90.

CONCLUSION

SVM analysis using parameters derived from gadoxetic acid-enhanced MRI scans was more accurate than the FIB4 index for the staging of minimal liver fibrosis.

CLINICAL RELEVANCE/APPLICATION

SVM analysis using gadoxetic acid-enhanced MRI scans of the liver is a promising method for assessing minimal liver fibrosis.

SSG04-09 Evaluation of Liver Fibrosis by Assessing Hepatic Extracellular Volume Fraction Before and After Direct-Acting Antiviral Therapy in Patients with Chronic Hepatitis C Infection: Comparison with Serum Fibrosis-4 Index

Tuesday, Dec. 3 11:50AM - 12:00PM Room: E353A

Participants
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PURPOSE

The utility of direct-acting antiviral therapy (DAA) in improving liver fibrosis in patients with chronic hepatitis C virus infection remains unclear. Recent studies demonstrated a strong correlation between hepatic extracellular volume fraction (ECV), assessed using contrast-enhanced CT (CE-CT), and histologic liver fibrosis. Additionally, the fibrosis-4 index (FIB-4) has been proposed as a surrogate marker for hepatic fibrosis in patients with chronic liver disease. This study aimed to evaluate time-dependent changes in ECV using multiphasic contrast-enhanced CT and FIB-4 before and after DAA, and to clarify the difference between both indices.

METHOD AND MATERIALS

Study participants included 41 patients with hepatitis C virus infection who achieved sustained virological response after DAA. All patients underwent multiphasic CE-CT and biochemical examination of blood before and after DAA (pre-treatment, time point 1 (T1); less than 6 months after DAA, T2; 6 to 12 months, T3; 12 to 24 months, T4; greater than 24 months, T5). Absolute

enhancements (in Hounsfield units) of the liver parenchyma (Eliver) and aorta (Eaorta) were measured on precontrast and equilibrium phase scans. ECV was calculated using the following equation: ECV (%) = ΔHUliver/ΔHUaorta × (100 - Hematocrit [%]). FIB-4 was simultaneously calculated using age, AST, ALT and platelet count.

RESULTS

ECV and FIB-4 after DAA showed a significant decrease at the end of the study period as compared to their values at T1 (ECV: 27.49 ± 3.72 and 29.45 ± 4.83, p=0.022; and FIB-4: 3.07 ± 1.88 and 4.40 ± 3.47, p=0.001, respectively). ECV showed a significant positive correlation with FIB-4 (r=0.458, p=0.003) at T1, although there was no correlation at the end of the study period (r=0.170, p=0.289). In ECV comparisons between the different time points, a significant difference was seen between T1 and T4, and T1 and T5 (p=0.046 and 0.022, respectively). In FIB-4 comparisons, significant differences were seen between T1 and all other time points (p=0.003 to p<0.001), although no differences in FIB-4 were seen in all comparisons between T2 to T5 (p>0.05).

CONCLUSION

ECV decreased slowly after DAA, suggesting an improvement in hepatic fibrosis. On the other hand, FIB-4 decreased immediately, probably due to an improvement in hepatic inflammation.

CLINICAL RELEVANCE/APPLICATION

ECV has the potential to be a non-invasive biomarker for the assessment of liver fibrosis after DAA.

Printed on: 10/29/20

SSG05

Gastrointestinal (MR Diagnosis)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: E351

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Cynthia S. Santillan, MD, San Diego, CA (*Moderator*) Consultant, Robarts Clinical Trials, Inc
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Sub-Events

SSG05-01 Recurrence of HBV-Related Hepatocellular Carcinoma: Diagnostic Algorithms on Gadoxetic Acid-Enhanced MRI

Tuesday, Dec. 3 10:30AM - 10:40AM Room: E351

Participants
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PURPOSE

to better characterize intrahepatic recurrence <20mm after resection of HCC using gadoxetic acid-enhanced MR imaging

METHOD AND MATERIALS

Between March 2012 and January 2017, a total of 373 nodules (median size, 1.4 cm; range, 5.5-19 mm) in 204 HCC patients (median age, 55 years; range, 27-79 years) with chronic hepatitis B virus (HBV) infection after hepatectomy underwent gadoxetic acid-enhanced MR imaging and were included in the retrospective study. Diagnostic performance of the LI-RADS systems were calculated for characterizing recurrence. The modified diagnostic algorithms were proposed by combining significant imaging biomarkers respectively related to subcentimeter and 10-20mm recurrences in multivariate analyses and were compared with the LI-RADS imaging criteria by using McNemar test.

RESULTS

The multivariate analyses showed that nonrim arterial phase hyperenhancement and the three LI-RADS ancillary features (hepatobiliary phase hypointensity, mild-moderate T2 hyperintensity and restricted diffusion) were significantly related with recurrence <20mm. For subcentimeter recurrence, the modified diagnostic algorithm of combining at least two of the three ancillary features achieved better diagnostic performance (sensitivity: 83.3%; specificity: 87.7%) than the LI-RADS 4 criteria (sensitivity: 88.9%, P=0.211; specificity: 70.8%, P=0.006). For 10-19 mm recurrence, combining nonrim arterial phase hyperenhancement and at least one of the three ancillary features achieved significantly enhanced sensitivity of 85.1% and relative high specificity of 86.5% than the LI-RADS 5 criteria (sensitivity: 63.5%, P<0.001; specificity: 94.2%, P=0.134).

CONCLUSION

The diagnostic algorithms for subcentimeter and 10-19mm recurrent HCC should be stratified. For subcentimeter recurrences, the modified diagnostic algorithm on gadoxetic acid-enhanced MRI demonstrated preserved high sensitivity with significantly enhanced specificity than LI-RADS 4 criteria.

CLINICAL RELEVANCE/APPLICATION

The multivariate analyses showed that arterial phase hyperenhancement was the most reliable major feature for characterizing 10-20 mm recurrence while the ancillary features were more valuable for characterizing <10mm recurrence. 3. Our modified diagnostic algorithms demonstrated significantly enhanced sensitivity with preserved high specificity for characterizing recurrent HCC <20mm.

SSG05-02 Exploring Prognostic Risk Factors and Survival Models for T3 Locally Advanced Rectal Cancer: What Can We Learn From the Baseline MRI?

Tuesday, Dec. 3 10:40AM - 10:50AM Room: E351

Participants
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PURPOSE

To evaluate the baseline MRI characteristics in predicting disease-free survival (DFS) and cancer-specific survival (CSS) in patients with T3 LARC and to explore individualized prognostic risk-stratification models.

METHOD AND MATERIALS

This study retrospectively reviewed 256 T3 LARC patients evaluated from January 2008 to December 2012 in our institution with an average follow-up period of 6.1 years. Two trained radiologists independently evaluated baseline MRI characteristics and reached consensus. Kaplan-Meier survival curves and Cox regression analysis were used to determine the relationship of MRI parameters and other clinicopathological factors to DFS and CSS using SPSS. R software was used to develop individualized risk-stratification nomograms for 3-year and 5-year DFS and CSS. Independent validation was assessed by Harrell concordance (C)-index.

RESULTS

Independent predictors of DFS were found to include baseline MRI-defined T3 substaging (hazard ratio, HR = 3.09, $P < 0.001$), extramural venous invasion (EMVI) grading (HR = 3.08, $P < 0.001$), rectal mucinous adenocarcinoma (RMAC) (HR = 2.44, $P < 0.001$), threatened mesorectal fascia (MRF) (HR = 1.73, $P = 0.038$), neoadjuvant chemoradiotherapy (NCRT) (HR = 0.44, $P < 0.001$) and an elevated pretreatment carcinoembryonic antigen (CEA) level (HR = 1.93, $P < 0.001$). In addition, T3 substaging (HR = 4.09, $P < 0.001$), EMVI grading (HR = 2.19, $P < 0.001$) and NCRT (HR = 0.58, $P = 0.006$) independently affected CSS. The nomograms permitted individualized prediction of 3-year and 5-year DFS and CSS probability with high performance (C-index range, 0.848-0.883).

CONCLUSION

Baseline MRI-defined T3 substaging, EMVI grading, threatened MRF, RMAC, and elevated pretreatment CEA were adverse prognosticators, whereas NCRT promoted positive outcome, in patients with T3 LARC. The models can facilitate individualized pretreatment survival risk-stratification.

CLINICAL RELEVANCE/APPLICATION

This study identified independent prognostic factors and developed nomogram models with high performance for individualized pretreatment prediction of 3-year and 5-year disease-free survival and cancer-specific survival in patients with T3 locally advanced rectal cancer. The models can facilitate individualized pretreatment survival risk-stratification and aid in clinical decision-making.

SSG05-03 Interobserver Variation in the Interpretation of MR Enterography for Crohn's Disease

Tuesday, Dec. 3 10:50AM - 11:00AM Room: E351

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PURPOSE

Quantifying interobserver variability is an important part in evaluating medical imaging. Interpretation of MR enterography (MRE) is complex, and to date there has been little research into interobserver variability across multiple observers.

METHOD AND MATERIALS

The study utilised datasets from a prospective trial comparing the diagnostic accuracy of MRE and US for CD (either newly diagnosed or relapsing disease) recruited from 8 centres. A construct reference standard (multidisciplinary panel diagnosis) was used, incorporating 6 months follow up. 73 (28 new diagnosis, 45 suspected relapse) trial MREs were interpreted 3 times by one of 27 radiologists via an online platform (Biotronics 3Dnet). Radiologists were randomly allocated datasets, blinded to each other's interpretation, patient's symptoms and history, and documented the presence/location of small bowel and colonic disease. Data was analysed separately for new diagnosis and relapse cohorts. Interobserver variability was measured by averaging percentage agreement with the consensus reference standard across the 3 reads, grouped as disease positive or negative. Prevalence

adjusted bias adjusted kappa (PABAK) was reported. Agreement between the radiologists irrespective of agreement with the reference standard was also reported.

RESULTS

For newly diagnosed patients, overall percentage agreement for small bowel disease presence against the consensus reference was 68%, with kappa coefficient(κ) 0.36 (fair agreement). Agreement for colonic disease presence was 61%, κ 0.21(fair agreement). For relapsing cohort, overall percentage agreement for small bowel disease presence against the consensus reference was 76%, κ 0.51(moderate agreement). Agreement for colonic disease presence was 61%, κ 0.21(slight agreement). Agreement was similar when reads were considered without reference to the consensus reference (72% and 60% for small bowel and colonic disease presence respectively).

CONCLUSION

Based on data from a multi-reader, multicenter prospective trial, there is fair to moderate agreement between radiologists for the presence of small bowel and colonic disease against an independent standard of reference

CLINICAL RELEVANCE/APPLICATION

Compared to an independent standard of reference there is fair to moderate agreement between radiologists for the presence of enteric disease on MRE. This indicates the need for standardised training.

SSG05-04 MRI Evaluation of Lateral Pelvic Lymph Node in Locally Advanced Rectal Cancer: Optimized Cutoff Value Chosen and the Relationship to Overall Survival

Tuesday, Dec. 3 11:00AM - 11:10AM Room: E351

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PURPOSE

To study the relationship between MRI-detected pretreatment lateral pelvic lymph node (LPLN) metastasis and prognosis in patients with locally advanced rectal cancer treated with neoadjuvant chemotherapy-radiation therapy (CRT).

METHOD AND MATERIALS

This retrospective study included 517 patients with locally advanced rectal cancer evaluated from August 2008 to December 2014. Baseline and post-CRT MRI and follow-up data were retrieved for all patients. MRI findings of LPLN metastasis were evaluated. Kaplan-Meier curves and ROC analysis were used to determine the relationship of baseline MRI findings to overall survival.

RESULTS

227 patients (43.9%) had visible LPLNs with short axis of at least 5mm on pretreatment MRI. Univariate cox analysis indicated that the short axis (HR=1.12, 95%CI: 1.04-1.21, p<0.01) as well as the long axis of the largest LPLN (HR=1.07, 95%CI:1.02-1.13, P=0.01) were associated with the overall survival (OS). However, there was no significant relation to the metastasis free survival or the local recurrence free survival. A cut-off of 8mm and 12mm were selected for short and long axis respectively by using survival ROC analysis. Kaplan-Meier method showed LPLNs with a short axis greater than 8 mm resulted in a significantly poor OS (3-year OS 92.5% vs 79.7% for less than 8mm vs equal to or greater than 8mm, P<0.01). LPLNs with a long axis greater than 12 mm resulted in a significantly poor OS (3-year OS 92.3% vs 77.3% for less than 12mm vs equal to or greater than 12mm, P<0.01).

CONCLUSION

The presence of lateral pelvic lymph node (LPLN) was associated with overall death in patients with locally advanced rectal cancer. Further research is needed about which pretreatment features of the LPLN predict prognosis and what is needed to prevent these from developing.

CLINICAL RELEVANCE/APPLICATION

The presence of lateral pelvic lymph node at baseline MRI in local advanced rectal cancer is associated with overall survival in patients with locally advanced rectal cancer.

SSG05-05 Visual Grading of Hepatic Steatosis on In and Opposed Phase Imaging: Validation by Reference to Proton Density Fat Fraction

Tuesday, Dec. 3 11:10AM - 11:20AM Room: E351

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PURPOSE

To develop and validate a qualitative, visual scale that can be used to grade severity of hepatic steatosis on in and opposed phase imaging.

METHOD AND MATERIALS

An IRB approved retrospective study was performed. From our institutional PACS, 429 MRI exams were identified that included both quantitative evaluation of proton density fat fraction (PDFF), and dual gradient echo in and opposed phase imaging. PDFF was calculated using the IDEAL-IQ technique (GE Healthcare, Milwaukee, WI). A subset of 113 patients was selected, (44 men and 66 women, ranging from 24-77 years of age), with PDFF ranging from 2% to 43%. Cases with abnormal hepatic iron concentrations (n=4) were excluded. Two readers independently provided visual steatosis score (VSS) according to our proposed 7-point scale based on visual cues, using in and opposed phase imaging only, without reference to clinical history, PDFF or other images. The VSS and PDFF were then compared for each study. ANOVA was performed to identify differences in PDFF as a function of VSS. 95% confidence intervals (CI) were constructed to determine the PDFF values that correlated with each VSS. Interclass correlation coefficient (ICC) was calculated to assess reliability (agreement and correlation).

RESULTS

ANOVA showed a statistically significant difference in PDFF for each VSS ($p < 0.05$). 95% CI of PDFF for each VSS were as follows. VSS-0: PDFF 4 to 6%; VSS-1: PDFF 7 to 12%; VSS-2: PDFF 15 to 18%; VSS-3: PDFF 26 to 29%; VSS-4: PDFF 31 to 40%; VSS-5: No exams scored; VSS-6: PDFF 35 to 45%. ICC was 0.92, indicating excellent reliability.

CONCLUSION

Specialized sequences for quantitative evaluation of hepatic steatosis are not always included in routine MR abdomen examination. Simple dual-echo technique (matched in and opposed phase) is routinely used as a component of abdominal MRI, including for detecting hepatic steatosis, but severity of steatosis on these sequences is subjective and not standardized. We propose a visual scale that can easily be employed during interpretation which can reliably differentiate various degrees of steatosis in the range commonly seen clinically (0 to 40%).

CLINICAL RELEVANCE/APPLICATION

Simple visual cues can be used to qualitatively grade hepatic steatosis on in and opposed phase imaging, providing greater standardization than currently utilized; these grades are reproducible between readers and demonstrate distinct degrees of steatosis as validated by PDFF.

SSG05-06 The Utility of MR Elastography for Differentiating Non-Cirrhotic Portal Hypertension from Cirrhotic Portal Hypertension

Tuesday, Dec. 3 11:20AM - 11:30AM Room: E351

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PURPOSE

In clinical practice, it is difficult to differentiate non cirrhotic portal hypertension (NCPH) from cirrhotic portal hypertension (CPH), based only on clinical and non-invasive objective methods. In this study we evaluated the utility of MR Elastography (MRE) for differentiating NCPH from CPH

METHOD AND MATERIALS

From our database we retrospectively identified 60 patients with NCPH and had MRE. Forty age and sex-matched patients with CPH who had MRE formed the control group. Liver morphologic features, signs of portal hypertension, and overall impression of cirrhosis and PH on MRI images were evaluated. MRE was performed with standard clinical 2D-GRE-MRE sequence. Regions of interest (ROI) were drawn on both liver and spleen on the stiffness map and mean stiffness measurements (kilopascals, kPa) were generated for liver stiffness (LSM) and spleen stiffness (SSM) for each subject. Chi-square analysis for morphologic features and non-parametric analysis for mean LSM, mean SSM, and mean SSM/mean LSM ratio (SSM/LSM) were performed for significant differences. Receiver operating curve (ROC) analysis was also performed when differences were significant.

RESULTS

Mean LSM was significantly higher in CPH group than NCPH [9.7 kPa (95% CI 6.3-13.1) vs. 3.4 kPa (95%CI, 2.0-4.8), $p<0.001$]. Meanwhile mean SSM was not significantly different between CPH and NCPH [7.8 kPa (95%CI, 6.1-9.5) vs. 8.0 kPa (95%CI, 3.7-12.3), $p=0.21$]. SSM/LSM ratio was significantly higher in NCPH than CPH [2.6 kPa (95%CI, 1.0-4.2), vs. 0.9 kPa (95%CI, 0.6-1.2), $p<0.001$]. ROC analysis showed that a mean LSM >5.3 kPa had 100% sensitivity, 99% specificity and 98% accuracy to differentiate NCPH from CPH. SSM/LSM ratio of <1.3 had 88% sensitivity, 84% specificity and 92% accuracy to differentiate NCPH from CPH. Among the MRI morphological features, only the presence of esophageal varices (CPH > NCPH, $p<0.018$), the presence of perisplenic collaterals (NCPH>CPH, $p<0.04$) and the overall impression of cirrhosis (CPH> NCPH, $p<0.01$) were significantly different.

CONCLUSION

MR Elastography is a useful, non-invasive tool that can help differentiate NCPH from CPH.

CLINICAL RELEVANCE/APPLICATION

Non cirrhotic portal hypertension (NCPH) is difficult to differentiate from cirrhotic portal hypertension (CPH). MRE is an accurate non-invasive technique that can help differentiate NCPH from CPH.

SSG05-07 Role of Volumetric Functional MRI in Predicting Histopathologic Grade of Untreated Hepatocellular Carcinoma and Patient Survival

Tuesday, Dec. 3 11:30AM - 11:40AM Room: E351

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PURPOSE

To evaluate the role of volumetric ADC (vADC) and volumetric venous enhancement (vVE) in predicting the grade of tumor differentiation in hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

This HIPPA compliant retrospective study was approved by our institutional review board. The study population included 136 HCC patients (188 lesions) who had baseline MR imaging and pathologic report of the HCC either by biopsy or liver transplantation between January 2001 and June 2017. Volumetric measurements of venous enhancement (VE) and apparent diffusion coefficient (ADC) were performed on baseline MRI. The tumors were histologically classified into two groups (low-grade and high-grade). The parameters between the two groups were compared using bivariate and multivariable analysis.

RESULTS

A total of 136 patients, with a median age of 61(56-67) were evaluated. 111 were male and 25 were female. Lesions with higher vADC values and higher absolute vADC-skewness were more likely to be high-grade on histopathology assessment ($p=0.001$ and $p=0.0291$, respectively). Also, venous enhancement showed a trend to be lower in high-grade lesions ($p=0.079$). vADC value of 1218.19 (x10-6 mm2/s) resulted in the highest sensitivity and specificity (77% and 74%, respectively) in distinguishing between the 2 groups. Additionally, vADC-skewness showed association with patient survival (HR=1.64, $p=0.035$; per increments in skewness).

CONCLUSION

vADC shows the highest accuracy in predicting HCC differentiation. Novel imaging biomarkers depicting tumor heterogeneity (e.g. skewness/kurtosis) could also be used to predict tumor features and patient's survival.

CLINICAL RELEVANCE/APPLICATION

Volumetric functional MRI metrics can be considered as non-invasive measures for determining tumor histopathology in HCC. These metrics can be used for modifying the management approach and reduce the need for tumor biopsy.

SSG05-08 Clinical Validation of Synthetic MRI in Assessing Rectal Cancer and Extramural Fat Invasion: Initial Experience

Tuesday, Dec. 3 11:40AM - 11:50AM Room: E351

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PURPOSE

To evaluate the Clinical validation of Synthetic MRI in rectal cancer and extramural fat invasion.

METHOD AND MATERIALS

38 patients pathologically proven rectal cancer were included in the retrospective study, ethical approval and consent forms were obtained. All the patients underwent MR scans with both conventional MR and synthetic MR. Two experienced radiologists independently reviewed the images and identified the regions of normal rectal wall, tumor and extramural fat. The T1/T2/PD values of these different regions were obtained using synthetic MR. T test, Wilcoxon signed-rank test, and Mann-Whitney U test were used to contrast T1/T2/PD values between normal rectal wall and tumor, and that of extramural fat in rectal cancer between T1/2 stage cases and T3/4 stage cases. The diagnostic efficacy was evaluated using the ROC curve. The $P<0.05$ was used to indicate

statistical significance

RESULTS

Compared with normal rectal wall, the rectal cancer had higher T2 value (P=0.00), however, T1 and PD values had no statistical difference. ROC curve analysis: T2 value (AUC=0.706; 95%CI=0.591-0.822). All of the PD, T1 and T2 values of the extramural fat of T3/4 stage rectal cancer higher than that of T1/2 stage rectal cancer (P=0.00). ROC curve analysis: PD value (AUC=0.808, 95%CI=0.685~0.930), T1 value (AUC=0.997, 95%CI=0.998~1.000), T2 value (AUC= 0.850, 95% CI = 0.699~1.000).

CONCLUSION

Synthetic MRI was useful in accessing rectal cancer and extramural fat invasion. Compare with the normal rectal wall, T2 value of rectal cancer has significantly diagnostic efficiency. T1 value of extramural fat has the highest diagnostic efficiency for invasion of rectal cancer.

CLINICAL RELEVANCE/APPLICATION

The results of this study indicated that Synthetic MRI was useful in evaluating rectal cancer and extramural fat invasion, especially in the diagnosis of extramural fat invasion.

SSG05-09 Comparison of Pre-Operative and Post-Operative MRI after Complex Fistula-In-Ano Surgery - Lessons Learnt in Interpreting Postoperative MRI Scans in an Audit of 1323 MRI

Tuesday, Dec. 3 11:50AM - 12:00PM Room: E351

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PURPOSE

The evaluation of MRI after fistula-in-ano surgery has never been done. The aim was to evaluate the utility of MRI in postoperative period after fistula-in-ano surgery.

METHOD AND MATERIALS

Preoperative MRI was done in all the patients and post-operative MRI was done to check radiological healing in clinically healed fistulas or when postoperative complication/ healing problem was seen

RESULTS

1323 MRI were done in 1003 fistula-in-ano patients, out of which, 702 patients underwent surgery. In 702 patients, there were 361-recurrent fistulas,153-associated abscess, 388-multiple tracts, 146-horseshoe and 76-supralevator fistula. 320 postoperative MRI were done in 180/702 patients.There were 189 grade I, 200 grade II, 52 grade III, 205 grade IV and 56 grade V fistula(St James classification). The requirement of postoperative MRI was significantly higher in complex (grade III-V) than simple fistulas (grade I-II) [43.5%(136/313) vs 11.3%(44/389) respectively, p<0.0001]. Lessons learnt in interpreting postoperative MRI scans -- MRI was quite accurate to assess healing as well as complications after fistula surgery. --Granulation tissue (healing tissue) and inflammation in tissues (post surgery) looked hyperintense on T2 and STIR and was difficult to differentiate from active fistula tract/ pus. Therefore MRI done in immediate postoperative period (upto 8 weeks post surgery) required care. --After complete healing, the complete tract and internal opening becomes hypointense on T2 and STIR --The complete radiological healing takes at least 10-12 weeks. So getting MRI scan for assessment of healing should be done after 12 weeks. --MRI is very accurate to identify and diagnose postoperative complications like abscess formation, missed tract during surgery or non-healing of a tract. MRI detects such complications even in clinically healed tracts. By early intervention, it helps to prevent delayed recurrence, abscess formation and further spread of tracts. --Closure/healing of internal opening and intersphincteric tract are assessed quite accurately by MRI and they correlate well with the fistula healing.

CONCLUSION

MRI is highly useful to assess healing and detect complications after fistula surgery espesially in higher grades.

CLINICAL RELEVANCE/APPLICATION

MRI is highly useful to assess healing and detect complications after anal fistula surgery. MRI scan for assessment of healing should be done at least after 12 weeks of surgery.

SSG06

Informatics (Artificial Intelligence: NLP and Reporting)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S406A

AI IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSG06-01 Prediction of Imaging Report Impression Sections Using Sequence to Sequence Long-Short-Term-Memory Neural Network Model with a Customized Healthcare Narrative Cloud Embeddings

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S406A

Participants
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PURPOSE

Natural language processing (NLP) has the potential to increase radiologist efficiency and even has potential to be a diagnostic assist tool. The purpose of this study was to determine if NLP could predict the impression of report based on the findings of report.

METHOD AND MATERIALS

In this IRB-approved retrospective study, 100,000 radiology reports were analyzed using a natural language processing tool. The findings and impressions of the reports were used to create a predictive model which could predict the impressions of reports based on the findings of an imaging report by incorporating sequence to sequence long-short-term-memory (LSTM) neural network model with a customized healthcare narrative cloud embeddings. An additional 1,000 predicted impressions were created based solely on the findings portion of imaging reports. Two radiologists then evaluated these predicted impressions (PIs) by the NLP tool as compared to the true impressions (TIs) created by the interpreting radiologist in these 1,000 reports based on a three-point scale: semantic concordance; mild discordance which would not affect patient management, prognosis, or diagnosis; or semantic discordance. Fifty reports were evaluated by both radiologists to assess inter-reader variation.

RESULTS

There was 98% concordance and substantial agreement (kappa: 0.675) between radiologists. The bilingual evaluation understudy score for machine PIs relative to radiologist generated TIs was 0.946 (SD 0.091) [range of 0-1]. There was >80% semantic concordance and mild discordance of PIs to TIs.

CONCLUSION

The evaluated NLP tool is highly accurate in the creation of PIs based solely on the findings portions of reports.

CLINICAL RELEVANCE/APPLICATION

Automated creation of impressions could decrease radiologist workloads and act as a diagnosis assist tool.

SSG06-02 Crowdsourcing with Amazon Mechanical Turk to Assess Patient Comprehension of Radiology Reports and Colloquialisms

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S406A

Participants
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CONCLUSION

AMT is an expeditious, cost-effective, and customizable tool for surveying laypeople for sentiment or task-based research. Patient

summaries can help increase patient comprehension of radiology reports. Radiology colloquialisms are likely to be misunderstood by patients.

Background

Direct patient access to radiology reports via "patient portals" is becoming the standard of care. Our objectives were to assess patient comprehension of 5 different radiology reporting styles and to identify radiology colloquialisms that are at risk for patient misinterpretation.

Evaluation

Survey participants as patient surrogates were crowdsourced utilizing Amazon Mechanical Turk (AMT). For the first AMT task, each participant was randomly assigned a set of radiology reports in a constructed reporting format: traditional unstructured; structured; impression only; patient summary; and traditional unstructured with patient summary. Radiology reports were modeled after real cases, to convey imaging results of a CT abdomen and pelvis pertaining to cancer care. For the second AMT task, each participant was randomly assigned a radiology colloquialism and asked to indicate whether the phrase indicated a normal, abnormal, or ambivalent finding.

Discussion

Within 48 hours, 207 participants responded to the first task and 1166 participants responded to the second task. Of 877 read radiology reports, 412 (47%) were interpreted by the patient surrogate correctly. Patient surrogates had higher rates of comprehension with the patient summary format compared to the traditional unstructured format (57% versus 39%, p <0.001). When the same patient summary was provided in conjunction with traditional unstructured text, statistical significance was lost (47% versus 39%, p=0.053). The majority of patient surrogates who were provided with an impression or patient summary alone expressed a preference for more information (65% and 54%). The majority of patient surrogates expressed a preference for receiving a full radiology report via an electronic patient portal (114 of 207, 55%). Radiology colloquialisms with modifiers such as "low", "underdistended", or "decompressed" had low rates of comprehension.

SSG06-04 Automatic Patient Data Summarization for Radiologist

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S406A

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PURPOSE

Additional patient information from the Electronic Health Records (EHRs) at the point of interpreting radiology exams can help improve radiologists' diagnostic decisions. However, manually extracting relevant patient information from the EHR can be time-consuming and thus skipped in the routine radiology workflow. Therefore, it would be beneficial to have a mechanism that automatically summarizes and presents to radiologists the most clinically relevant patient information pertinent to the case type they are reviewing in real time.

METHOD AND MATERIALS

We present the idea of EHR summarization using summarization templates crafted semi-automatically with clinician assistance. Clinicians manually generated an initial summarization template containing a high-level specification of the types of patient information that the radiologists would like to see in a holistic summary of the patient's EHR. This initial high-level template has a limited concept coverage, giving limited matches to the findings within an actual patient record. To address this problem, we have developed semantic expansion approach that leverages a rich biomedical knowledge-base. To expand the clinician identified seed clinical concepts in the initial template, we identify their clinical variants and related concepts based on an ontological hierarchy and relationships from the biomedical knowledge graph (UMLS). Further, the expanded concepts are automatically filtered by removing duplicate and semantically irrelevant concepts. Finally, the expanded template is reviewed and validated by clinicians.

RESULTS

The approach expands 1,385 seed concepts from the initial summarization template to 29,798 clinically, as well as semantically, relevant concepts (multi-fold expansion). After clinicians' review and validation of the expanded concepts, 97.32% of the concepts are identified as useful and relevant for the summarization template.

CONCLUSION

This study provides a useful and novel approach for EHR summarization by keeping the clinicians and radiologist at the center and leveraging their cognitive workflow in processing high yield patient information in the EHRs. This is the first EHR summarization approach developed that keeps the clinicians' inputs at the focal point and leverages the rich knowledge from the biomedical knowledge-base.

CLINICAL RELEVANCE/APPLICATION

The presented approach is used in a commercial product to assist radiologists for diagnostic decisions.

SSG06-05 Comprehensive Lesion Tagging on Diverse CT Images: Learning from Radiology Reports and Label Ontology

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S406A

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PURPOSE

We aim to develop an algorithm to describe a variety of lesions in CT images. For each lesion image, the algorithm can predict a set of 'tags', namely body part, type, and attributes.

METHOD AND MATERIALS

We use the DeepLesion dataset and its associated radiology reports in our study. DeepLesion is a large-scale and diverse dataset with 32,735 lesion images from 10,594 CT studies of 4,427 patients. First, we construct our lesion ontology (tags with relations) based on the RadLex lexicon. Then, we run a text-mining algorithm on reports to extract the relevant tags for each lesion and filter the irrelevant ones. These tags are mined automatically and minimum manual effort is required. They are used to train a multi-scale multi-label convolutional neural network (CNN). The CNN takes a lesion image patch as the input, and outputs a score for each tag. To leverage ontology-based medical knowledge, we incorporate label relations in the algorithm. The hierarchical relations between tags (e.g., lung is a parent of right lung) are used to infer missing parent tags in the training set. The mutually exclusive relations (e.g., left lung and right lung) are used to infer reliable hard negative tags. A score propagation layer is designed to capture implicit relations between tags. These three strategies are proved to improve tagging accuracy. We also combine lesion retrieval with tagging to enable interpretable prediction.

RESULTS

The final lesion ontology contains 171 tags with 115 body parts, 27 types, and 29 attributes. Compared to existing work, our tags are more comprehensive and fine-grained. Two radiologists manually annotated 500 random lesions to evaluate our algorithm. The area under the ROC curve averaged over all tags is 0.9398, showing that our algorithm can predict the tags with high accuracy. We found that body parts are generally easier to predict since their appearance is relatively stable. Some lesion types (e.g., metastasis) and attributes (e.g., lobular) are harder because they have variable or subtle appearance, or few training cases. See examples in the figure.

CONCLUSION

We proposed an effective algorithm to predict tags for a lesion in a CT image. Radiology reports and relations between tags provided knowledge to train the algorithm.

CLINICAL RELEVANCE/APPLICATION

The predicted tags are useful for downstream fine-grained diagnosis as well as the generation of structured reports.

SSG06-06 How Does Structured Reporting Impact Radiology Reporting Language?

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S406A

Participants
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PURPOSE

To investigate if the introduction of structured reporting has an impact on radiology reporting language in terms of report length, linguistic standardization and lexicon size.

METHOD AND MATERIALS

1,315,842 radiology reports from 2011 to 2018 were extracted from the institutional RIS without preselection. During this time period, body and cardiothoracic imaging sections introduced reporting templates (100% structured reporting). Musculoskeletal and neuroimaging sections continued reporting in prose. Findings and impression sections of each report were automatically separated and segmented with a linguistic natural language processing approach into part-of-speech categories such as character, word, noun, verb, adverb count. Furthermore, frequency of undesired uncertainty words (e.g. "prominent") and expressions ("cannot definitely exclude") was assessed. Data was aggregated per month and graphically analyzed as trending line graph.

RESULTS

A clear transition in the findings section line graphs for all part-of-speech categories corresponds to the introduction of structured reporting. Findings mean character count decreased significantly by 57.8% (240.4 to 101.5; $p<0.0001$) and distinct words by

52.7% (24.5 to 11.6; p<0.0001). Summary mean character count significantly increased by 17.8% (286.4 to 337.4; p<0.0001) and unique word count by 17% (30.0 to 35.1; p<0.0001). For prose reporting there was no significant change in linguistic metrics. Findings mean character count changed by 16.3% (258.1 to 216.1), summary by 2.4% (229.0 to 234.6). Findings mean unique word count varied by 6.9% (25.4.1 to 21.7) and summary by 1.3% (23.9 to 24.2). There was a significant decrease in undesired words from mean 0.77 to 0.67 (p<0.0002) for findings and 0.73 to 0.59 for summary (p<0.0001) in comparison to prose reporting (0.64 to 0.68 findings; 0.69 to 0.63 summary).

CONCLUSION

Length and variation of language in findings section of structured reports decreases and standardization increases. In comparison, length and variation of summary sections in structured reports increase. This reflects a growing effort of radiologists to communicate findings, recommend follow up according to guidelines and document phone calls.

CLINICAL RELEVANCE/APPLICATION

Both radiologists and referring clinicians benefit from increased standardization of language in radiology reports in terms of comparability, comprehensibility and potential big data analysis.

SSG06-07 Machine Learning Using Doc2Vec as a Similarity Report Search Tool in Radiology

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S406A

Participants
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Ross W. Filice, MD, Washington, DC (*Abstract Co-Author*) Co-founder, DexNote LLC; Research Grant, NVIDIA Corporation; Advisor, BunkerHill Health, Inc

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PURPOSE

Large-scale radiology report databases provide access to a vast library of imaging findings, however searches typically match small strings of text perhaps with regular expressions or additional syntax tools. Machine learning (ML) techniques could consider higher level context via the entire document. We applied a ML technique targeted at language similarity which allows the search query to be an entire report with the results being other similar reports. This could be useful for both trainee and faculty education. Our hypothesis was that this method would find similar reports better than standard search methods. We evaluated the quality of these similarity search results compared to typical keyword-based and random searches.

METHOD AND MATERIALS

Approximately 5 million reports from 9 sites were used to fit a doc2vec neural network with a 100 node hidden layer. A web tool could rapidly search all 5 million reports using single instruction multiple data instructions and the cosine distance metric. 203 variable reports were provided by an expert. For each, search results from doc2vec (n=15), text indexing (n=15), and random (n=10), were blinded and presented randomly for the expert to rank for similarity with Likert scale scoring where '1' meant very dissimilar and '5' meant very similar.

RESULTS

80 searches were performed with normalized vectors (NV) and 123 with non-normalized vectors (NNV). Using NV, 25% of doc2vec results had a '1' score, versus 99.9% with text indexing and 95.6% with random controls; 35% of doc2vec results had a '5' score, versus <0.1% with Solr and 0.5% with random controls (p<0.0001; t-test). With NNV, 56% of doc2vec results had a '1' score, versus 99.8% with Apache Solr and 98.8% with random controls; 17% of doc2vec results had '5' scores, with <0.1% for both other types(p<0.0001; t-test). Smaller cosine distance correlated with higher Likert scores (i.e. better similarity).

CONCLUSION

Doc2vec based ML methods demonstrated statistically significantly higher Likert scores. Both text indexing and random results were comparable and performed relatively poorly.

CLINICAL RELEVANCE/APPLICATION

Searching by report similarity enables physicians to rapidly compare their drafts or index reports with highly similar reports to optimize style, differential diagnoses, and best practices.

SSG06-08 Can AI Generate Clinically Appropriate X-Ray Reports? Judging the Accuracy and Clinical Validity of Deep Learning-Generated Test Reports as Compared to Reports Generated by Radiologists: A Retrospective Comparative Study

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S406A

Participants
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PURPOSE

Implementations of deep learning algorithms in clinical practice are limited by the nature of output provided by the algorithms. We evaluate the accuracy, clinical validity, clarity, consistency and level of hedging of AI-generated Chest X-Ray (CXRs) compared to radiologist-generated clinical reports.

METHOD AND MATERIALS

297 CXRs done on a Conventional X-Ray system (GE Healthcare, USA) fitted with a Retrofit DR (Konika Minolta, Japan) were pulled from the PACS along with their corresponding reports. The anonymised CXRs were analysed by a CE approved deep learning-based CXR analysis algorithm (ChestEye, Oxipit, Lithuania) which detects abnormalities and autogenerates clinical reports. The algorithm is an ensemble of multiple classification, detection and segmentation neural networks capable of identifying 75 different radiological findings and perform findings' location extraction. The outputs from this model are used by a custom automatic text generator tailored by multiple radiologists to produce a structured and cohesive report. These models were trained using around 1 million chest X-rays coming from multiple data sources. The algorithm was not trained or tested before on CXRs from our institution. An informed review was performed by a radiologist with 9 years' experience to evaluate both the reports for the accuracy as well the clinical appropriateness of the reports.

RESULTS

In 236 (79%) cases, algorithm-generated reports were found to be as accurate as the radiologists' reports. In 16 (5%) cases, algorithm-generated reports were found to be either more accurate or more clinically appropriate. In 18 (6%) cases, the algorithm made significant diagnostic errors and in 27 (9%) cases, the algorithm-generated reports were found to be clinically inappropriate or insufficient even though the significant findings were correctly identified and localised.

CONCLUSION

We demonstrate, for the first time as of this date, a comparison between reports auto-generated by a deep learning algorithm and a practicing radiologist. We report good comparability of the clinical appropriateness of the reports generated by a DL network having high accuracy, paving the way for a new potential deployment strategy of AI in radiology.

CLINICAL RELEVANCE/APPLICATION

We report on an algorithm with potential to produce standardized, accurate reports in a manner that is easily understandable and deployable in the clinical environment.

SSG06-09 Reducing the Amount of Training Data for Natural Language Processing (NLP) in Radiology by an Active Learning Approach

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S406A

Participants
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PURPOSE

Data labelling is a very time-consuming part of machine learning NLP projects in radiology. The aim of our study was to assess the potential of active learning (AL) for the reduction of training data needed to reach desired levels of models` accuracy as opposed to standard random sampling (RS), exemplified on reports of CT pulmonary angiograms (CTPAs).

METHOD AND MATERIALS

We identified all reports of CTPAs with the clinical question of PE acquired at our institution in 2016 and 2017 (n=2801). Impressions were extracted and then labeled by a radiologist (PE: yes/no). The following process was repeated 100 times to account for effects of random data distribution: We randomized the dataset and split it into a training dataset (TDS; 2/3; n=1901) and a test dataset (TS; 1/3; n=900). From the TDS, we selected the first 50 impressions to train a NLP model based on a support-vector-machine predicting the status of the impression regarding PE. Then, in a step-wise approach, we added 60 impressions at each cycle until all impressions of the TDS were included. The selection of added impressions was performed (a) by adding random samples and (b) by adding samples selected with AL, a selection method that chooses the next samples adding most to the models predictive power. Accuracy depending on the amount of training data was calculated on the independent TS for every cycle.

RESULTS

The active learning approach required less training data for reaching a defined level of performance than standard random sampling. For example, based on 100 simulations, AL achieved >95% mean accuracy with standard deviation of 0.8% at 230 samples, where RS achieved the same mean accuracy with standard deviation of 0.7% at 830 samples. This effectively means that for the mentioned accuracy, the RS approach needs 3.6 times more training data than the active learning approach.

CONCLUSION

Active learning reduces the amount of training data needed to reach a desired performance. This facilitates NLP projects in radiology as the data labeling cost is substantial. The effect size will depend on the concrete NLP project.

CLINICAL RELEVANCE/APPLICATION

High quality labeled data is a scarce resource in radiology. Therefore, it is recommended to try to understand and optimize the relation between the amount of training data and performance. Active learning can contribute to a better utilization of data.

Printed on: 10/29/20

SSG07

Molecular Imaging (New Tracers and Alternative Imaging Modalities)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S505AB

MI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Gabriel C. Fine, MD, Salt Lake City, UT (*Moderator*) Nothing to Disclose
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Sub-Events

SSG07-01 Targeted Delivery of Bismuth-Based Nanoparticles for the Diagnosis of Liver Fibrosis via Spectral CT

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S505AB

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

Early diagnosis of liver fibrosis is essential to prevent progression to cirrhosis. However, there is currently few effective medical imaging technique to accurately diagnose it. This study assesses the potential utility of targeting nanoparticles, BaBiF5@PDA@HA, as contrast agents for gemstone spectral computed tomography (GSCT) in the diagnosis of liver fibrosis.

METHOD AND MATERIALS

BaBiF5 nanoparticles were synthesized and transformed to be hydrophilic with polydopamine (PDA). Then hyaluronic acid (HA) derivatives, target-specific biomarkers for liver fibrosis, were conjugated onto the nanoparticles. The resulting BaBiF5@PDA@HA nanoprobes were further applied as contrast agents for GSCT. The CT Hounsfield unit (HU) value was measured on monochromatic images (40 to 140 keV) acquired by GSCT for experimental group for liver fibrosis mice models(induced by 8-week MCD diet), and sham mice group(regular diet). Resulting data were compared using Student-t and Mann-Whitney tests. All animal experiments were performed following protocols approved by the institutional animal care and use committee. Sirius red staining were performed for histopathological assessment.

RESULTS

After BaBiF5@PDA@HA nanoparticles were injected , the CT value of liver was significantly greater ($P < .0001$) in experimental group than in sham group from10 minutes to 80 minutes. The maximal difference of the liver CT value between two groups was observed 30 minutes after the injection (88.33±11.00 HU vs 47.78±3.53 HU), as a result of accumulation of BaBiF5@PDA@HA in the fibrosis zone of experimental group. Moreover, in the experimental group ,the spectral HU curve of liver analyzed at post-30 minutes indicated that the CT value of liver increased as the monochromatic energy level decreased. Such a characteristic of X-ray attenuation endowed BaBiF5@PDA@HA with comparatively potential for liver fibrosis diagnosis, in lower monochromatic energy images. Thus, monochromatic energy level at 40 keV increased detection sensitivity by revealing highest CT value (130.67±13.96 HU). Additionally, the area of liver fibrosis was more visible and closer to pathological results on 40keV monochromatic images.

CONCLUSION

BaBiF5@PDA@HA nanoparticles, as GSCT contrast agents, were successfully used to detect liver fibrosis.

CLINICAL RELEVANCE/APPLICATION

GSCT employing targeted bismuth-based nanoparticles may improve the early noninvasive diagnosis of liver fibrosis.

SSG07-02 Stem Cell Labeling and Tracking Using Mechanoporation

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S505AB

Participants
Hossein Nejadnik, MD, PhD, Stanford, CA (*Presenter*) Nothing to Disclose
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Anna Liu, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Until now, the only ways of labeling adipose fat derived stem cells (ADSC) for in vivo imaging have required manipulation of the cells in the laboratory. In a clinical setting, ADSC are harvested and transplanted within one surgery. To provide instant iron labeling, we tested the ability of a new microfluidic device to label ADSC with ferumoxytol nanoparticles within 15 minutes or less such that the labeled cells can be detected with magnetic resonance imaging (MRI) and magnetic particle imaging (MPI).

METHOD AND MATERIALS

Studies were performed with a custom-designed microfluidic device, which contains ridges to compress ADSC during their device passage. Cell relaxation after compression leads to cell volume exchange for convective transfer of nanoparticles and nanoparticle uptake into the cell. ADSCs were passed through our ferumoxytol-doped microfluidic device and the cellular iron uptake was evaluated by DAB-Prussian blue, fluorescent microscopy, and inductively coupled plasma spectrometry (ICP). To evaluate the effect of mechanoporation on MR signal, labeled and unlabeled ADSCs were imaged in vitro as well as ex vivo in pig knee specimen by MRI and MPI. T2 relaxation times and iron concentrations calculated by MPI were compared between labeled and unlabeled cell transplants using Student T-test with $p<0.05$.

RESULTS

DAB-Prussian blue, flourescent microscopy, and flowcytometry analysis demonstrated labeling efficiency of more than 95% of the ADSCs. ICP results showed iron uptake of more than one pg per cell in the labeling group. Ferumoxytol labeled ADSCs revealed significantly shorter T2 relaxation times (24.2±2.1 ms) compared to unlabeled cells (79.5±0.8 ms) on MRI ($p<0.05$). After implantation of the ADSCs into pig knee, labeled implants demonstrated significantly higher iron concentration (1.13±0.07 ug) compared to unlabeled cells (0.008±0.003 ug) on MPI and significantly shorter T2 relaxation times (33±6.2 ms) compared to unlabeled group (102.7±5.9 ms) ($p<0.05$).

CONCLUSION

Mechanoporation provided instant ferumoxytol labeling of ADSC within 15 minutes or less such that the labeled cells can be detected with MRI and MPI.

CLINICAL RELEVANCE/APPLICATION

Mechanoporation represents a new, fast, and readily clinically translatable method for labeling therapeutic cells with ferumoxytol. This facilitates iron labeling approaches for in vivo tracking of therapeutic cells with MRI and MPI.

SSG07-03 Ultrasmall Hybrid Protein-Copper Sulfide Nanoparticles Targeting Photoacoustic Image with a High Signal-to-Noise Ratio for Orthotopic Hepatocellular Carcinoma

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S505AB

Participants
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PURPOSE

Although photoacoustic imaging combined with second near infrared (NIR II) molecular probes for tumor diagnosis has drawn tremendous attention during the past few decades, the targeted photoacoustic imaging of orthotopic hepatocellular carcinoma (O-HCC) still remains a challenge due to high liver vascularization and non-specificity of probes in liver tumors.

METHOD AND MATERIALS

We report on cyclic arginine-glycine-aspartic acid (cRGD) peptide conjugated ultrasmall CuS@BSA-RGD NPs which encapsulate bovine serum albumin (BSA) and possess high optical absorption at 1064 nm. The encapsulation of BSA results in great biocompatibility of the NPs along with excellent photostability and physiological stability. The cRGD conjugation enables the improvement of tumor uptake of the NPs by virtue of its positive tumor cell targeting capability.

RESULTS

Ultrasmall CuS@BSA-RGD NPs were successfully synthesized for the photoacoustic imaging of targeted O-HCC. The NPs exhibited strong absorbance in the NIR II wavelengths. photoacoustic imaging in deep tissue areas with a lower background was achieved because the biological tissues show low optical absorption and photon scattering at the NIR II window, The efficient accumulation of the NPs in the tumor over time after intravenous administration to O-HCC bearing mice was achieved, which resulted in highly sensitive photoacoustic visualization. the active tumor targeting capability of the NPs enables them to accumulate significantly in the tumor region. and the O-HCC region showed significantly enhanced photoacoustic signals (consequently much higher SNR) compared to that of the normal liver tissue. in addition, the NPs were non-toxic both in vitro and in vivo.

CONCLUSION

The first time validation of the CuS@BSA-RGD NPs for targeting photoacoustic imaging of the O-HCC model revealed its great potential for highly sensitive and accurate HCC detection in future translational medicine.

CLINICAL RELEVANCE/APPLICATION

A targeted, highly effective and safe photoacoustic imaging were constructed by using the advantages of (NIR II). the team studied the CuS-NPs and image noise reduction,cutting and despecking , Research aim to explore theperforming fusion molecular imaging and promote deep cancer integrating diagnosis, targeted hybrid protein-CuS NPs which are for the first time, applied for

photoacoustic imaging of O-HCC with a high signal-to-noise ratio, has important clinical prospects and significance.

SSG07-04 Near-Infrared Fluorescence Labeled Anti-PD-L1-mAb For Tumor Imaging in Human Colorectal Cancer Xenografted Mice

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S505AB

Participants
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Mingyu Zhang, PhD, harbin, China (*Presenter*) Nothing to Disclose

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PURPOSE

Our objective of this study was to develop a non-invasive imaging technique to monitor the dynamic changes in PD-L1 expression in CRC tumor.

METHOD AND MATERIALS

The expression levels of PD-L1 in different CRC cell lines in vitro (SW620, SW480 and HCT8) were detected by FACS analysis and Western blot assay. Subsequently, we labeled an anti-PD-L1 monoclonal antibody with near-infrared (NIR) dye and tested the ability of the NIR-PD-L1-mAb probe to monitor PD-L1 expression in CRC-xenografted mice by performing optical imaging. Finally, based on the best time of in vivo imaging, different freshly dissected tissues were quantified by optical imaging for bio-distribution study.

RESULTS

The final protein concentration of NIR-PD-L1-mAb was 47.9 μg/ml and the dye/protein ratio was 1.954. SW620, SW480 and HCT8 cell lines showed positive expression of PD-L1, the expression level of PD-L1 in SW620 cells was significantly higher as compared to SW480 or HCT8 cell cells. Our in vivo imaging showed the highest fluorescence signal of the xenografted tumors in mice bearing SW620 CRC cells, followed by tumors derived from SW480 and HCT8 cell lines. We detected the highest fluorescent intensity of the tumor at 120 hours after injection of NIR-PD-L1-mAb. The highest fluorescence intensity was seen in the tumor, followed by the spleen and the liver in SW620 xenografted mice. In SW480 and HCT8 xenografted mice, however, the highest fluorescent signals were detected in the spleen, followed by the liver and the tumor.

CONCLUSION

Our findings indicate that SW620 cells express a higher level of PD-L1 among those three types of CRC cells, and the NIR-PD-L1-mAb binding to PD-L1 on the surface of CRC cells was specific. The technique was safe and could provide valuable information on PD-L1 expression of the tumor for development of therapeutic strategy of personized targeted immunotherapies as well as treatment response of CRC patients.

CLINICAL RELEVANCE/APPLICATION

The technique was safe and could provide valuable information on PD-L1 expression of the tumor for development of therapeutic strategy of personized targeted immunotherapies as well as treatment response of CRC patients.

SSG07-05 The Accumulation of Tumor-Derived Exosomes Can be Visualized by Molecular Imaging and Leads to Changes in the Immune Cell Composition in Target Sites of Metastasis

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

Exosomes, small vesicles carrying inter alia proteins, miRNA and RNA, are important mediators in intercellular communication. We assessed the in vivo biodistribution of exosomes from highly malignant breast cancer cells in comparison to exosomes from the serum of healthy mice, and their effect on the immune cell infiltrate in target organs of metastasis using molecular imaging.

METHOD AND MATERIALS

Exosomes were isolated from the tissue culture supernatant of highly malignant 4T1 breast cancer cells or the serum of healthy BALB/c mice using a protocol comprising size-exclusion chromatography and ultracentrifugation. The purity of the isolate was checked by electron microscopy and western blotting. After labeling with the fluorescent dye DiR (750/780 nm), exosomes were injected i.v. into healthy BALB/c mice and their distribution was assessed using fluorescence-reflectance imaging (FRI). After ex vivo imaging of the organs, lungs and spleen were stained for FACS analysis of granulocytes, T- and B-cells to identify changes in the immune cell content.

RESULTS

The assessment of the in vivo distribution of DiR-labeled exosomes with FRI showed exosomes from highly malignant 4T1 cells, in comparison to exosomes from the serum of healthy BALB/c mice, to preferentially accumulate in the target organs of metastasis, in this case lung, liver and spine (tumor-exosomes vs. serum-exosomes: lung 18.6 vs. 10.4, $p=0.01$; liver 72.2 vs. 56.5, $p=0.02$; spine 5.1 vs. 3.5, $p<0.01$). Furthermore, flow cytometry analysis of the immune cell composition revealed an increase of cytotoxic CD8+ T-cells and a decrease of CD4+ T-helper cells in the lung. Also, we observed an increase in macrophages and a trend towards a

decrease in monocytes.

CONCLUSION

Exosome accumulation changes the immune cell composition in target-organs of metastasis and can be visualized by FRI.

CLINICAL RELEVANCE/APPLICATION

In vivo imaging allows to track labeled tumor-derived exosomes, providing information about their role in the metastatic spread of solid tumors.

SSG07-06 Evaluation of the Efficacy of Superparamagnetic Iron Oxide-Labeled Bone Marrow Mesenchymal Stem Cells in the Treatment of Acute Myocardial Infarction in Rats by 7.0T MRI

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S505AB

Participants
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PURPOSE

To evaluated the efficacy of bone marrow mesenchymal stem cells (BMSCs) in the treatment of acute myocardial infarction (AMI) in rats by 7.0T MRI.

METHOD AND MATERIALS

20 male SD rats were randomized into experiment group (n = 7) and normal control group (n = 7). Rats were anesthetized with chloral hydrate (0.3ml/100g). Opened the rats' chest and ligated the left anterior descending coronary artery to modeled AMI. 25μg/ml Superparamagnetic Iron Oxide combined with 0.75μg/ml L-poly-lysine labeled BMSCs 48h, then BMSCs were collected and directly injected into the infarcted area. MRI scans were performed on D1 and D14 after modeling. Left ventricular ejection fraction (LVEF) and other cardiac function indexes, myocardial strain, the morphological changes of the infarcted area and the signal of infarcted area were used CVI42 software to analysis, then objectively evaluated the therapeutic effect of BMSCs on AMI.

RESULTS

The signal intensity of SPIO-labeled area in experimental group was significantly lower than control group and muscle ($P<0.001$). The values of end diastolic volume (EDV), end systolic volume (ESV), LVEF, peak strain radial (PSR) and peak strain circumferential (PSC) on D1 were 0.35 ± 0.12ml, 0.19 ± 0.09ml, 0.46 ± 0.08, 54.93 ± 15.83 and 24.50 ± 3.82 respectively in control group and were 0.38 ± 0.13ml, 0.21 ± 0.06ml, 0.46 ± 0.05, 59.16 ± 12.23 and 26.24 ± 2.51 respectively in experiment group. Left ventricular wall thickness on D14 was significantly thinner than D1, and the values of EDV, ESV, LVEF, PSR and PSC on D14 became to 0.7 ± 0.22ml, 0.46 ± 0.18ml, 0.35 ± 0.11, 38.84±15.84 and 20.24 ± 6.43 respectively in control group and were 0.54 ± 0.12ml, 0.33 ± 0.07ml, 0.38 ± 0.05, 65.48 ± 14.35 and 27.21 ± 2.06 respectively in experiment group. The EDV, ESV and LVEF on the D1 and D14 of the control group were no significantly different from the experimental group ($P>0.05$). There was no significant difference in PSR and PSC between the experimental group and the control group on D1 ($P>0.05$), but PSR and PSC on D14 of the control group were significantly lower than the experimental group ($P<0.05$).

CONCLUSION

BMSCs have no significantly improvement in EDV, ESV and LVEF in the treatment of AMI, but delay the myocardial strain impairment. MRI can be used to evaluate the effect of SPIO-labeled BMSCs transplanted into AMI.

CLINICAL RELEVANCE/APPLICATION

MRI can be used to evaluate the effect of SPIO-labeled BMSCs transplanted into AMI.

SSG07-07 Construction of Pepstatin A-Conjugated Ultrasmall SPIONs for Targeted Positive MR Imaging of Epilepsy-Overexpressed P-glycoprotein

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S505AB

Participants
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PURPOSE

To develop the ultrasmall superparamagnetic iron oxide nanoparticles (USPIONs) for the highly sensitive T1-wighted MR imaging of the epileptogenic region by the positively enhanced T1 effect.

METHOD AND MATERIALS

A peptide-targeted nanoprobe, based on ultrasmall superparamagnetic iron oxide nanoparticles (USPIONs), PA-USPIONs, was elaborately constructed to enable highly selective delivery and sensitive T1-weighted positive magnetic resonance (MR) imaging of the epileptogenic region. Especially, Pepstatin A (PA), a small peptide which can specifically target to P-glycoprotein (P-gp) overexpressed at the epileptogenic region in a kainic acid (KA)-induced mice model of seizures, was conjugated onto the surface of PEGylated USPIONs. The in vitro/vivo relaxivity of PA-USPIONs nanoprobes was conducted on a 3.0 T clinical MRI scanner at room temperature. Both of the in vitro/vivo biosafety evaluation of PA-USPIONs nanoprobes have been studied.

RESULTS

The as-constructed PA-USPIONs nanoprobes have favorable T1 contrast enhancement and high r1 relaxivity compared with the clinically used T1-MR contrast agent (Gd-DTPA) by systematic in vitro and vivo assessments. Importantly, the toxicity evaluation, especially to brains, was assessed by the histological as well as hematological examinations, demonstrating that the fabricated PA-USPIONs nanoprobes are featured with excellent biocompatibility, guaranteeing the further potential clinical application.

CONCLUSION

In this work, a highly targeted positive MR contrast agent based on USPIONs by surface modification with PEG, followed by conjugation with Pepstatin A, PA-USPIONs, has been successfully constructed for sensitive and precise molecular T1-weighted MR imaging of the epileptogenic region that holds the high potential for precise resection of the according lesion in order to achieve therapeutic, often curative purposes.

CLINICAL RELEVANCE/APPLICATION

N/A

SSG07-08 Gene Reporter Technique Visualizing Cellular Gene Expression Based on MRI

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S505AB

Participants
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PURPOSE

The recent innovations in biology provides with new potential therapeutic strategies in medicine such as gene therapy and stem cell therapy. The purpose of this study was to develop a gene reporter technique for visualizing cellular gene expression using gadoxetic acid enhanced MRI.

METHOD AND MATERIALS

We used a plasmid form human organic anion transporting protein (human OATP) 1B3 cDNA attached to CMV promoter (pCMV-hOATP1B3) to induce ectopic OATP expression in target cells. For comparison we used a blank plasmid with CMV promoter (pCMV-blank). HEK 293 cells (which are non-hepatocyte origin) were transfected with these DNAs. Western blot and confocal microscopy exam were performed to measure OATP protein expression. The cells were in vitro co-cultured at various concentrations of gadoxetic acid for 24 hours. We made a cell phantom and obtained T1, T2 weighted images and performed T1 and T2 mapping with 9.4T MRI. We also performed MRI of the xenograft tumor (pCMV-hOATP1B3 and pCMV-blank HEK 293) bearing nude mice before and after intravenously injecting gadoxetic acid (1.2ul/g).

RESULTS

Western blot and confocal microscopy after OATP1B3 immunofluorescence staining revealed that pCMV-hOATP1B3 transfected HEK 293 cells produced abundant OATP1B3 proteins which were localized on cell membrane. MRI of cell phantom showed that only the pCMV-OATP1B3 transfected cells could generate T1 contrast enhancement, which effect was strongest when the gadoxetic acid co-culture concentration was 1.2ul/ml. MRI of mice revealed that pCMV-OATP1B3 transfected HEK 293 xenografts but not pCMV-blank control xenografts showed contrast enhancement 15 minutes after gadoxetic acid enhancement which lasted up to 9 hours.

CONCLUSION

OATP1B3 gene can be genetically manipulated to induce OATP1B3 expression in target cells of non-hepatocyte origin and that these cells generate T1 contrast enhancement effect on gadoxetic acid enhanced MRI.

CLINICAL RELEVANCE/APPLICATION

OATP1B3 gene can be used as a MRI gene expression reporter, which implies it can be applied for non-hepatocyte target cell selective imaging and context-dependent imaging.

SSG07-09 Multimodality Molecular Imaging of Lung Disease Using PET, CT and Optical Imaging

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S505AB

Participants
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Akiva Mintz, MD, PhD, Paramus, NJ (*Presenter*) Consultant, Regeneron Pharmaceuticals, Inc

PURPOSE

Our long term goal is to develop novel therapies for lung diseases that involve pathologic permeability of the alveolar-capillary barrier. Exposure to toxins, commonly used drugs and even surgical intervention have the potential of causing abnormal epithelial permeability which is manifest as infiltrative processes on CT, including widespread infiltrates seen in acute respiratory distress syndrome (ARDS). However, anatomic changes do not quantitate the underlying disease, which does not allow real-time diagnosis of subacute disease, response to therapy or personalization of treatment regiments. Therefore, our objective in this work is to develop a translational quantifiable test of alveolar-capillary barrier integrity for the purpose of informing our drug discovery efforts.

METHOD AND MATERIALS

We used a published model of ARDS, which involved intranasal delivery of LPS. 72 hours post LPS delivery, we intravenously injected mice with Cy7- or 68-Gallium (68Ga) labeled mouse albumin. Two hours post tracer injection, we imaged mice using MILabs optical imaging (OI)/CT platform and an Inveon PET scanner. Images were scanned on a common bed and automatically coregistered. Lung counts were obtained and quantified for both PET and optical imaging.

RESULTS

We observed significantly increased lung activity of Cy7-albumin on OI at 72 hours after LPS injection, which correlated with the abnormal appearance on gated microCT as well as quantification of the Cy7-albumin in the bronchoalveolar lavage (BAL) fluid. In order to translate these findings, we radiolabeled albumin with 68Ga, a short half-life positron emitting radioisotope that is used in clinical PET scans. We found that 72 hours after lung injury, [68Ga]albumin PET correlated with our optical imaging findings and demonstrated abnormal activity in the lung fields, indicative of abnormal epithelial permeability.

CONCLUSION

[68Ga]albumin can be utilized as a translational radiotracer for quantifying the abnormal epithelial permeability that is the underlying cause of various lung pathologies, including ARDS. Furthermore, the ability to use Cy7-albumin optical imaging as a preclinical translational surrogate for [68Ga]albumin offers a high throughput means of rapidly screening potential therapeutics that aim to reverse the underlying disease process.

CLINICAL RELEVANCE/APPLICATION

[68Ga]albumin PET/CT can potentially be utilized as a biomarker for various lung pathologies, including ARDS

Printed on: 10/29/20

SSG08

Musculoskeletal (Machine Learning and Artificial Intelligence)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: E451A

AI MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Martin Torriani, MD, Boston, MA (*Moderator*) Nothing to Disclose
Jan Fritz, MD, Baltimore, MD (*Moderator*) Institutional research support, Siemens AG; Institutional research support, Johnson & Johnson; Institutional research support, Zimmer Biomet Holdings, Inc; Institutional research support, Microsoft Corporation; Institutional research support, BTG International Ltd; Scientific Advisor, Siemens AG; Scientific Advisor, General Electric Company; Scientific Advisor, BTG International Ltd; Speaker, Siemens AG; Patent agreement, Siemens AG

Sub-Events

SSG08-01 A Deep Learning System for Synthetic Knee MRI: Is Artificial Intelligence-Based Fat Suppressed Imaging Feasible?

Tuesday, Dec. 3 10:30AM - 10:40AM Room: E451A

Participants
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PURPOSE

To determine the feasibility of using a deep learning system (DLS) to create synthetic artificial intelligence-based fat-suppressed MR images (AFMRI) of the knee, for the detection of internal derangement.

METHOD AND MATERIALS

A DLS modified CNN based U-Net was developed to create synthetic AFMRI from non-fat-suppressed (FS) images. The U-Net CNN used a training set from 3T-acquired high-resolution 3D volumetric sequences, a FS PD (n=5,568 images) and non-FS-PD (n=6,960 images) in 29 subjects. Three musculoskeletal radiologists reviewed the images in two sessions, the original (PD + FSPD) and the synthetic (PD + AFMRI) imaging, and recorded image quality (diagnostic, diagnostic with artifact, non-diagnostic). Readers recorded the presence or absence of meniscal, ligament and tendon tears, cartilage defects and bone marrow abnormalities (edema/fracture). Contrast-to-noise (CNR) measurements were made between subcutaneous fat, fluid, bone marrow, cartilage, and muscle. Reader interpretations and CNR measures made on synthetic images were compared to the gold standard (original).

RESULTS

Image quality of the AFMRI sequence was uniformly rated as diagnostic with artifact, whereas 96.5% (28/29) of original sequences were of diagnostic quality. Diagnostic performance of AFMRI (sensitivity/specificity) for the presence of tears was excellent for the medial meniscus (n=17/29) (94.4%/100%), lateral meniscus (n=5/29) (100%/100%), cruciate ligaments (n=3/29) (100%/100%), collateral ligaments (n=1/29)(100%/100%), and tendons (n=1/29, 100%/100%), respectively. For the detection of cartilage defects (n=76), AFMRI offered an overall sensitivity/specificity of 94.7%/85.5%; for the detection of bone marrow abnormalities (n=51), the overall sensitivity/specificity was 94.1%/83.1%. Correlation coefficients for CNR measurements between original and AFMRI sequences were excellent (all >0.95).

CONCLUSION

AFMRI offers excellent sensitivity for the detection of internal derangement of the knee, with moderate specificity for the assessment of cartilage and bone marrow abnormalities. Although image quality is reduced with AFMRI, this technique is feasible for diagnostic imaging.

CLINICAL RELEVANCE/APPLICATION

The development of deep learning synthetic AFMRI could obviate the need for acquiring separate FS fluid-sensitive sequences, thereby offering a novel technique for fast imaging of the knee.

SSG08-02 Machine Learning Predicts Rate of Cartilage Loss: Data from the Osteoarthritis Initiative

Tuesday, Dec. 3 10:40AM - 10:50AM Room: E451A

Participants
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PURPOSE

The rate of annual cartilage loss can vary widely between patients at risk or already suffering from knee osteoarthritis (OA), but the causes for these differences are still unknown. We investigate whether quantitative and semi-quantitative radiographic features can be used to predict the rate of Joint Space Width (JSW) loss.

METHOD AND MATERIALS

We collected bilateral knee radiographs, acquired in the context of the OAI study, from 4100 patients (2383 female, 1717 male). Over a period of 8 years, each patient had follow-up radiographs up to 7 times, separated by at least 12 months. Each radiograph was analyzed by software to obtain Kellgren-Lawrence (KL) and OARSI grades for osteophytes, sclerosis and joint space narrowing (JSN), as well as JSW measurements for each individual knee. Linear regressions of JSW were performed per individual knee compartment (medial or lateral) to estimate the rate of JSW loss. Individual knees with rate of JSW loss above 0.072 mm/year (the average yearly loss within JSN grade) were classified as progressors (956 knees). From these, knees in the top 10% of JSW loss rate were classified as fast progressors (91 knees). A logistic regression model was used to predict fast progressors with KL and OARSI grades at baseline as independent variables. Model performance was estimated using 10-fold cross-validation training/testing dataset splits and used area under the curve (AUC) as performance criteria.

RESULTS

The logistic regression classifiers achieved AUCs of 0.71 (SE 0.015) and 0.66 (SE 0.013) at classifying individual knees as fast progressors for medial and lateral compartments, respectively. Analysis of the individual coefficients of the classifiers reveals that JSN and sclerosis OARSI grades are the main predictors of rapid JSW decrease.

CONCLUSION

Our results show that it is possible to predict rapid cartilage loss from quantitative and semi-quantitative readings from a single plain radiograph. Interestingly, neither KL grade nor Osteophytes OARSI grade contributed greatly to this prediction. Instead, Sclerosis and JSN grade seem to be the major predictors of rapid cartilage loss, suggesting a non-canonical mode of OA progression.

CLINICAL RELEVANCE/APPLICATION

Prediction of rapid cartilage loss is an important but unresolved problem. Our work suggests that these patients can be detected from radiographic features.

SSG08-03 Knee Cartilage Segmentation Using Deep Convolutional Neural Networks for 3D Quantitative Ultrashort Echo Time MR Imaging

Tuesday, Dec. 3 10:50AM - 11:00AM Room: E451A

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PURPOSE

To develop a deep learning-based knee cartilage segmentation method for 3D quantitative ultrashort echo time (UTE) imaging and to automatically calculate UTE-MRI biomarkers including T1, adiabT1ρ, and T2*.

METHOD AND MATERIALS

61 human subjects (aged 20-88 years, 30 males, 31 females) were recruited for this study. The input MR images were acquired using 3D UTE-Cones sequences at 3T (GE MR750). The protocol included a 3D UTE-Cones actual flip angle imaging with variable flip angle (Cones-AFI-VFA) sequence for accurate T1 measurement, an adiabatic T1ρ-prepared UTE sequence for adiabT1ρ measurement, and a fat-suppressed multi-echo UTE sequence for T2* measurement. A radiologist with 18 years of experience manually segmented the knee cartilage based on the UTE adiabT1ρ-weighted MR images. Then, the 2D slices from the UTE adiabT1ρ images and the corresponding masks were input to the deep learning networks. U-Net architecture was adopted for the proposed knee cartilage segmentation, where attention layers were additionally employed as skip connections to improve the segmentation performance. Transfer learning was employed using the VGG 19 model. The dataset was divided into training, validation, and test sets with a 36/10/15 split. The U-Net was trained using the following parameters: Adam optimizer, weights

initialized using Xavier uniform initializer, batch size=32, learning rate=0.001, and momentum=0.9. The networks were trained in Tensorflow. For the test set, the binary masks from the radiologist and CNN were used as ROIs to calculate T1, adiabT1ρ, and T2* parameters, respectively.

RESULTS

Dice coefficient between the masks from the radiologist and CNN was 0.82±0.10. Fig1a shows representative 2D slices with the segmented cartilage regions. Fig1b shows scatterplots for the average T1, adiabT1ρ, T2* values with the manual and automatic segmentations, which show high correlation: 0.95 for T1, 0.88 for T1ρ, and 0.86 for T2*. Fig1c summarizes the estimated parameters.

CONCLUSION

The proposed framework for automatic knee cartilage segmentation achieved performance similar to that of the radiologist, demonstrating feasibility in automatically providing UTE-MR-based biomarkers.

CLINICAL RELEVANCE/APPLICATION

The proposed framework can be used for assessment of knee osteoarthritis.

SSG08-04 Automated Detection and Classification of Shoulder Arthroplasty Models Using Deep Learning

Tuesday, Dec. 3 11:00AM - 11:10AM Room: E451A

Participants
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PURPOSE

Accurate identification of arthroplasty implant models is important for surgical planning and is a task which could be facilitated by deep learning. The purpose of this study was to develop and test the performance of deep convolutional neural networks (DCNNs) for automated identification and classification of shoulder arthroplasty (SA) models on radiographs.

METHOD AND MATERIALS

We collected a dataset of 156 AP shoulder radiographs with equal proportions of native shoulders and SA (equal proportions of total SA [TSA] and reverse TSA [RTSA]), and a dataset of 326 AP shoulder radiographs with 5 different TSA models: Biomet BioModular Choice (37), DePuy Global (125), DePuy HRP (63), Stryker Solar (51), and Zimmer Bigliani-Flatow (50). We trained ResNet DCNNs (pretrained on ImageNet) to 1) detect the presence of SA; 2) differentiate between TSA and RTSA; and 3) differentiate amongst the 5 TSA models. For each DCNN, the datasets were divided into training/validation/test splits of 70/10/20%; training and validation images were augmented up to 20x using crops, rotations, flips, and affine transformation. Receiver operating characteristic (ROC) curves were generated with area under the curve (AUC) calculated to assess test performance. Class activation mapping (CAM) was used to identify distinguishing imaging features used for DCNN classification decisions.

RESULTS

The DCNNs trained to detect SA and to distinguish between TSA and RTSA both achieved AUC of 1. In both cases, Heatmaps demonstrated appropriate emphasis of the arthroplasty components in decision-making (Figure 1A & B). The DCNNs trained to distinguish between the 5 TSA models achieved AUCs ranging from 0.94 for the Biomet Biomodular Choice TSA to 1 for the Zimmer Bigliani-Flatow TSA. Heatmaps for TSA model classifiers showed emphasis of unique features of TSA designs, such as the 3-holed lateral fin of the DePuy Global TSA (Figure 1C) and the 2-holed lateral fin of the Zimmer Bigliani-Flatow TSA (Figure 1D).

CONCLUSION

DCNNs can accurately identify presence of SA and distinguish between TSA & RTSA, as well as between 5 specific TSA models. The proof-of-concept of these DCNNs may set the foundation for an automated arthroplasty atlas for rapid model identification.

CLINICAL RELEVANCE/APPLICATION

Deep neural networks can accurately identify presence of shoulder arthroplasty and distinguish between specific models.

SSG08-05 Radiologist versus the Machine: Can a Machine Learning Algorithm Adequately Identify the Surgical Level in Patients Undergoing Lumbar Decompression

Tuesday, Dec. 3 11:10AM - 11:20AM Room: E451A

Participants
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PURPOSE

To determine if radiologists or a machine learning algorithm (MLA) can more accurately identify the surgical level for patients undergoing microdecompression.

METHOD AND MATERIALS

107 consecutive patients (mean age 65, range 28-89; 64 women, 43 men) with single level central lumbar microdecompression performed by one surgeon and lumbar MRI exams (< 1 year prior to surgery) were retrospectively evaluated. MRI reports by 29 faculty radiologists were reviewed for central canal stenosis (CCS) with the following grading: 1=normal, 2=mild, 3=moderate, 4=severe. Lateral recess stenosis and/or traversing nerve root displacement also was recorded. A MLA for automated evaluation of MRI exams (SpineNet; previously trained, validated, and tested with 12,078 disc levels from the Genodisc consortium; http://zeus.robots.ox.ac.uk/spinenet) was applied to sagittal T2-weighted images. At each level, the MLA provided CCS grades utilizing the same 1-4 scale. The radiologist report and MLA data were evaluated for their ability to predict the surgical level in a blinded fashion. Spearman correlation between the radiologist and MLA CCS grades was determined.

RESULTS

The worst lumbar level reported by radiologists matched the surgical level in 102/107 patients (95%), compared to 77/107 (72%) who had surgery at the level of greatest CCS determined by the MLA. Radiologist and MLA CCS grades correlated moderately ($r=0.53$, $p<0.001$). For each MLA CCS grade, the average radiologist CCS grade was as follows: MLA1 = 2.46, MLA2 = 3.13, MLA3 = 3.60, MLA4 = 3.81. The MLA yielded 24 normal CCS grades at the surgical level. Of these, the radiology report described lateral recess stenosis and/or nerve root displacement in 20/24 (83%), with variable CCS (severe in 3, moderate in 2, mild in 7, none in 1, grade not specified in 11).

CONCLUSION

This study highlights success with an automated approach to grade CCS using only sagittal images on most lumbar MRI exams, as compared to radiologist reports and eventual surgical level. However, the technology needs to be refined to incorporate axial images and lateral recess evaluation in order to match human interpretation.

CLINICAL RELEVANCE/APPLICATION

Automated approaches to MRI grading have the potential for improved patient care but need to be further augmented in order to match human interpretation.

SSG08-06 Prediction of Sarcopenia: Quantitative Evaluation of Skeletal Muscle Using Shear Wave Ultrasonographic Elastography by Radiomics and Deep Learning Convoluted Neural Network (CNN) Model Approach

Tuesday, Dec. 3 11:20AM - 11:30AM Room: E451A

Participants
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Young Han Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Seok Hahn, MD, Busan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate if deep features extracted via transfer learning can generate radiomics signatures for prediction of sarcopenia in by investigating the B-mode ultrasonography (USG) and shear wave ultrasonographic elastography (SWE) on right rectus femoris muscle with their radiomic features to build the deep learning-based radiomics model.

METHOD AND MATERIALS

This study comprised a data set of 44 patients and an independent validation data set of 18 patients. A total of 62 USG and corresponding 62 USE images were included. Qualitative evaluation of muscle grade was performed by 4 grades: Grade 0, normal; Grade 1, some area of increased echogenicity; Grade 2, echogenic as perimysial fat; Grade 3, isoechoic to fat. For quantitative radiomic features, 43 radiomic features were extracted from all the images: 3 global features, 9 features from the Gray-Level Co-occurrence Matrix (GLCM), 13 features from the Gray-Level Run-Length Matrix (GLRLM), 13 features from the Gray-Level Size Zone Matrix (GLSZM), and 5 features from the Neighborhood Gray-Tone Difference Matrix (NGTDM). After feature selection, top 5 features were selected by using the least absolute shrinkage and selection operator (LASSO) Cox regression model. For deep learning-based CNN, we used a GoogleNet Inception v3 CNN architecture that was pre-trained on 1.28 million images. The top layer of the Inception v3 network was re-trained using ultrasonography images to produce a model for the classification of USG and USE images.

RESULTS

The muscle degeneration on USG and SWE showed significant negative correlation ($r=-.641$, $p<0.001$). Four radiomics features showed correlations: sum of average, variance, autocorrelation of GLCM features and high gray-level zone emphasis (HGZE) of GLDZM. The CNN classification of muscle grade showed 90.5% (n=19/21) in independent test set. The radiomics features associated with sarcopenia were gray-level nonuniformity (GLN) and HGZE of GLDZM. The diagnostic accuracy of CNN in detection of sarcopenia was 94.4% (n=17/18).

CONCLUSION

Deep learning-based CNN and radiomics can be utilized to classify the muscle degeneration and sarcopenia. This approach for

muscle could be applied to determine sarcopenia, improving the patient care.

CLINICAL RELEVANCE/APPLICATION

Radiomics evaluation and deep-learning evaluation of USG and SWE improved the prediction of sarcopenia.

SSG08-07 Prediction of Cartilage Collagen and Proteoglycan Fractions Using Multiparametric Quantitative MRI and Machine Learning

Tuesday, Dec. 3 11:30AM - 11:40AM Room: E451A

Participants
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PURPOSE

In the early and possibly reversible stages of cartilage degeneration, the tissue remains structurally grossly intact while only slight changes in composition such as alterations in collagen (CO) and proteoglycan (PG) contents are present. This study aims at predicting the CO and PG fractions using quantitative MRI (qMRI) and sophisticated machine learning approach in efforts to non-invasively predict degeneration-related compositional features based on qMRI.

METHOD AND MATERIALS

11 histologically intact cartilage-bone samples were harvested from the medial femoral condyle and cut to 8 mm diameter were obtained after joint replacement. On a clinical 3T scanner (Achieva, Philips), T1, T1?, T2 and T2* maps were obtained at high resolution along the mid-sagittal plane (0.25x0.25 mm). Hereafter spatially resolved CO and PG fractions were determined using Fourier-Transform-Infrared Microspectrometry. An artificial neuronal network (ANN) and a multivariate linear model (MLM) were implemented and trained by leave-one-out cross validation to predict the CO and PG fractions in a voxel-wise manner. Predictive performance was assessed by calculating percentage deviations (PD) between modelled and measured contents.

RESULTS

The ANN performed better than the MLM (PD: 1.1% [PG-ANN], 11.9% [PG-MLM]), 0.3% [CO-ANN], 3.8% [CO-MLM]). Strong correlations (i.e. Pearson's correlation coefficients $r > 0.7$) between modelled and measured contents were found throughout, irrespective of the underlying model.

CONCLUSION

Trained properly, machine learning approaches are able to predict local CO and PG contents with high accuracy and precision and in a voxel-wise manner based on a multiparametric qMRI.

CLINICAL RELEVANCE/APPLICATION

Once modified for the clinical setting, machine learning approaches, in particular ANN, may be used to determine compositional features of cartilage based on qMRI parameters alone with potential implications for the diagnosis of (early) degeneration and for the monitoring of therapeutic outcomes.

SSG08-08 Performance of a Deep Learning-Based MR Reconstruction Algorithm for the Evaluation of Peripheral Nerves

Tuesday, Dec. 3 11:40AM - 11:50AM Room: E451A

Participants
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PURPOSE

To evaluate the clinical performance of a new deep learning-based MR prototype reconstruction method ('DLRecon') for evaluation of peripheral nerves.

METHOD AND MATERIALS

This was an IRB approved pilot study of 23 subjects (13F, mean age=49±16) undergoing routine clinical 3T MRI evaluation of neuropathy (MR750 GE Healthcare). Axial 2D intermediate weighted FSE sequences were acquired on each subject, and two sets of image series were reconstructed from the same raw dataset: standard of care MRI (SOC-MRI) using a conventional reconstruction method and DLRecon-MRI using a DLRecon method employing a convolutional neural network trained to reduce noise and ringing. All exams were anonymized, randomized, and scored by a blinded radiologist who evaluated: pulsation, aliasing, and bulk motion artifacts, fascicular architecture, and outer epineurium conspicuity (on a 4 point scale) as well as identification of DLRecon- vs SOC- MRIs. Agreement between DLRecon- and SOC- MRI grades were evaluated using ordinal weighted Gwet's agreement coefficients. Marginal ordinal logistic regression models analyzed grade differences between DLRecon- and SOC- MRIs.

RESULTS

Near perfect agreement (AC>0.81) was found between DLRecon- and SOC- MRIs for evaluation of pulsation artifact and outer epineurium conspicuity. Substantial agreement (AC>0.70) was found between the DLRecon- and SOC- MRIs for aliasing artifact, bulk motion, and fascicular architecture. With the exception of aliasing artifacts (OR=2; 95%CI: 1.3-3.1; p=0.002) no significant differences were found between DLRecon- and SOC- MRI outcome measure grades. Finally, the blinded radiologist's ability to correctly determine if an image set was DLRecon- vs SOC- MRI was 15%.

CONCLUSION

Results of the current pilot study suggest that DLRecon-MRIs perform comparably to SOC-MRIs for evaluation of peripheral nerves, preserving key anatomic details. DLRecon may provide clinically important information with visible noise reduction and image sharpening. In cases of peripheral neuropathy where SOC-MRIs had sufficient spatial resolution to detect the presence of pathology, associated DLRecon-MRIs demonstrated marked fascicular detail and architecture (FIG. 1).

CLINICAL RELEVANCE/APPLICATION

DLRecon-MRI provides statistically similar anatomic detail and artifacts compared to SOC-MRI for peripheral nerve evaluation, and may aid visualization of nerve fascicular detail and pathologic change.

SSG08-09 Rib Fracture Detection Algorithm in X-Ray Images Using Deep Learning

Tuesday, Dec. 3 11:50AM - 12:00PM Room: E451A

Participants
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PURPOSE

To develop an algorithm that mimics the exact way that radiologists look for rib fractures during conventional chest radiographic read.

METHOD AND MATERIALS

Our dataset includes 1200 unique patients each with frontal (AP or PA) x-ray image representing rib fracture(s). We asked 3 experienced radiologists to use a bounding box for annotating each fracture using labels such as: fracture age (acute (A), indeterminate (I), old (O)), and fracture displacement (large-(L), medium-(M), non-displaced(N)). The algorithm is comprised of two networks: 1) two-second glimpse, and 2) attention. Our rationale for using the glimpse model is due to radiologists rapid ability identifying the gist of fractures, often large-displacement, in several seconds. To this end, we used multiscale U-Net as detector followed by localization and verification models. If no fracture is found, then the attention model is deployed, consisting of multiscale patch generation and classification using ResNet model. This replicates when radiologists magnify images and track along each rib looking for any discontinuity or deformation. We trained and validated (80-20% split) our models using 2549 fractures (AL:253, AM:560, AN:454, IL:26, IM:157, IN:354, OL:43, OM:99, ON:603). A balanced dataset of 1000 patients with (n=893) and without fractures is used as test set.

RESULTS

The algorithm performed very well at the patient level, detecting fractures with specificity (SP), sensitivity (SEN) and area under ROC curve of 87%, 86%, and 92%, respectively. Fracture detection with large and medium displacement (SP=91%, SEN=87%) was better than non-displaced ones (SP=83%, SEN=81%). The performance was superior in detecting acute (SP=85%, SEN=83%) vs. non-acute (indeterminate+old) (SP=78%, SEN=77%) fractures. It also detected 39 fractures that had been missed during data (train+test) annotation process. There was a 1.1% improvement in detection but readers were told to focus more on identifying rib fractures in this enriched dataset with rib fractures. So, in general application, the improved detection we theorize would be higher.

CONCLUSION

We introduce a novel deep learning driven system on conventional chest radiographic images and achieved promising results.

CLINICAL RELEVANCE/APPLICATION

The proposed algorithm could assist radiologists in rib fractures detection during frontal conventional chest radiographic interpretation, and as a second reader to assess for missed fractures.

SSG09

Nuclear Medicine (Lymphoma PET)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S504CD

NM OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Don C. Yoo, MD, Lexington, MA (*Moderator*) Consultant, inviCRO, LLC

Sub-Events

SSG09-01 Impact of PET/CT on Clinical Management in Patients with Cancer of Unknown Primary

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S504CD

Participants
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PURPOSE

To evaluate the impact of PET/CT on clinical management decisions in patients with Cancer of Unknown Primary (CUP).

METHOD AND MATERIALS

A cohort of patients with CUP undergoing clinically indicated PET/CT was prospectively enrolled in a local PET/CT registry study between 01/2013 to 06/2018. Questionnaire data from referring physicians on intended patient management before and after PET/CT were recorded. The questionnaire included items on PET/CT indication (primary staging, re-staging, lesion characterization), intended diagnostic procedures (biopsy, additional imaging), and intended treatment concept (no treatment plan, curative treatment, palliative treatment, watchful waiting). Changes in management before and after PET/CT were analyzed. Patient outcome was measured as overall survival from initial diagnosis and drawn from available patient records.

RESULTS

155 patients (53 female; 63.4±12.1y) with CUP were included. PET/CT detected the primary in 36 patients (23.7%). Intended treatment concepts were changed in 74 patients (47.7%) on the basis of PET/CT results. The treatment plan changed from 'curative' or 'no treatment plan' before PET/CT to 'palliative' in 28 patients (18.1%) and from 'no treatment plan' to a 'curative' concept in 15 patients (9.7%). Minor therapy adjustments without change of treatment goal were documented in 30 patients (19.4%). Additional invasive procedures and imaging (CT, MRI) were intended in 40 (25.8%) and 98 (63.2%) patients before PET/CT and in 21 (13.5%) and 10 (6.5%) patients after PET/CT. Overall patient survival was significantly longer in patients with one CUP manifestation (4.6±0.4y) compared to patients with 2-3 (2.8±0.4y) or more than 3 manifestations (2.4±.4y)(p=.001). Patients with cervical CUP manifestations showed a significantly longer survival (4.3±0.3y) than patients with extracervical manifestations (3.5±0.5y)(p=.01), as well as patients with intended curative (4.0±3.6y) compared to palliative treatment (2.7±0.6y) after PET/CT (p=.001).

CONCLUSION

PET/CT significantly influences clinical management in patients with CUP. It helps referring physicians to select a more appropriate and individualized treatment and to avoid unnecessary additional diagnostics.

CLINICAL RELEVANCE/APPLICATION

PET/CT has a high impact on clinical management of CUP patients due to its potential as a method for detection of the primary and distant metastases that directly influences overall patient survival.

SSG09-03 Characterization of Interim Residual Lymphoma Masses Using Diffusion-Weighted MRI with Apparent Diffusion Coefficient Mapping: FDG-PET as the Reference Standard

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S504CD

Participants
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PURPOSE

To assess the value of diffusion-weighted MRI in characterizing residual lymphoma masses early during first-line chemotherapy, compared with FDG-PET as the reference standard.

METHOD AND MATERIALS

Our two-nation and two-institutional prospective study included 133 patients with bulky disease (at least one mass >7cm in diameter) at diagnosis. Whole-body diffusion-weighted MRI at 3.0-T (b = 50, 400, 800 sec/mm2) and FDG-PET/CT were performed within a week from each other, or simultaneously using FDG-PET/MRI in the later patients, before initiation in all and after 2 chemotherapy cycles (interim) in 126 patients. Volume-of-interest encompassing the entire bulky mass before and after treatment was drawn semi-automatically to obtain the mean apparent diffusion coefficient values (ADCmean). The 2014 Lugano classification was used for PET response interpretation and a Deauville score of 4 or 5 was considered positive.

RESULTS

There were 64 diffuse large B-cell (DLBCL), 45 Hodgkin (HL) and 24 follicular (FL) lymphoma patients with a total 157 bulky masses at diagnosis. Before treatment, ADCmean of these masses was 1.071 ± 0.352 x10-3 mm2/sec (range, 0.415-2.400). They were all FDG-avid with a maximum SUV of 17.0 ± 8.1 (range, 4.0-43.3). ADCmean values were comparable between two institutions for each histology subtype (P = .621-.769). Among three lymphoma subtypes, HL (52 masses) had significantly higher ADCmean values than either DLBCL (75 masses) or FL (30 masses), 1.321 v. 0.976 or 0.873 x10-3 mm2/sec, respectively (P < .0001), while only marginal difference was found between DLBCL and FL (P = .048). At interim, ADCmean values were lower in PET-positive (poor response, 50 masses) than in PET-negative (good response, 100 masses) residual masses, 1.442 ± 0.486 v. 1.865 ± 0.559 x10-3 mm2/sec (P < .0001).

CONCLUSION

Diffusion-weighted MRI with ADC mapping demonstrated in lymphoma patients with bulky disease at diagnosis different features between HL and the other two major histology subtypes. In addition, interim residual masses with good response on FDG-PET showed higher ADCmean values than those with poor response (NCT02300402).

CLINICAL RELEVANCE/APPLICATION

Diffusion-weighted MRI with ADC mapping seems useful in characterizing residual masses in lymphomas, by providing quantitative information of lesion cellularity.

SSG09-04 Comparison of FDG PET/CT-Guided Percutaneous Metabolic Bone Marrow Biopsy and Conventional Trephine Bone Marrow Biopsy for the Assessment of Lymphomatous Bone Marrow Infiltration in Newly Diagnosed Lymphoma

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S504CD

Participants
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PURPOSE

To compare the diagnostic-values of PET/CT-guided targeted metabolic bone marrow (BM) biopsy and trephine bone marrow-biopsy (TBMB) to assess lymphomatous infiltration in newly diagnosed lymphoma.

METHOD AND MATERIALS

Newly diagnosed patients of lymphoma were recruited for FDG PET/CT. FDG uptake in the marrow was classified as focal, multifocal, diffuse and negative and PET/CT guided BM biopsy was done from focal or multifocal marrow lesion. The PET-guided biopsies were done using a dedicated automated-robotic-arm assisted device on the same day of diagnostic PET/CT. The real-time tissue sample was retrieved after confirming the needle tip to the target lesion. All the patients underwent TBMB from bilateral posterior superior iliac spine as a routine staging work-up. The reference standard was histopathology results of the biopsies. The diagnostic values of PET/CT-guided BM-biopsy with TBMB was compared for assessment of BM infiltration. The PET/CT-guided procedure related complications and radiation exposure to the interventionist were also recorded.

RESULTS

From January 2017 to December 2018, 167 patients of lymphoma were recruited for baseline FDG PET/CT staging. The FDG uptake in bone marrow was classified as focal (n=8), multifocal (n=25), diffuse (n=32) and negative (n=102). Of these 33/167 patients underwent both, PET/CT guided targeted BM biopsies and TBMB. Of these 33 patients, PET-guided-biopsy revealed 30 true-positive (TP), no false-positive (FP), two true-negative (TN), and one false-negative (FN). The sensitivity, specificity, positive predictive

values, NPV and accuracy of 96.7%, 100%, 100%, 66.7%, 96.9 % respectively. TBMB revealed TP-18, FN-12, FP-0 and TN-3 with sensitivity, specificity, positive predictive values, NPV and accuracy of 60.0%, 100%, 100%, 20%, 63.6% respectively. No procedure related complications were encountered in the present study. The estimated absorbed radiation dose was 566.7 µSv/year for the interventionist.

CONCLUSION

PET/CT-guided targeted BM biopsy has shown a higher diagnostic performance as compared to routine TBMB from iliac spine. It is highly practical and useful in characterization of focal FDG avid lesion and negates the false negative results.

CLINICAL RELEVANCE/APPLICATION

TBMB is established method for evaluation of BM involvement in lymphoma but only a fraction of the BM is sampled leading to a FN results. PET-guided targeted BM biopsy may reduce these FN findings.

SSG09-05 Radiomic Features of Glucose Metabolism Enable Prediction of Outcome in Mantle Cell Lymphoma

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S504CD

Participants
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PURPOSE

To determine whether, in mantle cell lymphoma (MCL), [18F]FDG-PET/CT-derived radiomic features are predictive of 2-year progression-free survival (PFS), alone or in combination with clinical, laboratory and biologic data, and whether they enable outcome prognostication.

METHOD AND MATERIALS

107 treatment-naïve MCL patients scheduled to receive CD20-antibody-based immuno(chemo)therapy were retrospectively included. Standardized uptake values (SUV), total lesion glycolysis, and 16 co-occurrence matrix radiomic texture features were extracted from metabolic tumor volumes on pre-therapeutic [18F]FDG-PET/CT. A multi-layer perceptron neural network in combination with logistic regression analyses for feature selection was used for 2-year PFS prediction. Outcome prediction was first performed for radiomic features alone, and then and in combination with ECOG, WBC, LDH, and Ki67 index. International prognostic indices (MIPI and MIPI-b) were calculated, and combined with radiomic data (MIPI-m, MIPI-bm). Kaplan-Meier estimates with log-rank tests were used for PFS prognostication.

RESULTS

SUVmean (odds ratio OR, 1.272; P=0.013) and Entropy (heterogeneity of glucose metabolism; OR, 1.131; P=0.027) were significantly predictive of 2-year PFS: median areas-under-the-curve were 0.72 based on the two radiomic features alone, and 0.82 with addition of ECOG, WBC, LDH, and Ki67. Higher SUVmean in combination with higher Entropy, reflecting high 'metabolic risk', was associated with a poorer prognosis (median PFS, 20.3 vs. 39.4 months; hazard ratio HR, 2.285; P=0.005). Best PFS prognostication was achieved with the MIPI-bm (i.e., combination of MIPI-b and metabolic risk): median PFS was 43.2 months in the low risk group; 38.2 months in the intermediate risk group; and 20.3 months in the high risk group (P=0.005).

CONCLUSION

In MCL, [18F]FDG-PET/CT-derived radiomic features SUVmean and Entropy may improve 2-year PFS prediction and PFS prognostication. Best results may be achieved by a combination of metabolic, clinical, laboratory and biologic data.

CLINICAL RELEVANCE/APPLICATION

Radiomic features extracted from pre-therapeutic [18F]FDG-PET/CT may improve outcome prognistication in mantle cell lymphoma patients, and may therefore be useful for risk stratification and treatment decisions. Radiomic features could be easily integrated into an artificial intelligence-based outcome prediction model together with clinical, laboratory and biological data.

SSG09-06 The Potential Value and Pitfalls of Radiomics for Clinical Positron Emission Tomography (PET) in DLBCL: Results from the Phase 3 GOYA Study

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S504CD

Participants
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Paul E. Kinahan, PhD, Seattle, WA (*Presenter*) Research Grant, General Electric Company Co-founder, PET/X LLC

PURPOSE

We are using the large multi-center (207 sites) phase 3 GOYA study to investigate using quantitative image texture features (ITFs, i.e. 'radiomics') to improve the prognostic value of the FDG-PET baseline exams in patients with previously untreated diffuse large

B-cell lymphoma (DLBCL). Here we evaluate the robustness of ITFs in clinical practice.

METHOD AND MATERIALS

Images with regions of interest (ROIs) defined by qualified physicians were transferred to the imaging core laboratory. Analysis was performed on the original images and after interpolation to common voxel sizes of 2, 4, 5, 10mm. ITFs were computed using the open-source 'PET oncology radiomics test suite (PORTS). The stability of standard metrics (SUV-mean, SUV-max, MTV, TLG), SUV histogram metrics (variance, skewness and kurtosis), and ITFs were analyzed as a function of image voxel size. Supervised machine learning models (SVM, LDA, KNN, GBRM, RF) were applied to a training set (80% of patients) to differentiate the lesion from an ROI in liver. Diagnostic accuracy was calculated on the test set (20% of patients).

RESULTS

FDG-PET images came from a variety of PET/CT scanners; thus, a unified image reconstruction protocol was not possible. Using a threshold of > 5ml, a total of 1085 radiomics-evaluable patients with 9307 lesions were analyzed. Standard SUV and histogram metrics were stable w.r.t. to image voxel size. There was a substantial variation in the distribution of many of the ITFs w.r.t. to image voxel size. Eight of the ITFs were stable w.r.t. to image voxel size, in particular GTSDM Autocorrelation, and GLZSM High Gray-Level Zone Emphasis. While the rest of the ITFs were not stable, several were stable except for the 2 or 10 mm voxels (e.g. GTSDM Sum Entropy). The stable metrics were able to differentiate liver from lesions with a diagnostic accuracy for all ML models ranging from 0.995 to 0.999.

CONCLUSION

While radiomics signatures can potentially increase the prognostic value of risk prediction of DLBCL patients at baseline, the impact of variable voxel size inherent to clinical imaging, and the distributed nature DLBCL disease visualized by PET, imply caution in interpretation by image texture analysis.

CLINICAL RELEVANCE/APPLICATION

The impact of variable voxel size inherent due to variations inherent in clinical imaging, and the distributed nature DLBCL disease visualized by PET, imply caution in interpretation by image texture analysis.

SSG09-07 Is Inappropriate Imaging Really the Culprit? An Analysis and Comparison of Published PET/CT Guidelines

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S504CD

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PURPOSE

Inappropriate imaging strains patients and the health system. Several Positron Emission Tomography/Computed Tomography (PET/CT) imaging guidelines have been proposed with varying formats. Our purpose was to examine the current rates of inappropriate imaging and guideline coverage using several national guidelines to evaluate PET/CT imaging in Canada.

METHOD AND MATERIALS

Academic PET/CT centers across Canada were surveyed and asked to provide exam requests from a consecutive 7-day period. Four sets of guidelines were used to analyze the appropriateness of the exam requisitions by the author and verified by a senior radiologist: the Canadian Association of Radiologists (CAR) Referral Guidelines, the American College of Radiologists (ACR) Appropriateness Criteria, the National Cancer Care Network (NCCN) Practice Guidelines and the Institut National d'Excellence en Santé et Services Sociaux (INESSS) Interactive Tool.

RESULTS

In total, 521 exam requisitions were received from 8 PET/CT centers across Canada with most (435, representing 83%) submitted for oncological investigations, 36 (7%) for neurological conditions, 26 (5%) to investigate infectious/inflammatory processes, and the remaining 24 (5%) for various reasons. The guidelines indicated that 14-31 (3-7%) of the oncological cases were inappropriate, 123-301 (29-69%) were appropriate, and the remaining 118-299 (27-69%) were indeterminate. Among neurological exams, 0-1 (0-3%) were inappropriate, 0-29 (0-81%) were appropriate and 0-36 (0-100%) were deemed indeterminate. Of the infection/Inflammation requests, 0-1 (0-4%) were inappropriate, 0-14 (0-56%) were appropriate, and 11-25 (44-100%) were indeterminate.

CONCLUSION

While the rate of inappropriateness was similar across guidelines, the proportions deemed appropriate and indeterminate varied substantially. These results demonstrate that in addition to the existence of guidelines, further education for referring physicians, as well as development of consensus, integrated guideline assistance and override justification could prove useful.

CLINICAL RELEVANCE/APPLICATION

Insufficient information on requests and lack of guidelines are much more prevalent than inappropriate imaging, further review of PET/CT guideline utility is required.

SSG09-08 Is it Time to Reduce FDG PET Dose to 5 mCi? Findings from an NCI Quick Trial NCT03519659

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S504CD

Participants
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PURPOSE

FDG PET imaging dosing in the US is based on two recommendations, the NCI workshop guidance (10 to 20 mCi FDG (Shankar et al.)) and the FDA packaging label for the production of FDG which allows dosing above 5 mCi. These recommendations have remained unchanged in spite of major PET technology developments. We performed a prospective clinical quick trial aimed to validate equivalency of 5 mCi, low dose FDG PET/CT compared to current standard of care (SOC) FDG PET/CT based on both true low dose and simulated low dose imaging.

METHOD AND MATERIALS

Low dose PET/CT imaging was assessed in 228 whole body PET studies exams, 50% true 5 mCi dosing, 50% simulated by reduced frame time of the SOC. As intraindividual comparison with two dose and scan sessions was not feasible, a matched pair distribution in BMI, gender, and age was accomplished within the desired time frame. All PET acquisitions were performed using time of flight 75 minutes post-injection using 90 seconds per bed position. A subpopulation of 97 patients were imaged on two TOF PET systems in direct succession. The low dose group had a dose of 4.9 mCi +/- 0.4, the matched SOC group 13.0 mCi +/- 0.8. Target lesion SUVmax and visual image quality evaluation were the primary assessment points. Secondary assessments include qualitative and quantitative image quality, uptake in other tissues, diagnostic confidence, and presence/visibility of artifacts. As established in prior studies, optimized image reconstruction was BMI adapted for the low dose data sets.

RESULTS

Assessment of image quality, diagnostic confidence, and image artifacts demonstrates equivalency ($p<.01$) for the dose reduced 5 mCi FDG for whole-body oncologic PET imaging. There was no loss of diagnostic capabilities, even when maintaining an acquisition time consistent with standard of care examinations. We have found that the key is the re-optimization of TOF reconstruction parameters to account for the reduced relative count density.

CONCLUSION

This trial demonstrates the ability to perform oncologic whole-body imaging at the low dose of 5 mCi with high quality and quantitatively equivalent by using TOF optimized, BMI adapted reconstruction at the lower count density without any negative diagnostic impact.

CLINICAL RELEVANCE/APPLICATION

We demonstrate that FDG dose reduction to 5 mCi is feasible in oncologic whole body TOF PET provided that an optimized, BMI adapted reconstruction approach is implemented.

SSG09-09 Accelerating Whole-Body PET Acquisitions Using Deep Learning: External Validation on Foreign Country Data

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S504CD

Participants
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PURPOSE

The goal of this study was to evaluate the use of deep learning to enhance the image quality of 2-fold, 3-fold, and 4-fold accelerated whole-body PET acquisitions.

METHOD AND MATERIALS

Seven subjects (5 males, age: 57±14 years, weight: 81±10Kgs) referred for a whole-body FDG-18 PET/CT scan on a GE Discovery 710 scanner (GE Healthcare, Waukesha, WI) were recruited for this study following IRB approval and informed consent. The standard of care was a 2 min/bed PET acquisition acquired in list-mode. 2-fold, 3-fold, and 4-fold accelerated acquisitions were

synthesized using the first 30s, 40s, and 60s list-mode PET counts of the original 2min acquisition. All accelerated PET acquisitions were enhanced using a FDA-cleared commercially available deep learning software: SubtlePET (Subtle Medical, Menlo Park, CA). Quantitative image quality metrics such as normalized root-mean-squared-error (NRMSE), peak signal to noise ratio (PSNR), and structural similarity (SSIM) were calculated for all enhanced and non-enhanced accelerated PET scans, with the standard 2min acquisition as the ground-truth. Image slices in regions of elevated PET uptake (bladder and brain) were excluded from the analysis. Paired 2-tailed t-tests were computed to evaluate whether the quantitative metrics were superior for the deep-learning enhanced accelerated acquisitions compared to the non-enhanced acquisitions.

RESULTS

NRMSE, PSNR, and SSIM were significantly better ($p<0.001$) for all deep learning enhanced PET scans for all acceleration factors compared to the non-enhanced images (except 2-fold accelerated SSIM, $p<0.05$). All the deep learning enhanced images (2 to 4-fold) demonstrated similar perceptual image quality and lesion conspicuity when compared to standard of care scans. Representative PET images and quantitative metrics are seen in Figure 1.

CONCLUSION

Up to 4-fold faster PET scans can be enhanced using deep learning while maintaining similar image quality and diagnostic accuracy as the standard of care acquisition.

CLINICAL RELEVANCE/APPLICATION

Deep learning can enhance the speed of PET acquisitions for enhancing patient comfort and increasing efficiency and throughput of PET imaging, especially in resource constrained countries.

Printed on: 10/29/20

SSG10

Neuroradiology (Stroke 2)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: N229

ER MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSG10-01 Don't Be Cowed: Bovine Arch and Stroke Laterality

Tuesday, Dec. 3 10:30AM - 10:40AM Room: N229

Participants
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PURPOSE

Left-hemispheric strokes are more frequent and often have a worse outcome than their right-hemispheric counterparts. The present study aims to evaluate whether laterality of cardiogenic cerebral embolization is affected by anatomical characteristics of the aortic arch. We hypothesized that laterality varies between patients with a bovine versus standard arch branching.

METHOD AND MATERIALS

We retrospectively identified 1598 acute cardioembolic strokes in patients with atrial fibrillation from our institutional stroke database (2009-2017). Selecting the first event in each patient yielded 1459 infarcts. Inclusion criteria were an acute anterior circulation ischemic infarct and availability of both arch and brain imaging (MR or CT). Alternative causes of stroke (e.g. >50% intra/extracranial stenosis ipsilateral to the stroke, lacunar infarct, dissection) and anomalous arch were excluded. Imaging was reviewed for stroke characterization and laterality and arch branching pattern. Bovine arch denotes a common origin of the brachiocephalic trunk and the left common carotid artery. Strokes were classified as bilateral, left or right hemispheric. Univariate analysis was performed using Chi square tests.

RESULTS

The final cohort comprised 615 patients, mean age 77 (SD 11.8) with 376 women (61%). The majority were ethnic minorities (33% white, 30% black, remainder mixed/Hispanic). Standard arch (n=424) stroke distribution was left 43.6% (185), right 45.1% (191) and bilateral 11.3% (48). Bovine arch (n=191) stroke distribution was left 51.3% (98), right 35.6% (68) and bilateral 13.1% (25). Bovine arches were associated with more left sided strokes compared with standard arches (p=0.035). Of note, 43% of patients with bovine arch were black and there was an association between black race and bovine arch (p=0.0001).

CONCLUSION

Bovine aortic arch configuration is associated with left hemispheric laterality of cardioembolic stroke.

CLINICAL RELEVANCE/APPLICATION

Our study enriches the understanding that arch anatomy influences stroke laterality and highlights the need for further research into the causative hemodynamic factors.

SSG10-02 Reporting Quality and MR Technical Heterogeneity of Intracranial Vessel Wall MR Imaging: A Systematic Review of the Literature

Tuesday, Dec. 3 10:40AM - 10:50AM Room: N229

Participants
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PURPOSE

A systematic review of the literature was performed to identify studies using vessel wall MR imaging (VWI) to study intracranial vasculopathies. A qualitative synthesis of each study and an assessment of MR technical heterogeneity and reporting quality was conducted.

METHOD AND MATERIALS

PubMed, MEDLINE and EMBASE databases were searched up to September 2018 using inclusion/exclusion criteria for studies assessing intracranial vasculopathies with VWI. Two independent reviewers screened potential studies and extracted data. Foreign language articles were translated. The 22-point Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline was used to appraise reporting quality of analytic observational studies by calculating a Complete Reporting Score (CRS=yes/[yes+no]) for each study; criteria were scored as 'yes' if reporting was fulfilled. Scores of each manuscript section (introduction, methods, results, discussion) were also assessed. Inter-rater agreement was summarized by a Cohen's kappa (κ). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline was used.

RESULTS

Among 2431 articles, 79 met the inclusion criteria. Work was contributed most frequently from Asia (68%, n=54), received federal funding (62%, n=49), was retrospective (52%, n=42), and designed as analytic observational studies (51%, n=40). Intracranial atherosclerosis (ICAD) was the most commonly studied intracranial vasculopathy (52%, n=41). Considerable MR technical heterogeneity in magnet strength (range: 0.5T to 7T), spatial resolution (in-plane voxel size range: 0.11 to 1.27), and MR protocol was present with postcontrast imaging performed in 62% (n=49) of the exams. Among the 40 analytic observational studies, the overall mean STROBE CRS was 0.64 (range= 0.32-0.82); the introduction section had the strongest mean reporting score (CRSIntro=0.99) compared to the methods section, which emerged as the weakest (CRSMethods=0.53).

CONCLUSION

Assessment of the literature showed considerable MR technical heterogeneity in MR imaging methods. Among the analytic observational studies, the completeness of reporting based on STROBE guidelines, was variable.

CLINICAL RELEVANCE/APPLICATION

Reducing the heterogeneity of MR protocols in VWI studies and more consistent adherence to STROBE guidelines should maximize effective synthesis and clinical translation of findings for intracranial vasculopathies.

SSG10-03 Radiomic Analysis on Symptomatic Intracranial Atherosclerotic Plaque Using High Resolution MRI

Tuesday, Dec. 3 10:50AM - 11:00AM Room: N229

Participants
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PURPOSE

This study aims to evaluate a quantitative radiomic approach based on High-resolution magnetic resonance imaging (HR-MRI) to differentiate symptomatic intracranial artery plaque from asymptomatic plaque.

METHOD AND MATERIALS

This study retrospectively analyzed 158 patients with middle cerebral artery (MCA) and basilar artery (BA) stenosis underwent HR-MRI between September 2013 and October 2016. Atherosclerosis plaques from MCA and BA were extracted as the region of interest (ROI) for quantitative evaluation. The stenosis value, plaque area/burden, lumen area, intraplaque hemorrhage (IPH), contrast enhancement ratio and 109 quantitative radiomic features were extracted and compared between symptomatic and asymptomatic patients. Univariate analysis was applied first to find possible variable that was associated with symptoms. Student t-test or two-sample Wilcoxon test was used if the variable was/was not normally distributed. P-values <0.05 were considered as statistical significant. Multi-variate logistic analysis and a random forest model were used to evaluate the diagnostic performance.

RESULTS

A total of 158 patients met the inclusion criteria. There were 75 acute, 36 sub-acute symptomatic patients, and 47 asymptomatic patients. Smoking (odds ratio [OR]=2.724; 95%CI,1.200-6.183), IPH (OR=11.340; 95%CI, 1.441-89.221) and enhancement ratio (OR=6.865; 95%CI, 1.052-44.802) were independently associated with symptomatic plaques. The combined smoking, IPH and enhancement ratio had an area under the curve (AUC) of 0.714 for identifying symptomatic plaques. Radiomic features in T2, T1 and CE-T1 images were associated with symptomatic plaques , whose AUC respectively are 0.801,0.835 and 0.846. The combined all radiomic approach had a significantly higher AUC of 0.953. Combination of all features reached an AUC of 0.976, with accuracy

of 87.4%. (Figure-1)

CONCLUSION

Radiomic analysis of intracranial artery plaque on HR-MRI accurately distinguished between plaques in patients who were symptomatic and plaques in patients who were asymptomatic. The highest accuracy was achieved by combining radiomic features with traditional assessment of clinical and morphological features.

CLINICAL RELEVANCE/APPLICATION

The favorable accuracy values in this study over those previously reported by conventional HR-MRI support the use of radiomic analysis to improve identification of acute symptomatic plaque.

SSG10-04 Arterial Transit Artefacts on ASL Perfusion-Weighted MRI in Patients with Carotid Artery Stenosis are a Better Predictor of Recent Symptoms than Degree of Stenosis or Carotid Plaque Morphology

Tuesday, Dec. 3 11:00AM - 11:10AM Room: N229

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PURPOSE

Using comprehensive advanced MR imaging at 3T, including carotid plaque imaging and ASL perfusion MR, we aim to identify parameters that best distinguish between asymptomatic and symptomatic carotid stenosis, and to gather new evidence regarding the mechanisms causing clinical symptoms.

METHOD AND MATERIALS

We recruited patients with ICA stenosis participating in ongoing trials, who had ASL and carotid plaque imaging in the same sitting. Patients were assessed clinically for recent symptoms of TIA or stroke. MR images were analysed for the degree of stenosis, plaque morphology, presence of intraplaque haemorrhage (IPH), collateral circulation of the circle of Willis, presence and severity of arterial transit artefacts (ATAs). We used t-test and Fisher's exact test to investigate which features were associated with symptomatic status.

RESULTS

44 patients met the inclusion criteria, 22 of these were symptomatic. ATAs were only seen in patients with a >70% stenosis (p for association <0.001), and were associated with the configuration of the circle of Willis (p=0.001), particularly the absence of anterior communicating artery (ACOM) (p=0.003). Associations between symptoms and degree of stenosis, IPH, and plaque surface morphology were non-significant. However, patients with ATAs (n=16) were significantly more likely to be symptomatic than those without ATAs (n=28) (p=0.004). Symptomatic status correlated further with the severity of ATAs (p=0.002).

CONCLUSION

ATA was the only predictor of recent ischaemic symptoms in patients with carotid stenosis.

CLINICAL RELEVANCE/APPLICATION

Haemodynamic factors play a greater role in the mechanism of TIA and stroke associated with carotid stenosis of >70% than currently appreciated.

SSG10-05 Susceptibility-Weighted Imaging in Hyperacute Phase of Ischemic Stroke

Tuesday, Dec. 3 11:10AM - 11:20AM Room: N229

Participants
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PURPOSE

Using a large animal experimental middle cerebral artery occlusion model, this work sought to determine if there was a significant change in the SWI signal intensity on regions of interest drawn in the penumbra and ischemic core based on perfusion and diffusion-weighted imaging.

METHOD AND MATERIALS

Eight mongrel canines (20-30kg) underwent permanent endovascular occlusion of an M1 segment of the middle cerebral artery (MCA) and acute ischemic stroke MR imaging. Anesthesia was chosen so as not to influence cerebrovascular reactivity. MRI was

acquired on a 3 Tesla unit (Achieva, Philips Healthcare, Best, Netherlands) and included susceptibility- weighted imaging (SWI), diffusion-weighted imaging (DWI) with the corresponding apparent diffusion coefficient (ADC) maps, and perfusion imaging. Susceptibility- weighted imaging was acquired within the first 60 minutes of MCA occlusion. The signal intensity was calculated on SWI images using Image J software (National Institutes of Health, Bethesda, Maryland). Regions of interests (ROI) were drawn manually on the infarct core, penumbra, and deep gray matter and was compared to that of the corresponding contralateral side. The infarct core was selected based on the hypointense areas on the ADC maps, penumbra chosen based on the perfusion imaging and identified by the defect between the ADC abnormality and the perfusion defect. The normality of data was assessed using the Shapiro-Wilk W test.

RESULTS

The median (interquartile range) of signal intensity on the infarct core (374.6 (366.5-393.6), vs. 432.6 (412.3-448.2), P-value<0.0001), and on the penumbra (433.7 (407.6-458.9) vs. 491.6 (467.6-510), P-value<0.0001) was significantly lower than signal intensity on their uninvolved contralateral side. The mean ± SD of signal intensity was also significantly lower on deep gray matter compared to the uninvolved contralateral side (418.1 ± 44.89 vs. 464.5± 42.61, P-value<0.0001).

CONCLUSION

Signal intensity significantly drops during the hyperacute phase of MCA occlusion in the infarct core, penumbra, and deep gray matter comparing to the contralateral side. Presumably, this is a result of deoxyhemoglobin effect and venous vasodilation in the early stages of ischemia.

CLINICAL RELEVANCE/APPLICATION

Susceptibility- weighted imaging could possibly be used as a fast and noninvasive imaging to predict cerebral hemodynamic changes.

SSG10-06 Improvement of the Diagnostic Performance for Brain Hemorrhage Using Deep Learning-based Computer-Aided Detection System

Tuesday, Dec. 3 11:20AM - 11:30AM Room: N229

Participants
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PURPOSE

To elucidate the diagnostic performance with deep learning-based computer-aided detection (CAD) for non-expert and expert doctors in detecting cerebral hemorrhage from head CT.

METHOD AND MATERIALS

40 head CT datasets were evaluated by 15 doctors (5 board certificated radiologists, 5 radiology residents, and 5 interns). The CT datasets have 16 normal and 24 hemorrhagic patients with 48 intracranial hemorrhagic lesions including 5 types of cerebral hemorrhages: extradural hematoma, subdural hematoma, intracerebral hemorrhage, subarachnoid hemorrhage, and intraventricular hemorrhage. The doctors attended 2 reading sessions: diagnosing without and with CAD (more than a week between 2 reading sessions). All doctors annotated the hemorrhagic regions and gave them the degree of confidence on a scale of one to ten. Our CAD system was developed with 522 patients' head CT which consist of 242 normal (5,929 slices) and 280 hemorrhagic patients (2,899 slices), and detection results were displayed as corresponding probability heat maps using U-Net and a machine learning-based false-positive removal method. The normal and hemorrhagic patients were randomly split into training (90%) and validation (10%) datasets and used for constructing CAD. Sensitivity, specificity, and accuracy were evaluated using a paired t test. In addition, a figure of merit (FOM) derived from the jackknife free-response receiver operating characteristic were evaluated.

RESULTS

The mean accuracy of all doctors with patient-based evaluation significantly increased from 83.7% to 89.7% ($p<0.01$) by using CAD. In addition, the accuracies of board certificated radiologists, radiology residents, and interns showed 92.5%, 82.5%, and 76.0% (without CAD) and 97.5%, 90.5%, and 81.0% (with CAD), respectively. The rate of increase of the mean accuracy for non-expert doctors was 6.5%; it was greater than that for expert doctors (5.0%). The mean FOM of all doctors increased from 0.78 to 0.82 ($p<0.05$) by using CAD.

CONCLUSION

The diagnostic performance and confidence of intracranial hemorrhage detection improved among all doctors, especially for non-expert doctors by using CAD.

CLINICAL RELEVANCE/APPLICATION

Our CAD software could improve the diagnostic performance of all doctors in detecting hemorrhage from head CT and reduce the missed reports of faint or small hemorrhage, especially for non-expert doctors.

SSG10-07 Deep Learning Model to Predict Patient Outcome in ICH Using Fluid-Attenuated Inversion Recovery Imaging Data

Tuesday, Dec. 3 11:30AM - 11:40AM Room: N229

Participants
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PURPOSE

Timely and accurate outcome prediction in intracerebral hemorrhage (ICH) patients is important for optimizing rehabilitation strategy. The objective of this study was to investigate if a deep neural network model can predict recovery outcome in patients with ICH at 3 months using T2-weighted fluid-attenuated inversion recovery (FLAIR) imaging data.

METHOD AND MATERIALS

A convenience sample of 53 left thalamocapsular ICH patients (hemorrhagic volume < 20cc; mean age = 52.4 yrs) were included from the Ethnic/Racial Variation in Intracerebral Hemorrhage (ERICH) study. T2-weighted FLAIR data were acquired using clinical protocols in this multicenter cohort. A deep learning model was trained to identify patients likely to have unfavorable outcomes, defined as 3-month modified rankin scale (mRS) score 3-6. As shown in Figure 1, we employed a pre-trained VGGNet-19 model as a feature generator to learn high-level features from input FLAIR images. We then built a convolutional neural network (CNN) classifier based on the high-level features to identify the patients with unfavorable outcomes. Rotation and shift-based data augmentation strategy was implemented to increase the training samples by 20 times (but not testing samples). Performance was evaluated using 5 fold cross-validation with the metrics of accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC).

RESULTS

Our model was able to correctly identify patients likely to have unfavorable outcomes with an accuracy of 81.8% (95% confidence interval: 80.7%, 82.9%), AUC of 0.82 (0.80, 0.83), sensitivity of 90.6% (89.6%, 91.6%) and specificity of 72.6% (70.1%, 75.1%).

CONCLUSION

This work demonstrates the feasibility of deep learning approach for predicting outcomes of ICH patients using only FLAIR imaging data with a promising accuracy. Future model improvements will include the incorporation of clinical data. A larger multidimensional study is important to validate our approach.

CLINICAL RELEVANCE/APPLICATION

Deep learning model on FLAIR imaging data can identify ICH patients likely to have unfavorable outcome. Such prognostic model can potentially help with the treatment decision and rehabilitation strategy optimization.

SSG10-08 Microstructural ASYmmetry (MASY) of DTI in Stroke Reveals Interaction Effect of Sex and Clinical Covariates

Tuesday, Dec. 3 11:40AM - 11:50AM Room: N229

Participants
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PURPOSE

Microstructural investigation of stroke is one of the flagship clinical applications of diffusion tensor imaging (DTI). The purpose of this work was to examine the interaction effect of sex and clinical scores on stroke microstructure measured using DTI. It was hypothesized that using the microstructural *difference* between the contra and ipsilesional regions would be statistically more powerful than using the microstructural measures within the lesion. It was further hypothesized that considering the *distributional difference* of their microstructure, instead of the difference between their averages, would be more sensitive in gleaning this effect.

METHOD AND MATERIALS

Diffusion weighted MR images on n=16 subjects (ages: 52.8+/-14.5(n=6 females), 62.4+/-14.1(n=10 males)) were acquired with a b-value of 2000 s/mm2 along 56 unique non-colinear gradient directions, in addition to 10 non-diffusion weighted (b=0) images. Preprocessing was performed using FSL's eddy to remove distortions from eddy currents and motion. The analysis was performed using the four main (DTI) measures: fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD) and radial diffusivity (RD) and two clinical covariates: the ratio of acute time period to age and normalized verbal fluency (corrected for age and education) at the time of MRI. The acute time period is the number of days between MRI visit and stroke onset. A linear model that

includes the interaction effect of sex and clinical covariates was fit for each of the following dependent variable: (1) average DTI in the acute ipsilesion mask, (2) difference between the average DTI in contra and ipsilesional masks and (3) *microstructural asymmetry (MASY)* computed using symmetrized Kullback-Leibler divergence between DTI distributions of contra and ipsilesional masks. The p-values for the interaction effect from the models were reported.

RESULTS

The main results are summarized in Figure 1. The microstructural features were positively correlated with acute time period ratio and inversely correlated with verbal fluency.

CONCLUSION

The relationships between clinical scores and microstructural asymmetry of DTI in stroke were more pronounced in males compared to females.

CLINICAL RELEVANCE/APPLICATION

(delaing with interaction effects in stroke microstructure) '*Distributional difference approach* is recommended for greater statistical sensitivity to relationships between clinical scores and imaging.'

SSG10-09 High Definition Imaging Reduces Procedure Time Without Impacting Patient Dose in Image-Guided Neuro Interventional Procedures

Tuesday, Dec. 3 11:50AM - 12:00PM Room: N229

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PURPOSE

To quantify the clinical impacts and radiation dose of a novel fluoroscopic x-ray detector that combines high definition (Hi-Def) crystalline-Si imaging modes with 76µm pixels and high efficiency amorphous-Si imaging modes with 194µm pixels.

METHOD AND MATERIALS

DICOM Radiation Dose Structured Report (RDSR) data was collected for all neurointerventional procedures performed before and after installation of the Hi-Def detector at a single center over a 32 month period. There were 1,702 pre- and 2,499 post-Hi-Def cases with over 390k irradiation events in total. A real-time patient skin dose tracking system was used to monitor peak skin dose during the Hi-Def cases. A two-sample student's t-Test analysis was performed to compare various technical parameters included in the RDSR before and after installation of the new Hi-Def technology. To further investigate any potential impacts on radiation dose, cumulative air kerma, dose area product and peak skin dose were plot as a function of Hi-Def utilization as a percentage of the total number of irradiation events.

RESULTS

Hi-Def modes were used in more than 50% of the most complicated cases defined as having procedure times lasting more than 90 minutes. Improved visualization capabilites were demonstrated especially during device deployment and manipulation. Average procedure time and the total number of irradiation events were both significantly reduced by 9% ($p < 0.01$). Average fluoro time, number of CBCT scans and cumulative air kerma were trending lower (5-10% less) but not yet reaching statistical significance ($0.05 < p < 0.16$). Peak skin dose data was available for 1,518 cases with 97.7% and 99.5% of cases below 3Gy and 5Gy, respectively. No correlation was observed ($R2 < 0.10$) using a best of all fits for all dosimetric indications as a function of Hi-Def utilization.

CONCLUSION

Preliminary results from over 4,000 neurointerventional procedures at a single center demonstrate that the improved spatial resolution of the Hi-Def detector may result in reduced procedure time and number of irradiation events. In addition, there was no observable increase in patient dose with the utilization of the Hi-Def detector.

CLINICAL RELEVANCE/APPLICATION

This is the first study investigating clinical benefits of a new detector that can provide more than 2x the spatial resolution of any other clinically available technology and no patient dose penalty.

SSG11

Neuroradiology (Cognition/Memory)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: N230B

NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSG11-01 Cerebral Lobar Volume: Concordance of Visual and Quantitative Assessment

Tuesday, Dec. 3 10:30AM - 10:40AM Room: N230B

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PURPOSE

To assess concordance of visual and quantitative assessment of individual cerebral lobe volume. The inter-rater agreement in visual assessment is very low. There however are variations in assessment based on individual interpreting radiologists experience that can have implication particularly with the availability of dedicated softwares. Our study intends to evaluate the rate of concordance amongst radiologists of varying experience and the quantitative assessment software in assessing the age-appropriateness of individual lobe volumes.

METHOD AND MATERIALS

MRI brain of mild cognitive impairment patients for quantitative volumetric assessment were retrospectively reviewed by three Neuroradiologists of varying experience. Axial T2, Axial FLAIR, Sagittal 3D-T1 were utilized to rate lobar volume as age-appropriate or low (below 25th percentile). The data was compared to software results. Concordance was assessed for each individual eight lobes, and defined as agreement amongst all neuroradiologists and software data, whether age-appropriate or low.

RESULTS

Concordance of lobar volumes of the reviewed pilot data of 25 patients was only 70 lobes out of the 200 lobes(35%). Highest concordance in right occipital lobe(13/25; 52%), and lowest in both frontal lobes(6/25; 24%) was noted. Whereas concordance for low-volume for age was 50%(32/64), that for age-appropriate volume was surprisingly low(38/136; 28%). For the low-volume for age, left parietal lobe had maximum(6/8; 75%) and left occipital lobe had minimum concordance(0/3). Amongst age-appropriate volume, right occipital lobe had maximum(12/23; 52%) and the left frontal lobe had minimum concordance(1/16; 0.06%).

CONCLUSION

While it has been thought that assessment of low for age overall brain volume can have significant individual variation, our pilot data suggests that the assessment of age-appropriate lobar volume may have much more individual variation, especially when compared to available quantitative tools.

CLINICAL RELEVANCE/APPLICATION

Identifying the cerebral lobes that are more vulnerable to escape accurate volume assessment, may help in appropriately establishing patterns of lobar volume loss which are important in classifying different dementia types. Additionally, this may promote appropriate labelling of age-appropriate brain volume by radiologists, which otherwise may lead to misdiagnosis and potential social, family, insurance or employment implications.

SSG11-02 The Right Hippocampus Cornus Ammonis 1 Region for Alzheimer's Disease Diagnosis Based on Simultaneous 18F-FDG PET/fMRI Study

Tuesday, Dec. 3 10:40AM - 10:50AM Room: N230B

Participants
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PURPOSE

Hippocampal dysfunction is an early hallmark of Alzheimer's disease (AD) and the hippocampus subfield cornus ammonis (CA1) region is a selectively affected functional region in AD-related neuropathology. We aimed to compare hybrid fluorine 18 (18F) fluorodeoxyglucose (FDG) PET/MR CA1 global functional connectivity (gFC) and hypometabolism in distinguishing patients with AD and mild cognitive impairment (MCI) from normal control (NC) participants.

METHOD AND MATERIALS

We simultaneously acquired resting-state functional MRI (rs-fMRI) and 18F-FDG PET data from patients with AD (n=18), MCI (n=29) and NC (n=27) using hybrid PET/MR. The gFC of the bilateral CA1 regions was computed through seed-based resting-state fMRI correlations through each voxel in the gray matter. 18F-fludeoxyglucose (FDG)-PET metabolism in the CA1 regions was scaled by the mean standard uptake value of the cerebellum. Model was analyzed with sensitivity, specificity and receiver operating characteristic (ROC).

RESULTS

Analyses revealed decreased CA1 metabolism in patients with AD and MCI compared with NC participants both in the right and left CA1 regions. In addition, a higher right CA1 gFC was associated with lower hypometabolism and higher Mini-Mental State Examination score specific in AD not the left. In the right CA1 region, the 18F-FDG PET biomarker achieved larger area under the receiver operating characteristic curve (AUC) of 0.94 (0.86-1.00) (100% specificity, 77.78% sensitivity) in discriminating AD patients from NC than rs-fMRI (AUC of 0.90 (0.79-1.00), 96.3% specificity, 83.3% sensitivity). In MCI patients, the rs-fMRI biomarker achieved larger AUC of 0.788(0.669 to 0.907)(77.78 specificity, 65.52 sensitivity) in discriminating MCI patients from NC than 18F-FDG PET (AUC of 0.710 (0.571-0.849), 74.07% specificity, 72.41% sensitivity).

CONCLUSION

By using hybrid PET/MR, 18F-FDG PET demonstrated hypometabolism in right CA1 region higher specificity but lower sensitivity than rs-fMRI in discriminating AD from NC. However, rs-fMRI had higher sensitivity in distinguishing MCI from NC compared with the 18F-FDG PET hypometabolism.

CLINICAL RELEVANCE/APPLICATION

(dealing with functional MR and FDG PET)18F-FDG PET demonstrated quantitative hypometabolism in right CA1 region has higher specificity than rs-fMRI in distinguishing AD from NC. However, when distinguish MCI from NC, rs-fMRI had higher sensitivity compared with 18F-FDG PET hypometabolism.

SSG11-03 'ERICA' Score and Posterior Cingulate and Pre-Cuneus ASL Perfusion in Differentiating Mild Cognitive Impairment and Dementia due to Alzheimer's Disease

Tuesday, Dec. 3 10:50AM - 11:00AM Room: N230B

Participants
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PURPOSE

The aim of this study was to test the diagnostic utility of 'ERICA' (Entorhinal Cortical Atrophy) score along with measured cerebral blood flow (CBF) in the posterior cingulate and precuneus using pseudo-continuous ASL in differentiating patients with mild cognitive impairment (MCI) and Alzheimer's Dementia (AD).

METHOD AND MATERIALS

MR imaging of a prospectively recruited, age-matched groups of subjects, 21 cognitively normal healthy controls (HC), 20 MCI and 19 AD patients were analysed. 'ERICA' score is a 4 point atrophy rating scale of parahippocampal gyrus, from 0 to 3, where 0 indicates no evidence for atrophy of the entorhinal cortex and 3, marked atrophy. ERICA score was determined by 2 independent neuroradiologists and an atlas based estimation of CBF in the posterior cingulate and precuneus (PCG +PC) with ASL was done in all the three groups. Statistical comparison was performed between the groups for disease prediction probability with these parameters independently and in combination using a binary logistic regression model.

RESULTS

ERICA score performed well in distinguishing AD from HC, with predicted probability of 0.887 (area under the curve, P< 0.001). The mean CBF of PCG + PC also predicted this (AUC 0.810, P= <0.001). Combining the ERICA score and ROI CBF was the best marker for distinguishing AD from HC with the predicted probability of 0. 957(area under the curve, P< 0.001). In distinguishing between MCI and AD also ERICA score did well with an AUC of 0.838 (P< 0.001). However regional CBF was not useful in differentiating these two groups (AUC= 0.589, (P= 0.339). Combining ERICA and CBF marginally decreased the predictability by ERICA alone (AUC= 0.829, P< 0.001). ERICA scored poorly in distinguishing between MCI and HC (AUC= 0.571, P= 0.493). Here regional CBF fared well, with an AUC of 0.776 (P=0.002). Combining ERICA and CBF marginally improved the predictability (AUC= 0.781, P= 0.002).

CONCLUSION

ERICA score performed well in distinguishing between AD- HC and AD- MCI, but not in differentiation of MCI- HC. Regional CBF in

PCG + PC independently predicted MCI from HC and AD from HC but not between AD and MCI. Combining both ERICA and regional CBF helped in distinguishing between all the three groups.

CLINICAL RELEVANCE/APPLICATION

ERICA + regional ASL score may be better than ERICA score alone in differentiating MCI from AD

SSG11-04 APOE4 is Associated with BBB Permeability Change in Cognitive Impaired Subjects: A Prospective Study Using DCE MRI

Tuesday, Dec. 3 11:00AM - 11:10AM Room: N230B

Participants
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PURPOSE

We hypothesized that subtle BBB damage would be observed in patients with mild cognitive impairment (MCI) depending on the status of APOE4 mutation, by comparing the BBB permeability seen in DCE-T1WI of MCI patients with that of normal controls.

METHOD AND MATERIALS

In this study, 26 patients (mean age, 70.9 ± 6.8 years) with clinically diagnosed MCI and 27 cognitively normal control subjects (mean age, 64.1 ± 5.8 years) underwent DCE-T1WI with gadobutrol and 10 min acquisition time. We processed the DCE data to generate permeability map. Concentration of the contrast in tissue was calculated by using relative signal change and T1 mapping. Vascular input function was generated from superior sagittal sinus by semiautomatic method in Nordic ICE software. For calculating the tissue permeability, we used Patlak model to generate the permeability parameter, K trans. Student t-test and chi-square test was performed for parametric and non-parametric variables, respectively. In addition, the analysis of co-variance (ANCOVA) was performed with an age as a covariate for K trans.

RESULTS

The patient group was older than the normal control group ($p<0.001$). The patient group showed lower MMSE score compared to the control group (25.8±2.7 vs 27.9±1.9, respectively, $P=0.003$). Patients with MCI demonstrated increased Ktrans in the left fronto-parietal white matter ($p=0.033$), right and left temporal white matter ($p=0.004$ and $p=0.006$), right and left hippocampi ($p=0.023$ and $p=0.028$). Even after controlling for age as a covariate, left fronto-parietal white matter ($p=0.025$), right and left temporal white matter ($p=0.011$ and $p=0.018$, respectively), left hippocampus ($p=0.030$) showed the higher Ktrans (increased BBB permeability) in MCI group. In a subgroup analysis of subjects with known APOE status ($n=26$), there was a tendency of increased Ktrans of right hippocampus and right temporal white matter depending on the presence of APOE4 mutation, but not with statistical significance ($p = 0.069$).

CONCLUSION

BBB permeability is increased in MCI subjects as compared to normal control subjects. BBB permeability increase in MCI shows spatial predilection in hippocampus and temporal white matter, which may contribute to cognitive decline as in AD.

CLINICAL RELEVANCE/APPLICATION

Our study indicates that DCE-MRI with K trans mapping can be an early imaging marker for representing underlying BBB breakdown in the cognitively impaired subjects.

SSG11-05 Regional Variation in Interhemispheric Functional Connectivity (IFC) for Different Types of Dementia: A Resting State fMRI Study

Tuesday, Dec. 3 11:10AM - 11:20AM Room: N230B

Participants
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PURPOSE

To explore Interhemispheric functional connectivity (IFC) in patients of Alzheimer's disease (AD), Mixed Dementia (MD), Vascular Dementia (VD) and Subjective Cognitive Decline (SCD) based on Default Mode Network (DMN), Salience Network (SN) and Executive Control Network (ECN) with Heathy control (HC). The IFC was analyzed using voxel-mirrored homotopic connectivity (VMHC).

METHOD AND MATERIALS

75 participants (25 HC, 21 AD, 6 MD, 18 VD and 6 SCD) were recruited to undergo MRI scanning using Siemens 3T scanner. All

participants were asked to remain quiet and relax during the scan, with their eyes closed but not to fall asleep. Resting state functional images were acquired using echo-planning imaging (EPI) technique. The fMRI images were preprocessed by SPM12 with Mathlab 2018a. It included elimination of the first 10 time points, slice timing correction and head motion correction. For VMHC, we adopted the method of calculation used by Kelly et al 2011 and Zuo et al 2010. VMHC map was obtained. T-test was performed by SPSS (v.25.0) to compare each group with HC.

RESULTS

AD group showed significant lower VMHC values in DMN (T=-2.48 to -3.49, p<0.05) than that of HC. For SCD group showed significant higher VMHC values in SN (T=+2.68 to +4.336, P<0.05) and ECN (T=+2.537 to +3.203, P<0.05) than HC. For MD, significant higher VMHC values was found in SN (T=+2.743 to +4.464, p<0.05) but lower VMHC values in other networks (T=-2.989 at mid temporal gyrus to -4.487 at lateral occipital cortex, p<0.05). For VD group, VMHC values was significantly lower in DMN (T= -2.942 to -3.065, p<0.05) than that of HC, while having higher VMHC values in ECN (T=+2.502 to +3.540, P<0.05).

CONCLUSION

Resting state fMRI showed different patterns in interhemispheric functional connectivity for AD, VD, MD, and SCD groups when comparing to HC group based on the DMN, SN, and ECN. Consistent with other studies, AD showed decreased IFC in all three networks. While for VD and MD, coexistence of decreased and increased IFC among three networks. The result suggested that recruitment of other brain regions as adaptations to compensate for the reduced IFC.

CLINICAL RELEVANCE/APPLICATION

Characterization of different types of dementia, including AD, MD, VD and SCD by IFC using resting state fMRI. Resting state fMRI can be a non-invasive tool for early diagnosis of dementia.

SSG11-06 Blood-Brain Barrier Opening in the Hippocampus and Entorhinal Cortex Using MR-Guided Focused Ultrasound in Patients with Alzheimer's Disease

Tuesday, Dec. 3 11:20AM - 11:30AM Room: N230B

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PURPOSE

Alzheimer's disease (AD) is the most common cause of dementia and has no effective treatment. MR-guided low intensity focused US (LIFU) has been shown to reversibly open the blood-brain barrier (BBB), reduce amyloid-ß plaque burden, improve memory and allow for targeted drug and stem-cell delivery in animals. As a proof of concept, a recent phase I clinical trial demonstrated safe and temporary opening of the BBB with LIFU in the dorsolateral prefrontal cortex in 5 patients with AD. We report initial results and MRI findings of a phase II trial, which is currently in progress to assess safety and efficacy of BBB opening within the hippocampus and entorhinal cortex at sites of abnormal amyloid burden in patients with early AD.

METHOD AND MATERIALS

Inclusion criteria of this phase II Insightec-sponsored and FDA/IRB-approved trial includes early stage AD and amyloid-PET positivity. Three successive treatments were administered to two female patients (aged 61 and 73 years) at two week intervals. Treatments consisted of stereotactic headframe placement followed by MR-guided LIFU sonication with 220kHz using the ExAblate Neuro Type 2 system and concomitant IV microbubble (Definity®) bolus injection. Three sonication targets in the right (first patient) and left (second patient) hippocampus/entorhinal cortex, were targeted based on anatomy and amyloid burden.

RESULTS

Post-sonication brain MRI revealed immediate IV contrast enhancement within the targeted hippocampus/entorhinal cortex and adjacent subcortical regions (figure), indicating BBB opening focally within treated areas. Resolution of contrast enhancement, indicating BBB closure, was observed at each parenchymal target within 24 hours. There were no clinical or radiologic treatment-related adverse effects. A distinctive perivascular pattern of enhancement and FLAIR hyperintensity was consistently observed.

CONCLUSION

This report of the first two patients to undergo MR-guided LIFU sonication of the hippocampus/entorhinal cortex for AD demonstrates safe, precise, reversible, and reproducible BBB opening in the hippocampus/entorhinal cortex, and a distinctive postsonication MR imaging pattern.

CLINICAL RELEVANCE/APPLICATION

Preliminary results of the first two patients to undergo MR-guided LIFU sonication of the hippocampus/entorhinal cortex for AD demonstrates safe and reversible targeted BBB opening with no adverse effects.

SSG11-07 Using Convolutional Neural Networks to Determine the Impact of White Matter Hyperintensities on

Cognitive Performance

Tuesday, Dec. 3 11:30AM - 11:40AM Room: N230B

Participants
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PURPOSE

Some degree of ischemic damage to white matter tracts is common in older adults; this damage is visible on magnetic resonance imaging (MRI) as focal or confluent white matter hyperintensities (WMH). Although growing evidence suggests links between WMH and Alzheimer's disease, the effects of WMH on cognition are unclear. Convolutional neural networks (CNN) have proven useful in image analysis in different domains. We compared the usefulness of CNN and Fazekas' visual rating scale for determining whether WMH burden is related to cognitive impairment.

METHOD AND MATERIALS

We studied 418 healthy participants (mean, 66.67±7.96 years [range, 50-96 years]) consecutively recruited for a population-based study of aging. All imaging studies were obtained on a 1.5 T MRI system (Vantage Elan, Canon Medical Systems, Japan). CNNs were used to assess WMH volume, mean distance, number, and mean entropy. Two radiologists also rated WMHs on Fazekas' scale. Cognitive performance was evaluated with Symbol Digit Modalities Test (SDMT), Verbal Fluency Test, Semantic Verbal Fluency Test (SVFT), Delayed Free Recall, Digit Span Test (forward), and Stroop Color and Word Test (SCWT). Multivariate linear regression models were adjusted to assess the association between WMH measured by the Fazeka's scale or the CNN approach on several neuropsychological tests. Standardized beta coefficients and coefficients of determination were estimated. All models were adjusted by age, gender, scholarship and cerebral volume.

RESULTS

WMH burden was associated with SDMT, SCWT, and SVFT. In all models, compared to visual rating with Fazekas' scale (R2SDMT=0.464, ß= -0.085, P=0.020), CNN-metrics found that WMH burden was a more significant contributor to information processing (R2SDMT=0.478, ßmean entropy= -0.233, P<0.001), executive function (R2SCWT=0.306, ßmean entropy= -0.416, P<0.001; ßmean distance= 0.154, P=0.005), and verbal functioning (R2SVFT=0.186, ßmean entropy= -0.223, P-value=0.013; ßlesion number= 0.215, P-value=0.012; ßlesion volume= 0.241, P-value=0.040).

CONCLUSION

Our results suggest the impact of WMHs on cognitive performance can be better assessed by CCN than by conventional visual rating.

CLINICAL RELEVANCE/APPLICATION

CNN-based quantification could be useful to characterize the pathology of cerebral small vessel disease that affects the vasculature of white matter tracts, subcortical structures and cognitive performance.

SSG11-08 Brain Network Alterations in Subjects with Smartphone Dependence

Tuesday, Dec. 3 11:40AM - 11:50AM Room: N230B

Participants
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PURPOSE

Smartphone dependence (SPD) is regarded as a psychological problem on the rise, yet the underlying neural substrates of SPD are still not clear. In this study, a functional network analysis based on a resting state BOLD fMRI was used to investigate the changes of brain connectivity and hub functions in young adults with SPD.

METHOD AND MATERIALS

Forty-nine right-handed young adult volunteers were recruited and subsequently placed in the control or SPD group depending on the score obtained in the Mobile Phone Addiction Tendency Scale (MPATS). The fMRI scanning was conducted on a 3.0-Tesla Siemens Skyra MRI System with a 32-channel phase array head coil. A gradient echo T2*-weighted pulse sequence was used. Functional image preprocessing was conducted using SPM8 under a typical pipeline. Voxel-wise degree centrality was calculated and group comparisons of DC measures were performed. Functional network construction and statistical analysis was performed using GRETNA toolbox. The interregional connectivity was calculated using the Pearson correlations between the regional mean time series of all possible pairs of the 90 brain regions. A two-sample t test was conducted for all possible connections represented in the correlation metrics between the patients and controls.

RESULTS

Subjects with SPD, showed decreased DC in right rostral middle frontal gyrus, bilateral superior frontal gyrus, and bilateral medial orbitofrontal cortex. Compared with other healthy controls, 30 connections showed significant decrease in positive connections in SPD, including intrahemispheric connections between temporal and parietal regions, frontal and parietal regions, regions within occipital lobe, as well as interhemispheric connections between temporal and parietal regions, frontal and parietal regions. The most significantly altered connections involved on one hand the left inferior temporal gyrus and right superior parietal gyrus, and on the other the left hippocampus and right posterior cingulate gyrus. The result demonstrates that SPD is characterized by the impairment of network connections and hub functions in the brain regions involved in visual processing, somatosensation, attention span & memory, and behavior control.

CONCLUSION

Functional network analysis based on a resting state BOLD fMR offers a new approach to understanding brain changes in subjects with SPD.

CLINICAL RELEVANCE/APPLICATION

Brain network alterations in subjects with SPD

SSG11-09 Brain Connectivity in Tobacco Dependent Patients: Correlations of the Default Mode Network with the Smoking Cessation Outcome after Neurofeedback Assisted Therapy

Tuesday, Dec. 3 11:50AM - 12:00PM Room: N230B

Participants
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PURPOSE

The aim of the study was to explore the potential of resting state functional connectivity (rsfc) MRI for predicting the succees of smoking cessation in patients with tobacco dependence after group psychotherapy and realtime(rt)-fmri neurofeedback training.

METHOD AND MATERIALS

Fifty-four tobacco-dependent patients conducted three rt-fmri neurofeedback sessions including rsfc-MRI-runs each within a period of four weeks after professionally assisted smoking cessation. Patients were randomized into two groups performing either real neurofeedback of a brain region associated with addiction (ACC, insula, DLPFC) or sham neurofeedback. The aim was to reduce neural activity during nicotine cue exposure. Rsfc was measured before and after each neurofeedback session. After preprocessing the rsfc data were statistically evaluated using a seed based ROI approach with the UK Biobank DMN template taking into account the smoking status of patients after three months into account (abstinence or relapse) with a family-wise error (FWE) correction and a Threshold-Free Cluster Enhancement (TFCE) correction of each $p<0.05$.

RESULTS

The preliminary results of the baseline runs of eighteen subjects of the real feedback group revealed several significant co-activations in frontal and temporal brain regions of the relapse group (n=10) including bilateral insular regions exceeding the UK DMN template with much more activated voxels than the abstinence group (n=8). The positive correlations from the DMN seed to whole-brain were significantly increased in the relapse group, while the abstinence group shows a less positive correlation to all other regions in the brain. The abstinence group showed significantly higher correlations within the DMN than the relapse group.

CONCLUSION

Variations in the intrinsic DMN in patients with tobacco dependence seem to be associated with a negative therapeutic outcome.

CLINICAL RELEVANCE/APPLICATION

Rsfc MRI after rt-fmri neurofeedback assisted therapy of tobacco dependent patients may be useful as an early indicator of later therapy response or non-response.

SSG12

Physics (CT Image Quality)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S501ABC

CT PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSG12-01 DQE of Si and CdTe Detectors for Photon-Counting CT: Impact of Object Scatter

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S501ABC

Participants
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PURPOSE

Silicon (Si) and cadmium telluride (CdTe) have been proposed as detector materials for photon-counting CT, but the relative performance of these materials is incompletely understood. Previously, a linear-systems model has been used to compare the DQE of Si and CdTe detectors, but this model ignores scatter from the object. This work extends this comparison by incorporating object scatter and the anti-scatter grid, resulting in a more complete model for photon-counting detector DQE at low flux.

METHOD AND MATERIALS

Monte Carlo simulation was performed of a CT geometry with a water cylinder of 30 cm diameter in the isocenter and a curved detector with 79 mm isocenter coverage and sensitive absorption lengths of either 60 mm Si or 3 mm or 1.6 mm CdTe. A 1D or 2D anti-scatter grid with 25 mm high W lamellae was placed in front of the detector. From the resulting scatter-to-primary ratio (SPR) in the central 20 cm of the detector, a DQE factor could be calculated as (geometric efficiency)/(1+SPR) where SPR is the scatter-to-primary ratio. This factor was combined with the intrinsic detector DQE obtained from linear-systems models of Si and CdTe detectors incorporating intradetector scatter, fluorescence and charge sharing.

RESULTS

For all studied detector configurations, the optimal DQE factor is 0.79-0.81, attained for an 1D grid of 0.1 mm thick lamellae with 1 mm spacing. Combined with the linear-systems model for typical detector configurations, so far ignoring pulse pileup and signal induction crosstalk but adding object scatter, this gives the 1.6 mm CdTe detector 5-25% higher zero-frequency DQE for detection and 44-54% lower DQE for two-material quantification compared to a 60 mm Si detector with interspersed W foils.

CONCLUSION

A geometric efficiency of 86-90% is optimal for photon-counting detectors, in contrast to the ~70% used in current CT scanners. Including interspersed W foils in the Si detector can reduce object scatter, and together with an orthogonal 1D anti-scatter grid can give an SPR comparable to that of a 2D grid without interspersed foils. This work is an important step towards a future, complete model for detector performance incorporating pileup and improved charge transport models.

CLINICAL RELEVANCE/APPLICATION

Photon-counting CT detectors promise better image quality. The improved performance model presented here will help developers optimize detector design and attain the best possible imaging performance.

SSG12-02 Innovative Methodology to Mimic Lung Parenchyma Based on Voronoi Models: Application to 3D-Printed Anthropomorphic CT Image Quality Phantoms

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S501ABC

Participants

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PURPOSE

To design and develop voronoi 3D-printed structures resembling lung parenchyma, to be used in realistic anthropomorphic lung vessel phantoms for CT image quality assessment.

METHOD AND MATERIALS

Voronoi grids were created using Rhino software (McNeel, Barcelona, Spain) to resemble lung parenchyma. The designs (eight samples, 2x2x1cm3) varied in number of cells and cell border thickness and were 3D printed (ProJet® MJP 2500+) with VisiJet Armor material (ρ=1.14 g·cm-3). The samples were placed in foam, inserted inside a thorax-shaped PMMA holder (300x200x2.5cm3), and scanned (Canon Aquilion Genesis CT). Comparisons were made to CT image volumes of interest (VOIs) of 3 patients parenchyma (5 samples per patient) using the same CT acquisition and reconstruction protocol (High Resolution-thorax). Analysis was performed in terms of attenuation (mean pixel value of VOIs), pixel value distribution (histograms) and visual comparison.

RESULTS

The CTDIvol for the thorax phantom was 2.1 mGy and for the 3 patients 2.1, 2.2 and 4.1 mGy. The attenuation of the voronoi samples (0.2mm cell border thickness) increased linearly with the number of cells [-972±3HU (200 cells);-953±2HU (350 cells);-941±3HU (500 cells);-921±3HU (800 cells);-916±5HU (900 cells)]. Attenuation also increased linearly with cell border thickness (samples with 350 cells) [-953±2HU (0.2mm);-924±3HU (0.3mm);-885±7HU (0.4mm);-837±5HU(0.5mm)]. For patients the average attenuation values were [(-859±7HU);(-849±5HU);(-902±4HU)]. The sample of 350 cells and 0.4mm cell border thickness resembled lung parenchyma most closely, according to visual comparison of CT images and histogram pixel distribution, by three human observers. The mean pixel value of this sample (-885±7HU) was within the HU value range for patients lung parenchyma (-870±27HU).

CONCLUSION

CT appearance and attenuation of human lung parenchyma was mimicked by CT scans of 3D printed voronoi grids. A sample of 350 cells and 0.4 mm cell border thickness showed best resemblance with patient CT images. These voronoi structures will be added to an in-house developed lung vessel phantom to create a more realistic anthropomorphic surrogate for patients in CT image quality assessment.

CLINICAL RELEVANCE/APPLICATION

Our method to 3D-print lung parenchyma (missing in most commercial CT image quality phantoms) can be used to create realistic patient surrogates, especially required with iterative reconstruction.

SSG12-03 Improving Visualization of Basilar Artery Branches by Combining Spectral CT Imaging and Adaptive Statistical Iterative Reconstruction-V Algorithm

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S501ABC

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PURPOSE

Improving visualization of basilar artery branches by combining spectral CT imaging and adaptive statistical iterative reconstruction-V algorithm

METHOD AND MATERIALS

A total of 15 patients with suspected posterior cerebral circulation ischemia underwent head-neck CT angiography (CTA) using a 256-row MDCT (Revolution CT, GE Healthcare). The scanning parameter were tube voltage of 80/140kVp fast switch and GSI Assist with a noise index of 6. The contrast medium was Iohexol (370mgI/ml) with amount of 50ml and injection rate of 5.0ml/s. 100 kVp-like with FBP (group A) and 40keV monochromatic energy image with 50% ASiR-V (group B) were reconstructed. For both image sets, the CT value and contrast to noise ratio (CNR) were measured at maximum diameter of the basilar artery. maximum intensity projection (MIP) images were used for evaluation the visualization of vertebrobasilar arteries and branch vessels (post-cerebral arteries, superior cerebellar arteries, anterior inferior cerebellar artery, and posterior inferior cerebellar artery). Vessel visibility was quantified by counting the number of artery branches. A five-point scale (from 1= poor to 5 = excellent) was used to evaluate the image quality.

RESULTS

40keV images had higher enhancement of basilar artery (664.95±106.11 vs 288.81±31.03, P=0.001) and higher CNR (27.36± 7.01 vs 20.49±6.48, P=0.009) than 100 kVp-like images. A total of 165 blood vessels was visible on 40keV images, compared to 160 vessels in 100 kVp-like image. The subjective image quality of 40keV images was better that of 100 kVp-like image (4.53±0.54 vs 3.38±0.81, P=0.012).

CONCLUSION

Combining 40keV images and 50% ASiR-V can significantly improve image quality of basilar artery branches, compared to 100 kVp-like images.

CLINICAL RELEVANCE/APPLICATION

Combining monochromatic image and ASiR-V can significantly improve image quality of artery. This protocol is expected to provide more reliable information for the diagnosis and treatment of patients with posterior cerebral circulation ischemia

SSG12-04 CT Protocol Optimization in Neck Imaging Using Anatomically Realistic 3D Printed Phantoms

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S501ABC

Participants
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PURPOSE

To simulate patient neck CT imaging with 3D printed phantoms for a systematic evaluation of CT acquisition protocol settings regarding dose and image quality.

METHOD AND MATERIALS

Radiopaque 3D printed patient head and neck phantoms manufactured with potassium iodide doped ink were used for simulation of patient imaging. Two tube voltage settings, six tube current settings, and three pitch settings were systematically combined. Images were reconstructed with filtered back projection (FBP) and iterative reconstruction (IR). Image quality was evaluated with rater experiments (ten radiologist readers) and contrast-to-noise ratios. Dose reduction was evaluated with multiple phantoms with different anatomies and compared with patients that were retrospectively identified from our clinical database. A protocol with fixed 120 kVp, AEC (SD 7.5), a pitch of 0.8, and iterative reconstruction was used as reference to illustrate protocol optimization potential.

RESULTS

54 data sets were acquired and analyzed. Inter-rater reliability of the image grading experiments was excellent (ICC = 0.921; 95%CI 0.882 to 0.950). The benefit-to-risk ratio in terms of achievable image quality and required dose exposure was optimal with ATVS, AEC (SD 14), a pitch of 0.8, and IR. However, image quality was limited (46% for subjective and 26% for objective image quality). An optimal balance between dose and high image quality was achieved with lower noise level AEC (SD 7.5). This protocol required 37% lower dose than the reference protocol. The retrospective analysis of patients that were imaged with different protocol settings yielded similar dose reduction.

CONCLUSION

Patient simulation with 3D printed phantoms provides opportunities for testing and optimization of CT acquisition protocols in a clinical context. The results from this study were in good agreement with clinical observations.

CLINICAL RELEVANCE/APPLICATION

CT protocol optimization entails significant dose reduction potential. Patient simulation with 3D printed phantoms provides opportunities for systematic and rapid protocol optimization.

SSG12-06 Analysis of the 3D Modulation Transfer Function (MTF) of a High-Resolution Diagnostic CT Scanner

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S501ABC

Participants
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PURPOSE

The spatial resolution characteristics of a recently introduced high-resolution diagnostic CT scanner (Precision, Canon Medical) is investigated using a multi-sphere phantom designed to probe the 3D modulation transfer function (MTF), quantifying performance among various scan protocols.

METHOD AND MATERIALS

The phantom presented an array of 9 acrylic spheres (25.4 mm diameter) as a basis for measurement of the oversampled edge-spread function (ESF) and presampling 3D MTF. Spherical edge profiles were converted to spherical coordinates and analyzed as a function of direction (elevation: \phi=0, axial, to \phi~90, z longitudinal). Directionality was held to \phi <= 80 to avoid cone-beam sampling effects. The 3D MTF was measured for 3 detector modes [normal-res NR (0.5x0.5mmx80slice), high-res HR (0.25x0.5mmx80slice), and super-high-res SHR (0.25x0.25mmx160slice)], filtered backprojection with 3 nominal filters [smooth Fc 18, bone Fc30, and high-res Fc81], 3 focal spot settings, and 3 pitch settings (0.57-1.38).

RESULTS

The 3D MTF provided quantitative insight on performance, limitations, tradeoffs, and the degree to which resolution was isotropic. The SHR detector mode increased the axial MTF (f50=1.03/mm) compared to NR (f50=0.84/mm) and improved z-resolution (f50=0.91/mm) compared to HR (f50=0.71/mm) for the Fc30 filter. SHR and HR modes gave the same axial MTF, as expected. Analysis of the 3D MTF characteristics showed that the 3 nominal filters acted primarily in the axial plane, imparting non-isotropic 3D resolution characteristics. Improvement in MTF with finer focal spot was quantified, and the 3D MTF was observed to be invariant with to helical pitch.

CONCLUSION

A multi-sphere phantom and ESF oversampling method provided an insightful probe of 3D MTF characteristics for a recently introduced ultra-high-res CT scanner, demonstrating the resolution advantages and limitations for various scan protocols. The SHR detector mode demonstrated improved axial and z direction MTF compared to NR mode, evident in clearer depiction of anatomical structure (e.g., temporal bone).

CLINICAL RELEVANCE/APPLICATION

Quantitative characterization of the 3D MTF is an important aspect of technical assessment for new CT scanner technology claiming high-resolution performance beyond that of previous systems.

SSG12-07 Whole-Body Low-Dose CT Combined with Model-Based Iterative Reconstruction Algorithm in the Follow-Up of Oncologic Patients: Image Quality and Dose Deduction

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S501ABC

Participants
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PURPOSE

To compare radiation dose and image quality of low-dose CT protocol combined with iterative model-based reconstruction algorithm (IMR) with standard-dose CT approach combined with hybrid-iterative reconstruction algorithm (iDose) in the follow-up of oncologic patients.

METHOD AND MATERIALS

We enrolled a hundred and thirty patients with known oncological diseases; all patients were examined, during their clinical follow-up, with both a low-dose CT performed on 256-row scanner,with 100 kV and automated mAs modulation (depending on patient weight),and a standard-dose CT performed on 256-row scanner, with 120 kV and automated mAs modulation. Images were reconstructed with IMR for the low-dose CT protocols and iDose algorithm for the standard-dose CT studies. In both studies we measured density values and image noise in liver and spleen and we calculated the signal-to-noise ratio(SNR) and the radiation dose exposure. The diagnostic quality evaluation was also performed with a 4-point scale.

RESULTS

Noise of images expressed as SD values, measured in liver and spleen, was significantly lower in IMR images (liver 11,63 vs 14,79, p<0,001) whereas SNR was statistically higher (liver 10,46 vs 7,86, p<0,001) compared to iDose reconstruction. Volumetric-CT-Dose-Index (CTDIvol) and Dose-Length-Product (DLP) were significantly lower in IMR compared to iDose studies (DLP 624,40 vs 1013,90 mGy*cm, p<0,001), with an overall dose reduction of 38,42%. The qualitative analysis did not reveal any significant differences in terms of diagnostic quality (p=0,04).

CONCLUSION

MAs modulation combined with IMR algorithm and low kV setting allows dose reduction of 45,72% in whole body CT imaging without loss of diagnostic quality. Therefore, it represents a useful diagnostic approach to reduce radiation dose exposure in oncologic patients who undergo several follow-up CT studies.

CLINICAL RELEVANCE/APPLICATION

CT has a main role in the follow-up of oncologic patients; therefore, lowering doses is desirable, according to the A.L.A.R.A. principle. Low-kV CT with IMR allows to significantly reduce doses, offering a high diagnostic image quality.

SSG12-08 Machine Learning and Deconvolution to Improve the Spatial Resolution of the Adaptive Statistical Iterative Reconstruction (ASir-V) at the Same Noise Level

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S501ABC

Participants
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PURPOSE

For the same noise reduction characterized by the noise power spectrum (NPS), the machine learning approach of PixelShine (PS) by AlgoMedica preserves better the central frequency ratio (CFR) in NPS than the adaptive statistical iterative reconstruction (ASir-V) by GE. CFR was taken between the central frequencies of the NPS of the noise reduction and the baseline CT images to indicate the degree of shift in central frequency after noise reduction. Smaller CFR means more shift of the NPS curve or more image blurring. As the noise texture is highly correlated with CFR, PS may be preferred over ASir-V. The purpose of this study is to improve ASir-V by deconvolution to decrease the blurry appearance of the ASir-V while maintaining the same level of noise reduction already achieved by ASir-V.

METHOD AND MATERIALS

The homogeneous module of the ACR CT phantom (model 464, Gammex-RMI, Wisconsin) was scanned on a GE revolution HD 64-slice CT at 3.6 mGy (CTDI-16 cm). Each scan was repeated twice for NPS calculation. Radiation exposure was increased from 3.6 to 72 mGy to simulate ideal noise reduction without PS or ASir-V. We designed a set of deconvolution filters for the various strengths of ASir-V, followed by PS and name this approach as ASir-VDPS. The images of the ASir-V and ASir-VDPS settings from 10 to 100% and the PS settings of 1 to 9 were compared. Noise magnitude ratio (NMR) was taken between the areas under the NPS curve of the noise reduction and the baseline FBP images to indicate the amount of noise removed by the reconstruction. Smaller NMR means more noise reduction. A desirable noise reduction shall maintain CFR of close to 1 and a NMR of close to 0.

RESULTS

When the radiation exposure was increased from 3.6 to 72 mGy, NMR can be reduced without any change of CFR for the ideal noise reduction. At 3.6 mGy, noise reduction was better achieved by either ASir-VDPS or PS, followed by ASir-V. However, the results of ASir-VDPS (80 to 100%) demonstrated that our current design of deconvolution was not sufficient for resolution recovery introduced by ASir-V.

CONCLUSION

Combination of deconvolution and machine learning can improve ASir-V in spatial resolution or image sharpness without sacrificing the noise reduction already achieved by ASir-V.

CLINICAL RELEVANCE/APPLICATION

ASir-V blurs the CT images during noise reduction. Our approach rectifies this issue without sacrificing the noise reduction already achieved by ASir-V.

SSG12-09 Investigating the Relationship between Image Noise and Noise Index of Dose Modulation Behavior

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S501ABC

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CONCLUSION

Save the efforts of clinical protocol development/management and improve the operational work flow.

Background

Purpose: To evaluate the behavior of dose modulation performance for optimizing clinical image acquisition protocols. Methods: Four tissue equivalent abdominal CT dose phantoms (CIRS 007TE) were scanned using a GE Revolution CT scanner. To simulate an extra-large size patient, a 5th phantom (60cm by 40cm) was assembled from a QRM-Abdomen phantom attached to two extension rings. Abdominal CT protocol: 120kVp, 0.6s rotation time, 80mm beam width, 0.508 pitch, 2.5 mm image thickness and Large Scan Field-of-View. With Auto-mA and Smart-mA enabled, Noise Index (NI) was varied resulting in various levels of image quality. Images were reconstructed using Standard algorithm. For each phantom size/NI combination, ROI (n=3/image) and noise measurements (standard deviation of ROI) in 5 consecutive images of the central portion of the phantom were performed. The relationship of noise versus NI was plotted for each phantom size.

Evaluation

Results: For the scans of each phantom size, the achieved mA values functioned as expected to the set NI values. For each phantom size, the measured noise increased linearly as NI value increased (R2 = 0.9981, 0.9978, 0.9980, 0.9963, for 15-yr old, small adult, medium adult, large adult, respectively). The noise values were within 7% of the mean noise values at a NI level among phantom of different sizes, indicating that the measured noise values were similar as a function of NI value regardless of the sizes of the phantoms. Moreover, the measured noise were within 12% of the 10 NI levels that were evaluated, at 2.5mm nominal image thickness; this suggests a direct correlation of the anticipated image noise to the NI value under this 2.5mm acquisition condition.

Discussion

Conclusion: The same NI value produced similar noise level in images across phantoms of different sizes. Unlike the multiple patient size-based approach for optimizing protocols of other GE scanner platforms, the one-size based protocol approach on the Revolution CT could save the efforts of clinical protocol development/management and improve the operational work flow.

Printed on: 10/29/20

SSG13

Physics (Deep Learning - Clinical Applications)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S502AB

AI PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSG13-01 Pre-Trained Deep Learning Convolutional Neural Network for Feature Extraction: Pitfalls and Potential

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S502AB

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PURPOSE

Pre-trained deep convolutional neural network (DCNN) are often used as feature extractor due to small data sets in medical imaging. We analyzed the pitfalls and potential of pre-trained DCNNs as feature extractor for mass classification in mammograms.

METHOD AND MATERIALS

With IRB approval, 4577 masses were collected and divided into 3222 training, 508 validation and 847 independent test sets. Pre-trained ImageNet-AlexNet DCNN without fine-tuning was deployed to the mammography data, a total of 4096 features from *F1* layer were extracted for each mass. Four types of analysis were studied: (#1) For a baseline study without feature selection, two classifiers: (#1a) random forest (RF) and (#1b) 5-layer neural network using the 4096 features as input were trained on the training set to optimize the classifier weights, and independently deployed on the validation and the test sets. (#2) Two feature selection methods: (#2a) genetic algorithm (GA) and (#2b) sequential forward selection (SFS), were studied using the validation set to guide feature selection and linear discriminant analysis (LDA) as the classifier. Area under the ROC curve (AUC) was used as performance measure. The trained classifiers with the selected features were applied to the test set for evaluation of generalizability.

RESULTS

Without feature selection, no over-fitting was observed for #1a and #1b, with validation and test AUCs between 0.71 and 0.73. GA evolved over 7000 feature combinations in 9 generations. SFS was analyzed with over 12 million selected feature combinations. With GA (#2a), moderate over-fitting was observed with AUC of 0.80 on the validation set and 0.73 on the test set. With SFS (#2b), severe over-fitting was observed with AUCs of >0.90 on the validation set and ~0.72 on the test set.

CONCLUSION

ImageNet-trained DCNNs without fine-tuning has moderate discriminative power for masses (AUC~0.7). Future studies could leverage this characteristic of pre-trained DCNNs when available data set is small. Reporting the performance on a data set that is used to guide feature or parameter selection can optimistically bias the result. It is important to evaluate the generalization performance using a truly independent test set.

CLINICAL RELEVANCE/APPLICATION

Feature selection from the large feature space extracted from DCNN risks the curse of dimensionality. The generalizability of classifiers with the selected features should be tested with unseen data.

SSG13-02 Do Different Deep Convolutional Neural Nets Learn Differently? An Analysis Using Lung Nodule Detection in Computed Tomography

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S502AB

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PURPOSE

Different types of deep neural nets (DCNNs) are used for a variety of medical imaging tasks. In this study we analyzed if different DCNNs learn differently for lung nodule detection in CT.

METHOD AND MATERIALS

From 1,010 LIDC-IDRI cases, we used 651 cases for training and cross-validation and 254 cases for independent testing. All nodules marked by at least one radiologist and of diameter > 3mm were included. Three popular DCNNs, VGG16, InceptionV1 (IC1), and Inception-ResNet (ICRes) pre-trained with ImageNet were studied. Top 200 lung nodule candidates detected in each CT volume using multiscale Hessian enhancement were used to extract 184 radiomics features and fine-tuning the DCNNs. Features from the first fully connected layer of the DCNNs and the output DCNN scores were analyzed with two methods: (a) feature embedding and (b) score ranking. Feature embedding was performed using uniform manifold approximation and projection (UMAP), which is a fast and highly scalable method to reduce high dimensional features to 2 dimensions. DCNN scores were analyzed using rank-rank hypergeometric overlap (RRHO) distributions to visualize the degree of correlation between scores from different DCNNs. Features extracted from the DCNNs fully connected layer were merged with radiomics features and used to train a random forest classifier. Competition Performance Metric (CPM) calculated from FROC curves used in the LUNA16 challenge was used for comparison.

RESULTS

UMAP analysis shows TPs and FPs have different distributions of overlap. RRHO maps show varied correlation for different levels of high to low ranking DCNN scores indicating potential complementary information if combined. Merging features from VGG16 (CPM=0.62) and IC1(CPM=0.65) improved the performance to CPM=0.69. Merging ICRes (CPM=0.70) and IC1(CPM=0.65) improved the performance to CPM=0.73. For comparison, the CPM obtained by 10-fold cross-validation ranged from 0.61 to 0.81 in the LUNA16 challenge for the LIDC-IDRI set.

CONCLUSION

Different DCNNs learn different feature representations for the same task, which may offer complementary information. Further research is needed to intelligently merge relevant information to improve performance.

CLINICAL RELEVANCE/APPLICATION

With the availability of large number of different DCNN structures, understanding their characteristics and leveraging the complementary information can potentially improve machine learning.

SSG13-03 Deep Learning for Automatic Landmark Localization in CTA for Transcatheter Aortic Valve Implantation

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S502AB

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PURPOSE

Fast and accurate automatic landmark localization in CT angiography (CTA) scans can aid treatment planning for patients undergoing transcatheter aortic valve implantation (TAVI). Manual localization of landmarks can be time-consuming and cumbersome. Automatic landmark localization can potentially reduce post-processing time and interobserver variability. Hence, this study evaluates the performance of deep learning for automatic aortic root landmark localization in CTA.

METHOD AND MATERIALS

This study included 672 retrospectively gated CTA scans acquired as part of clinical routine (Philips Brilliance iCT-256 scanner, 0.9mm slice thickness, 0.45mm increment, 80-140kVp, 210-300mAs, contrast). Reference standard was defined by manual localization of the left (LH), non-coronary (NCH) and right (RH) aortic valve hinge points, and the right (RO) and left (LO) coronary ostia. To develop and evaluate the automatic method, 412 training, 60 validation, and 200 test CTAs were randomly selected. 100/200 test CTAs were annotated twice by the same observer and once by a second observer to estimate intra- and interobserver agreement. Five CNNs with identical architectures were trained, one for the localization of each landmark. For treatment planning of TAVI, distances between landmark points are used, hence performance was evaluated on subvoxel level with the Euclidean distance between reference and automatically predicted landmark locations.

RESULTS

Median (IQR) distance errors for the LH, NCH and RH were 2.44 (1.79), 3.01 (1.82) and 2.98 (2.09)mm, respectively. Repeated annotation of the first observer led to distance errors of 2.06 (1.43), 2.57 (2.22) and 2.58 (2.30)mm, and for the second observer to 1.80 (1.32), 1.99 (1.28) and 1.81 (1.68)mm, respectively. Median (IQR) distance errors for the RO and LO were 1.65 (1.33) and 1.91 (1.58)mm, respectively. Repeated annotation of the first observer led to distance errors of 1.43 (1.05) and 1.92 (1.44)mm, and for the second observer to 1.78 (1.55) and 2.35 (1.56)mm, respectively. On average, analysis took 0.3s/CTA.

CONCLUSION

Automatic landmark localization in CTA approaches second observer performance and thus enables automatic, accurate and reproducible landmark localization without additional reading time.

CLINICAL RELEVANCE/APPLICATION

Automatic landmark localization in CTA can aid in reducing post-processing time and interobserver variability in treatment planning for patients undergoing TAVI.

SSG13-04 Improving Detection of Microcalcification Clusters in Low-Dose Digital Breast Tomosynthesis Using Deep Residual Learning

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S502AB

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PURPOSE

To improve the detectability of microcalcification (MC) clusters in low-dose digital breast tomosynthesis (DBT) by using very deep convolutional neural network (DCNN).

METHOD AND MATERIALS

To generate a synthesized high-dose (SHD) image from a low-dose image, we trained a 20-layer super-resolution CNN (SRCNN) to learn the residual image between the high-dose (HD) and low-dose (LD) images. The loss function is a weighted sum of the Euclidean distances between the gray levels over the image and between the contrast-to-noise ratios (CNR) of the MCs in the LD and HD patches. With IRB approval and informed consent, DBTs of human subjects were acquired with a GE prototype system at 21 projections over a 60º arc and reconstructed as HD DBT volume. LD DBTs were simulated by reconstructing with the central 9 projections over a 24º arc. The SRCNN was trained to generate SHD patches using 449 pairs of corresponding HD and LD MC patches extracted from the training DBT set. Each patch was 32 x 32 pixels at a pixel size of 0.1 mm x 0.1 mm and centered at an MC. A validation set of 191 LD MC patches was used to assess the improvement in CNR in the SHD patches. We previously developed a computer-aided detection (CAD) system that detects MCs in the HD DBT by using joint information from the reconstructed DBT volume and a 2D planar projection image generated from the same DBT volume. In this study, we adapted the joint-CAD system to MC detection in the LD DBT and compared the detection performances with and without deploying the trained SRCNN to the MC candidates detected at the pre-screening stage. The detection performance was evaluated by FROC analysis using an independent test set of 104 DBT volumes with MC clusters and 76 DBT volumes without MC clusters.

RESULTS

For MC cluster detection in the LD DBT, at 85% case-based sensitivity, the FP rate was reduced from 2.6 without to 1.1 FPs/DBT volume with the SRCNN for CNR enhancement. The improvement was statistically significant (p = 0.0001) by JAFROC analysis.

CONCLUSION

SRCNN significantly improves MC cluster detection by the CAD system in low-dose DBT, indicating a potential for reducing dose in DBT imaging.

CLINICAL RELEVANCE/APPLICATION

Improved performance of CAD in low-dose DBT has potential implications on reducing patient dose for DBT imaging particularly during screening.

SSG13-05 Fuzzy Edge Attentional Generative Adversarial Network for Automated Fibroglandular Tissue Segmentation in Breast MRI

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S502AB

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PURPOSE

To investigate the efficacy of a fuzzy edge attentional deep learning approach for automated fibroglandular tissue (FGT) segmentation in breast MRI as an essential step for FGT and background parenchymal enhancement (BPE) quantitative analysis.

METHOD AND MATERIALS

Previous research has shown that deep learning with U-Net outperformed the traditional image processing methods for FGT segmentation. However, U-Net segmentation performed poorly around the fuzzy edges of FGT region. In this study, we proposed a robust fuzzy edge attentional generative adversarial network(FEA-GAN) to overcome this difficulty. An improved U-Net was designed as generator to generate FGT candidate areas while a patch deep convolutional neural network (DCNN) was designed as discriminator. To reconcile the semantic features from different scales, the convolutional layers in generator were replaced by inception-like multiscale blocks. Residual convolutional layers were incorporated with the skip connections to reduce the semantic

gap between encoder and decoder. To reduce false candidate areas caused by fuzzy edges, the patch DCNN restricts attention to edge structures in local image patches. With IRB approval, we retrospectively collected 100 patients aged 22-78 years old at an academic hospital. Axial T1-weighted fat-suppressed images from 200 breasts were acquired from 1.5T Siemens Magnetom Espree system. An experienced radiologist manually marked contours of FGT on 3D slices as the reference standard. Five-fold cross-validation was applied for training and testing. The results were evaluated in three measures: Dice similarity coefficient (DSC), Jaccard index (JI) and Hausdorff distance (HD).

RESULTS

With five-fold cross-validation, the DSC, JI and HD for segmentation with FEA-GAN were 87.0±7.0%, 77.6±10.1%, 3.69±0.71mm, respectively. With U-Net, the corresponding values were 81.1±8.7%, 69.0±11.3%, 4.18±0.77mm, respectively. Compared with U-Net, the improvement for all measures achieved statistically significant ($p<0.0001$).

CONCLUSION

The proposed FEA-GAN model significantly outperformed the U-Net model in terms of DSC, JI and HD. Further work is underway to apply the proposed FGT segmentation method for FGT and BPE quantitative analysis.

CLINICAL RELEVANCE/APPLICATION

Automated FGT segmentation is a crucial step for quantitative assessment of FGT and BPE in breast MRI, which are strong risk factors for breast cancer.

SSG13-06 Evaluation of the Performance of Deep Learning Models Trained on a Combination of Major Abnormal Patterns on Chest Radiographs for Major Chest Diseases at International Multi-Centers

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S502AB

Participants
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PURPOSE

To evaluate the abnormal classification performance for major chest diseases using a deep learning model that was trained on a combination of major abnormal patterns on chest radiographs.

METHOD AND MATERIALS

We experimented with the abnormal classification performance for a deep learning model for major diseases (tuberculosis and pneumonia) that was trained on a combination of different patterns (nodule, consolidation and interstitial opacity) on CRs. To evaluate the effect of each pattern combination on performance for major diseases, we tested five cases of patterns, which is composed of the nodule case, the consolidation case, the interstitial opacity case, the combination of consolidation and interstitial opacity case, and the combination of all three cases. When training each case, all normal data was used for training. CRs with three abnormal patterns and normal patterns were used as training datasets, which were received from two hospitals and consisted of 2095, 2401, 1290, and 3000 images for nodule, consolidation, interstitial opacity, and normal patterns, respectively. And all abnormal CRs were clinically confirmed by CT scans. For an explicit evaluation, the public dataset was used as the test dataset, which consists of the Shenzhen (normal: 326, tuberculosis: 336) and PadChest (normal: 300, pneumonia: 127, randomly selected) dataset, which was used to evaluate tuberculosis and pneumonia, respectively.

RESULTS

In the test dataset, for tuberculosis and pneumonia, the classification performance of the models trained with the five cases of patterns showed AUC 0.58 / 0.69 for nodule case, 0.76 / 0.82 for consolidation, 0.52 / 0.76 for interstitial opacity case, 0.79 / 0.83 for combination of consolidation and interstitial opacity case, 0.79 / 0.82 for combination of all three case, respectively.

CONCLUSION

We have shown through experimentations that the deep learning model trained from data with major patterns (nodule, consolidation, interstitial opacity) can classify major diseases (tuberculosis, pneumonia) as abnormal. Also, consolidation was highly correlated with tuberculosis and pneumonia. On the other hand, interstitial opacity and nodule were more correlated with pneumonia, tuberculosis, respectively.

CLINICAL RELEVANCE/APPLICATION

The diagnosis based on the patterns of abnormal findings allows detection of various diseases.

SSG13-07 Automatic Quantification of 3D Body Composition from Abdominal CT with an Ensemble of Convolutional Neural Networks

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S502AB

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PURPOSE

Analysis of body composition based on CT, primarily comprising quantification of fat and muscles, is an important prognostic factor in cardiovascular disease and cancer. However, manual segmentation is time consuming and in 3D practically infeasible. The purpose of this study is to investigate the use of a deep learning-based method for automatic segmentation of subcutaneous fat, visceral fat and psoas muscle from full abdomen CT scans.

METHOD AND MATERIALS

We included a dataset of 20 native CT scans of the entire abdomen (Siemens Somatom Volume Zoom / Siemens Somatom Definition, 120 kVp, 375 mAs, in-plane resolution 0.63-0.75 mm, slice thickness 5.0 mm, slice increment 5.0 mm). Trained observers defined the reference standard by voxel-wise manual annotation of subcutaneous fat, visceral fat and psoas muscle in all slices that visualize the psoas muscle. Images of 10 patients were used to train a dilated convolutional neural network with a receptive field of 131 × 131 voxels to distinguish between the three tissue classes. To ensure robust results, 5 different networks were trained and subsequently ensembled by averaging the probabilistic results. Voxels were assigned to the class with the highest probability. Images from the remaining 10 patients were used to evaluate the performance of the method. Performance was evaluated with Dice coefficients between the manual and automatic segmentations. Additionally, linear correlation coefficients (Pearson's r) were computed between the manual and automatic segmentation volumes.

RESULTS

The average Dice coefficients over 10 test scans were 0.89 ± 0.02 for subcutaneous fat, 0.92 ± 0.04 for visceral fat, and 0.76 ± 0.05 for psoas muscle. At the L3 vertebrae level, the average Dice coefficients were 0.92 ± 0.02 for subcutaneous fat, 0.93 ± 0.05 for visceral fat, and 0.87 ± 0.04 for psoas muscle. Pearson's r between the manual and automatic volumes were 0.996 for subcutaneous fat, 0.997 for visceral fat, and 0.941 for psoas muscle. On average, segmentation of a full scan was performed in about 15 seconds.

CONCLUSION

The results show that accurate fully automatic segmentation of subcutaneous fat, visceral fat and psoas muscle from full abdominal CT scans is feasible.

CLINICAL RELEVANCE/APPLICATION

The proposed method allows fast and fully automatic analysis of 3D body composition in abdominal CT that can aid in individualized risk assessment in cardiovascular disease and cancer.

SSG13-08 Perceptive Feature Learning with Deep Semantic Network for Breast Mass Diagnosis on Digital Mammography

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S502AB

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PURPOSE

Malignant/Benign classification on digital mammography (DM) remains challenging in current clinical practice. Our purpose of this study is to use a perceptive feature learning scheme for computerized breast mass diagnosis on DMs.

METHOD AND MATERIALS

Recently, deep learning (DL) has been widely used for computerized cancer diagnosis. However, most of the DL approaches have the poor clinical interpretation. Aimed to improve breast cancer diagnosis and increase DL's interpretability, we proposed a perceptive feature learning scheme with a deep semantic network (DSN) for breast mass diagnosis on DMs. With IRB approval, DMs of 220 Chinese women were retrospectively collected. In total, 220 biopsy-proven masses (108 benign and 112 malignant) were reviewed by an experienced breast radiologist. Shape and margin of each mass were assessed based on ACR's BI-RADs lexicon and the assessment results were empirically encoded into five labels: irregular shape, round/lobulated shape, microlobulated margin, speculated margin and circumscribed/obscured/indistinct margin. Our DSN with 5 encoded labels as target was designed to learn the human reader's visual perceptions of masses. A mass-centered patch and its corresponding segmentation mask were concatenated as an input of DSN (patch size of 288x288x2). The trained DSN without output layer was served as feature learning network for the extraction of 128 perceptive features. We compared the perceptive features with previously developed radiomics features. Ten-fold cross validation was used for model selection. At each fold, we applied stepwise linear discriminant analysis (LDA) for dimension reduction and malignant/benign classification. Area under the ROC curve (AUC) was used as a figure of merit for the performance evaluation.

RESULTS

In model selection, we selected an average of 30 features in each fold. It was found that the improvement of the classifier with radiomics+perceptive features (AUC of 0.95 ±0.03) to radiomics alone (AUC of 0.91±0.03) was statistically significant ($p < 0.05$).

CONCLUSION

The features learned by DSN with expert's visual perceptions of masses significantly improved the diagnostic performance of breast mass on DMs.

CLINICAL RELEVANCE/APPLICATION

Perceptive features learned from reader's visual perception have the added value for computerized breast mass diagnosis on DMs and such features have potential to increase the interpretability of CAD.

SSG13-09 A PIRADS Based Similar MRI Retrieval System for Prostate Cancer

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S502AB

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PURPOSE

To compare different deep learning algorithms to retrieve images with similar lesions in term of PIRADS score. In particular we evaluate the performance of a Siamese convolutional neural network (SIAM-CNN) against a standard convolutional Autoencoder (AE-CNN). We hypothesize that SIAM-CNN works better at retrieving similar images based on PIRADS score.

METHOD AND MATERIALS

We use a set of 601 consecutive multiparametric prostate MRIs from 2016 acquired in our hospital that contains 890 PIRADS reported lesions. The image similarity was based on the axial computed high b-value series. Both CNNs were designed to operate with 40x40x3 voxel ROIs selected around the reported lesion location. SIAM-CNN is a supervised algorithm that is trained to find the most similar images with the same PIRADS score. Instead, AE-CNN is unsupervised and assesses similarity only based on image appearance. We used 672, 90 and 128 images as training, validation and test set, respectively, and used a 3-fold cross validation for the performance estimation. The performance was quantified in terms of Mean Absolute Error (MAE) between the PIRADS of the query and that of the retrieved images. We provide the score for the TOP-1 and 3 retrieved lesions.Additionally, qualitative visual assessment was performed.

RESULTS

The TOP-1 MAE for the SIAM-CNN is 0.75±0.12 while the AE-CNN score is 0.87±0.02 (p-value=0.15). The TOP-3 score for the SIAM-CNN is 0.75±0.09 while the AE-CNN score is 0.97±0.05 (p-value=0.02).

CONCLUSION

The Siamese CNN is better than the Autoencoder CNN at retrieving similar images based on PIRADS, both quantitatively (MAE) and qualitatively based on visual assessment. Future work aims at integrating multi-parametric and/or multi-view MRI, in order to obtain further performance improvements.

CLINICAL RELEVANCE/APPLICATION

Siamese CNN can be a valuable aid in prostate cancer MRI assessment by retrieving similar images with similar PIRADS score. This could help reduce prostate MRI interpretation variability.

SSG14

Physics (MRI - Clinical Applications)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S504AB

MR PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Matthew A. Bernstein, PhD, Rochester, MN (*Moderator*) Former Employee, General Electric Company; Intellectual property, General Electric Company

Sub-Events

SSG14-01 Development of Respiratory Motion-Resolved Hepatobiliary Phase Cine-MRI Using Compressed SENSE for Stereotactic Body Radiotherapy in Liver Tumor

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S504AB

Participants
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CONCLUSION

The CS with denoising improved tumor-to-liver contrast and image quality in high temporal resolution HBP cine-MRI, which can be potentially applied for stereotactic body radiotherapy.

Background

For radiotherapy of the liver, cine-MRI has been used to track respiratory-induced motion of the liver and tumor, and to assist accurate delineation of tumor volume. However, tumor boundaries cannot be clearly defined when using balanced SSFP and single-shot T2-weighted sequences because of poor tumor-to-liver contrast. Recent development of Compressed SENSE (CS) enables to accelerate temporal resolution while maintaining contrast resolution. This study aimed to develop and assess hepatobiliary phase (HBP) cine-MRI using CS.

Evaluation

Twenty patients underwent HBP cine-MRI after gadoxetic acid injection, consisted of modified 2D-GRE T1-weighted TFE sequence with saturate recovery prepulse (TR/TE, 3.1/1.46 ms; FA, 30°; FOV, 380 mm; acquisition matrix, 112×201; slice thickness, 3mm) in every 0.5 second for one minute. The images were acquired with SENSE (factor, 4), CS (factor, 4) without denoising (CS-no), and CS with strong denoising level (CS-strong) to assess the capability of CS for image quality improvement. For quantitative analysis, signal noise ratio of the liver and tumor (SNRLiv, SNRTum) and liver-to-tumor contrast ratio (CRLiv/Tum) were measured. For qualitative analysis, two radiologists evaluated lesion conspicuity, contrast enhancement, image noise, motion smoothness, and overall quality on a 4-point scale. The SNRLiv and SNRTum were 6.8 ± 2.7 and 2.8 ± 0.8 for SENSE, 6.7 ± 2.8 and 3.0 ± 1.0 for CS-no, and 14.4 ± 3.9 and 5.7 ± 2.8 for CS-strong, respectively ($P<.001$, repeated measures ANOVA). The CRLiv/Tum was 0.47 ± 0.13 for SENSE, 0.43 ± 0.12 for CS-no, and 0.49 ± 0.16 for CS-strong ($P>.05$). The CS-strong showed significantly higher image quality ($P<.01$, Kruskal-wallis H test) except for motion smoothness ($P=.11$).

Discussion

The CS can suppress aliasing artifact using random undersampling of k-space trajectory, enabling to apply wavelet transformation and denoising. This algorithm substantially increased SNR, contributed to improvement of contrast ratio and image quality in HBP cine-MRI.

SSG14-02 Multi Band-SWeep Imaging with Fourier Transformation (MB-SWIFT) MRI Can Quantify Bone Mineral Density while Concurrently Characterizing Material-Level and Biochemical Changes in Bone In Vivo

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S504AB

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PURPOSE

Multi-Band SWeep Imaging with Fourier Transformation (MB-SWIFT) MRI could have novel and specific application in bone where capturing mineral and remaining 40% of the composite tissue that confers to bone quality and strength is desired. We describe a comprehensive set of biomarkers to characterize material-level and biochemical components that are "missed" when using gold-standard bone imaging approaches (clinical DXA, pre-clinical µCT). Further, we establish the efficacy of MB-SWIFT to measure bone mineral density (BMD) in comparison to µCT.

METHOD AND MATERIALS

In vivo µCT (Bruker SkyScan1176, 35 µm3) and MB-SWIFT MRI (Agilent 9.4T, 156 µm3) of the proximal tibiae were obtained at baseline and 2, 4, 10 and 12 wks post ovariectomy (OVX) in 7 rats (F, 6 wks old). µCTs were registered to corresponding MRIs per timepoint and resulting transforms were applied to µCT-derived cortical and trabecular VOIs guiding analysis across modalities. Cortical water fraction, marrow fat fraction and cortical matrix volumetric T1 relaxation using the variable flip angle method were quantified from MB-SWIFT images. Sensitivity to cortical water loss during sequential drying was confirmed in excised tibia. µCT and MRI images were converted to Hounsfield units and BMD was calculated using a concurrently imaged calcium hydroxyapatite standard. Pearson's correlation coefficients, simple linear regressions and RM-ANOVAs were employed and significant at $p <= 0.05$.

RESULTS

MB-SWIFT cortical and trabecular BMD correlated significantly with µCT BMD (cortical: $R=0.67$, $p<0.0001$; trabecular: $R=0.62$, $p<0.0001$) which significantly increased longitudinally. Growth appeared to overcome estrogen-deficient changes in bone mass yet MB-SWIFT distinguished significant decreases in cortical water, increases in marrow fat and increases cortical matrix volumetric T1 relaxation consistent with OVX by 10 weeks. MB-SWIFT cortical water fraction significantly correlated to cortical water loss (% by volume) during sequential drying ($R=-0.98$, $p=0.01$).

CONCLUSION

MB-SWIFT MRI could have a novel and specific application in bone where capturing information on both mineral and matrix properties that confer quality and strength is highly desired.

CLINICAL RELEVANCE/APPLICATION

MB-SWIFT can quantify biomarkers of bone quality and mineral phase of bone without the use of harmful ionizng radiation holding promise for clinical adaptation allowing for safe longitudinal analysis of bone.

SSG14-03 Quantitative Biliary Tree Imaging by MRI: A Novel Method of Assessing Change Over Time in Hepatobiliary Disease via MRCP

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S504AB

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CONCLUSION

We demonstrate that state-of-the-art quantitative MRCP enables the extraction of quantitative biomarkers of biliary anatomy able to objectively identify changes in ducts over time, which correlates with biliary disease that were not identified via biochemical markers. Quantitative biliary tree imaging warrants ongoing investigation prospectively as a means of a potential standardised application for disease and therapy monitoring in PSC.

Background

Magnetic resonance cholangiopancreatography (MRCP) is a non-invasive imaging technique for the evaluation of hepatobiliary disease. Despite widespread use there remains a lack of objective assessment of biliary duct changes, and detecting changes in scans can be difficult, hindering monitoring of disease progression. Furthermore, serum biomarkers for hepatobiliary disease lack sensitivity to longitudinal changes biliary disease status. Here we evaluate the utility of novel quantitative biomarkers of biliary anatomy, extracted from 3D MRCP scans, to assess changes in biliary ducts over 1 year in patients with autoimmune liver diseases.

Evaluation

Patients with primary sclerosing cholangitis (PSC, n=44), autoimmune hepatitis (AIH, n=35) and primary biliary cholangitis (PBC, n=59) were recruited for heavily T2-weighted MRCP imaging at base-line and 1-year follow-up. A total of 284 scans were processed with quantitative image analysis to enhance and quantify the tubular structures. The underlying algorithms combine multi-scale Hessian analysis, gradient vector flow analysis, intelligent path search algorithm and novel duct modelling algorithms.

Discussion

Quantitative imaging, evaluating MR-apparent biliary duct size and length distinguished PSC from AIH and PBC patients ($p<0.001$). At baseline, the number of strictures was a better classifier of PSC and AIH patients (AUC=0.72) than bilirubin (AUC=0.65). At 1 year follow up PSC patients contained significantly more strictures ($p<0.01$) and greater stricture severity ($p<0.01$) compared to AIH and PBC, whilst alkaline phosphatase (ALP) and bilirubin were found to exhibit no significant changes from baseline across the 3 cohorts. High risk PSC patients (ALP>1.5xULN) were found to have more dilatations ($p<0.01$) and greater stricture severity ($p<0.01$) than low risk at baseline. Abnormal length sum, stricture length sum (AUC=0.74, 0.73 respectively) were found to accurately classify high and low risk patients. Interestingly, metrics in high risk patients did not change from baseline at follow up, whilst low risk PSC patients were found have an enlarged tree volume ($p<0.01$), duct length ($p<0.01$) and stricture severity ($p<0.01$) at follow up.

SSG14-04 Validation of Highly Accelerated Wave-CAIPI 3D-T1 Sampling Perfection With Application Optimized Contrast Using Different Flip-Angle Evolutions (Wave-3D-T1 SPACE) with Conventional 3D-T1 SPACE for Post-Contrast Brain Imaging

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S504AB

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PURPOSE

To evaluate the image quality and diagnostic performance of highly-accelerated Wave-CAIPI 3D-T1 Sampling Perfection with Application-optimized Contrasts by using flip angle Evolution (Wave-T1 SPACE) compared to conventional 3D-T1 SPACE for the detection of intracranial enhancing lesions on post-contrast brain MRI.

METHOD AND MATERIALS

Consecutive patients (N=38) undergoing 3T clinical brain MRI with contrast were prospectively enrolled. The most common indications for MRI were screening for brain metastases (N=21), and evaluation of primary brain tumors (N=8). All MRI scans included a conventional post-contrast T1 SPACE (R=4, acquisition time TA=4min 19s) and resolution-matched (slice thickness = 0.9mm) post-contrast Wave-T1 SPACE sequence (R=9, TA=1min 40s). Studies were performed on a clinical 3T MRI scanners (MAGNETOM Prisma; Siemens, Erlangen). Two neuroradiologists evaluated the images head-to-head for the visualization of enhancing lesions and nonenhancing pathology, grading of motion artifacts and noise, and diagnostic quality using a predefined 5-point scale. Discrepancies were adjudicated by a third reader. Wave-T1 SPACE was tested for non-inferiority compared to conventional T1 SPACE using a 10% non-inferiority margin.

RESULTS

Compared to conventional post-contrast T1 SPACE, Wave-T1 SPACE showed no difference in the visualization of enhancing lesions ($P<0.001$) and non-enhancing pathology ($P=0.003$), and no difference in diagnostic quality ($P<0.001$). Wave-T1 SPACE images demonstrated comparable or reduced motion artifact in the majority of cases and slightly greater image noise, with no impact on overall diagnostic quality. The figure shows representative examples demonstrating the comparable image quality of the post-contrast Wave- and conventional T1 SPACE sequences in delineating leptomeningeal disease and brain tumor.

CONCLUSION

A 1.6-minute Wave-T1 SPACE acquisition demonstrates comparable performance to a 4.3-minute resolution-matched conventional T1 SPACE sequence in identifying enhancing lesions, with an approximate 3-fold reduction in acquisition time. The findings support clinical application of Wave-T1 SPACE over conventional T1 SPACE for routine post-contrast clinical brain imaging.

CLINICAL RELEVANCE/APPLICATION

Wave-T1 SPACE is comparable to conventional T1 SPACE in detecting enhancing lesions with up to 3-fold reduced scan time and less motion, supporting its clinical application in routine brain imaging.

SSG14-05 Application of Magnetic Resonance Imaging with Free-Breathing T1-Weighted Star-VIBE for Improving Image Quality in Chest: A Study Compared with T1-Weighted Conventional Breath-Hold VIBE

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S504AB

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PURPOSE

To explore the application of free-breathing T1-weighted Star-VIBE sequence for improving image quality in chest compared with T1-weighted conventional breath-hold VIBE sequence in magnetic resonance(MR) imaging.

METHOD AND MATERIALS

Twenty patients underwent MR chest examination on a 3.0T scanner (MAGNETOM Skyra, Siemens Healthcare, Erlangen, Germany). The scan sequences included T1-weighted conventional breath-hold VIBE(group A: TE 1.29 ms, TR 3.97 ms) and free-breathing T1-weighted Star-VIBE (group B: TE 1.39 ms, TR 2.79 ms). The signal intensity (SI) and standard deviation (SD) of ascending aorta, main pulmonary artery and descending aorta were measured at the level of main pulmonary artery. The signal-to-noise ratio (SNR=SI/SD) and coefficient of variation (CV=SD/SI) of signal intensity were calculated. The image quality was subjectively scored double-blindly using a 5-point scoring system by two radiologists who had five or more years of working experience (5 point, the image quality is best; 4 point, the image quality is better; 3 point, the image quality is general; 2 point, the image quality is poor; 1 point, the image can not be evaluated).

RESULTS

There was no significant difference in population characteristics between the two groups (P>0.05). The signal-to-noise ratio (SNR) of ascending aorta, main pulmonary artery and descending aorta in group B were significantly higher than those of group A(P<0.05), while the coefficient of variation of signal intensity about group B were significantly lower than those of group A(P < 0.05). The subjective scores of image quality by the two MR radiologists had excellent consistence (kappa value>0.80, P<0.05), the subjective score of group B were significantly higher thangroup A (P < 0.05).

CONCLUSION

Magnetic resonance imaging with free-breathing T1-weighted Star-VIBE sequence can significantly improve image quality in chest compared with T1-weighted conventional breath-hold VIBE sequence.

CLINICAL RELEVANCE/APPLICATION

In thoracic magnetic resonance imaging, free-breathing T1-weighted Star-VIBE sequence can be used to improve image quality, which can obtain better image quality compared with T1-weighted conventional breath-hold VIBE sequence.

SSG14-06 Design Your MSK MRI: It Needs to be Planned by Radiologist

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S504AB

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PURPOSE

To evaluation the recall rate and causes of musculoskeletal MRI scanned at a tertiary center

METHOD AND MATERIALS

From January to July 2018, 1639 musculoskeletal MRI were performed in our institution. Two musculoskeletal radiologists reviewed, recalled, and rescanned cases. Evaluation for reasons of recalled cases by consensus were in the following categories: resolution issue, field of view issue, coil issue, artifact issue, missed sequence issue, newly detected lesion issue, and miscellaneous. Then radiologists reviewed the rescanned images and assessed a 4-point confidence level before and after an additional scan. Finally, they were asked if a rescan could have been avoidable if they were asked to designed the protocol before scanning (yes, not sure, no).

RESULTS

The total recalled cases were 47 out of 1639 (2.8%). The causes of recall were FOV issue (14), adding the sequence (9), resolution issue (8), coil issue (3), metal artifact control (3), incidental lesion (2), changing position (2), and miscellaneous (5). The confidence score significantly increased after a rescan compared with the initial image (3.2 vs. 2.7, respectively, P<0.05). Two radiologists reported 33 out of 47 cases would not need a rescan if the radiologist were able to design the protocol prior to the scan.

CONCLUSION

Musculoskeletal MRI can offer insufficient information at an initial scan for various reasons; and for a better diagnosis, a rescan is necessary. However, the number of rescans may decrease when radiologists design the protocol prior to the scan

CLINICAL RELEVANCE/APPLICATION

Musculoskeletal MRI is complex when designing the protocol compared to other MRI (e.g., brain, breast, liver, etc.). Hence, musculoskeletal MRI needs planning well before scanning, and this is best done by a radiologist.

SSG14-07 Dynamic Contrast-Enhanced Magnetic Resonance Imaging during Free Breathing for Hepatic Lesions: Clinical Applicably and Limitations

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S504AB

Participants
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PURPOSE

To evaluate the clinical applicability and limitations of this new prototype volume-interpolated breath-hold examination (VIBE) with compressed sensing (VIBEcs) for rapid multiphase MRI with free selectable variable temporal resolution for hypervascularized hepatic lesions.

METHOD AND MATERIALS

Twenty patients with hypervascularized hepatic lesions were included in this study and underwent contrast-enhanced liver MRI at 3 T. In all patients, VIBEcs was used for rapid arterial multiphase imaging. Results were analyzed regarding image quality and clinical applicability of the dynamic lesion evaluation. Evaluation of image quality, visibility and conspicuity was performed by three independent radiologist, each with more than 5 years of experience in oncology imaging, based on a 5-point Likert scale (5=excellent). Results were correlated with the lesion entity. Limitations for the use of VIBEcs in image acquisition were defined. Time curves of dynamic contrast enhancement were plotted for each patient and quantification of attenuation performed to isolate the optimal time-point for image acquisition.

RESULTS

All patients were successfully evaluated. Individual setting of acquisition time point (best point 8 seconds) instead of fixed delay allowed high reading scores for image quality, visibility and conspicuity for all lesions (mean score >4). Lesion entity showed no significant impact on the reading performance (p=0.765). Limitation were defined as following: small lesion size (<8 mm), subdiaphragmatic localization, large necrotic area (>80% of lesion).

CONCLUSION

Free-breathing MRI with VIBEcs allows image acquisition with high temporal and spatial resolution using individual acquisition time points during contrast phase to gain optimal results with a robust acquisition protocol.

CLINICAL RELEVANCE/APPLICATION

VIBEcs allows image acquisition with high temporal and spatial resolution for variable time points with a robust acquisition protocol and is recommended quantitavie measurements of hypervascularized liver lesions.

SSG14-08 Myocardial Extracellular Volume from T1 Mapping Measurements by Magnetic Resonance Imaging in Healthy Volunteers

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S504AB

Participants
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PURPOSE

To investigate the characteristics of myocardial extracellular volume fraction (ECV) derived from pre- and post-contrast T1 measurements among healthy volunteers.

METHOD AND MATERIALS

A total of 57 healthy volunteers underwent standard CMR imaging with administration of gadolinium. T1 measurements were performed with a Look-Locker sequence followed by gradient-echo acquisition (GRE). We tested the segmental, interslice,inter-, intra-, and test-retest characteristics of the ECV ,as well as the association of the ECV with other variables.

RESULTS

57 healthy volunteers were recruited and were included in the analysis. There were 26 men (46%) and 31 women. The mean age of volunteers was 47±17 years(range 21 to 78 years). The average body mass index was 27±4kg/m2,systolic blood pressure was 119±11mmHg,diastolic blood pressure was 74±4mmHg,heart rate was 67±6 beats/min, and hematocrit was 43±2%. The ECV

averaged 0.27±0.04(range 0.21 to 0.34). The intraclass coefficients for the intraobserver, interobserver and test-retest absolute agreements of the ECV were 0.95 (95% confidence interval: 0.85 to 0.98), 0.87 (95% confidence interval: 0.64 to 0.96), and 0.97(95% confidence interval: 0.84 to 0.99), respectively. In volunteers, the ECV was associate with age (r=0.81, P<0.001), maximal left atrial volume index (r=0.38, P=0.00036(P<0.01)), and indexed left ventricular mass. There were no differences in the ECV between segments in a slice or between slices.

CONCLUSION

In summary, the ECV is a novel and potentially useful index for quantification of the myocardial extracellular volume fraction. The findings suggest that in healthy volunteers, the myocardial ECV ranges from 0.21 to 0.34, In humans, the myocardial ECV increases with age, is associated with left ventricular mass and left atrial volume, and has reliable test characteristics. Further work will need to be done to test the application of this technique to patients with cardiovascular disease associated with the development of myocardial fibrosis.

CLINICAL RELEVANCE/APPLICATION

In cardiac magnetic resonance (CMR) imaging, the T1 relaxation time for the 1H magnetization in myocardial tissue may represent a valuable biomarker for a variety of pathological conditions

SSG14-09 CAIPIRINHA-Dixon-TWIST (CDT)-Volume-Interpolated Breath-Hold Examination (VIBE) Imaging of the Abdomen at 3.0 Tesla: Optimization and Comparison of Time Resolution and Image Quality

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S504AB

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PURPOSE

In order to get a higher time resolution or spatial resolution of CAIPIRINHA-Dixon-TWIST (CDT)-Volume-Interpolated Breath-Hold Examination (VIBE) imaging of abdomen at 3.0 Tesla, we optimized the scanning parameters at three conditions and evaluated the time resolution and image's quality of them.

METHOD AND MATERIALS

Twelve patients (8 males, age 42±3.52; 4 females, 39±2.35) with focal liver lesions and eight healthy volunteers (5 males, age36±4.23; 3 females, 40±3.89) were enrolled and underwent abdomen CDT-VIBE imaging MR exam with breath-hold mode before and after contrast-enhancement. The scanning sequences, which included 4 phases within a breath hold, include three optimized sequence with time resolution of 0.4s/phase, 0.6s/phase and 1.5s/phase. The quantitative evaluation index included the signal-to-noise ratio (SNR) of spleen, left and right liver lobe, and the contrast to noise ratio (CNR) of left and right liver lobe. All quantitative indexes were measured in in-phase, opp-phase and water-phase images before and after contrast enhancement. Finally, the homogeneity, the sharpness and the artifacts of whole image was scored by two radiologists independently on the basis of a three-point scale, and the average of data was used as the final scores. All the quantitative and quality parameters were analyzed with One-way ANOVA and Kruskal-Wallis One-way ANOVA were applied for group comparison with Bonferroni correction.

RESULTS

After optimization of the parameters of CDT-VIBE, the highest time resolution can reach 0.4s/phase, and when compared with the optimized protocols with time resolution of 0.6s/phase and 1.5s/phase, no significant difference was found for CNR and SNR at spleen, left and right liver lobe (p>0.05) (Table 2-7). About subject evaluation scores, the average scores of image quality for sharpness in sequence with time resolution of 1.5s/phase was significantly higher than the other two optimized sequence (p<0.001). No significant difference was found for the homogeneity and the artifacts of image quality among three optimized conditions

CONCLUSION

Through optimization of the parameters of CDT-VIBE in abdomen imaging, a higher time resolution (0.4s/phase) or a higher spatial resolution can be acquired, which means a wider clinical application in abdomen imaging of the CDT-VIBE sequence.

CLINICAL RELEVANCE/APPLICATION

CDT-VIBE sequence will be a wider clinical application in abdomen imaging

SSG15

Radiation Oncology (Lung, Mediastinum, Pleura)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S503AB

CH RO

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSG15-01 Radiographic Patterns of Symptomatic Radiation Pneumonitis in Lung Cancer Patients: Imaging Predictors for Clinical Severity and Outcome

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S503AB

Participants
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PURPOSE

To investigate the imaging characteristics of radiation pneumonitis (RP) in lung cancer patients and define radiographic patterns associated with high-grade RP and RP-related death.

METHOD AND MATERIALS

Eighty-two patients with lung cancer (35 males, 47 females, median age 68) treated with conventional chest radiotherapy who had symptomatic RP (CTCAE Grade 2 in 60, Grade 3 in 15, Grade 5 in 7 patients) were identified from the radiation oncology database. Chest CT scans at the time of RP were retrospectively reviewed by a consensus of 2 chest radiologists. The imaging features of RP were studied for association with high-grade RP (Grade >=3) and RP-related death.

RESULTS

The CT findings of RP extended beyond the radiation field in 67 patients (82%) and were confined to the radiation field in 15 (18%). Both lungs were involved in 48 patients (59%). All lobes were involved in 28 patients (34%). CT findings included ground glass and reticular opacities in all patients, with traction bronchiectasis in 77 (94%) and consolidation in 74 (90%). In 67 patients with findings beyond the radiation field, the most common pattern was cryptogenic organizing pneumonia (COP) pattern with multifocal/focal distribution (n=54; 81%), followed by acute interstitial pneumonia (AIP)/acute respiratory distress syndrome (ARDS) pattern with diffuse distribution (n=10; 15%), nonspecific interstitial pneumonia (NSIP) pattern with peripheral distribution (n=2; 3%) and hypersensitivity pneumonitis (HP) pattern with diffuse distribution (n=1; 1%). High-grade RP was associated with higher extent of lung involvement ($p=0.0025$), diffuse distribution ($p<0.001$), AIP/ARDS pattern ($p<0.001$) and COP pattern ($p=0.03$). RP-related death was associated with higher extent ($p=0.003$), all lobe involvement ($p=0.006$), diffuse distribution ($p=0.0003$), AIP/ARDS pattern ($p=0.0001$) and COP pattern ($p=0.04$).

CONCLUSION

CT findings of symptomatic RP were noted to extend beyond the radiation field in most cases. COP pattern with multifocal distribution was most common. Higher extent of lung involvement, diffuse distribution, AIP/ARDS pattern and COP pattern were associated with high grade RP and RP-related deaths.

CLINICAL RELEVANCE/APPLICATION

Awareness of the imaging features of RP and radiographic patterns associated with high-grade RP and RP-related death is important for accurate image interpretation and optimal patient management.

SSG15-02 First Report of Salvage Stereotactic Body Radiotherapy after Prior Thermal Ablation for Primary and Secondary Lung Cancers

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S503AB

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PURPOSE

Stereotactic body radiotherapy (SBRT) and thermal ablation (TA) are both techniques to treat small lung tumors. To this date, there is no report of salvage SBRT after thermal ablation. We therefore aim to describe the efficacy and toxicity of SBRT for recurrent primary or secondary lung tumors after prior thermal ablation.

METHOD AND MATERIALS

We retrospectively reviewed patients from 2007 to 2018 who were initially treated with microwave thermal or radiofrequency ablation, who later developed local recurrence within the ablation cavity for which salvage SBRT was then performed. Dose and fractionation were based on tumor size and location. Toxicity was standardized using the Common Terminology Criteria for Adverse Events v5.0. Local control (LC) was estimated using the Kaplan-Meier method.

RESULTS

We identified 33 consecutive patients with 34 lesions with a median follow-up time of 21.6 months. Thirty patients (91%) had primary non-small cell lung cancers and 3 patients (9%) had lung metastases from non-lung primaries. The majority of lesions (82%) underwent initial microwave TA. Eleven lesions (32%) received additional local therapy prior to SBRT including 8 lesions (24%) receiving prior salvage TA and 3 (9%) receiving adjuvant radiation therapy with initial TA. Salvage SBRT was delivered with a median prescription dose of 50 Gy (range 28-54 Gy in 3-5 fractions). Median time to recurrence after TA was 10.1 months (interquartile range [IQR] 6.4-18.1). Median recurrence size was 1.95 cm (IQR 1.35-2.9) within a median ablation cavity size of 2.9 cm (IQR 2.5-3.75). After salvage SBRT, two in-field local failures occurred at 10.7 and 26.2 months resulting in an crude LC rate of 94%. The 2-year actuarial LC rate was 95.2% (95% CI, 70.7%-99.3%). One patient (3%) developed grade 2 symptomatic radiation pneumonitis and another patient (3%) developed grade 3 chest wall pain.

CONCLUSION

Salvage SBRT after prior TA for locally recurrent primary and secondary lung cancer is safe and effective.

CLINICAL RELEVANCE/APPLICATION

We report the first analysis of the toxicity and efficacy of salvage SBRT after initial TA. SBRT allows for potential disease cure in patients with local recurrence.

SSG15-03 Quantifying Anatomic Changes for Radiation Therapy Lung Patients to Predict the Benefit for Mid-Treatment Adaptive Radiation Therapy

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S503AB

Participants
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PURPOSE

To evaluate the efficacy of quantifying mid-treatment anatomic changes in Stage III lung cancer patients being treated with radiation therapy to predict when adaptive radiotherapy (ART) may benefit the patient.

METHOD AND MATERIALS

Simulation CT and daily on-treatment conebeam CT (CBCT) images for fifteen patients treated with radiation therapy (45Gy/15fx to 66Gy/33fx) from 2014-2018 were evaluate. All CBCTs were classified into ART/non-ART following published guidelines for on-treatment anatomic changes, including tumor regression, tumor misalignment, surrogate misalignment, and lung density changes. Six regions of interest (ROI) were defined around the tumor, carina, spinal cord, and lungs by geometrically expanding contours used in the treatment planning process. Daily anatomic change was quantified on each axial slice of the CBCTs within each defined ROI using six common deformable image registration metrics. The median, 75th percentile, and 90th percentile of the daily quantified changes across all axial slices were evaluated as thresholds to automatically delineate between ART and non-ART classified patients.

RESULTS

Seven patients were classified as benefitting from ART, divided between tumor regression (7), lung density changes (4), surrogate alignment (4), tumor alignment (2). Boxplots for each calculated metric within the ITV+15mm ROI for all patients and daily CBCTs were produced, with the lower/upper box borders representing the 25th/75th percentile across all axial slices. Treatment days benefitting from ART for tumor regression had a correlation with the mean squared error metric. The average±stdev for the median, 75th, and 90th percentiles occurring on the first classified ART fraction for the 7 patients were 10.8±3.8, 15.3±6.6, and 20.5±9.5, respectively. The 75th percentile for two non-ART daily CBCTs exceeded the 75th percentile ART threshold. A similar range of results were observed for other combinations of ART classifications, ROIs, and quantifiable metrics.

CONCLUSION

Automatically triggering on-treatment lung patients for ART by quantifying anatomic changes on daily CBCTs is feasible and would be ideally suited for development of machine learning algorithms.

CLINICAL RELEVANCE/APPLICATION

Predictive ART models utilizing quantifiable metrics generated from daily CBCT imaging can improve theefficacy of identifying when ART would benefit patients treated for lung cancer.

SSG15-04 Quantification of Image-Guidance Benefit in Image-Guided Radiotherapy of Cancers

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S503AB

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PURPOSE

Image-guidance has been widely used in the clinic for accurate radiotherapy. However, a practical and effective method to evaluate the effect of image-guidance in the radiotherapeutic management of cancers is absent. The goal of this study is to quantify the benefit of image-guidance in image-guided radiotherapy (IGRT) of cancers.

METHOD AND MATERIALS

In this study, a new metric termed image-guidance index (IGI), has been proposed to quantify the benefit of image-guidance in cancer radiotherapy. It is calculated as a ratio of the square sum of dose differences between planning dose matrix and actual delivery dose matrix to the square sum of dose summation between the two matrixes, summing over all dose scoring voxels. Ranging from 0 to 1, larger IGI values indicate larger benefit out of image-guidance. An in-house MATLAB code with matrix operation was developed for the calculation of IGI. With IRB approval, IGI values were calculated based on the DICOM RT files of 716 patients with chest cancer. The patients were divided into 12 groups according to cancer sites including esophagus (upper, middle, lower, upper & middle, middle & lower, and whole), breast (left & supine, right & supine, left & prostrate, and right & prostrate) and lung (with or without mediastinum). Finally, the IGI values were calculated and compared among the various site groups and various techniques of SBRT, 3DCRT, IMRT and VMAT.

RESULTS

Overall, IGI increases monotonously as shift increases, with different slopes among various directions and various groups. With a shift of 1, 2 and 3 mm, respectively in each of the AP, RL and SI directions, the medians of IGI were 0.0002, 0.0009, 0.0017 in AP, 0.0002, 0.0008, 0.0017 in RL, and 0.0002, 0.0008, 0.0018 in SI for esophagus, 0.0008, 0.0030, 0.0061 in AP, 0.0006, 0.0026, 0.0052 in RL, and 0.0004, 0.0016, 0.0034 in SI for breast, and 0.0002, 0.0009, 0.0019 in AP, 0.0002, 0.0007, 0.0016 in RL, and 0.0005, 0.0021, 0.0045 in SI for lung, respectively. With a shift of 1 mm, except for lung in SI, the IGI values are different significantly among sub-groups for esophagus, breast and lung groups ($P = <0.003$).

CONCLUSION

IGI values vary significantly among various cancer types and IGRT techniques. Our results indicate that IGI can be used as an effective tool to quantify the benefit of image guidance in IGRT.

CLINICAL RELEVANCE/APPLICATION

IGI can be used as an effective tool to quantify the benefit of image guidance in IGRT.

SSG15-05 Evaluation of High-Risk Imaging Features for Detection of Local Progression After Pulmonary Stereotactic Body Radiotherapy

Tuesday, Dec. 3 11:10AM - 11:20AM Room: S503AB

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PURPOSE

Detection of local progression (LP) after stereotactic body radiotherapy (SBRT) for lung lesions can be difficult because of radiation-induced lung changes in CT scans. High-risk CT-features (HRF-CT) for prediction of LP have been proposed, the role of 18F-FDG-PET remains unclear. Here HRF-CT and 18F-FDG-PET-imaging features (HRF-PET) were evaluated in a prospective SBRT-trial cohort under "real-life conditions".

METHOD AND MATERIALS

Four independent and blinded observers scored follow-up (FU)-CT and 18F-FDG-PET/CT images of 65 pulmonary lesions after SBRT with a structured questionnaire assessing RECIST and HRF-CT ((sequential) enlarging opacity, bulging margin, linear margin disappearance, loss of air bronchogram, craniocaudal growth). If LP was suspected, the respective 18F-FDG-PET images were analyzed qualitatively, then quantitatively. Inter-observer Agreement (IOA) was determined using Cohen's kappa. Sensitivity and specificity of HRFs for detecting LP were calculated using the reference standard defined by clinical long term courses, including

information on imaging and biopsy.

RESULTS

IOA for presence of individual HRF-CT were "slight" (k=0.119 to k=0.288), for overall suspicion on LP after CT assessment k= 0.308 for HRF-CT, k= 0.289 for RECIST and k= 0.604 after qualitative additional PET assessment. Sensitivity and specificity were 0.22-0.46 and 0.73-0.92 for HRF-CT, 0.30 and 0.94 for RECIST. Qualitative 18F-FDG-PET/CT analysis was highly sensitive (1.0; specificity 0.79), semi-quantitative evaluation using SUVmax revealed no further diagnostic benefit (sensitivity 1.0; specificity 0.67). Sensitivity / specificity of CT-assessment versus qualitative PET-assessment for detection of LP were 0.43 / 0,86 and 1,0 / 0,85, respectively.

CONCLUSION

While we could neither confirm RECIST nor defined HRF-CT as reliable predictors of LP, qualitative 18F-FDG-PET/CT assessment seems to offer more diagnostically accurate information about local progression after SBRT, not being improved by quantitative 18F-FDG uptake analysis.

CLINICAL RELEVANCE/APPLICATION

Qualitative 18F-FDG-PET/CT assessment seems to offer more diagnostically accurate information about local progression after SBRT than CT assessment, not being improved by semi-quantitative 18F-FDG uptake analysis.

SSG15-06 Preliminary Evaluation of Inhale/Exhale Quantitative CT for Functional Avoidance Radiotherapy Treatment Planning in Non-Small Cell Lung Cancer Patients

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S503AB

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PURPOSE

Minimizing severe pulmonary toxicity has become a major therapeutic aim for radiation treatment (RT) for non-small cell lung cancer (NSCLC) patients. While V/Q SPECT is a valuable tool for functional lung assessment, it has not been adopted for use in routine radiation treatment planning. In this study, we evaluate our quantitative CT technique as an alternative to V/Q SPECT for functional treatment planning in NSCLC patients undergoing RT.

METHOD AND MATERIALS

Paired inhale/exhale CT scans were acquired from 6 NSCLC patients at pre-tx as part of single site clinical trials. CT scans were co-registered and analyzed using the Parametric Response Mapping (PRM) technique, which classifies local lung parenchyma as normal or diseased. A Jacobian map (Jm), a measure of local deformation between inflation levels, was also calculated. The Jacobian map and PRM data were compared over the whole lung and locally to V/Q SPECT functional maps.

RESULTS

As seen in Figure 1, regions of high ventilation as identified by SPECT had high Jm values. In contrast, regions of low ventilation consisted of small airways disease (SAD) and parenchymal disease (PD). Jm was positively and negatively correlated to percent volume of PRM-derived normal (R2=0.924) and PD (R2=0.878), respectively, but not SAD (R2=0.088). Patients with elevated PD (40-90% of lung volume) were found to have low normalized ventilation (<0.95).

CONCLUSION

Classification of lung parenchyma by PRM and Jacobian maps offer the ability to quantify local estimates of healthy lung and various forms of pulmonary dysfunction. The comparison of PRM- and SPECT-based functional metrics showed similar spatial features. Quantitative CT techniques may improve functional treatment planning by more readily providing functional and descriptive lung information for RT planning.

CLINICAL RELEVANCE/APPLICATION

Patients treated for non-small cell lung cancer (NSCLC) often suffer from respiratory comorbidities. PRM of high-resolution inhale/exhale CT scans offers the ability to quantify various chronic pulmonary disease phenotypes. By identifying regions of normal and diseased lung through CT imaging, which is more readily available than V/Q SPECT, PRM has the potential to be adapted for use in functional radiation treatment planning. As such, this study sought to investigate the use of PRM in radiation treatment planning by comparing PRM-based functional metrics with SPECT-based functional metrics.

SSG15-07 Quality of Life After Pulmonary Stereotactic Fractionated Radiotherapy: Long-Term Results of the Phase II STRIPE Trial

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S503AB

Participants
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Felix Momm, MD, Freiburg, Germany (*Abstract Co-Author*) Nothing to Disclose
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Anca-Ligia Grosu, Freiburg, Germany (*Presenter*) Nothing to Disclose

PURPOSE

Preserving health related quality of life (HRQOL) plays an important role in considering stereotactic body fractionated radiotherapy (SBRT). The prospective monocenter phase II STRIPE trial investigated long-term HRQOL after SBRT, efficacy and toxicity.

METHOD AND MATERIALS

Patients with <= 2 pulmonary lesions <= 5cm were treated with 4DPET/CT-based SBRT (3X12.5Gy or risk-adapted 5X7Gy, to the 60% isodose). Follow up (FU) was performed 2 and 7 weeks after SBRT, then 3monthly for 2 years with assessment of response (primary endpoint: 2-year cumulative incidence of local progression (LP); secondary endpoints: local progression free (LPFS), overall survival (OS) and toxicity (CTCAE)). Impact of predefined patient and treatment related factors on HRQOL (EORTC QLQ-C30 and EORTC QLQ-LC13) was evaluated.

RESULTS

Between 02/2011 and11/2014, 100 patients were given SBRT for 56 NSCLC and 44 pulmonary metastases. Long-term FU overall revealed stable Quality of Life (QoL)/Global health status (GHS), functions-scores and symptoms. For QoL/GHS, patients with low initial QoL/GHS-Score below the median of 50, revealed significantly stronger improvement than those with good QoL/GHS-scores ($p < 0.001$). Probability for LP, LPFS and OS 2 years after SBRT was 8.1%, 53.3% and 62.2%. Lower risk for LP was revealed for 3X12.5Gy ($p=0.043$) and for Dmin (Biological Effective Dose10) in the Planning Target Volume>100Gy ($p=0.023$). >=G3-Toxicity was < 4%, except dyspnea: >=G3 dyspnea was 6% at baseline and 14.5% 2 years after SBRT.

CONCLUSION

These prospective data on a representative cohort of pulmonary SBRT patients confirm a stable preservation of HRQOL after SBRT and furthermore demonstrate a QoL/GHS-benefit for patients with low initial QoL/GHS-scores, the regimen of 3x12.5 Gy SBRT being efficient and well tolerated. This result may inform shared decision making when discussing SBRT for frail patients.

CLINICAL RELEVANCE/APPLICATION

Pulmonary SBRT can lead to long lasting QoL/GHS improvemnt in patients with low initial QoL/GHS-scores.

SSG15-08 Survival Outcomes of Patients Receiving Systemic Therapy With and Without Definitive-Dose Thoracic Radiotherapy for Metastatic Non-Small Cell Lung Cancer

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S503AB

Participants
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Khush S. Aujla, MD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

We aimed to investigate the overall survival (OS) outcomes of patients with metastatic non-small cell lung cancer (mNSCLC) who received definitive-dose thoracic radiotherapy (RT) in conjunction with systemic therapy (ST) compared to those who received lower-dose RT with ST or ST alone using the National Cancer Database (NCDB).

METHOD AND MATERIALS

We identified 46,315 mNSCLC patients in the NCDB who received ST and thoracic RT diagnosed between 2004 and 2014. RT patients were grouped by BED: <40 Gy and 40-70 Gy (LD-RT), 70-100 Gy and >100 Gy (HD-RT). Our comparison cohort was composed of 113,009 m NSCLC patients who received ST and did not receive thoracic RT, or RT to another body site as part of their initial treatment course (ST-only). OS outcomes were compared using the Kaplan-Meier method and Cox proportional hazards models accounting for clinical and demographic co-variables. Propensity score matching (PSM) balanced across co-variables was used to confirm the impact of BED on OS.

RESULTS

Median follow up was 9.1 months overall, and 25.8 months among survivors. The most common RT regimen was 30 Gy in 10 fractions (n=7,181, 17.15% of RT patients). HD-RT patients comprised 19.2% of the study cohort (BED 70-100 Gy; n=7806, 16.9%, and BED >100 Gy; n=1046, 2.3%). Compared to those in the ST-only group, HD-RT patients receiving BED of 70-100 Gy (HR 0.69, $p<0.001$) or >100 Gy (HR 0.69, $p<0.001$) had improved OS versus LD-RT patients receiving BED <40 Gy (HR 1.40, $P<0.001$) or 40-70 Gy (HR 0.95, $p<0.001$) on multivariable analysis. Patients in HD-RT had improved survival compared to PS matched controls in ST-only (HR 0.68, $p<0.001$).

CONCLUSION

The HD-RT group regimens were associated with improved OS compared to the LD-RT regimens and ST-only on multivariable and PSM analyses. These findings are limited by the retrospective nature of the NCDB data but are in line with the results of recently resulted phase II data suggesting a survival advantage with aggressive local therapy added to systemic therapy for limited metastatic burden in patients with NSCLC.

CLINICAL RELEVANCE/APPLICATION

Definitive-dose thoracic RT in conjunction with systemic therapy is associated with improved OS compared to systemic therapy alone with or without lower-dose thoracic RT in metastatic NSCLC.

SSG15-09 Chemical Exchange Saturation Transfer (CEST) Imaging versus FDG-PET/CT: Capability for Therapeutic Effect Prediction of Chemoradiotherapy in Non-Small Cell Lung Cancer

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S503AB

Participants
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Masao Yui, Otawara, Japan (*Abstract Co-Author*) Employee, Canon Medical Systems Corporation
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Takeshi Yoshikawa, MD, Kobe, Japan (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation

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PURPOSE

To directly and prospectively compare the capability for prediction of therapeutic effect for chemoradiotherapy between chemical exchange saturation transfer (CEST) imaging and FDG-PET/CT in non-small cell lung cancer (NSCLC) patients.

METHOD AND MATERIALS

32 consecutive and pathologically diagnosed stage III NSCLC patients (18 males and 14 females; mean age 73 year) underwent CEST imaging at a 3T MR system, FDG-PET/CT, and chemoradiotherapy and follow-up examinations. According to the results of follow-up examination, all patients were divided into recurrence (n=7) and non-recurrence (n=25) groups. In each patient, magnetization transfer ratio asymmetry (MTRasym) was calculated from z-spectra at 3.5ppm in each pixel, and MTRasym map was computationally generated from CEST data. In each lesion, MTRasym and SUVmax were assessed by ROI measurements. To compare all indexes between two groups, Student's t-test was performed. Then, multivariate logistic regression analyses were performed to investigate the discriminating factors of two groups. ROC-based positive test was performed to determine each feasible threshold value, and diagnostic performance was compared between two indexes by McNemar's test. Finally, disease free and overall survivals between responders and non-responders assessed by each index were compared by Kaplan-Meier method followed by log-rank test.

RESULTS

MTRasym and SUVmax had significant difference between two groups ($p<0.05$). Multivariate regression analyses identified MTRasym (Odds ratio [OR]: 0.23, $p=0.04$) and SUVmax (OR: 0.09, $p=0.008$) as significant differentiators. There were no significant differences of sensitivity, specificity and accuracy between MTRasm and SUVmax ($p>0.05$). MTRasym and SUVmax had significant difference of disease free survival between responder and non-responder groups (MTRasym: 23.4±3.5 [mean±standard error] month vs. 14.4±1.5 month, $p=0.01$; SUVmax: 28.5±3.8 month vs. 14.2±1.3 month, $p=0.0006$).

CONCLUSION

CEST imaging has a potential for predicting therapeutic effect of chemoradiotherapy and considered at least as valuable as FDG-PET/CT in NSCLC patients.

CLINICAL RELEVANCE/APPLICATION

CEST imaging has a potential for predicting therapeutic effect of chemoradiotherapy and considered at least as valuable as FDG-PET/CT in NSCLC patients.

Printed on: 10/29/20

SSG16

Vascular/Interventional (Liver Cancer)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: E260

GI IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Ronald S. Arellano, MD, Boston, MA (*Moderator*) Nothing to Disclose
Juan C. Camacho, MD, Charleston, SC (*Moderator*) Research Grant, El.en.
Paula Novelli, MD, Pittsburgh, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSG16-01 Ultrasound-Guided Percutaneous Brachytherapy for the Treatment of Hepatocellular Carcinoma with Portal Vein Branch Tumor Thrombus

Tuesday, Dec. 3 10:30AM - 10:40AM Room: E260

Participants
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PURPOSE

To evaluate the safety and efficacy of ultrasound guided iodine-125 implantation for the treatment of hepatocellular carcinoma with portal vein branch tumor thrombus (PVBTT).

METHOD AND MATERIALS

From June 2013 to August 2018, a total of 69 HCC patients complicated with PVBTT were included in this single-center retrospective study. 34 patients underwent iodine-125 seeds implantation combined with transarterial chemoembolization (TACE), while 35 patients underwent TACE alone. Outcomes were measured in terms of tumor response, overall survival (OS), progress free survival (PFS) and adverse events.

RESULTS

The technique was successfully performed in all patients. No complications grade 3 or higher according to Common Terminology Criteria for Adverse Events (CTCAE) version 3.0 occurred. In the analysis for PVTT response 1 month after treatment, TACE-Iodine125 group, 5 patients (14.7%) achieved CR, 15 patients (44.1%) achieved PR. Whereas in the TACE group, no patient achieved CR, 2 patients (5.7%) achieved PR. Patients receiving TACE-Iodine125 had a median OS and PFS of 11 months (95% CI: 8.5, 13.5) and 9 (95% CI: 6.0, 12.0), compared with 7 months (95% CI: 5.9, 8.1) and 3 months (95% CI: 1.7, 4.3) for those who receiving TACE only. Treatment strategy, type of PVTT were significant predictors of OS.

CONCLUSION

Ultrasound guided iodine-125 seed implantation is a safe and effective treatment for HCC patients with PVBTT.

CLINICAL RELEVANCE/APPLICATION

This study provide a convenient and efficient method in addition to Sorafenib and radiotherapy for unresectable HCC with PVBTT.

SSG16-03 Predictors of Successful Bridging to Liver Transplantation in Patients with Hepatocellular Carcinoma Undergoing Yttrium-90 Radioembolization Therapy

Tuesday, Dec. 3 10:50AM - 11:00AM Room: E260

Participants
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William V. Wagstaff, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
James Zhang, BS,PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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Nima Kokabi, MD, Atlanta, GA (*Abstract Co-Author*) Research support, Sirtex Medical Ltd

PURPOSE

To identify key clinical and imaging predictors of successful bridging to liver transplantation (LT) in patients undergoing Yttrium-90

radioembolization (Y90 RE) therapy for hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

A retrospective analysis was conducted in patients with HCC who were deemed by a multidisciplinary tumor board as candidates or potential candidates for LT by Milan Criteria (MC) and underwent Y90 RE as bridging therapy. Patients were divided into favorable and unfavorable Y90 RE response groups based on changes to their MC eligibility, with maintained or achieved eligibility defined as favorable, and unchanged or lost eligibility defined as unfavorable. Pre Y90 baseline prognostic factors were compared between favorable and unfavorable responders using chi-square, Fisher's exact test, and student's t-test analysis.

RESULTS

Between 2014 and 2018, 144 patients were deemed candidates or potential candidates for LT by MC and underwent Y90 RE bridging. Out of the 56 (39%) patients within MC, eligibility was maintained in 45 (80%) and lost in 6 (11%) patients. Out of the 88 (61%) patients outside MC, eligibility was achieved in 40 (45%) patients and remained unchanged in 45 (51%) patients. Among the 85 (59%) patients who experienced a favorable therapy response, 22 (26%) patients went on to receive LT. Comparison analysis between the favorable and unfavorable response groups suggested that younger age (p=0.0461), female gender (p=0.0095), unilobar distribution (p=0.0238), <=4 viable tumors (p=0.0058), smaller dominant lesion diameter (p=0.0058), lower tumor burden (p=<0.0001), lower Barcelona Clinic Liver Criteria (BCLC) stage (p=<0.0001), lower alkaline phosphatase (p=0.0456) and higher sodium blood levels (p=0.0084) were all associated with successful bridging to liver transplantation.

CONCLUSION

Certain favorable clinical and imaging characteristics in patients with HCC appear to be positive prognostic factors for the successful bridging to liver transplantation using Y-90 Radioembolization.

CLINICAL RELEVANCE/APPLICATION

Positive prognostic factors in patients with HCC can provide clinicians with opportunities to personalize Y-90 radioembolization treatments for potential liver transplant patients in need of maintaining or achieving transplantability status.

SSG16-04 Long-Term Outcomes of Combined Radiofrequency Ablation and Multipronged Ethanol Ablation for the Treatment of Unfavorable Hepatocellular Carcinoma

Tuesday, Dec. 3 11:00AM - 11:10AM Room: E260

Participants
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PURPOSE

To evaluate the local efficacy, safety and long-term outcomes of combining radiofrequency ablation (RFA) and multipronged ethanol ablation (EA) in the treatment of unfavourable hepatocellular carcinoma (HCC) and determine the prognostic factors for survival.

METHOD AND MATERIALS

Between August 2009 and December 2017, 98 patients with 110 unfavourable HCC nodules who underwent combining RFA and multipronged EA were enrolled retrospectively in this study. Unfavourable HCC is defined as medium (3.1-5.0 cm) or large (5.1-7.0 cm) HCC, tumour located at a high-risk site or perivascular tumour. Treatment response, overall survival (OS) and recurrence-free survival (RFS) were analysed. The Kaplan-Meier method and Cox proportional hazards regression model were used to evaluate the prognostic factors.

RESULTS

Complete ablation (CA) was obtained in 80.9% (89/110) of the tumours after initial treatment. Major complications were observed in 3 (3.1%) patients. The cumulative incidence of local tumour progression (LTP) was 23.5% at 5 years, and no variable was found to be an independent predict factor for LTP. The five-year OS and RFS rates were 41.9% and 18.6%, respectively. Multivariate analysis showed that the serum alpha-fetoprotein (AFP) level and number of tumours were significant prognostic factors for OS (P= 0.017 and P< 0.001, respectively) and RFS (P= 0.014 and P= 0.001, respectively). Perivascular tumour was not an independent factor predicting OS or RFS.

CONCLUSION

Combining RFA and multipronged EA is a safe and effective treatment for unfavourable HCC, especially for perivascular tumours. A high serum AFP level and multiple tumours had significant negative effects on OS and RFS.

CLINICAL RELEVANCE/APPLICATION

Combined RFA and multipronged EA is a safe and effective modality for unfavorable HCC. Combined RFA and multipronged EA expand the indication of thermal ablation to tumors in diameter of 5cm. High serum AFP level and multiple tumours had a significant negative effect on OS and RFS.

SSG16-05 Ultrasound-Guided Percutaneous RFA in 287 Patients with Isolated Recurrent Hepatocellular Carcinoma: 10-Year Survival Rates and Prognostic Analysis - The Effect of Primary Treatment Modalities on Outcomes

Tuesday, Dec. 3 11:10AM - 11:20AM Room: E260

Participants
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PURPOSE

The therapeutic outcomes of RFA for recurrent hepatocellular carcinoma (RHCC) after different primary treatment modalities have not been compared. The aim of this study was to assess the long-term outcome of RFA in RHCC and evaluate the effect of primary treatment modalities on outcomes.

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board. Between January 2005 to December 2016, 287 patients who underwent ultrasound guided percutaneous RFA for single RHCC (mean diameter 2.9 cm) were enrolled. Of these 287 patients, 134 patients had RHCC from previous hepatectomy, 128 patients from TACE and the other 25 patients from local ablation therapy. There were 235 males and 52 females with mean age of 60.5 years.

RESULTS

For 287 patients, 336 sessions of RFA were performed. Major complications were observed in 5 patients (2.0%). The technical success was achieved in 95.1% of lesions. Local tumor progression was detected in 42 lesions (14.6%). Local tumor progression rate in RHCC with previous local ablation was significant higher than that in RHCC with previous hepatic resection (28.0% vs 11.9%, P=0.036). The estimated 1-, 3-, 5-, and 10-year OS for RHCC patients after RFA were 92.3%, 73.1%, 58.8%, and 39.6%, respectively. There was no significant difference in OS among the three different primary treatment groups (P=0.777). Based on multivariate analysis, tumor size (P=0.017), Child-Pugh class (P=0.045), portal vein hypertension (P=0.036), and serum alpha fetoprotein level (P=0.018) were associated with OS.

CONCLUSION

RFA is a safe and effective modality with an overall 10-year survival rate of 39.6 % in patients with single RHCC. The primary treatment modality had significant effect on the local tumor progression and OS (only for patient with RHCC > 3cm).

CLINICAL RELEVANCE/APPLICATION

The RHCC patients accounted for more than one of third of RFA cases in our center, most of them received one of the three main treatments, including hepatectomy, TACE or local ablation. So far, few studies reported 10-year survival rates of RFA for RHCC treatment. Also, it is not clear if the primary treatment modalities would impact the long-term outcomes. In our study, the primary objective was to analyze the long-term survival and prognostic factors of RFA in RHCC, and the second objective was to compare the difference in outcome after RFA among different primary treatments.

SSG16-06 Impact of Post-Therapy Prophylaxis on Radiation-Induced Liver Disease

Tuesday, Dec. 3 11:20AM - 11:30AM Room: E260

Participants
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PURPOSE

Radioembolization (RE) with yttrium-90 (90Y) resin microspheres is an effective treatment in patients with primary or secondary liver cancer. Radiation-induced liver disease (RILD) is a potentially life-threatening complication with higher prevalence in cirrhotics or patients exposed to previous chemotherapies. This study aimed to evaluate the impact of post-therapeutic RILD-prophylaxis in a relatively homogeneous cohort of liver metastatic breast cancer patients.

METHOD AND MATERIALS

Ninety-three patients with liver metastases of breast cancer received RE between 2007 and 2016. Patients received RILD prophylaxis for 8 weeks post-RE. From January 2014, RILD prophylaxis was changed from ursodeoxycholic acid (UDCA) and prednisolone (standard prophylaxis [SP]; n=59) to pentoxifylline (PTX), UDCA and low-dose low molecular weight heparin (LMWH) (intensified prophylaxis [IP]; n=34). The primary endpoint was toxicity including symptoms of RILD, secondary endpoints included overall survival (OS).

RESULTS

Median OS (95% CI) after RE was 8.0 (6.2-9.8) months. IP (HR 0.47; p=0.033;) and pre-RE alkaline phosphatase >=2 µmol/s.L (HR 2.01; p=0.013) were independent predictors of survival. Subclinical RILD events (bilirubin >=21 µmol/L [but < 30 µmol/L] or ascites) or treatment discontinuations were observed more frequently in the SP group, albeit without significance (5 vs. 1; p=0.397). Symptomatic RILD (bilirubin >=30 µmol/L and ascites) occurred in the SP group only (n=2; p>0.1).

CONCLUSION

Intensified post-therapeutic RILD prophylaxis with PTX, UDCA and LMWH has an independent positive impact on OS in patients with metastatic breast cancer and may reduce RILD frequency and severity.

CLINICAL RELEVANCE/APPLICATION

Radioembolization is an effective treatment in patients with chemotherapy-resistant liver metastases of different primary tumours

Radioembolization is an effective treatment in patients with chemotherapy-resistant liver metastases of different primary tumors as well as primary liver cancer. However, radioembolization may cause injury to the healthy tissues of the liver leading to radiation-induced liver disease (RILD); a potentially life-threatening complication which pathophysiologically resembles venous occlusive disease. Intensive prophylactic (preventative) treatment, with a combination of ursodeoxycholic acid (UDCA) pentoxifylline (PTX), and low-dose low molecular weight heparin (LMWH), has a positive impact on patients' survival and might reduce RILD frequency and severity.

SSG16-07 Local Tumor Control and Survival Rates in Unresectable or Recurrent Hepatic Cholangiocarcinoma (CCC): Transarterial Chemoembolization (TACE) versus Combined TACE and Microwave Ablation (MWA)

Tuesday, Dec. 3 11:30AM - 11:40AM Room: E260

Participants
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PURPOSE

To evaluate the effect of local targeted liver therapy using transarterial chemoembolization (TACE) with or without microwave ablation (MWA) in patients with unresectable or recurrent cholangiocarcinoma (CCC) regarding overall survival and local tumor control.

METHOD AND MATERIALS

In this retrospective study from January 2007 to December 2017 152 patients (69 males/83 females; mean 58.7 years; range 25-86) with CCC with either unresectable (123/152=80.2%) or recurrent (29/152=19.8%) lesions were treated with at least three sessions (range 3-26) of TACE. Patients were subclassified into non-metastatic (86/152=56.5%), nodal metastatic (39/152=25.7%), systemic metastatic (18/152=11.8%) and both nodal and systemic metastatic (9/152=5.9%). 30 patients received combined TACE and MWA. Follow-up was performed using MRI and CT to evaluate local tumor control according to the modified RECIST criteria and survival was evaluated using the Kaplan-Meier method.

RESULTS

Mean survival for all patients was 28.7 months (CI 21.8-35.7). The survival for patients with non-metastatic, nodal, systemic metastatic and combined metastases was 37, 23.4, 17.5 and 12.4 months, respectively (p value = 0.006). Tumor response after three cycles of TACE was either stable (35.5%), partial response (41.4%) or progressive (23%) and the response at the last follow up was 25.7%, 15.2%, 59.2% and 3.5%, respectively. Patients who received additional MWA showed significantly longer survival vs those with only TACE (median 28 momths and 18 months, respectively, p<0.007). Significant prognostic factors for local tumor control and survival were nodal and/or systemic metastases, pre-therapeutic tumor size, initial local tumor response and additional application of MWA. However, no significant correlation was found between recurrent and unresectable tumors.

CONCLUSION

Local targeted liver therapy of unresectable or recurrent hepatic CCC using TACE or combined TACE and MWA provides an adequate therapeutic option for loca tumor control and improves patient survival

CLINICAL RELEVANCE/APPLICATION

TACE with additional MWA is a promising therapeutic tool in patients with advanced CCC involvement.

SSG16-08 Automated Pattern-Based and Voxelwise Analysis of Lipiodol Deposits on Computed Tomography after Conventional Transarterial Chemoembolization and their Effect on Tumor Response

Tuesday, Dec. 3 11:40AM - 11:50AM Room: E260

Participants
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PURPOSE

To establish Lipiodol as a theranostic imaging biomarker for therapeutic efficiency of conventional transarterial chemoembolization (cTACE) using automated quantitative and pattern-based image analysis techniques on 24h post cTACE computed tomography (CT).

METHOD AND MATERIALS

This was a retrospective review of prospectively collected clinical trial data including 42 primary and secondary liver cancer patients with 65 tumors treated using cTACE (2012-2018). Hounsfield Unit (HU) thresholds were used to automatically characterize the presence and density of Lipiodol on 24h post cTACE CT scans. Additionally, Lipiodol deposition patterns within a volumetric tumor mask were automatically assessed with regards to homogeneity, sparsity, rim, and peripheral deposition of Lipiodol. Following 3D image registration of baseline (BL) and 1-month follow-up (F/U) MRI to post-TACE CT, Lipiodol deposition was correlated with enhancing tumor volume (ETV) on BL MRI and F/U MRI, using Wilcoxon signed-rank test, Mann-Whitney U test, Kruskal Wallis test, Spearman's rank correlation, and linear regression.

RESULTS

Cut-off values of 87 HU, 155 HU, and 241 HU were found to achieve good separation of areas with low, mid and high Lipiodol density. ETV on BL MRI was significantly correlated with Lipiodol deposition on 24h CT ($p<0.0001$). Tumor regions where Lipiodol was present became necrotic at a higher rate on F/U MRI than areas without Lipiodol ($p=0.0475$). Specifically, ETV decrease in tumor areas with low, mid and high density Lipiodol compared to areas without Lipiodol was -0.87% ± -15.98 ($p=0.3393$), -9.32% ± -22.20 ($p=0.0066$) and -17.91% ± -23.42 ($p=0.0003$), respectively. Moreover, homogeneous ($p=0.0006$), non-sparse ($p<0.0001$), rim deposition within sparse tumors ($p=0.045$), and peripheral deposition ($p<0.0001$) of Lipiodol showed improved response on F/U MRI.

CONCLUSION

In this study, a quantitative automated threshold-based technique was developed and applied to characterize Lipiodol patterns and densities on post-cTACE CT. Strong correlation with radiographic tumor response supports the prognostic value of Lipiodol as an imaging biomarker that can be easily incorporated into the management of liver cancer patients treated using cTACE.

CLINICAL RELEVANCE/APPLICATION

Automated tools to characterize Lipiodol deposition may improve clinical workflow efficiency and allow for a more personalized treatment by earlier identification of non-responders to cTACE.

SSG16-09 Comparison between Percutaneous and Laparoscopic Microwave Ablation of Hepatocellular Carcinoma

Tuesday, Dec. 3 11:50AM - 12:00PM Room: E260

Participants
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PURPOSE

Based on patient and nodule characteristics, some authors favor laparoscopic over percutaneous HCC microwave ablation (MWA) , however data are controversial. We compared the two approaches in terms of technical success, complication and local tumor control rates.

METHOD AND MATERIALS

From October 2014 to February 2019, 86 consecutive patients underwent percutaneous or laparoscopic MWA of 98 HCC nodules with a 2450MHz/100W Microwave generator (Emprint, Medtronic). Complete ablation (technical success) and Local Tumor Progression (LTP) at follow-up were assessed by contrast-enhanced CT/MRI. Seventy patients (79 HCC nodules) satisfied inclusion criteria, of which 49 (52 nodules) underwent percutaneous MWA and 21 (27 nodules) underwent laparoscopic MWA.

RESULTS

Baseline analysis showed higher rates of multifocal disease in the laparoscopic group ($p=0.0001$) and higher rates of patients previously treated for HCC in the percutaneous group ($p=0.034$). All other patient and nodules characteristics were homogeneous. Technical success did not significantly differ between the two groups ($p= 0.3$). 7/64 patients (10.9%) suffered procedure-related complications (CIRSE classification grade-3): 2 cases (abscess, haematoma) in the percutaneous group (3.4%) and 5 (pneumothorax, respiratory failure, fever, portal thrombosis, hematoma) in the laparoscopic group (18.5%) ($p=0.02$). 6/79 (7.6%) HCC nodules showed local progression with 1- and 2-year LTPFS rates of 95% and 83.8%, respectively. Five LTPs occurred in the percutaneous group (9.6%), while 1 LTP in the laparoscopic one (3.7%) ($p=0.9$). At logrank analysis, operative approach was not a statistically significant predictor of LTPFS ($p=0.48$). Subgroup analysis showed a trend toward worse LTPFS after percutaneous procedures of subcapsular nodules (2-year LTPFS 100% laparoscopic vs 65.2% percutaneous, $p=0.15$)

CONCLUSION

Higher complication rate in the Laparoscopic group can be explained by the greater technical invasiveness and by the higher rate of multifocal disease treated in one session. Tendency toward better local tumor control in the laparoscopic group when dealing with subcapsular nodules is possibly due to the better visualization and monitoring of the ablation area achieved through laparoscopic guidance.

CLINICAL RELEVANCE/APPLICATION

Despite its higher complication rate, laparoscopic MWA is a an effective therapeutic option and should be considered for treatment of subcapsular HCC.

SSJ01

Breast Imaging (Quantitative Imaging and CAD)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E450A

BQ BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Shandong Wu, PhD, MSc, Philadelphia, PA (*Moderator*) Nothing to Disclose
Matthias Dietzel, MBA,MD, Erlangen, Germany (*Moderator*) Nothing to Disclose

Sub-Events

SSJ01-01 Multiparametric Preoperative Breast MRI for Predicting Ki-67 and Histologic Grade in Early-Stage Luminal Breast Cancer

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E450A

Participants
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PURPOSE

To investigate whether 3T multiparametric magnetic resonance imaging (mpMRI) can predict Ki-67 proliferation index and histologic grade in stage I-II luminal breast cancer

METHOD AND MATERIALS

In this retropective study, 239 consecutive women with luminal cancers underwent mpMRI and surgery. For mpMRI model, morphologic characteristics using Breast Imaging Reporting and Data system lexicon, kinetic feature using a computer-aided diagnosis (CAD), and apparent diffusion coefficient (ADC) at diffusion-weighted imaging were evaluated by two radiologists. Performance for predicting Ki-67 and histologic grade were assessed by using logistic regression analysis and the receiver operating characteristic curve (ROC) analysis.

RESULTS

Among 239 cancers, 166 (69.5%) had low Ki-67 and 73 (30.5%) had high ki-67, and 193 (80.8%) were low grade and 46 (19.2%) were high grade. Multivariate analysis showed that intratumoral high signal intensity (odds radio [OR] = 1.844; *P* = .046), and higher washout component (OR = 1.024; *P* = .001) were associated with higher Ki-67, and the presence of axillary adenopathy (OR = 2.719; *P* = .033), intratumoral high signal intensity (OR = 2.338; *P* = .028), larger angio-volume (OR = 1.186; *P* = .001), and higher washout component (OR = 1.033; *P* = < .001) were associated with higher histologic grade. The median ADC value was 0.95 ± 0.18 x 10 -3 mm2/s and ROC analysis showed that it was impossible to differentiate Ki-67 and histologic grade using ADC values (*P* = .701 and *P* = .056).

CONCLUSION

The mpMRI- derived biomarkers using tumor morphology and kinetic feature can be used for predicting proliferation activity and histologic grade in early-stage luminal breast cancer.

CLINICAL RELEVANCE/APPLICATION

Preoperative mpMRI-derived features may be used as biomarkers that help predict proliferation index and grade in patients with luminal breast cancers, thereby enabling improved personalized treatment.

SSJ01-02 Computer-Aided Diagnosis - Extracted Kinetic Heterogeneity of Breast Cancer at Preoperative MR Imaging: Relationship to Distant Metastasis-Free Survival

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E450A

Participants
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PURPOSE

To investigate whether computer-aided diagnosis (CAD)-extracted kinetic features of breast cancer at preoperative magnetic resonance (MR) imaging are associated with distant metastasis-free survival in women with invasive breast cancer.

METHOD AND MATERIALS

Between November 2011 and November 2012, 283 consecutive women (mean age, 52.9 years; age range, 32-88 years) with newly diagnosed invasive breast cancer who underwent preoperative breast MR imaging were evaluated. A commercially available CAD system was used to extract the peak enhancement (highest pixel signal intensity in the first post-contrast series) and delayed enhancement profiles (washout, plateau, and persistent components of a tumor) of each breast cancer from preoperative MRI, and kinetic heterogeneity (a measure irregularities in the proportions of washout, plateau, and persistently enhancing components within a tumor) was calculated to evaluate the intratumoral heterogeneity. Cox proportional hazards models were used to reveal the associations between CAD-extracted kinetic features and distant metastasis-free survival after adjusting for clinicopathological factors.

RESULTS

In 28 (9.9%) women, distant metastasis developed at a median follow-up of 76.7 months. CAD-extracted kinetic heterogeneity was higher in women with distant metastasis than in those without distant metastasis (0.702 ± 0.197 vs 0.434 ± 0.297, P < 0.001). Multivariable Cox proportional hazards analysis showed that a higher kinetic heterogeneity (hazard ratio [HR], 17.582; 95% confidence interval [CI]: 3.852; 80.263; P = 0.009), a higher peak enhancement (HR, 1.001; 95% CI: 1.000, 1.002; P = 0.039), the presence of lymphovascular invasion (HR, 3.442; 95% CI: 1.529, 7.750; P = 0.003), and a higher histological grade (HR, 2.285; 95% CI: 1.043, 5.009; P = 0.039) were associated with poorer distant metastasis-free survival.

CONCLUSION

Higher values of CAD-extracted kinetic heterogeneity and peak enhancement at preoperative breast MR imaging are associated with poorer distant metastasis-free survival of women with invasive breast cancer.

CLINICAL RELEVANCE/APPLICATION

Kinetic heterogeneity assessed by computer-aided diagnostic (CAD) at preoperative MR imaging might serve as a quantitative biomarker of distant metastasis-free survival in women with breast cancer.

SSJ01-03 Quantitative Analysis of Ultrasonographic Feature of Invasive Breast Cancer: Correlation with Molecular Subtypes

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E450A

Participants
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PURPOSE

To investigate the correlations between ultrasonographic features quantitatively assessed by a computer-aided quantification system (S-DetectTM) and molecular subtypes of breast cancer.

METHOD AND MATERIALS

An IRB-approved retrospective review was performed for 282 invasive breast cancers (<5cm) in 282 women (mean age, 53.5 years; range, 29-85 years) who underwent surgery between February 2016 and April 2017. Morphologic characteristics of breast cancer on B-mode ultrasonography (US) with respect to shape of mass, margin, orientation, echogenicity, and posterior features were measured using S-DetectTM software, and quantitative scores (0-1) of each descriptor of breast cancer were recorded. The associations between quantitative scores and tumor subtype, tumor size, and lymph node status were compared using the one-way analysis of variance test or Student's T-test.

RESULTS

Of the 282 breast cancers, 144 (51.1%) were classified as luminal A tumors, 77 (27.3%) as luminal B tumors, 22 (7.8%) as HER2-enriched tumors, and 39 (13.8%) as triple-negative tumors (ER, PR, and HER2 negative). Luminal A tumors exhibited higher irregularity scores than triple-negative tumors (mean 0.6328 vs. 0.4679, p=0.031). Luminal B tumors exhibited higher spiculated margin scores than triple-negative tumors (mean 0.1654 vs. 0.0276, p=0.026). In addition, tumors larger than 2cm in size had higher scores for irregular shape (p=0.000-0.004) than tumors smaller than 2 cm in size all tumor subtype except for HER2-enriched tumors.

CONCLUSION

Luminal A tumors and Luminal B tumors were more likely to exhibit irregular shapes and spiculated margins than triple-negative tumors. Smaller tumors tended to be rounder and more oval-shaped and to have more circumscribed margins than larger tumors in most tumors except for HER2-enriched tumors.

CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of morphologic characteristics using B-mode US with the S-DetectTM software can provide useful information regarding imaging phenotypes of breast cancer.

SSJ01-04 Quantitative Analysis of MRI Response to Preoperative Stereotactic Ablative Body Radiotherapy (SABR) in Early Stage ER+ HER2- Breast Cancer Correlates with Histologic Tumor Bed Cellularity

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E450A

Participants
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PURPOSE

The purpose of this study is to evaluate breast MRI response to pre-operative SABR for ER+ HER2- breast cancer and determine quantitative imaging predictors of pathologic response.

METHOD AND MATERIALS

Enrolled subjects in this phase II trial of early stage ER+ HER2- breast cancer patients underwent baseline breast MRI, SABR treatment (28.5 Gy in 3 fractions), follow-up MRI 6 weeks post-SABR, and breast conserving surgery. Pre and post-SABR MRIs were individually compared. The % tumor volume remaining (%VR) and % long diameter remaining (%DR) were calculated using quantitative metrics to evaluate MRI Response. This was correlated with pathologic response, defined by % tumor bed cellularity (%TC) in the surgical specimen. MRI analysis included 3D orthogonal measurements, semi-automated segmentation volume, and quantitative microcluster segmentation analysis of the dynamic constrast T1-weighted images. Microcluster voxel analysis of the segmented tumor was performed, assigning clusters based on binary high or low maximum enhancement intensity using Otsu algorithm and by dynamic sequence of maximum enhancement. This yielded 8 microcluster volumes within the tumor for each MRI. Statistical analysis was performed using Pearson's correlation coefficients.

RESULTS

Twelve patients completed the trial, and %TC ranged from 20-80%. For MRI response, analysis of %VR using various methods had stronger correlation with %TC (R=0.788-0.892) than %DR (R=0.727, p=0.007). The %VR by 3D measurements (R=0.844, p=0.0006) and by semi-automated segmentation (R=0.829, p=0.0009) were both very strongly correlative. For quantitative microcluster analysis, while total cluster %VR had strong correlation with %TC (R=0.747, p=0.005), correlation was stronger for %VR of the high enhancement clusters (R=0.86, p=0.0003) and even higher for %VR of the first three dynamic phase high enhancement clusters (R=0.892, p=0.0001).

CONCLUSION

In patients undergoing pre-operative SABR treatment for ER+ HER2- breast cancer, quantitative analysis of %VR on MRI, including microcluster segmentation analysis, very strongly correlates with pathologic response.

CLINICAL RELEVANCE/APPLICATION

Quantitative MRI tumor analysis, including microcluster segmentation analysis comparing pre and post SABR-treated ER+ HER2- breast cancer can help predict pathologic response to preoperative radiation in low risk tumors for which pathologic complete response to neoadjuvant treatment is rare.

SSJ01-05 Pharmacokinetic Quantitative Parameters with Histogram and Texture Features on Preoperative Dynamic Contrast-Enhanced Magnetic Resonance Imaging Differentiate between Luminal A and B Molecular Subtypes of Breast Cancer

Tuesday, Dec. 3 3:40PM - 3:50PM Room: E450A

Participants
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PURPOSE

The aim of the present study was to use pharmacokinetic quantitative parameters with histogram and texture features on dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) to differentiate between the luminal A and luminal B molecular subtypes of breast cancer.

METHOD AND MATERIALS

We retrospectively reviewed the data of 94 patients with histopathologically proven breast cancer. The pharmacokinetic

quantitative parameters (Ktrans, Kep, and Ve) with their corresponding histogram and texture features based on preoperative DCE-MRI were obtained. The parameters were compared using the Mann-Whitney U-test between the luminal A and luminal B groups, the HER2-positive luminal B and HER2-negative luminal B groups, and the lymph node metastasis (LNM)-positive and LNM-negative groups. Receiver operating characteristic (ROC) curves were generated for parameters that presented significant between-group differences.

RESULTS

The maximum values of Ktrans, Kep, and Ve, and the mean and 90th percentile values of Ve were significantly higher in the luminal B group than in the luminal A group. Among the texture features, only skewness of Ktrans significantly differed between the luminal A and B groups. All histogram features of Ktrans were higher in the HER2-positive luminal B group than in the HER2-negative luminal B group. No parameter differed between the LNM-positive and LNM-negative groups.

CONCLUSION

Pharmacokinetic quantitative parameters with histogram and texture features obtained from DCE-MRI are associated with the molecular subtypes of human breast cancer, and may serve as potential imaging biomarkers to differentiate between the luminal A and luminal B molecular subtypes.

CLINICAL RELEVANCE/APPLICATION

(Dealing with quantitative DCE-MR and the luminal A and luminal B molecular subtypes classification in breast cancer)'Quantitative parameters with histogram and texture features can be linked to two ER-positive cancer.'

SSJ01-06 Using Machine Learning to Quantify the Distribution and Morphology of Microcalcifications to Improve Cancer Prediction

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E450A

Participants
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PURPOSE

To develop a machine learning approach to classify whether suspicious microcalcifications (MC) are malignant based on their distributional patterns.

METHOD AND MATERIALS

We used 1481 mammographic images with MC findings from a public screen-film mammography dataset (DDSM), which provided radiologist-assigned BI-RADS scores and biopsy-proven diagnoses. We developed an automated algorithm to detect MCs by rescaling the image to different resolutions and applying morphological operations. Given our interest in distributional patterns, we only considered images with three or more detected MCs, reducing the total images to 743. We used principal component analysis of the MC locations to get the directions and values of the largest possible variance and it's orthogonal. We utilized these features and the number of MCs as the basis for our quantitative description of MC distribution. Using five-fold cross validation, we trained an ensemble classifier (gradient boosting) to predict malignancy, inputting the aforementioned features along with the BI-RADS score. As a baseline, we compared the model to the predictive performance of using BI-RADS only.

RESULTS

Of the 743 studies, 403 were benign, and 340 malignant. When building a classifier solely using our MC distribution features, the model achieved an area under the curve (AUC) of 0.650 (sensitivity (SEN) 0.535, positive predictive value (PPV) 0.598). Using BI-RADS alone, the model AUC was 0.791 (SEN 0.385, PPV 0.835). When both were combined into a single model, the AUC improved to 0.802 (SEN 0.615, PPV 0.694). Increasing the minimum number of MCs to generate our features reduced the sample size but improved the AUC.

CONCLUSION

We demonstrate that using a quantitative measure of MC distribution in addition to the BI-RADS assessment adds information to predict whether suspicious MCs are malignant. Our model could be further expanded by examining additional texture features and employing deep learning techniques to discover informative features.

CLINICAL RELEVANCE/APPLICATION

MCs can be a sign of breast cancer, and the indication for biopsy is based on BI-RADS. However the morphology and appearance of MCs is affected by the overlying breast fibroglandular tissue, leading to subjective interpretations and interreader variability. We hope that by employing our approach, we can increase the accuracy of interpretation and decrease the number of unnecessary biopsies and patient anxiety.

SSJ02

Breast Imaging (Artificial Intelligence in Mammography)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E451B

AI BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Hiroyuki Abe, MD, Chicago, IL (*Moderator*) Nothing to Disclose
Jessica W. Leung, MD, Houston, TX (*Moderator*) Scientific Advisory Board, Subtle Medical

Sub-Events

SSJ02-01 Training Deep Learning Models as Radiologists: Breast Cancer Classification Using Combined Whole 2D Mammography and Full Volume Digital Breast Tomosynthesis

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E451B

Participants
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Jinze Liu, Lexington, KY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Digital beast tomosynthesis (DBT) or 3D mammography in combination with 2D mammography has emerged as a promising clinical approach to breast cancer detection but at a cost of increased interpretation time by radiologists. Numerous deep learning models have been developed with promising results in automatic classification of breast cancer. However, existing models typically focus on using either 2D or 3D mammograms. Inspired by clinical practice, we proposed novel convolutional neural networks (CNN) for breast cancer classification utilizing combined whole 2D mammogram and full volume DBT to increase the model performance.

METHOD AND MATERIALS

In this retrospective study, we collected both 2D mammograms and DBT of biopsy proven lesions (342 benign and 165 malignant) from 507 patients. The whole mammographic images were labeled as benign or malignant without lesion annotation. Instead of using DBT directly, we first converted each DBT to a dynamic image which captured the subtle changes between two successive slices. Then, the 2D mammograms and dynamic images were fed into five ImageNet pretrained deep learning networks (Alexnet, VGG, Resnet, Densenet, and Squeezenet) as feature extractors. Finally, the feature maps of both the 2D mammograms and dynamic images were fused and used in a 3D CNN classifier.

RESULTS

Based on the receiver operating characteristic (ROC) analysis of all the 507 lesions, the combined 2D and 3D mammography achieved high performance with area under the ROC curve (AUC) of 0.93 in the task of differentiation of cancer from benign lesions. This is better than the performance of the 2D or 3D mammography alone (AUC= 0.72 for 2D and 0.66 for DBT) on the same dataset in breast cancer classification. The consistently better performance (up to 40.91% increase) of the combined images was observed in all the proposed CNN models.

CONCLUSION

The increased performance of combined 2D and 3D mammogram strongly suggests that deep learning models, like radiologists, can benefit from training with the 2D and 3D mammography together. One limitation of this study is that the dataset size is small, which may limit the predicting power of the proposed model.

CLINICAL RELEVANCE/APPLICATION

With increasing adoption of DBT in clinical practice, more accurate automatic deep learning tool using combined 2D mammogram and tomosynthesis can improve breast cancer diagnostic efficiency and have meaningful impact in clinical practice.

SSJ02-02 Prospective Analysis of CNN Based Approach of Distinguishing Atypical Ductal Hyperplasia from Ductal Carcinoma in Situ in Breast

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E451B

Participants
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Michael Z. Liu, MS, New York, NY (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

We have previously developed and published a convolutional neural networks (CNN) based algorithm to distinguish atypical ductal hyperplasia (ADH) from Ductal Carcinoma in Situ (DCIS) using a mammographic dataset. Purpose of this is to further validate our CNN algorithm by prospectively analyzing unseen new dataset to evaluate the diagnostic performance our algorithm.

METHOD AND MATERIALS

An IRB-approved study was performed. New dataset composed of 280 unique mammographic images from 140 patients were used to test our CNN algorithm. All patients underwent stereotactic-guided biopsy of calcifications and underwent surgical excision with available final pathology. ADH group consisted of 122 images from 61 patients with the highest pathology diagnosis of ADH. DCIS group consisted of 158 images from 79 patients with the highest pathology diagnosis of DCIS. Two standard mammographic magnification views (CC and ML/LM) of the calcifications were used for analysis. Calcifications were segmented using an open source software platform 3D Slicer and resized to fit a 128x128 pixel bounding box. Our previously developed CNN algorithm was used. Briefly, a 15 hidden layer topology was used. The network architecture contained 5 residual layers and dropout of 0.25 after each convolution. Diagnostic performance metrics were analyzed including sensitivity, specificity, accuracy and area under the ROC curve (AUC). The 'positive class' was defined as pure ADH group in this study and thus specificity represents minimizing the amount of falsely labeled pure ADH cases.

RESULTS

Area under the ROC curve (AUC) was 0.90 (95% CI ± 0.04). Diagnostic accuracy, sensitivity and specificity was 80.7%, 63.9% and 93.7% respectively.

CONCLUSION

Our CNN model prospectively distinguished pure ADH from DCIS using mammographic images with high specificity.

CLINICAL RELEVANCE/APPLICATION

Using the patients' mammographic images, our CNN algorithm can be used to predict patients with pure ADH who may be safely observed rather than undergo surgery.

SSJ02-03 Developing an Artificial Intelligence Algorithm Pipeline for Predicting Malignancy Risk for Mammographic Microcalcifications Leveraging the ACR Data Science Institute (DSI) Use Case Library

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E451B

Participants
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Vikas Singh, Madison, WI (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

This study implements a pipeline to develop artificial intelligence (AI) algorithms to diagnose mammographic microcalcifications using the publicly-available use case authored by the Data Science Institute (DSI) breast imaging panel.

METHOD AND MATERIALS

Our pipeline, focuses on the clinical goals of the DSI use case entitled 'Classifying Suspicious Microcalcifications,' simultaneously codifying how to 1) extract relevant mammography cases using widely available National Mammography Database (NMD) fields, 2) construct AI algorithms integrating computational and clinical input, and 3) formalize clinically-relevant evaluation metrics; all designed to support proof of generalizability. We collected mammograms with microcalcifications using an NMD database of consecutive screening and subsequent diagnostic mammograpms (1/1/2006-12/31/2015) from an academic practice for women $\geq$40. Matched outcomes from a Cancer Center registry confirmed final pathology using 6 ordinal subcategories: 4 malignant categories (invasive>DCIS grade 3> DCIS grade 2> DCIS grade 1) and 2 benign categories (high risk>normal). According to the DSI use case, we developed AI algorithms to calculate malignancy risk (using 10-fold cross validation) for ROC curve comparison using the DeLong method-as an example. We also derived a binary classification (benign versus malignant) and a 6-class stratification in order to classify pathologic severity and use BI-RADS to derive generalizable metrics.

RESULTS

Our final dataset contained 10,834 images with microcalcifications and ground truth pathology: 778 cancers (385 invasive; 89 DCIS grade 1; 183 DCIS grade 2; 121 DCIS grade 3) and 10,056 benign (283 high risk; 9773 normal). An example result from our pipeline: our Graph Neural Network algorithm achieved an area under the ROC curve of 0.65 which was statistically significantly superior to a baseline model using logistic regression (AUC = 0.52; $p < 0.001$). Generalizability planning includes specification of a pre-assigned threshold to use for evaluation metrics according to BI-RADS.

CONCLUSION

We demonstrate feasibility of developing an AI pipeline for realizing an important DSI use case in breast imaging.

CLINICAL RELEVANCE/APPLICATION

Assessing if microcalcifications on mammography are malignant is a clinically important pursuit. The relevant DSI use case effectively guided a promising pipeline for AI algorithm development.

SSJ02-04 Deep-Learned Mammographic Phenotypes Indicate Racial Differences in Breast Parenchymal Patterns

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E451B

Participants
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PURPOSE

To investigate racial differences in breast parenchymal patterns extracted from full-field digital mammography (FFDM) screening studies using deep learning, while also accounting for differences in age, body-mass index (BMI) and breast density.

METHOD AND MATERIALS

We analyzed a random sample of FFDM studies from 2000 self-identified African-American (AA) and 2000 Caucasian women, who underwent routine mammographic screening (Selenia Dimensions, Hologic Inc.) at our institution between September 2010 and December 2014. A deep learning model (ResNet-34 architecture) was built to learn mammographic phenotypes differentiating AA from Caucasian women, using all four standard mammographic views of the raw (i.e., 'FOR PROCESSING') imaging data from each FFDM study. To evaluate the ability of the deep-learned mammographic phenotypes to identify differences in parenchymal patterns between AA and Caucasian women while also testing for potential confounding, three Random Forest classification models were evaluated using an 80%-20% train-test split-sample approach and inputs from: (1) the deep-learned mammographic phenotypes alone, (2) the deep-learned mammographic phenotypes combined with potential confounding variables such as age, BMI, and automated area-based and volumetric percent density measures estimated with the Volpara software (v1.5.3, Volpara Health Technologies), and (3) these potential confounding variables alone. The area under the curve (AUC) of the receiver operating characteristic on the independent test set was used as performance metric to measure the ability to classify the two races based on the features evaluated.

RESULTS

The performance of the deep-learned mammographic phenotypes alone was significant (AUC = 0.88, $p<0.05$), while combining them with age, BMI and Volpara density did not change the performance (AUC = 0.88). Substantially lower race classification capacity was demonstrated when age, BMI and Volpara density were evaluated alone (AUC = 0.69, $p<0.05$).

CONCLUSION

Deep learning elucidated racial differences in mammographic parenchymal phenotypes, which can only be partially explained by factors such as age, BMI and breast density.

CLINICAL RELEVANCE/APPLICATION

Differences in parenchymal phenotypes may provide new insight on racial disparities in breast cancer's onset age and outcomes, as well as the need for adjusting breast screening guidelines by race.

SSJ02-05 Diagnostic Performances of Artificial Intelligence (AI)-Based Diagnostic Support Software for Mammography: Results Using a Standardized Test Set Built for External Validation

Tuesday, Dec. 3 3:40PM - 3:50PM Room: E451B

Participants
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PURPOSE

To evaluate the diagnostic performances of a artificial intelligence (AI)-based diagnostic support software for mammography when applied to a standardized test set built for external validation.

METHOD AND MATERIALS

A total of 1,986 mammograms were collected consecutively from four participating centers to construct a standardized test set for validation. Cancer diagnosis was based on pathologic diagnosis (n=1,189, 59.9%), while benign diagnosis was based on either biopsy or benign imaging features showing stability for more than 2 years follow-up (n=797, 40.1%). Mammography images were analyzed using Lunit INSIGHT for Mammography (Lunit Inc., South Korea), a deep learning-based software that provides per-breast malignancy scores with region-of-interests (ROIs) for suspicious malignant lesions on mammography. Diagnostic performances were calculated using the optimized cutoff for malignancy scores.

RESULTS

Diagnostic performances using Lunit INSIGHT for Mammography on the 1,198 cases were as follows (optimal cutoff 0.068): sensitivity 90.2%, specificity 90.9%, accuracy 90.2%, and AUC 0.960, respectively. Diagnostic performances were significantly higher in mammographically-fatty breasts than dense breasts: 95.2%, 93.4%, 94.3%, 0.978 vs 88.6%, 87.7%, 88.3%, and 0.947, respectively, and in cancer size >2cm than <2cm: 96.7%, 90.1%, 92.5%, 0.981 vs 85.6%, 90.1%, 87.8%, 0.939, respectively.

CONCLUSION

The AI-based diagnostic support software for mammography showed high diagnostic performances in general, including cases of mammographically-dense breasts and small cancers. Further validation studies using standardized test sets are anticipated to prove the clinical feasibility of various diagnostic support softwares in real-world practice.

CLINICAL RELEVANCE/APPLICATION

The artificial intelligence-based diagnostic support software for mammography showed high diagnostic performances when applied to a standardized test set constructed for validation, proving its potential to provide guidance in mammography interpretation in real-world practice.

SSJ02-06 Data-Driven Imaging Biomarker for Breast Cancer Screening in Mammography: Prediction of Tumor Invasiveness in Mammography

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E451B

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PURPOSE

To assess feasibility of data-driven imaging biomarker in mammography (DIB-MMG; an imaging biomarker derived from large-scale mammography data based on deep learning technology) whether prediction of tumor invasiveness is applicable on mammography - discrimination of ductal carcinoma in situ (DCIS), DCIS with microinvasion (DCIS-MI), and invasive ductal carcinoma (IDC).

METHOD AND MATERIALS

A total of 151,764 exams of 4-view mammograms were collected from multiple institutions for developing DIB-MMG, where 31,776 were cancer (confirmed by biopsy), 49,644 were benign (confirmed by biopsy or at least 1 year of follow-up imaging), and 70,344 were normal exams (confirmed by at least 1 year of follow-up imaging). Surgical assessment of tumor invasiveness (459 DCIS, 373 DCIS-MI, and 6,365 IDC) was collected for 7,197 out of 31,776 cancer exams. A separate set of 777 cancer exams (46 DCIS, 49 DCIS-MI, 682 IDC) were used for evaluation. Previously, we assessed the feasibility of DIB-MMG as a diagnostic-support tool for breast cancer screening in mammography. In this study, we further investigated whether DIB-MMG is applicable to predict tumor invasiveness in mammography. DIB-MMG-TI (i.e. Tumor Invasiveness) was developed via two stages of training - 1) training with diagnosis labels (normal, benign, cancer), followed by 2) fine-tuning with invasiveness labels (DCIS, DCIS-MI, IDC) on the subset of cancer exams. We exploited the location of cancer lesions (6,229 among 7,197 exams) for the purpose of attention (i.e. attention mechanism in AI) in order to predict the invasiveness in more effective way.

RESULTS

AUC was summarized on two tasks: 1) discrimination of IDC from DCIS and DCIS-MI, and 2) discrimination of DCIS from DCIS-MI and IDC. For each task, per-exam AUC of DIB-MMG-TI on 777 exams of validation dataset was 0.781 and 0.690 respectively, while per-breast AUC for each task was 0.775 and 0.690. Fig.1 shows examples.

CONCLUSION

This study showed that discrimination of DCIS-MI from DCIS is more difficult than that from IDC in mammography. Experimental results showed that DIB-MMG-TI is feasible to discriminate IDC from the rest. Further clinical validation with observer performance study is needed.

CLINICAL RELEVANCE/APPLICATION

With further clinical validation, DIB-MMG-TI can be used as a preoperative diagnostic-support tool for prediction of tumor invasiveness in mammography.

SSJ03

Cardiac (Myocarditis and Inflammation)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: N227B

CA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ03-01 Layer-Specific Strain Analysis in Patients with Suspected Acute Myocarditis: Comparison of Diagnostic Performance

Tuesday, Dec. 3 3:00PM - 3:10PM Room: N227B

Participants
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PURPOSE

Myocardial strain parameters based on cardiac magnetic resonance (CMR) feature tracking (FT) have been described to provide additional diagnostic information for the assessment of regional or global myocardial dysfunction in patients with acute myocarditis. Recent software developments allow the assessment of layer-specific myocardial strain. We aimed to determine the diagnostic performance of different layer-specific strain parameters for the diagnosis of acute myocarditis.

METHOD AND MATERIALS

68 patients with suspected acute myocarditis and 51 control subjects underwent multiparametric CMR at 1.5 Tesla. Layer-specific FT strain measurements were derived from cine images using dedicated software (Medis Suite MR, QStrain RE). Left ventricular global peak systolic longitudinal (GLS), circumferential (GCS) and radial strain (GRS) with determination of endocardial, mid-myocardial and epicardial layers, were assessed. Receiver operating characteristic analysis was performed to calculate areas under the curve (AUC).

RESULTS

Left ventricular ejection fraction was slightly reduced in patients with myocarditis (54.59±10.74% vs. 60.51±4.04%). Patients with acute myocarditis showed markedly reduced endocardial, mid-myocardial and epicardial GCS and GLS values when compared to healthy controls ($p<0.001$ for all parameters). No difference were found for radial strain values ($p>0.05$, respectively). Best diagnostic performance was observed for mid-myocardial GCS values (AUC: 0.82, cutoff: >-24.3%, sensitivity: 72%, specificity: 84%). Except for epicardial GLS (AUC: 0.74, $p=0.057$ vs. mid-myocardial GCS), the diagnostic performance of mid-myocardial GCS outperformed all other investigated strain parameters ($p<=0.01$ for all other comparisons).

CONCLUSION

CMR FT layer-specific strain values are reduced in patients with acute myocarditis. Especially, mid-myocardial GCS showed a high performance for the diagnosis of acute myocarditis and might further broaden the diagnostic targets of CMR in these patients. These findings correspond with the physiological model of strain layers, where mid-myocardial fibers determine predominantly the circumferential strain and, if affected, may contribute to a higher level of myocardial dysfunction.

CLINICAL RELEVANCE/APPLICATION

Mid-myocardial global circumferential strain has a high diagnostic performance and may serve as a reliable new diagnostic parameter in cases of suspected acute myocarditis.

SSJ03-02 Degree of Agreement between New Lake Louise Criteria and Old Lake Louise Criteria in Suspected Acute Myocarditis Patients among Different Clinical Presentation

Tuesday, Dec. 3 3:10PM - 3:20PM Room: N227B

Participants

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PURPOSE

To assess the degree of agreement of new Lake Louise Criteria (nLLC) and old LLC (oLLC) in suspected acute myocarditis patients among various clinical presentations including infarct-like (IL), arrhythmic (A) and cardiomyopathic (CM).

METHOD AND MATERIALS

104 consecutive patients with clinical suspicion of acute myocarditis were scanned on a 1.5T MR [45.5±17.5 years, 35 females (33%)]. Cardiac MR (CMR) protocol included: Cine-sequences, T2wSTIR, late and early Gd enhancement, T2 mapping, native T1 mapping and post-Gd T1 mapping. 4 patients were excluded for unknown clinical history. Frequency of clinical presentations were: 50/99(50%) IL, 21/99(21%) A and 29/99(29%) CM. Ventricular functions were recorded and compared. Patients were evaluated both with nLLC and oLLC. The degree of agreement was assessed with Cohen's kappa test for the whole population and per each group.

RESULTS

Statistically significant differences were highlighted between CM and both A and IL groups, in terms of EDV/BSA(mL/m2) and EF(%) (101.50 [87.68 to 120.90] vs 76.10 [68.99 to 96.52] and 74.87 [70.40 to 80.72]; 37.70 [31.30 to 45.40] vs 55.50 [41.60 to 58.08] and 56.04 [54.90 to 58.08]; p0,05, respectively). CMR diagnosis of myocarditis was performed in 41/104 (39.4%) patients with oLLC and in 43/104 (41.3%) with nLLC (κ= 0.68 CI95% 0.54 to 0.82). A good agreement was found in IL presentation between oLLC and nLCC (28/50, [56.0%] vs 25/50 [50.0%] κ= 0.72 CI95% 0.53 to 0.91). On the contrary, a moderate degree of agreement was detected for A and CM patients (oLLC vs nLLC; 4/21 [19.0%] vs 5/21 [23.8%]; 7/29 [24.1%] vs 10/29 [34.5%]; κ= 0.58 CI95% 0.15 to 1; κ= 0.59 CI95% 0.28 to 0.90, respectively).

CONCLUSION

The degree of agreement between original and new Lake Louise Criteria is different among various clinical presentation.

CLINICAL RELEVANCE/APPLICATION

The different degree of agreement between original and new Lake Louise Criteria reflects the various performance of the criteria for the diagnosis of acute myocarditis in diverse clinical scenarios.

SSJ03-03 Comparison of Original and 2018 Lake Louise Criteria for Diagnosis of Acute Myocarditis: Results of a Validation Cohort

Tuesday, Dec. 3 3:20PM - 3:30PM Room: N227B

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PURPOSE

Cardiac magnetic resonance (CMR) is frequently performed in patients suspected of having acute myocarditis. Imaging diagnosis is based on the Lake Louise criteria (LLC). The 2018 LLC added parametric mapping techniques as part of a T1- and T2-based criterion. We aimed to compare the diagnostic performance of the original LLC and the 2018 LLC and simultaneously validate previously reported cutoff values for parametric mapping techniques.

METHOD AND MATERIALS

A total of 40 patients with suspected acute myocarditis and 26 control subjects underwent CMR. CMR protocol allowed for assessment of T2 signal intensity ratio, early gadolinium enhancement ratio, late gadolinium enhancement, T1 relaxation times, extracellular volume and T2 relaxation times. The original and the 2018 LLC were assessed and differences between sensitivities and specificities were calculated using McNemar's test.

RESULTS

The 2018 LLC yielded a sensitivity of 87.5% (95% confidence interval [CI]: 73.9%-94.5%) and a specificity of 96.2% (95% CI: 81.1%-99.3%). The original LLC had a sensitivity of 72.5% (95% CI: 57.2%-83.9%) and a specificity of 96.2% (95% CI: 81.1%-99.3%). Sensitivity of the 2018 LLC was significantly higher compared to the sensitivity of original LLC (P=0.031). No differences in specificity were observed between both scores (P=0.999).

CONCLUSION

Multiparametric CMR has a high diagnostic value for the diagnosis of patients with suspected acute myocarditis. The 2018 LLC further improve the diagnostic performance of CMR by increasing its sensitivity. An implementation of the new score into routine diagnostic protocols should be considered.

CLINICAL RELEVANCE/APPLICATION

Novel 2018 Lake Louise criteria provide a high diagnostic accuracy for the diagnosis of acute myocarditis and significantly increase the sensitivity compared to the original score. Existing local reference/ cutoff values can be used to implement the new criteria into clinical routine.

SSJ03-04 Incremental Value of Cardiac Deformation Analysis in Fulminant Myocarditis: A Cardiovascular Magnetic Resonance Imaging Study

Tuesday, Dec. 3 3:30PM - 3:40PM Room: N227B

Participants
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PURPOSE

To evaluate the diagnostic value of cardiac magnetic resonance (CMR) feature-tracking (FT) myocardial strain analysis in patients with fulminant myocarditis and its association with myocardial oedema.

METHOD AND MATERIALS

A total of 26 patients with Fulminant Myocarditis(FM)and 25 patients with non- Fulminant acute Myocarditis(NFAM)underwent a comprehensive CMR protocol at 3.0T MR. Cardiac MR imaging approaches included late gadolinium enhancement, native T1 mapping, T2 mapping and extracellular volume fraction. FT CMR analysis of systolic longitudinal (LS), circumferential (CS) and radial strain (RS) was performed. Receiver operating characteristic analysis was performed to compare diagnostic performance.

RESULTS

When compared with NFAM, FM patients demonstrated reduced CS and LS values (LS: -12.23 ± 3.74% vs. -16.11 ± .44%, CS: -17.24 ± 4.14% vs. -20.71 ±2.62%, $P < 0.05$, respectively). LS (ECV: $r = 0.639$, $P < 0.001$; T2: $r = 0.517$, $P < 0.05$) and CS (ECV: $r = 0.631$, $P < 0.001$; T2: $r = 0.464$, $P < 0.05$) showed the strongest correlations with ECV and T2 relaxations times . The extent of LGE in patients did not correlate to their respective strains. Regarding the differentiation between FM and NFAM patients, the addition of global strain parameters to native T1, ECV and T2 enhanced the diagnostic performance in such patients (AUC=0.913) (Fig. 1).

CONCLUSION

Our study demonstrate that the assessment of cardiac strains applying FT on standard cine images is feasible in patients with fulminant myocarditis. And Cardiac strains parameters, especially, global peak systolic circumferential and longitudinal strain are significantly impaired in patients with FM. Myocardial strain metrics can sufficiently discriminate between FM and NFAM patients and show basic associations with the extent of myocardial inflammation.

CLINICAL RELEVANCE/APPLICATION

Myocardial strain metrics can sufficiently discriminate between FM and NFAM patients and show basic associations with the extent of myocardial inflammation.

SSJ03-05 Mapping Cardiac Magnetic Resonance (CMR) for Early Prediction of Unfavorable Left Ventricle Remodeling in Acute Myocarditis: MIAMI Study

Tuesday, Dec. 3 3:40PM - 3:50PM Room: N227B

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PURPOSE

Acute myocarditis is a multifaceted disease with non-specific clinical presentations and unpredictable outcome, ranging from complete recovery to end-stage dilated cardiomyopathy. A key element in the unfavorable left ventricle remodeling is the chronicization of the inflammation. Pixel-wise mapping technique resulted more sensitive than conventional CMR images in the diagnosis of acute myocarditis. However, the role in the detection of subtle inflammation is still under investigation and imaging predictors of outcome are still largely unknown.

METHOD AND MATERIALS

Thirty-eight patients with clinical suspicions of acute myocarditis underwent cardiac MR (CMR) at 1.5 T scanner for the evaluation of morpho-functionality and hyperaemia with ce-SSFP images, oedema with STIR and T2 mapping, scarred myocardium with LGE, native-T1 and ECV. When clinically indicated endomyocardial biopsy (EMB) was performed. A second CMR was performed 2 month after baseline. Forty-five healthy volunteers underwent CMR as control group.

RESULTS

Thirty-three patients out of 38 completed CMR follow-up. EMB was performed in 26 patients and confirmed CMR diagnosis. Infart-

like presentation was the most frequent [21 patients (55%) vs. 10 (27%) with heart failure and 7 (18%) with sudden cardiac death/arrhythmia]. At baseline CMR: LV-EDV was 135 ml with EF 53%, LL criteria were positive (T2-ratio: 2.8, Hyperemia: 13%, LGE: 6%) and T1, T2 mapping and ECV were significantly higher than normal values. No differenced were observed among clinical presentation (p>0.05). Mapping parameters showed excellent diagnostic accuracy for myocarditis in acute phase (AUC: 95%, 98%, 90% for T1 map, T2 map and ECV) and convalescent phase (90%, 85%, 89% for T1 map, T2 map and ECV) At short-term follow-up, a slight recovery of EF was experimented with a reduction of all LL and mapping parameters without differences among clinical presentations. The modification of native-T1 values correlated to the recovery of EDV (R=0.8242, p=0.0005) and ejection fraction (R= -0.4559, p=0.0378).

CONCLUSION

Lower recovery of T1 value in convalescent phase is associated to higher EDV and lower EF.

CLINICAL RELEVANCE/APPLICATION

Early evaluation of mapping modification may predict worst outcome and could be useful for risk stratification and for guiding personalized therapy.

SSJ03-06 A New Perspective to Myocarditis with Dual-Energy CT

Tuesday, Dec. 3 3:50PM - 4:00PM Room: N227B

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PURPOSE

Dual-energy computed tomography (DECT) is an evolving technology that provides information about material composition. In recent years, it has become possible to evaluate myocardial tissue by dual energy applications. The purpose of this study is to evaluate myocardium on an iodine map in DECT and to compare the DECT with MRI findings, which is the current gold standard in acute myocarditis.

METHOD AND MATERIALS

A prospective study was conducted involving patients with findings of myocarditis without any coronary artery pathology. Patients were assessed for acute myocarditis on DECT and cardiac MRI by two observers. The 17-segment-model analysis was used to assess myocardial abnormalities in terms of the number of segments, location and pattern involved, and an interobserver agreement was calculated.

RESULTS

A total of 22 patients were evaluated by CMR within 24 hours following DECT, which was within 12 hours of the onset of chest pain. Transmural diagnosis was good, subepicardial and centromyocardial diagnosis was excellent, and a perfect match was found in nodular and band-like pattern for both observers. The correlation was found to be statistically significant in terms of the total number of segments diagnosed between the DECT findings of Observer 1 and the MRI and Observer 2 and the MRI (p <0,001).

CONCLUSION

This study demonstrates that the combination of coronary angiography and iodine map images with DECT within a single examination can accurately diagnose malign coronary artery anomalies, coronary artery disease and acute myocarditis, which can cause symptoms of acute coronary syndrome with accuracy.

CLINICAL RELEVANCE/APPLICATION

• On dual-energy CT, iodine mapping shows iodine distribution in the myocardium. • Dual-energy CT may be used successfully in the diagnosis of acute myocarditis.

SSJ04

Cardiac (MRI: General Topics)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: N230B

CA MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSJ04-01 Prevalence and Pattern of Cardiac Injury Identified by Late Gadolinium-Enhancement of Cardiac Magnetic Resonance Image in Acute Moderate to Severe CO Poisoning with Elevated High-Sensitivity Troponin I: Prospective Observational Study

Tuesday, Dec. 3 3:00PM - 3:10PM Room: N230B

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PURPOSE

Myocardial injury is a frequent consequence of moderate to severe carbon monoxide (CO) poisoning. In addition, long-term mortality is significantly higher in patients who experienced myocardial injury than patients without myocardial injury. No studies have investigated myocardial injury due to carbon monoxide poisoning through cardiac magnetic resonance image (CMR). We want to know whether there are actually cardiac muscle changes identified by late gadolinium-enhancement (LGE) in CMR in acute phase after acute CO poisoning

METHOD AND MATERIALS

This prospective observational study collected data from consecutive patients who were diagnosed with acute CO poisoning and myocardial injury, defined as elevated high-sensitivity TnI (hs-TnI) level above the upper limit, at the ED between August 2017 and February 2019. CMR was performed to evaluate cardiac muscle changes identified by LGE. Patients with coronary artery disease were excluded. We classified the location of myocardial injury into 4 categories (subepicardium, mesocardium, subendocardium, and transmural) and examined the distribution of injured myocardium

RESULTS

Seventy-five patients were included. Fifteen patients (20.0%) had cardiac injury identified by LGE in CMR. The territory of left anterior descending artery (LAD) (7 patients, 46.7%) was the most common distribution in patients with positive LGE. Patients with LAD territory pattern all showed damage to the subendocardial area. In addition, mesocardium (6 patients, 40.0%) was second common site in patients with positive LGE and there was no transmural damage. Two patients with damage to the subepicardial area also showed in the RCA territory pattern. One patient had global damage distribution, defined as including distribution of all three coronary artery (LAD, left circumflex artery, and right coronary artery). Male sex was significantly more in the positive LGE group than in the negative LGE group (p=0.011). Decreased initial mental status was significantly more in the positive LGE group than in the negative LGE group (p=0.006).

CONCLUSION

Cardiac injury identified by LGE of cardiac MRI was found in 15 patients (20.0%) in acute moderate to severe CO poisoning with elevated hs-TnI.

CLINICAL RELEVANCE/APPLICATION

This is the first report about CMR results of CO poisoning. This prospective observational study collected data from consecutive patients who were diagnosed with acute CO poisoning and myocardial injury

SSJ04-02 Feature Tracking Cardiac Magnetic Resonance Imaging: A Supplementary Parameter to Improve the Risk Stratification in Patients with Ischemic Cardiomyopathy

Tuesday, Dec. 3 3:10PM - 3:20PM Room: N230B

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PURPOSE

The aim of this study was to evaluate retrospectively the prognostic value of feature tracking (FT) derived cardiac magnetic resonance imaging (CMR) strain parameters such as Global Circumferential Strain (GCS), Global Longitudinal Strain (GLS) and Global Radial Strain (GRS) for cardiovascular mortality and appropriate therapy in a cohort of patients with severe ischemic cardiomyopathy (ICM).

METHOD AND MATERIALS

ICM patients (n=246) who underwent CMR imaging prior to primary or secondary ICD implantation were retrospectively included. The following CMR parameters were assessed: GCS, GLS and GRS, calculated for both left and right ventricles, cardiac mass, ventricular and atrial volumes, atrial and ventricular functions, scar characteristics, such as ratios between left ventricular mass, infarct core mass and peri-infarction mass. FT parameters were generated from short-axis and two long axis (4-chamber; left 2-chamber) cine (SSFP- sequences) views with dedicated software (cvi42, Circle Cardiovascular Imaging Inc., Calgary, Canada). The primary endpoint was a composite of cardiovascular mortality and appropriate ICD therapies (defined as antitachycardia pacing (ATP) and adequate shock).

RESULTS

A total of 246 patients with ICM were followed up to a median of 3.7 years (1336 days; interquartile range (IQR) 460-2.062 days). 11 patients were excluded due to lack of image quality or lack of sequence acquisition resulting in 235 patients. Cardiovascular mortality occurred in 22 patients, while appropriate ICD therapies occurred in 49 patients. Those patients affected by the primary endpoint were associated with significantly reduced GRS (13.44±5.23 vs 15.20±7.63; p=0.04) and GLS (-5.99±1.75 vs -6.60±2.44 ; p=0.037) compared to patients without. In multivariable Cox regression analysis, peri-infarction scar (HR 1.11, 95%CI: 1.04-1.22, p=0.005) and GRS (HR 0,94, 95%CI: 0.90-0.98, p=0.003) were independently and significantly associated with the primary endpoint, whereas LVEF and core scar and GLS were not.

CONCLUSION

Reduced GRS seems to be an independent predictor of cardiovascular mortality and/or appropriate ICD therapy. Additionally GRS can identify a subgroup of ICM patients with an increased risk of life-threatening VA and hence could help in clinical decision making.

CLINICAL RELEVANCE/APPLICATION

Feature Tracking derived Global Radial Strain can identify a subgroup of ICM patients with an increased risk of life-threatening VA.

SSJ04-03 Cardiac Magnetic Resonance for Asymptomatic Type 2 Diabetics with Cardiovascular High Risk (CATCH) - Pilot Study

Tuesday, Dec. 3 3:20PM - 3:30PM Room: N230B

Participants
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PURPOSE

Stress cardiac magnetic resonance (CMR) for silent myocardial ischaemia in asymptomatic high risk type 2 diabetics has never been performed and the effectiveness of a screening programme is unknown. To assess feasibility of a screening programme we aimed to (i) determine the prevalence of silent myocardial ischaemia (ii) determine the number of false positive cases.

METHOD AND MATERIALS

We prospectively recruited patients with a Framingham risk score >=20% from 3 sites from August 2017 to January 2019. Adenosine stress CMR was performed in all patients. Positive stress CMR cases were referred for catheter coronary angiography with fractional flow reserve (FFR) measurements. Positive catheter coronary angiography was an FFR<=0.8 or coronary artery narrowing >=70% if FFR was not performed. Myocardial perfusion reserve index (MPRI) was measured in all cases.

RESULTS

63 patients were recruited (mean age 66yrs +/- 4.4; 77.8% male). There were 25 positive stress CMR scans. 3 patients refused

catheter coronary angiography (CCA). 9 positive stress CMR patients were shown to have FFR positive (14.3% of patient population). 13 patients had false positive stress CMRs. 3 negative stress CMR patients had CCA outside the study protocol and were confirmed as true negatives at catheter coronary angiography. 5 patients (7.9%) had infarcts detected of which 2 patients had no evidence of stress perfusion defects. Patients with false positive stress CMR had lower MPRI than true positive patients and patients without perfusion defects (1.32+/-0.29 vs 1.42+/-0.25 vs 1.45+/-0.29 respectively) although this was not statistically significant (p>=0.05). After a median follow-up of 382 days, there was no deaths, myocardial infarcts, heart failure or stroke.

CONCLUSION

14.3% of asymptomatic patients with type 2 diabetes and a Framingham risk >=20% had silent obstructive coronary artery disease which were confirmed by FFR. A false positive rate of 20.6% was demonstrated using stress CMR.

CLINICAL RELEVANCE/APPLICATION

Stress CMR screening of asymptomatic diabetic patients with Framingham risk score >20% found that ~14% of patients have obstructive coronary artery disease but there is a high false positive rate probably due to microvascular disease.

SSJ04-04 Decreased Left Atrial Longitudinal Strain is Significantly Associated with All-Cause Mortality in Restrictive Cardiomyopathy

Tuesday, Dec. 3 3:30PM - 3:40PM Room: N230B

Participants
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PURPOSE

Restrictive cardiomyopathy (RCM) represents a spectrum of disorders with a common physiology but divergent etiologies. The overall prognosis of RCM is poor with progression to heart failure and increased mortality. In this single institution retrospective cohort study, we aim to evaluate the association between cardiac magnetic resonance (CMR) variables and all-cause mortality. The secondary aim is to assess the difference of CMR imaging variables in RCM between women and men.

METHOD AND MATERIALS

98 patients with RCM (30 women and 68 men); age 61 ± 13 years referred to CMR from 2007 to 2015 were included in the study. All patients were followed to date to evaluate all-cause mortality. The CMR exam consisted of late gadolinium enhancement (LGE) images and cine images which were used for measuring indexed left ventricular (LV) mass, ventricular volume, ejection fraction (EF), and ventricular and left atrial (LA) strain. Logistic regression analysis adjusted for cardiovascular disease risk factors were performed to identify CMR variables associated with all-cause mortality.

RESULTS

50 patients (51%) had multiple myeloma and 39 (40%) had amyloidosis. 46 (47%) patients demonstrated signal enhancement on the LGE images and 35 (36%) experienced death. While mortality in patients with RCM was significantly associated with lower body mass index (p=0.03) and higher indexed LV mass (p=0.05), only LA longitudinal strain (p= 0.001) (Figure 1), older age (p=0.05), and presence of amyloid and diabetes (p=0.02 and 0.05) remained significantly associated after adjustment in the regression analysis (table 1). The presence of LGE was not associated with mortality (p=0.29). Women with RCM demonstrated higher LV circumferential strain peak (mean ± SD = 7.4 ± 1.7 versus 6.5 ± 1.6, p=0.03) smaller indexed ventricular end-diastolic volumes (p=0.005 and 0.01 for LV and RV respectively) and smaller LA volume (0.05). Mortality in women was not significantly different than in men (p=0.36).

CONCLUSION

Decreased LA longitudinal strain is independently associated with all-cause mortality in patients with RCM beyond the need for gadolinium administration. Women with RCM demonstrated higher LV circumferential strain peak.

CLINICAL RELEVANCE/APPLICATION

Left atrial longitudinal strain is associated with mortality in patients with restrictive cardiomyopathy and can play role in patients' prognosis.

SSJ04-05 Diastolic Dysfunction in Competitive Male Triathletes with Myocardial Fibrosis following a Strenuous Endurance Exercise

Tuesday, Dec. 3 3:40PM - 3:50PM Room: N230B

Participants
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PURPOSE

The purpose of this study was to analyse left ventricular (LV) diastolic function by cardiac magnetic resonance (CMR) following an endurance competition in triathletes with (LGE+) and without myocardial fibrosis (LGE-).

METHOD AND MATERIALS

30 asymptomatic male triathletes (45 ±10 years) underwent CMR (Philips, Achieva) before and 2.1 ±1.1 hours after an official endurance competition. To detect focal and diffuse myocardial fibrosis late gadolinium enhancement (LGE) imaging and native and post-contrast T1 Mapping were part of the baseline CMR protocol. The modified Look-Locker inversion recovery (MOLLI) sequence was used for T1 Mapping. Diastolic LV function was determined by time-volume analysis using cine SSFP sequences (25 phases of the cardiac cycle). Early peak-filling rates (EPFR) and atrial peak-filling rates (APFR) as well as peak-filling rate ratio (PFRR=EPFR/APFR) were determined at baseline and post-competition.

RESULTS

LGE+ triathletes demonstrated higher LV mass (89 ±7 vs. 78 ±10 g/mSquared, P<0.01) and ECV (26.2 ±1.4 vs. 24.5 ±1.3 %, P<0.01) than their LGE- counterparts. At baseline, APFR was higher in LGE+ compared to the LGE- triathletes (161 ±34 vs. 121 ±30 ml/s/mSquared, P<0.01). While APFR in LGE- triathletes showed a significant increase (121 ±30 vs. 163 ±57 ml/s/mSquared, P<0.001), it remained unchanged in LGE+ triathletes before and after the competition (161 ±34 vs. 169 ±50 ml/s/mSquared, P=0.75). EPFR and PFRR remained unchanged in both groups. There were no significant post-competition differences regarding LVEF. However, LGE+ triathletes had higher post-competition left atrial volumes than LGE- triathletes (43 ±9 vs. 34 ±7 ml/mSquared, P<0.01) and decreased LAEF (53 ±6 vs. 59 ±6 %, P<0.05).

CONCLUSION

Post-competition diastolic function in LGE- triathletes was characterized by a significant compensatory increase of APFR. In contrast, the LGE+ group did not show any relevant changes coming from already increased baseline values and had decreased post-competition LAEF compared to LGE- triathletes. This suggests exhaustion of left atrial compensatory mechanisms most likely related to impairment of diastolic function in LGE+ triathletes.

CLINICAL RELEVANCE/APPLICATION

Triathletes with focal non-ischemic LGE and increased ECV in the remote myocardium might be in danger of developing subclinical diastolic dysfunction.

SSJ04-06 Myocardial Microvascular Dysfunction in Type 2 Diabetes Mellitus Patients Accompanied with Obesity: Assessment Using 3.0T Cardiovascular Magnetic Resonance Imaging

Tuesday, Dec. 3 3:50PM - 4:00PM Room: N230B

Participants
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PURPOSE

To determine the effect of obesity and type 2 diabetes mellitus (T2DM) on myocardial microvascular function referred for cardiovascular magnetic resonance (CMR) first-pass perfusion imaging, and to clarify the important risk factors contributing to microvascular dysfunction in T2DM patients.

METHOD AND MATERIALS

A total of 79 healthy controls and 120 clinically diagnosed T2DM patients underwent CMR examination. All clinical data and image parameter were recorded and analyzed. Univariable analysis was performed to identify the predictors of myocardial microvascular dysfunction. Variables with a probability value of <0.1 in the univariable analysis were included in a backward multivariable analysis that was based on a linear regression model.

RESULTS

All perfusion parameters showed a trend that the microvascular function decreased in T2DM patients when compared with controls on the same weight scale. For the T2DM subgroup and controls subgroup, the perfusion function gradually reduced as BMI increased, which was confirmed by all perfusion parameters, except TTM (all P < 0.01). In univariable analysis, multiple variables were associated with microvascular perfusion dysfunction, such as gender, BMI, high-density lipoprotein (HDL) levels, smoking history, diabetes duration, HbA1c, heart rate. With further multivariable analysis, the perfusion parameter models demonstrated that different risk factors have varying influences on microvascular function. The microvascular wash-in function and blood flow were mainly related to BMI, and perfusion time was mainly related to heart rate.

CONCLUSION

multiple variables contribute to myocardial microvascular dysfunction and have varying influences on different pathways of microvessels in T2DM patients. Obesity is one of the important risk factors for myocardial microvascular dysfunction, and myocardial microvascular function gradually reduced as BMI increased.

CLINICAL RELEVANCE/APPLICATION

It is well established that obesity is consistently associated with a high incidence of T2DM in the general population, and the underlying cardiovascular diseases are a principal cause of morbidity and mortality in both of them. Microvascular dysfunction, which has emerged as an important role of myocardial impairment, enables the early assessment of patient status and the prediction of prognosis.

SSJ05

Chest (Artificial Intelligence/Machine Learning - Lung Malignancy)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S102CD

AI CH OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSJ05-01 Incidence Lung Cancer after a Negative CT Screening in National Lung Screening Trial: Deep Learning for Detection of Missed Lung Cancers

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S102CD

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PURPOSE

To retrospectively analyze the screening CT examinations of the National Lung Screening Trial (NLST) participants with incidence lung cancer after a negative screening round and evaluate the value of deep learning-based computer-aided detection (CAD) system in the detection of missed lung cancers.

METHOD AND MATERIALS

The images of NLST participants diagnosed with incidence lung cancer after verifiable negative CT screen were retrospectively analyzed (n = 122). Two experienced radiologists classified each of the previous-round CT screens as positive or negative and determined if missed lung cancer was present according to the NLST criteria and Lung-RADS classification in a consensus manner. A CAD system based on DenseNet 3D convolutional neural networks, trained with LIDC-IDRI dataset, was then introduced. Patient-wise and lesion-wise sensitivities along with the patient-wise false-positive rates of the CAD system were analyzed according to the NLST criteria and Lung-RADS classification separately.

RESULTS

According to the NLST criteria, 84% (103 of 122) of the previous-round CT screens were determined as positive and 60% (73 of 122) had missed lung cancers. The CAD system found 95% (98 of 103) of the CT screens as positive with 16% (3 of 19) of false-positive rate, and successfully detected 74% (54 of 73) of the missed lung cancers. Following the Lung-RADS classification, 79% (96 of 122) CT screens were determined as positive and 54% (66 of 122) had missed lung cancers. The CAD system found 89% (85 of 96) as positive with 19% (5 of 26) of false-positive rate, and detected 74% (49 of 66) of the missed lung cancers.

CONCLUSION

In this retrospective study of incidence lung cancers, the majority of the previous-round CT screens met the criteria for a positive screen and had missed lung cancers. The sensitivity of deep learning-based CAD system was 89-95% for positive screens and 74% for missed lung cancer detection, while the false-positive rate was limited.

CLINICAL RELEVANCE/APPLICATION

Lung cancers are frequently missed in low-dose CT screening and a deep learning-based CAD system has the potential to improve early diagnosis.

SSJ05-02 How Many Malignancies Present at Baseline That Get Diagnosed in the Next Screening Round? Could Their Workup Be Accelerated?

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S102CD

Participants

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PURPOSE

In the context of screening, a high proportion of diagnosed cancers have been reported to be higher than Stage I in both the NELSON (33%) and NLST (46%) trials, even after baseline scanning in NLST (34%). We hypothesise that many cancers may be visible in the baseline low-dose CT (LDCT) despite only being diagnosed from the LDCT obtained one year later. We further hypothesise that an AI-based lung cancer prediction (LCP) score would help identify some of these missed cancers on the earlier CT.

METHOD AND MATERIALS

The data consisted of 3914 subjects from the NLST with at least one solid or semi-solid nodule with a long-axis diameter >=6mm in the baseline LDCT. Subjects either only had benign findings or were diagnosed with cancer at baseline or one year later. A manual evaluation was performed of malignancies diagnosed at time-point 1, to check if a nodule >=6mm in size was visible at baseline. Thresholds to rule-in malignancies using the LCP score and the Brock model were selected by matching the specificity to that (87.2%) reported for baseline LDCTs in a retrospective evaluation of LungRADS (Pinsky et al., 2015) with a reported sensitivity of 84.9%.

RESULTS

98 of the 147 cancers diagnosed at timepoint 1 were visible at baseline. Seven of the "non-visible" cancers presented with sizes between 3 and <6mm and were not considered further. The LCP score ruled-in 68 (16 Stage II+) of these 98 visible cancers while Brock ruled-in 38 (9 Stage II+) cancers. The sensitivity and 95% confidence interval (CI) of the LCP risk score of patients diagnosed at baseline was 94.6% (90.9, 97.1). The sensitivity when including cancers diagnosed at time-point 1 was 86.9% (82.1, 92.0). For Brock, that sensitivity was 65.1% (59.2, 71.3).

CONCLUSION

Cancers only diagnosed at time-point 1 have a less malignant appearance at baseline, but in many cases accelerated workup is possible with either method if an operating point is chosen appropriately (e.g. to match the specificity of LungRADS). Despite the introduction of cancers only diagnosed at the next screening round, the LCP score achieves a sensitivity at least as good as LungRADS when applied to baseline-diagnosed cancers alone.

CLINICAL RELEVANCE/APPLICATION

AI-based lung cancer prediction could accelerate the diagnostic work-up of cancers visible in baseline screening low dose CTs. This may lead to some cancers being diagnosed at an earlier stage.

SSJ05-03 Lung Malignancy Overlooked at Chest Radiography: Performance of a Deep Learning-Based Automatic Detection Algorithm

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S102CD

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PURPOSE

To evaluate the performance of a recently developed deep learning-based automatic detection algorithm (DLAD) to detect lung malignancy overlooked at initial interpretation of chest radiograph by radiologists.

METHOD AND MATERIALS

Among the 5439 lung malignancies pathologically confirmed between April 2003 and May 2018 in a tertiary hospital, we identified patients who had overlooked lung malignancies on chest radiographs for this diagnostic cohort study. A total of 155 patients (mean patient age was 67 years [range, 29-90; 87 male patients {mean age, 67 years; range, 34-90} and 68 female patients {mean age, 64 years; range, 29-85}]) with overlooked malignant pulmonary lesions on chest radiographs were included in this study. Two radiologists independently determined whether the overlooked lesions were actionable or not. Discordant classifications were arbitrated by a third adjudicator radiologist. DLAD performance was measured in terms of sensitivities for the detection of overlooked lung malignancy and number of false-positive marks per radiograph.

RESULTS

Among 155 patients with overlooked malignancies, 127 patients were judged to have actionable lesions. When the threshold of activation value was set as 0.3, the sensitivity of DLAD for actionable lung malignancies (54% [68 of 127]) were higher than that for non-actionable lung malignancies (14% [4 of 28]). The number of false-positive marks per patient was 0.24 (31 of 127). When the threshold of activation value was set as 0.15, the sensitivity of DLAD for actionable lung malignancies increased to 60% (76 of 127), and the number of false-positive marks per patient was 0.35 (44 of 127).

CONCLUSION

The current DLAD algorithm can detect slightly more than half of the lung malignancy overlooked by radiologists at chest

radiography, with only a small number of false-positive marks.

CLINICAL RELEVANCE/APPLICATION

Our study demonstrates the potential of a DLAD algorithm to reduce the number of lung malignancies that may be overlooked by radiologists.

SSJ05-04 The Utility of a Convolutional Neural Network (CNN) Model Score for Cancer Risk in Indeterminate Small Pulmonary Nodules Compared to Clinical Practice According to British Thoracic Society Guidelines

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S102CD

Participants
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PURPOSE

To assess the potential utility of a convolutional neural network (CNN) model score for cancer risk compared to clinical practice performed following the British Thoracic Society (BTS) guidelines (2015), to improve care in patients with incidentally detected indeterminate small, < 15mm, pulmonary nodules at a UK tertiary referral centre.

METHOD AND MATERIALS

Following the implementation of BTS guidelines in 2015, 148 consecutive patients with 162 benign nodules and 10 malignant nodules were included in the analysis. It was necessary to boost the number of independent cancer nodule scores in order to power calculations based on the score distribution, so the population was enriched with 23 additional incidentally detected cancers detected over a wider time period. A review of the imaging and intervention recommendations and time intervals to establish the diagnosis, according to histology or 2-year follow-up, was conducted, blinded to the CNN model score. A CNN model, which had been trained on a manually-curated US National Lung Screening Trial (NLST) dataset was used to generate a score, which was applied to both cohorts. 6 nodules (1 cancer) were unable to be scored by the CNN and were excluded from analysis. In each case, the highest-scoring nodule in a patient was used as the index nodule.

RESULTS

Use of a threshold CNN score of 5.0 would have prevented 38 CT and 3 PET-CT scans in patients with benign nodules without missing any cancers, accounting for 41.3% of the total number of CT and 37.5% of the total PET-CT of follow-ups on these patients. 15 benign nodules would not have required any follow-up whatsoever, preventing 23 CTs, using a threshold of 0.56. In 11 patients (35.5%) with cancer, their investigation and intervention would have been expedited by 3.4 months using a CNN threshold score of 80.

CONCLUSION

A CNN generated model score applied to incidentally detected indeterminate small pulmonary nodules reduces the need for follow-up imaging in benign cases, whilst expediting imaging and intervention in cancer cases compared to actual practice.

CLINICAL RELEVANCE/APPLICATION

Our work shows the potential of CNNs in reducing the need for follow-up scans and intervention in low-scoring benign nodules, whilst potentially accelerating the investigation and treatment of high-scoring cancer nodules.

SSJ05-05 A Deep Learning-Based CAD that Can Reduce False Negative Reports: A Preliminary Study in Health Screening Center

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S102CD

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PURPOSE

To evaluate the clinical value of a deep learning-based computer-aided detection (DLCAD) model that can reduce false negative reports on screening chest CTs that were considered normal.

METHOD AND MATERIALS

A DLCAD consisting of a 2.5D CNN for candidate detection and a 3D CNN for false positive reduction was trained with a public LIDC-IDRI dataset. Preliminary validation performance for the same dataset was 90.7% sensitivity under one false-positive per scan

threshold. Ten thousand low dose chest CT cases that were reported normal were collected from a single-center screening cohort from the year 2011 to 2015. 'Normal' was defined as containing no malignant or benign lesions. The deep learning-based CAD analyzed these cases reported as normal and detected nodule candidates. Four radiologists reviewed the results of CAD independently. When the candidate nodule was accepted, the type (solid, part-solid and ground-glass nodule [GGN]) and size of nodules were annotated.

RESULTS

DLCAD analyzed 9952 cases (48 cases with inappropriate parameters, scan range or field of view were excluded) and detected 471 nodule candidates. Among them, 283 nodules from 269 patients were reported to be the true nodules by more than three radiologists. Excluding 67 nodules (with insufficient consensus), 216 nodules were categorized to be the same diameter range and nodule type by more than three radiologists. Among 216 nodules, 151 (69.9%) nodules were solid, three (1.4%) were part-solid, and 62 (28.7%) were GGN. Among 151 solid nodules, 10 (6.6%) nodules were larger than or equal to 6mm (eight [5.3%] 6 to 8mm, two [1.3%] 8 to 15mm) and 141 (93.4%) were smaller than 6mm. All three part-solid nodules were smaller than 6mm. All 62 GGN were smaller than 20mm. According to the Lung-RADS, two solid nodules were category 4A, eight solid nodules were category 3, and the remaining 206 nodules were category 2.

CONCLUSION

The deep learning-based CAD has detected 2.7% (269/9952) false negative cases with neglected nodules. 4.6% (10/216) nodules were higher than Lung-RADS category 3, which require follow up scans.

CLINICAL RELEVANCE/APPLICATION

The deep learning-based CAD will perform an ancillary role as a safeguard and a competent second reader by reducing false negative rates.

SSJ05-06 Added Value of Machine Learning in Follow-Up Lung Cancer Screening

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S102CD

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PURPOSE

Current challenge in lung cancer screening is the high false positive rate and overdiagnosis of indolent cancers. We examined if a machine learning predictor (ML) developed from combined longitudinal CT image features, patient demographics and clinical history could improve screening positive predictive value (PPV) and identify aggressive cancers.

METHOD AND MATERIALS

In a double-blinded study, we developed a ML predictor from 25,097 National Lung Screening Trial (NLST) individuals, and blindly validated it in 2,294 Pan-Canadian Early Detection of Lung Cancer Study (PanCan). All individuals who had received 2 or more CT screenings from both studies were included. We compared area under the time-dependent ROC curve (AUC) and PPV between ML and LungRADS, and examined the added value of ML to LungRADS in identifying aggressive cancers.

RESULTS

In PanCan validation sample, ML has higher 3-year time-dependent AUC(=0.899) as compared to LungRADS (AUC=0.858), p=0.028. When fixing the same sensitivity in the range of 80% - 90% for both ML and LungRADS, the ML has 28%-65% higher PPV than the LungRADS throughout all fixed sensitivity levels. Although ML high-risk group included only 9.6% of the total sample, it included 94.4% and 84.7% of all lung cancers diagnosed within 1 and 2 years. In the NLST, within LungRADS 4B individual, ML high-risk subgroup had higher lung cancer mortality (HR=31.8, P<0.001). In contrast, within ML high-risk subgroup, LungRADS 4B individuals had lower but non-significant lung cancer mortality (HR=0.93, p=0.59). Among N=404 NLST screening detected stage I&II lung cancers who received surgery, ML high-risk patients had higher lung cancer mortality (HR=44.3, p<0.001).

CONCLUSION

The ML predictor has higher sensitivity and PPV than LungRADS in lung cancer screening. It has added value in identifying more aggressive lung cancers among screening detected stage I&II cancers who received surgery.

CLINICAL RELEVANCE/APPLICATION

The ML predictor has potential added value to LungRADS in identifying aggressive lung cancers. It could help clinicians to determine the optimal nodule follow-up strategy and treatment of screen detected lung cancer.

SSJ06

Emergency Radiology (Trauma Imaging: New Concepts)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S406A

ER

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Ludo F. Beenen, MD, Amsterdam, Netherlands (*Moderator*) Nothing to Disclose
Michael E. O'Keeffe, MBBCh, Vancouver, BC (*Moderator*) Nothing to Disclose

Sub-Events

SSJ06-01 Prognostic Utility of Magnetic Resonance Imaging (MRI) in Predicting Neurological Outcomes in Patients with Acute Thoracolumbar Spinal Cord Injury

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S406A

Participants
Muhil Kannan, MD, Coimbatore, India (*Presenter*) Nothing to Disclose
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PURPOSE

Utility of MRI for predicting neurological outcomes in acute cervical spinal cord injury (SCI) is well established but its value in thoracolumbar (TL) SCI needs to be evaluated.

METHOD AND MATERIALS

Seventy six patients operated for acute TL spinal injuries between january 2014 to march 2016 were reviewed to obtain demographic details, neurology at admission and at final follow up. Patients were divided based on the neurology at presentation into group 1 (ASIA A), group 2 (ASIA B, C, D), group 3 (normal neurology). Preoperative MRI and CT scans were evaluated to measure parameters like osseus canal compromise (OCC), spinal cord compression (SCC), spinal cord swelling (SCS), length of cord swelling (LOS), length of edema (LOE) and presence of hemorrhage. The MRI parameters were compared between the groups for their predictive value of neurology on admission and at final follow up.

RESULTS

Of the 38 patients in group 1, 6 patients recovered by 1 grade, 9 patients recovered by 2 grades and there was no recovery in 23(60.5%) patients. Among group 2 patients, 9 (40.9%) out of 22 recovered to ASIA E neurology. On univariate analysis SCC (P=0.009), LOS (P=0.021), length of edema (P=0.002) were associated with complete neurological deficit at presentation. However on multivariate regression analysis only LOE was significant (P=0.007) in predicting neurology at admission and at follow up.

CONCLUSION

Greater the rostrocaudal Length of edema (LOE), worse is the neurology at presentation and it is associated with poor neurological recovery at follow up.

CLINICAL RELEVANCE/APPLICATION

Among the MRI parameters, Length of edema had the highest individual correlation with poor neurological presentation Length of edema - poor prognostic sign for recovery.

SSJ06-02 Can Quantification of Pulmonary Contusion in the Setting of Blunt Trauma Predict Patient Outcome?

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S406A

Participants
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PURPOSE

To analyze patients with variable degrees of pulmonary contusion and assess correlation with complications of blunt thoracic trauma.

METHOD AND MATERIALS

This retrospective study was IRB approved and HIPAA compliant. Informed consent was waived. Patients >=16 years old who sustained blunt thoracic trauma with Injury Severity Score (ISS) >=15 and CT scan within 24 hours of admission from 1/30/13 to 6/30/17 were included. 153 patients met inclusion criteria. Of the 153 patients included, 121 were male (79.1%) and 32 were female (20.9%). The mean age was 46.2 [16-97] and the mean ISS was 22. AAST lung injury scale was assessed in a blinded fashion by fellowship-trained radiologist with >10 years of trauma experience. Pulmonary contusion was measured using the 3 largest dimensions on orthogonal planes. Other CT variables included pneumothorax, pleural effusion, hemothorax, pulmonary laceration, pneumatocele, rib/sternal/scapular fractures, flail chest, and number of lobes injured. Clinical parameters collected were ISS, pulmonary/cardiac/renal comorbidities, intubation on presentation, ventilation associated pneumonia (VAP), and ARDS. Statistical analysis was performed using t-test, Fisher's exact test, and logistic regression.

RESULTS

With respect to CT imaging findings, the number of pulmonary lobes injured was associated with ARDS (p=0.01) and the presence of rib fractures was associated with VAP (p=0.03). Flail chest was associated with mortality (p=0.03). For every 100 mL increase in volume of pulmonary contusion, the odds of death increased by 1.20 times (p=0.04). For every 100 mL increase in volume of pulmonary contusion, the odds of ARDS increased by 1.21 times (p=0.015). With respect to clinical parameters, ISS, thoracostomy tube placement, supplemental O2 requirement, and age were associated with ARDS. ISS and age were associated with VAP. ISS and intubation on presentation were associated with mortality (all p-values <0.05).

CONCLUSION

The volume of pulmonary contusion is associated with patient mortality with statistical significance. In the setting of blunt trauma, the number of pulmonary lobes injured, rib fracture and flail chest are associated with ARDS, VAP and mortality, respectively.

CLINICAL RELEVANCE/APPLICATION

With the importance of adequate resource allocation in trauma, CT imaging findings seen in the setting of blunt thoracic trauma that prognosticate morbidity and mortality may assist in optimizing triage.

SSJ06-03 Injury Incidence and Patterns Associated with Electric Scooter Accidents

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S406A

Participants
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Mark S. Frank, MD, Indianapolis, IN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Electric motorized rental scooters (e-scooters, such as Bird and Lime), touted as a solution for 'last mile' problem, have the potential for significant utility in urban areas and college campuses. These vehicles can reach speeds up to 15 miles per hour. Since their legalization in our municipality on September 4, 2018, anecdotal observations have included a spike in imaging exams for 'scooter' accidents performed within our hospital system. The purpose of this study was to describe the injury incidence and imaging ordering patterns associated with the use of e-scooters in our municipality.

METHOD AND MATERIALS

Electronic medical records (EMRs) and radiology archives in our institutional database were searched for instances of imaging exams ordered to for injuries related to scooter accidents. Inclusion criteria include age 18 years or higher, seen at the ER of a performance site from 2013 to 2018, and 'scooter' included as a key word in the imaging request. Basic statistical analysis of the number and distribution of injuries diagnosed on imaging were performed.

RESULTS

A total of 69 exams performed on 36 unique emergency department patients with a definitive description of involvement of an e-scooter were identified. Two-thirds of these patients were ages 18-30 years. Of the imaging exams, a total of 44 (63.8%) were radiographs of the extremities, including 15 (34.1% of extremity exams) of the forearm/hand/wrist and 17 (38.6% of extremity exams) of the knee/leg/ankle/foot. A total of 18 CT exams (26.1%) were performed, including 13 (72.2% of CT exams) of the head, face or cervical spine. Of the 36 patients, 52.8% (N=19 patients) had documented injuries on 29 separate imaging exams with an overall exam positivity rate of 42.0%. The most common injuries included distal radial fracture (N=6), followed by soft tissue injury of the head, face, wrist, and ankle (N=5).

CONCLUSION

Over half of individuals who received imaging in the setting of e-scooter accidents were found to have a radiographically apparent injury. The injuries vary but the most common patterns include distal radial fracture and soft tissue injuries involving the head,

face, wrist and ankle.

CLINICAL RELEVANCE/APPLICATION

Within our health system, imaging performed in the setting of e-scooter injuries was positive in over one half of instances. Radiographs of the extremities as well as CT of the head, face and cervical spine were the exams most lilkely to be ordered.

SSJ06-04 Assessment of an AI-Powered Algorithm for the Automatic Detection of Rib Fractures

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S406A

Participants
Luca Noordtzij, MD, Basel, Switzerland (*Presenter*) Nothing to Disclose
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PURPOSE

To analyze the diagnostic performance of a deep learning-based algorithm for the automated detection of rib fractures in trauma CT scans.

METHOD AND MATERIALS

We retrospectively identified all whole-body trauma CT scans referred from our emergency department between 01/2018 and 12/2018 (n=461). The exams were categorized as positive (n = 158) and negative (n = 303) for rib fractures according to the clinically approved written reports. After full anonymization, CT datasets (1.5 mm bone kernel) were analyzed using an algorithm for the detection of rib fractures based on a convolutional neural network that had previously been trained on an independent sample (n = 11,000). The review of the results was performed on a web-based feedback system by comparing the detected results with the findings in the written reports.

RESULTS

Twelve cases had to be excluded due to technical problems. Overall, the algorithm achieved a sensitivity of 78.8% (115/146; 95% confidence interval [CI]: 71.2%-85.1%) and a specificity of 94.1% (285/303; 95% CI:90.8%-96.4%) on a per exam level (positive predictive value of 86.5%; 95% CI: 80.2%-90.1%, F1 score: 83%). On a per finding level there were 285 false negative findings out of 855 fractures mentioned in our reports, corresponding to a sensitivity of 66.7% (570/855; 95% CI: 63.4%-69.8%) and a specificity of 80.7% (285/353; 95% CI: 74.3%-83.4%). Furthermore, 85 positive findings (58 acute and 27 chronic fractures) detected by the algorithm were not mentioned in our reports.

CONCLUSION

We found good performance of an algorithm automatically detecting rib fractures in whole-body trauma CT scans on a per exam level. On a per finding level, some limitations become evident. Fractures that had not been documented in the written reports were detected by the algorithm. Thus, it constitutes a fundament for further developments in direction of a clinical decision support tool that improves accuracy of healthcare provision.

CLINICAL RELEVANCE/APPLICATION

Rib fractures are often underdiagnosed due to time-restrictions and focus on urgent findings in an emergency setting. AI-based detection has the potential to support without reader distraction.

SSJ06-05 Optic Nerve Sheath Diameter is a Prognostic Biomarker of Computed Tomography (CT) in Patients with Traumatic Brain Injury and Its Comparison with Standard Rotterdam and Marshall Computed Tomography Scores (CT Scores)

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S406A

Participants
Naveen Kumar, MD, Gulbarga, India (*Presenter*) Nothing to Disclose

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PURPOSE

The aim of this study is to prove that the optic nerve sheath diameter (ONSD) is an important and isolated predictor of outcome in patients with traumatic brain injury (TBI) and its comparison with standard Rotterdam and Marshall Computed tomography (CT scores).

METHOD AND MATERIALS

A prospective study of 100 patients performed in the department of radiology. About 100 patients underwent CT imaging for traumatic brain injury between January 2018 to June 2018. Bilateral ONSD was measured 3mm posterior to the eyeball in axial and sagittal planes and the mean value was calculated. RCTS and Marshall Score was assessed on the same CT images, the bias was eliminated by blinding RCTS and Marshall score to ONSD measurement.

RESULTS

100 patients were included, mean age of the group was 40-50years. ONSD in mild TBI includes RCTS-2 and RCTS-3 was 3.3mm (SD

0.39 mm) and 4.1 mm (0.047 mm) respectively. Mean ONSD in moderate and severe TBI (RCTS score 4 and above) was 4.83 mm and above (SD 0.4 mm). Mean ONSD correlated with occurrence of diffuse cerebral edema, presence of subdural and extradural hematoma however, in isolation there was no statistical significance.

CONCLUSION

Diameter of optic nerve sheath is considered as a valid, reliable, and non-invasive screening tool in determining the elevated intracranial pressure in cases with traumatic brain injury and its indirect predictor of outcome in patients with TBI.

CLINICAL RELEVANCE/APPLICATION

Calculation of Optic nerve sheath diameter and its comparison with standard Rotterdam and Marshall CT scoring in TBI patients to confirm ONSD as a Prognostic Biomarker of outcome in TBI patients.

SSJ06-06 Laryngeal and Hyoid Fracture Detection in Forensic Post-Mortem CT: Comparison of Standard Post-Mortem CT with High Resolution Post-Mortem Cervical CT and Autopsy Findings

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S406A

Participants
Andreas Bucher, MD, Frankfurt am Main , Germany (*Presenter*) Travel support, Guerbet SA;
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Sara Heinbuch, Frankfurt am Main, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the detection rate of laryngeal and hyoid fractures in suspected homicide victims with suspicion of strangulation in standard full body forensic CT imaging and high-resolution reconstructions from dedicated cervical CT against autopsy findings.

METHOD AND MATERIALS

This single-centre, observer-blinded study included a total 15 full post mortem full body CT examinations. All CT series were acquired on a third generation dual source CT. For each case an additional high-resolution scan was performed of the larynx and hyoid bone (CTHR). CTN was acquired as a neck spiral from full body CT at a tube voltage of 120 kV and reference tube current of 300 mAs; CTHR was acquired at a fixed tube current of 350 mAs at 120 kV. CTN was reconstructed with standard clinical reformations of the neck in axial, coronal and sagittal orientations at 3 mm slice thickness and 2 mm increment. CTHR was reconstructed in anatomically oriented sections of the larynx and hyoid bone in axial, coronal and sagittal orientation at 1 mm slice thickness and 1 mm increment. Macroscopic correlation by autopsy report was available for all cases. Fracture location was recorded in a binary fashion for all anatomic regions. Image reporting was performed by an independent reader for reconstructions from CTN and CTHR seperately in a blinded fashion.

RESULTS

A total of 105 anatomical regions were compared from autopsy reports, CTN and CTHR reports. 17 fractures were identified on autopsy. Most fractures were located at the base of the right superior horn of the thyroid cartilage (29%). Sensitivity of fracture detection from CTN was 20% (4/17 fractures). Sensitivity of fracture detection from CTHR was 92.9% (15/17 fractures; p=0.001). Youden-index was improved from 0.17 in CTN to 0.82 in CTHR. Fractures of the hyoid bone were significantly less common, detection rate was identical in CTN and CTHR (1 of 2 cases each).

CONCLUSION

Post mortem CT imaging in cases of suspected strangulation provides good detection rate of larynx fractures with dedicated high resolution acquisition and reconstruction protocol, but is not adequate for fracture detection when standard reconstruction of clinical cervical protocol is performed.

CLINICAL RELEVANCE/APPLICATION

Post mortem CT imaging of the neck should include an additional high-resolution CT spiral with dedicated reconstructions to guide autopsy when cervical trauma or strangulation is suspected.

SSJ07

Gastrointestinal (Pancreas Diffuse Disease)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S403B

GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Temel Tirkes, MD, Indianapolis, IN (*Moderator*) Nothing to Disclose
Kyuran A. Choe, MD, Cincinnati, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSJ07-01 Validation of Apparent Diffusion Coefficient MR Parameters for Differentiation between Mass-Forming Autoimmune Pancreatitis and Pancreatic Ductal Adenocarcinoma

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S403B

Participants
Hainan Ren, BMedSc, Sendai, Japan (*Presenter*) Nothing to Disclose
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PURPOSE

Several studies reported the effectiveness of apparent diffusion coefficient (ADC) to differentiate mass-forming autoimmune pancreatitis (AIP) and pancreatic ductal adenocarcinoma (PDAC); however, the results are inconsistent. The purpose of our study was to validate ADC parameters to differentiate the two conditions.

METHOD AND MATERIALS

Twenty-one patients with AIP and 101 patients with PDAC who met the criteria of Japan Pancreas Society 2011 or European Society for Medical Oncology were enrolled in this retrospective study. Regions of interest (ROIs) were placed where the ADCs visually appeared to be most decreased and increased within the lesions on ADC maps to obtain ADCmin and ADCmax. We obtained the secondary derivation as follows: ADCdiff = ADCmax-ADCmin. As for the conventional method, oval or round ROIs to cover entire lesions as much as possible were placed on ADC maps to obtain ADCmean. All the ADC parameters were compared between AIP and PDAC by using Mann-Whitney U test. $P < .05$ was considered significant. After Bonferroni correction of 4 multiple comparisons, the critical value became < 0.0125 (0.05/4).

RESULTS

No significant difference was found in patient background factors including lesion size. The ADCmin, ADCmax, ADCdiff and ADCmean in mass-forming AIP were significantly lower than those in PDAC ($p<0.0001$, $p<0.0001$, $p<0.0001$ and $p<0.0001$, respectively). Receiver operating characteristic curve analysis to differentiate mass-forming AIP from PDAC revealed that area under curves of ADCmin, ADCmax, ADCdiff and ADCmean were 0.76, 0.98, 0.88 and 0.94, respectively. Using the optimal cut-off value 1.38×10-3mm2/sec of ADCmax, sensitivity, specificity, positive predictive value and negative predictive value were 93, 96, 98 and 64 %, respectively. Using the optimal cut-off value 1.23×10-3mm2/sec of ADCmean, sensitivity, specificity, positive predictive value and negative predictive value were 85, 96, 98 and 58 %, respectively.

CONCLUSION

All the ADC parameters showed significant difference between mass-forming AIP from PDAC. Particularly, the diagnostic performance of ADCmax was highest and ADCmax might help in differentiating the two conditions.

CLINICAL RELEVANCE/APPLICATION

ADCmax which was obtained by placing ROI on visually most increased area within the lesion might help in differentiating mass-forming autoimmune pancreatitis and pancreatic ductal adenocarcinoma.

SSJ07-02 Pancreatic T1 Mapping and Extracellular Volume Fraction in Patients with Glucose Intolerance

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S403B

Participants
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Masayuki Matsuo, MD, Gifu, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the feasibility of pancreatic T1 mapping and extracellular volume fraction (ECV) for assessing patients with impaired glucose tolerance (IGT).

METHOD AND MATERIALS

This prospective study was approved by our institutional review board and written informed consent was obtained. Forty-four consecutive patients with known or suspected pancreatic disease underwent contrast-enhanced magnetic resonance (MR) imaging including T1 mapping using saturation recovery sequence. Patients were classified into two groups according to American Diabetes Association criteria: HbA1c < 6.5% (Low value group), and HbA1c >= 6.5% (High value group). Pre-contrast pancreatic T1 value and ECV of the pancreas were computed. Pre-contrast pancreatic T1 value, ECV and HbA1c values were then compared.

RESULTS

HbA1c values positively correlated with pre-contrast pancreatic T1 value and ECV (*r = 0.79, P < 0.001 and r = 0.60, P < 0.001, respectively). The pre-contrast pancreatic T1 value and ECV were significantly higher in High value group than in Low value group (P < 0.0001). Although there was no significant difference between two qualitative values (P = 0.14), the sensitivity, specificity, and area under the receiver-operating-characteristic curve for differentiating High and Low value groups were superior in ECV (100%, 93.5%, and 0.990) compared to pre-contrast pancreatic T1 value (84.6%, 96.8%, and 0.906).*

CONCLUSION

ECV of the pancreas could serve as a potential imaging biomarker for the assessment of pancreatic fibrosis leading to IGT.

CLINICAL RELEVANCE/APPLICATION

Our study demonstrated ECV possibly indicates severity of glucose intolerance. This index may be an important quantitative imaging biomarker for the screening of patients with IGT.

SSJ07-03 *Pancreaticobiliary Lesions Developed in Treated Type 1 Autoimmune Pancreatitis: Nature, Image Pattern, and Risk Factors*

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S403B

Participants
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Patrick Asbach, MD, Berlin, Germany (Abstract Co-Author) Nothing to Disclose
Bernd K. Hamm III, MD, Berlin, Germany (Abstract Co-Author) Research Consultant, Canon Medical Systems Corporation; Stockholder, Siemens AG; Stockholder, General Electric Company; Research Grant, Canon Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Siemens AG; Research Grant, General Electric Company; Research Grant, Elbit Imaging Ltd; Research Grant, Bayer AG; Research Grant, Guerbet SA; Research Grant, Bracco Group; Research Grant, B. Braun Melsungen AG; Research Grant, KRAUTH Medical KG; Research Grant, Boston Scientific Corporation; Equipment support, Elbit Imaging Ltd; Investigator, CMC Contrast AB
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PURPOSE

To determine the incidence and nature of pancreaticobiliary lesions developed in a prospective cohort of patients with treated type 1 autoimmune pancreatitis (AIP), to evaluate the imaging pattern, and to identify risk factors for disease relapse.

METHOD AND MATERIALS

From a prospectively managed radiological and clinical database (since 2012) of consecutive AIP patients who were treated and followed up (>=18 months) at our institution, patients with pancreaticobiliary lesion(s) development during follow-up were identified. Imaging pattern was compared to the initial attack. Univariate and multivariate analysis was conducted for factors predicting relapse.

RESULTS

Among 103 patients with treated type 1 AIP, 44 (42.7%) patients had pancreaticobiliary lesions during follow up (median time interval to initial diagnosis: 17 months, range 3 to 62 months). The majority of them were after steroid discontinuation (63.6%), the others during maintenance therapy (29.5%) or with steroid tapering (6.8%). All lesions were disease relapse, which responded to steroid treatment. Imaging pattern change was common. Pancreas involvement was less frequent (81.8% vs 100%, p=0.003), and pancreas size was smaller (p<0.01) at relapse. Extra-pancreatic bile duct (ExPanBD) involvement was more severe and extensive at relapse (both p<0.01). Multivariate analysis revealed ExPanBD involvement (hazard ratio 1.976, 95% CI 1.149-3.570, p=0.023) and a lower serum response index (hazard ratio 1.834, 95% CI 1.073-3.322, p=0.037) as significant independent predictors of relapse.

CONCLUSION

AIP relapse is common, often with image pattern change mimicking a new neoplasm. ExPanBD involvement at initial diagnosis and a poorer serum response at the induction phase suggests high risk of relapse.

CLINICAL RELEVANCE/APPLICATION

In treated type 1 AIP, it is not uncommon to observe new pancreaticobiliary lesion development, when the original lesions have

subsided. The lesions may be mass-like, and the image pattern may differ from the initial attack. However, disease relapse is much more likely than development of a new malignancy. Close radiological follow-up shows lesion resolution after re-administration of steroid treatment.

SSJ07-04 Risk Assessment for Pancreatic Fistula after Pancreaticoduodenectomy with Preoperative Computed Tomography

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S403B

Participants
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Adam J. Cybulski, MD, Verona, Italy (Abstract Co-Author) Nothing to Disclose
Riccardo Valletta, MD, Verona, Italy (Abstract Co-Author) Nothing to Disclose
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PURPOSE

to evaluate the predictive value of preoperative CT features for the risk of postoperative pancreatic fistula.

METHOD AND MATERIALS

this IRB-approved retrospective study included 88 Patients who underwent pancreaticoduodenectomy in two centers. Patients were divided in 2 groups according to clinical data: 44 patients with clinically-relevant postoperative pancreatic fistula (POPF group), and 44 patients without POPF (non-POPF group). One reader experienced in pancreatic imaging (at least 10 years' experience) for each center reviewed the preoperative MDCTs of the patients of the center and measured at the planned resection plane the main pancreatic duct (MPD) diameter, the density of the parenchyma in the different enhancement phases and the parenchymal thickness. The difference in attenuation between the venous and arterial phase was calculated as a surrogate for parenchymal fibrosis: increasing attenuation from the arterial to the venous phase was interpreted as a sign of fibrosis. Body composition was analysed by calculating visceral adipose tissue area (VAT), subcutaneous adipose tissue area (SAT), and skeletal muscle area at the L2-level using ImageJ software. Retrorenal fat thickness and psoas density were also measured. Fisher's exact test was used for categorical variables and Mann-Whitney test for continuous variables.

RESULTS

MPD diameter was 2,7±2,6 mm in the fistula group and 6,3±3,1 mm in non-fistula group (P<0,0001). The mean attenuation difference between venous and arterial phase was 2,6 HU in POPF group and -13,2 HU in non-POPF group (P=0,0010). SAT was 18018,6 mm2 in POPF group and 12269,7 mm2 in non-POPF group (P=0,004). No significant difference observed for the other parameters.

CONCLUSION

fibrosis, expressed by increasing enhancement of the normal pancreatic parenchyma at the planned resection plane, MPD diameter and increased SAT may express increased risk for pancreatic fistula after pancreaticoduodenectomy.

CLINICAL RELEVANCE/APPLICATION

a preoperative assessment based on standard CT imaging of the risk of developing POPF could be useful for patient risk stratification and better and more personalized treatment planning.

SSJ07-06 The Selection of an Optimal Energy Level for Improving Necrosis Depiction in Acute Pancreatitis Using Mono-Energetic Algorithm during Dual-Energy CT of Pancreas

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S403B

Participants
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PURPOSE

To determine optimal energy level using mono-energetic algorithm for necrosis depiction in acute pancreatitis in terms of necrosis conspicuity and image quality during dual-energy CT of pancreas.

METHOD AND MATERIALS

Retrospectively enrolled 48 patients of acute pancreatitis with proven necrosis (24 male and 24 female) between March 2015 and January 2016. The median age was 46 years. Dual-energy (100kVp and Sn140kVp) was performed. And portal venous phase was chosen to be the acquisition phase. Three imaging series (100kVp, Sn140kVp and mixed imaging) were reconstructed automatically after acquisition. In addition 12 Image data sets, at energy levels ranging from 40keV to 150keV (in 10-keV increment) were reconstructed using mono-energetic algorithm. Two radiologists blindly evaluated these 15 image datasets and graded subjective image quality in 4-point scale on a per necrosis basis. Five parameters of image quality, including difference of CT value between pancreatic parenchyma and necrosis, CNR of pancreatic parenchyma-to-necrosis, signal to noise ratio (SNR) of pancreas, image noise and score of subjective diagnosis were compared between image sets. ANOVA and bonferroni correction were used to do the statistic analysis.

RESULTS

The inter-observer agreement was excellent (ICC: 0.8).Difference of CT value between pancreatic parenchyma and necrosis was significantly higher on 40keV images than others(p <0.001), but the score of subjective diagnosis couldn't meet the diagnosis standard. The second was 50keV, and the score could just meet the diagnosis standard. Image noise of 80keV was significantly lower than others(p <0.001),while CNR,SNR and score of subjective diagnosis of 80keV were significantly higher than others respectively(p <0.001).

CONCLUSION

It is demonstrated in the study 50keV image reconstructed by mono-energetic algorithm might improve depiction of necrosis for acute pancreatitis on second generation dual-source scanner, while 80keV image might improve CNR, SNR and image quality.

CLINICAL RELEVANCE/APPLICATION

Since the necrosis is illustrated to be the most serious morphologic findings closely relating to mortality, it is crucial to have a correct assessment of it in acute pancreatitis. Dual-energy CT allows a better delineation of necrosis by applying mono-energetic post-processing. It is suggested to use 50keV as the optimal energy level to detect necrosis of acute pancreatitis.

Printed on: 10/29/20

SSJ08

Gastrointestinal (CT Dose and Abbreviated MR Screening Techniques)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S401CD

CT GI MR SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Jessica B. Robbins, MD, Madison, WI (*Moderator*) Nothing to Disclose
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Sub-Events

SSJ08-01 Diagnostic Performance and Image Quality of Low-Tube Voltage and Low-Contrast Agent Dose Protocol for Hepatic Dynamic Computed Tomography

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S401CD

Participants
Shintaro Ichikawa, MD, PhD, Chuo, Japan (*Presenter*) Nothing to Disclose
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Tatsuya Shimizu, MD, Yamanashi, Japan (*Abstract Co-Author*) Nothing to Disclose
Marie-Luise Kromrey, MD, Greifswald, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate diagnostic performance and image quality of low-tube voltage and low-contrast agent dose protocol for hepatic dynamic computed tomography (CT).

METHOD AND MATERIALS

This retrospective study, held between January and May 2018, included 424 patients (mean age, 70.5±10.1 years; 289 men, 135 women). They underwent hepatic dynamic CT using one of two protocols: tube voltage, 80 kVp; contrast dose, 360 mgI/kg, and iterative reconstraction (n=180) and tube voltage, 120 kVp; contrast dose, 600 mgI/kg, and filtered back projection (n=224). Two radiologists independently scored lesion conspicuity and image quality using 5- and 3-point scales, respectively. Another radiologist measured CT number of abdominal organs, musclues, and hepatocellular carcinoma (HCC) in each phase. Lesion detectability, diagnostic ability for HCC, image quality of the arterial phase, CT number including lesion-to-liver ratio, and radiation dose were compared between protocols.

RESULTS

Both protocols showed high lesion detectability (sensitivity, 86.1%-92.5%; specificity, 94.6%-97.3%; accuracy, 92.8%-95.0%) and diagnostic ability for HCC (sensitivity, 85.7%-93.3%; specificity, 93.6%-98.6%; accuracy, 93.3%-96.6%). The 120-kVp protocol showed better image quality for the arterial phase than the 80-kVp protocol (P<0.0001 for both); however, the ratio of fair image quality was not significantly different (P=0.3161 and 0.4084). CT number of abdominal organs and muscles was higher in the 80-kVp protocol than in the 120-kVp protocol in each phase (P<0.0001-0.0357) for all structures, except portal vein in the arterial phase and renal medulla in the portal venous phase (P=0.1760 and 0.1280). Lesion-to-liver ratio was not significantly different for all phases (P=0.2108-0.8653). Volume CT dose index and dose-length product in the arterial phase were significantly lower for the 80-kVp protocol than for 120-kVp protocol (15.2±3.6 vs 32.1±9.3 mGy and 397.3±122.2 vs 880.2±312.7 mGy·cm, respectively, P<0.0001 for both).

CONCLUSION

The 80-kVp protocol has diagnostic performance and image quality, equivalent to the 120-kVp protocol, with lower radiation and contrast agent doses.

CLINICAL RELEVANCE/APPLICATION

Low-tube voltage with iterative reconstruction for hepatic dynamic CT may decrease radiation and contrast agent doses, with equivalent diagnostic performance and image quality than the 120-kVp protocol.

SSJ08-02 Pilot Study to Assess Feasibility of Fast Whole Body MRI Imaging in Oncologic Screening

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S401CD

Participants
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PURPOSE

Assess the feasibility of whole-body MRI imaging in 30 minutes in oncologic applications.

METHOD AND MATERIALS

Our IRB approved this HIPPA-compliant prospective study. Twenty-six adult patients assessed for metastatic diseases were scanned with WB-DWI methods using a 3T MRI scanner. Axial fat-suppressed T2-weighted (T2WI), DWI, precontrast TS T1-weighted (T1WI) followed by post contrast FS T1WI in the arterial, portal venous and delayed phases were acquired (gradient time of 30 minutes). A single reader utilizing a five-point-scale recorded image quality of each WB-MRI study. Findings on whole-body MRI were recorded. The number of lesions was compared to those detected on CT or PET-CT studies, performed with 12 months of whole-body MRI if available. The WB-MRI, CT, and PET-CT were divided into standard anatomical location including chest, abdomen, and pelvis. The number of lesions within each anatomic location was compared in all three modalities.

RESULTS

Our study included 14 males and 12 females with the mean (±standard deviation) age of 55(±14) years. All whole-body MRI examinations were successfully obtained in the median time of 35 (IQR, 29-39) minutes. There were 17,21 and 8 lesions detected from chest, abdomen and pelvis, respectively in CT studies (N=19). Additionally, total of 0, 3, 2 lesions were detected in the chest, abdomen and pelvis respectively by assessing PET-CT studies (N=5). The WB-MRI detected 15 Lesions in chest, 38 Lesions in abdomen and 8 lesions in pelvis. All lesions detected on PET-CT were also detected on WB-MRI. Four lesions (16%) detected on WB-MRI in abdomen parts were missed on CT, while WB-MRI missed 2 lesions (11%) detected by CT in the chest parts; all were less than 10 mm. These two studies are comparable in detecting lesions in the pelvis. The overall image quality of whole-body MRI was 4/5.

CONCLUSION

We have demonstrated that fast multiparametric WB-MRI may be preformed in approximately 30 minutes, with relatively high image quality. Lung lesions <10mm may not be readily detected by WB-MRI.

CLINICAL RELEVANCE/APPLICATION

Whole-body MRI might be an acceptable alternative for CT or PET, in staging, assessment and monitoring of treatment response in oncologic applications.

SSJ08-03 Assessment of Noise Reduction Potential and Image Quality Improvement of a Deep Learning-Based Image Reconstruction Algorithm in Abdomen CT

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S401CD

Participants
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PURPOSE

To evaluate the image quality improvement and noise reduction in routine dose, non-enhanced abdomen CT imaging by using a deep learning-based image reconstruction algorithm in comparison with ASIR-V .

METHOD AND MATERIALS

9 patients who underwent routine dose, abdomen CT using GE Revolution CT (GE Healthcare, Waukesha, WI) were included . After scanning, all scans were reconstructed with the recommended level of 40% ASIR-V and for comparison purpose and deep learning-based image reconstruction algorithm (TrueFidelityTM, GE Healthcare).DLIR-L, DLIR-M, DLIR-H. The CT attenuation values and SD of the subcutaneous fat, back muscle and descending aorta were measured at the level of tracheal carina of all reconstructed images. The signal-to-noise ratio (SNR) was calculated with SD representing image noise. The subjective image quality was independently evaluated by two experienced radiologists.

RESULTS

For all DLIR images, the objective image noise (SD) of fat, muscle and aorta decreased and SNR increased along with DLIR-L, DLIR-M, DLIR-H. The SD of DLIR images were significantly lower than that of 40% ASIR-V. In terms of subjective image evaluation, all DLIR reconstructions and 40% ASIR-V had good diagnostic acceptability. However, DLIR-M, DLIR-H showed significantly superior visibility of small structures when compared with the 40% ASIR-V and DLIR-L, and DLIR-H was the best series of TrueFidelity images, with a highest subjective image quality, at the same time the image sharpness was not significantly decreased in DLIR-H images.

CONCLUSION

In routine dose, non-enhanced abdomen CT, DLIR show greater potential in reducing image noise and artefacts and maintaining image sharpness when compared to the recommended level of 40%ASIR-V algorithm. Combining both the objective and subjective evaluation of images, non-enhanced abdomen CT images reconstructed with DLIR-H have the highest image quality.

CLINICAL RELEVANCE/APPLICATION

Recently a deep learning-based image reconstruction algorithm has been introduced . This image reconstruction technique employs deep CNN-based models, including millions of trained parameters, to improve the image quality with natural image texture, lower image noise, and high-resolution

SSJ08-04 Deep-Learning-Based Abdominal CT Denoising: Impact of Changes in Reconstruction Parameters Relative to Training Data

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S401CD

Participants
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PURPOSE

Deep-learning-based CT denoising methods are typically trained on images using a single set of reconstruction parameters. However, reconstruction parameters vary considerably between abdominal CT exam types and practices. This work aimed to quantify the performance of a convolutional neural network (CNN) denoising algorithm when applied to abdominal CT images with reconstruction parameters different from the training data.

METHOD AND MATERIALS

A CNN with 36 convolutional layers was trained on 250,000 image patches clipped from ten contrast-enhanced abdominal CT scans reconstructed with a Siemens' D30 kernel, 3 mm image thickness, and 275 mm field of view (FOV). Supervised learning was used for training, with simulated quarter dose images used as inputs, full dose images as the ground truth, and a mean-squared-error loss function. Six patients were reserved for testing the network. Baseline performance was evaluated with test data that had the same reconstruction parameters as the training data. Without retraining, the network was then applied to data with a range of reconstruction settings: FOV from 100 mm to 450 mm, kernel strength from D10 to D50, and image thickness from 1 to 5 mm. Performance was evaluated by visual assessment, root mean square error, noise level, and spatial resolution. Percent noise reduction was calculated as the difference in noise level from quarter dose to CNN output divided by quarter dose noise level.

RESULTS

The CNN demonstrated 73±6 % noise reduction relative to quarter dose at baseline, with no degradation of spatial resolution (i.e., when test data reconstruction = training data reconstruction). CNN denoising efficacy was decreased, to only 47±5 % noise reduction, when FOV was decreased by 50 mm ($p = 0.0004$), or to only 60±7 % noise reduction, when a smoother (D20) kernel was used ($p = 0.001$). Resolution loss was noted (visual and line profile inspection) when the network was applied to larger FOVs or sharper kernels. CNN performance was largely maintained when applied to test data with different image thicknesses.

CONCLUSION

Performance of the evaluated CNN-based CT denoising method varied significantly with FOV and kernel strength, but not with image thickness.

CLINICAL RELEVANCE/APPLICATION

While impressive noise reduction can be obtained using CNNs, reconstruction parameters must be carefully considered. Improvements in generalizability are therefore necessary.

SSJ08-05 Hepatocellular Carcinoma Screening with Abbreviated MRI: Comparison of Noncontrast, Dynamic-Contrast Enhanced and Hepatobiliary Phase Protocols Post Gadoxetic Acid

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S401CD

Participants
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PURPOSE

To compare the performance of reconstructed abbreviated MRI (AMRI) protocols derived from a full gadoxetic acid-enhanced MRI for HCC screening in an at risk population.

METHOD AND MATERIALS

This retrospective study included 237 consecutive eligible patients (M/F 146/91, mean age 58y) with chronic liver disease (cirrhosis or HBV without cirrhosis) who underwent gadoxetic acid MRI in 2017 for HCC screening. Patients with history of HCC/other malignancies, liver transplantation and acute liver disease were excluded. Three reconstructed AMRI sets were assessed separately by 3 independent radiologists: non contrast (NC-AMRI: T2WI HASTE+diffusion weighted imaging (DWI)), Dynamic-AMRI (Dyn-AMRI: T2WI+Dynamic T1WI) and EOB-AMRI (T2WI+DWI +T1WI hepatobiliary phase). Lesions were characterized using a composite scoring system for NC-AMRI and EOB-AMRI [negative, subthreshold (<10mm), positive] and LI-RADS v2018 algorithm was used for Dyn-AMRI. Only LI-RADS5 lesions were considered HCC. A preliminary cost-effectiveness analysis was performed comparing each AMRI set to published ultrasound (US) sensitivity in USA (60%).

RESULTS

The reference standard demonstrated 13/237 patients with HCC (incidence 5.5%, mean size 33.7±30mm, range:10-120mm). Inter-reader agreement was substantial for NC-AMRI and EOB-AMRI (k=0.76 and 0.75) and excellent for Dyn-AMRI (k=0.86). Pooled per-patient sensitivities were 61.5% for NC-AMRI [CIs: 34.4-83%], 84.6% for Dyn-AMRI [60.8-95.1%] and 80.8% for EOB-AMRI [53.6-93.9%], without significant difference between sets (p-values range:0.06-0.16). Pooled per-patient specificities were 95.5% [92.4-97.4%], 99.8% [98.4-100%] and 94.9% [91.6-96.9%], respectively, with a significant difference between Dyn-AMRI and the other sets (p<0.01). All AMRI methods were cost-effective compared to US. Dyn-AMRI was the most cost-effective with incremental cost-effectiveness ratios (ICER) of $11,253 and life-year gain of 11months compared to US.

CONCLUSION

We observed limited sensitivity of NC-AMRI protocol for HCC detection. EOB-AMRI and Dyn-AMRI showed a similar sensitivity with a slightly better specificity and cost-effectiveness for Dyn-AMRI. Further confirmation in a larger study is needed.

CLINICAL RELEVANCE/APPLICATION

Non contrast abbreviated MRI (AMRI) showed low diagnostic performance for HCC screening. AMRI with dynamic T1 (Dyn-AMRI) showed higher specificity and better cost effectiveness compared to AMRI with hepatobiliary phase.

SSJ08-06 Accuracy of an Abbreviated Screening MRI Protocol without Contrast Media for Patients at Risk for Hepatocellular Carcinoma

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S401CD

Participants
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PURPOSE

To evaluate the accuracy of an abbreviated screening MRI protocol without contrast media for patients at risk for hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

This retrospective study was approved by our institutional review board. Four-hundred and twenty eight MRI exams were performed at our institution in patients with increased risk for hepatocellular carcinoma , from January 2015 to December 2015. Exclusion criteria were: history of treated HCC (166 cases) and subsequent studies of the same patient (123 cases). A total of 139 MRI cases were anonymized without post-contrast series (abbreviated protocol) and retrospectively analysed by three radiologists with different levels of experience (10, 8 and 1 year of experience with abdominal MRI). Later, one senior radiologist re-evaluated the full protocol as the reference standard, using LI-RADS v.2018. The abbreviated protocol included T2 weighted, fat-saturated T2 weighted, diffusion-weighted and GRE in/out-of-phase sequences. The following criteria were evaluated: presence of nodule suspicious for HCC, lesion size, lesion location and presence of nodule on each MRI sequences of the abbreviated protocol.

RESULTS

One-hundred and thirty nine patients were included, 38 women and 101 men, with an average age of 54.1 years. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of abbreviated protocol for detection of nodules categorized as LI-RADS 4 and 5 (reference standard) were: 88.3%, 77.2%, 74.6%, 89.7% and 82.0% (most experienced reader), 85.0%, 78.5%, 75.0%, 87.3% and 81.3% (intermediate experienced reader) and 85.0%, 73.4%, 70.8%, 86.6% and 78.4% (less experienced reader), respectively. Interobserver agreement was moderate for lesion detection (weighted K= 0.57, CI=0.41-0.78). The sensitivity of each MRI sequence was 71.7%, 73.3% and 76.7% on T2-weighted, 68.3%, 75.0% and 73.3% in fat-saturated T2-weighted, 76.7%, 75.0% and 73.3% in in/out-of-phase and 63.3%, 70.0% and 68.3% in DWI for most experienced, intermediate experienced and less experienced readers, respectively.

CONCLUSION

The abbreviated MRI protocol demonstrated high sensitivity for hepatocellular carcinoma screening in risk patients.

CLINICAL RELEVANCE/APPLICATION

HCC is the most common primary malignancy of the liver and a common cause of death from cancer worldwide. Abbreviated MRI protocol possibly allows more cost-effective, high sensitivity imaging for HCC screening.

Printed on: 10/29/20

SSJ09

Gastrointestinal (Quantitative Imaging Techniques)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S403A

BQ GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ09-01 Evaluation of Hepatic Perfusion in Pancreatitis Patients by 3rd-Generation Dual-Source Computed Tomography

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S403A

Participants
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PURPOSE

A number of studies have demonstrated that acute pancreatitis (AP)can result in liver damage, which is often without obvious clinical symptoms, but plays an important role in the progression of AP and other organ damage.Fewer studies published about the difference in hepatic perfusion parameters in patients with AP, Therefore, we quantitatively investigated hepatic perfusion in patients with mild AP(MAP) and severe AP (SAP)compared to control group using perfusion CT.

METHOD AND MATERIALS

The clinical and abdominal CT data on all patients were retrospectively analyzed, including 61 patients with AP and 15 cases as a control group,and the AP group further classified into mild AP(26 cases)and severe AP(35 cases) according to CT severity index (CTSI).Upper abdomen perfusion CT imaging was performed in all cases by 3rd-generation dual-source CT. Perfusion CT imaging was obtained for 54 s beginning with a bolus injection of 60 ml of contrast agent (600-630 mgI/kg) at a flow rate of 5 ml/s. Perfusion data were analyzed by the deconvolution method to obtain blood flow(BF, mL/100mL/min),blood volume(BV, mL/100mL),arterial liver perfusion (ALP, mL/100mL/min) , portal venous liver perfusion (PVP, mL/100mL/min),mean transit time(MTT,s) and hepatic perfusion index(HPI,%). Finally, hepatic perfusion parameters were compared for any significant ($P < 0.05$) differences among mild AP patients, severe AP patients and control group.

RESULTS

Various perfusion parameters was significantly higher in the control group than severe AP patients (BF:p=0.002 BV:p=0.000, PVP:p=014,MTT:p=0.000,HPI:p=0.039, $p < 0.05$; ALP: p=964>0.05). There was no significant difference in various perfusion parameters between mild AP patients and the control group ,except in MTT(8.53±0.92s vs 7.59±1.30s,p=0.018).

CONCLUSION

Using quantitative analysis on hepatic perfusion CT, we demonstrated the decrease of various hepatic perfusion parameters ,namely hepatic blood perfusion in SAP, responding to the changes in hepatic hemodynamics in SAP,hepatic perfusion CT is useful for evaluation and prediction of liver damage in patients with SAP.

CLINICAL RELEVANCE/APPLICATION

(dealing with adjunct to imaging) ' In patients with pancreatitis, CT liver perfusion imaging is a non-invasive method to help assess hemodynamics and microvascular changes in the liver.'

SSJ09-02 Comparative Effectiveness of Noninvasive Tests for Staging Chronic Liver Disease

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S403A

Participants
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PURPOSE

To prospectively compare the diagnostic performance of multiple noninvasive tests for staging hepatic fibrosis in patients with chronic liver disease using histology as the reference standard

METHOD AND MATERIALS

This is a single-center, IRB-approved, HIPAA-compliant, prospective pilot study. Adults with chronic liver disease presenting to Interventional Radiology for random liver biopsy are enrolled prior to biopsy. Ultrasound shear-wave elastography of the liver is performed using a Philips scanner with standard acquisition parameters to measure liver stiffness (USE). MR elastography of the liver is performed using a 1.5 T Siemens scanner with standard acquisition parameters to measure liver stiffness (MRE). All patients undergo CT-guided liver biopsy and obtained CT images of the liver are used to measure liver surface nodularity (LSN score) using a previously described semi-automated method. Serum labs within 30 days of liver biopsy are used to calculate the FIB-4 score, a serum biomarker of hepatic fibrosis. The concordance of FIB-4 score, LSN score, USE, and MRE with histologic Metavir staging of hepatic fibrosis are assessed using Harrell's C statistics. Odds Ratios (OR) from ordinal logistic models are reported.

RESULTS

The preliminary data includes fifteen adults (11 female; age range 34 - 72, mean 55). Mean interval between liver biopsy and ultrasound/MR is 0 days. The histologic range of hepatic fibrosis includes 7 livers with no fibrosis (F0), 3 with mild-moderate fibrosis (F1-2), and 5 with advanced fibrosis-cirrhosis (F3-4). Mean and range of FIB-4 score are 1.7 (0.5 - 4.4). Mean and range of LSN score are 2.7 (2.0 - 4.1). Mean and range of hepatic stiffness measured by USE and MRE are 8.8 kPa (3.9 - 17.9) and 5.4 kPa (2.4 - 15.7), respectively. The C-stat concordance for FIB-4 score, LSN score, USE, and MRE are 0.84, 0.87, 0.77, and 0.85 respectively. Odds of moving up one fibrosis stage are 3.84 (p=0.013), 69.8 (p=0.005), 1.01 (p=0.267), and 1.53 (p=0.019), respectively, per one unit increase.

CONCLUSION

In this pilot study, liver surface nodularity score has non-inferior diagnostic performance compared to FIB-4 score, USE, or MRE in staging hepatic fibrosis in patients with chronic liver disease.

CLINICAL RELEVANCE/APPLICATION

Liver surface nodularity score may serve as a quantitative biomarker for staging hepatic fibrosis in patients with chronic liver disease.

SSJ09-03 Quantifying Non-Alcoholic Fatty Liver: Liver-Spleen CT Ratio or Fat Concentration in Dual-Energy Spectral CT? Accuracy Comparison with Magnetic Resonance Q-Dixon Technique

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S403A

Participants
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PURPOSE

To compare the accuracy of using conventional liver-spleen (LS) CT ratio or fat concentration (FC) in spectral CT to quantify non-alcoholic fatty liver using the fat fraction (FF) determined using magnetic resonance Q-dixon (MRQd) technique as a reference standard.

METHOD AND MATERIALS

Retrospectively analyzed 80 liver patients with both MRQd and spectral CT within one week. Using MRQd results, patients were divided into normal and fatty liver groups (normal: n=20, FF<5%; mild: n=26, FF=5%-10%; moderate: n=20, FF=11%-25%; and severe: n=14, FF>25%). The liver FC was measured on the lipid-based material decomposition images in spectral CT by 2 senior abdominal radiologists by placing regions of interest in two different hepatic lobes over 7 image slices centered at the hepatic portal level. Final FC values were obtained by averaging the measurements. The two doctors also measured the LS CT ratio on the 70keV images. Measurements were repeated three times weekly to evaluate the repeatability using intra-group or inter-group correlation coefficient (ICC). The correlation between MRQd and spectral CT results was analyzed. The diagnostic efficacy of using FC in spectral CT for differentiating normal and mild fatty livers was tested by ROC curve.

RESULTS

The ICC values were high indicating consistent measurements. There were differences in FC between any groups (P<0.05), while the LS ratio was not significantly different between the normal and mild fatty liver group (p>0.05). There was a positive correlation

between FC in spectral CT and FF in MRQd (r=0.959, P<0.001), and a negative correlation between LS ratio and FF (r=-0.848, P<0.001). ROC curve analysis showed that with a FC cut-off value of 351.19mg/ml, the sensitivity, specificity and area under curve were 95%, 100% and 0.990, respectively in differentiating the normal and fatty liver group.

CONCLUSION

The fat concentration in spectral CT has excellent correlation with the fat fraction by MR Q-dixon and is better than that determined by liver-spleen CT ratio. FC in spectral CT has high accuracy to differentiate normal and fatty livers for non-alcoholic fatty liver patients.

CLINICAL RELEVANCE/APPLICATION

The fat concentration measurement in spectral CT can replace the Liver-Spleen CT Ratio as an imaging method for the diagnosis of fatty liver, and its accuracy is high.

SSJ09-04 MRE Practice Improvement: Comparison of Clinical MRE Liver Stiffness Measurements Made by MR Technologists versus Expert MRE Analysts

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S403A

Participants
Walter Henderson, La Jolla, CA (*Presenter*) Nothing to Disclose
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PURPOSE

MR elastography (MRE) is increasingly used clinically to noninvasively assess hepatic stiffness, an imaging biomarker used to detect and monitor liver fibrosis. Although MRE is well studied in research settings, less is known about its performance in clinical settings where measurements are typically made by MR technologists who may be unfamiliar with the analysis. As part of a quality practice improvement project, we compared liver stiffness measurements made by MR technologists on clinical MRE exams with those made by expert MRE analysts.

METHOD AND MATERIALS

We retrospectively identified 46 MRE slices from 10 patients (60% female, age 27 to 69) who underwent 3T clinical MRE exams (2D SE-EPI at 60 Hz) at our institution. The MR technologist who performed each exam analyzed each MRE slice using commercial clinical analysis software on the GE scanner console by drawing regions of interest (ROIs) on the liver. Two expert MRE analysts (each with >= 300 research MRE exams analyzed) also analyzed the MRE slices, drawing ROIs according to QIBA MRE analysis guidelines using MRE-Quant analysis software (Mayo Clinic). Mean stiffness values (kPa) measured by MR technologists and expert analysts were compared pairwise by intraclass correlation coefficient (ICC) and Bland-Altman analyses, using bootstrap-based tests to adjust for within-patient dependence.

RESULTS

ICC between analysts (0.981) was higher than between technologists vs Analyst 1 (0.857, p<0.001) and vs Analyst 2 (0.869, p<0.001). MRE measurements by MR technologists were 0.39 (p<0.001) and 0.30 (p<0.001) kPa lower than those by Analyst 1 and 2, respectively, with limits of agreement (LOA) of (-1.52, 0.73) and (-1.46, 0.85) kPa. Bias between analysts (0.09 kPa, LOA [-0.45, 0.63 kPa]) was small but significant (p=0.002).

CONCLUSION

In clinical patients, there is less agreement in MRE stiffness measurements between MR technologists and expert MRE analysts than between two expert analysts. Compared to expert analysts, MR technologists underestimate liver stiffness. Research is needed to determine whether additional MR technologist experience and/or training will improve agreement between their measurements and those made by expert analysts.

CLINICAL RELEVANCE/APPLICATION

Stiffness measurements by MR technologists may differ meaningfully from those by expert analysts. Additional training may be required before MR technologists' measurements are reported clinically.

SSJ09-05 Prediction of Liver Regeneration in Recipients after Adult-To-Adult Living Donor Liver Transplantation Using Preoperative CT Texture Analysis

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S403A

Participants
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Ji-Eun Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To predict the rate of liver regeneration in recipients after living donor liver transplantation (LDLT) using preoperative CT texture and shape analysis of the future graft.

METHOD AND MATERIALS

103 donor-recipient pairs who underwent LDLT using right lobe graft were retrospectively included for this study. All donors underwent preoperative liver CT using same CT scanner. We semi-automatically segmented the right lobe of the liver which was to be a future graft using commercially available software. The volume of the future graft (Vpre) was measured and texture and shape analysis of Vpre was performed. All recipients underwent follow-up CT (mean, 12.0 ± 1.1 months) after surgery. The graft liver was segmented in the same manner, and the volume of the graft (Vpost) was measured. The regeneration index (RI) was defined by the following equation: [(Vpost-Vpre)/Vpre]×100 (%). We performed a stepwise, multivariate linear regression analysis to investigate the correlation between clinical features, texture and shape parameters and RI, and made the best-fit model for predicting RI.

RESULTS

The mean RI was 49.8 ± 44.7%. In the univariate analysis, Vpre, effective diameter, surface area, sphericity, roundness, compactness, energy and grey level co-occurrence matrix inverse difference moment (GLCM IDM) were significantly correlated with RI ($p<0.05$). In the multivariate analysis, Vpre (ß, -0.121, 95% CI: -0.176 - -0.066) and roundness_m (ß, -1.34, 95% CI: -2.67 - -0.01) as well as the sex (ß, 27.75, 95% CI: 10.60 - 44.91) of the donor and preoperative serum protein (ß, 9.85, 95% CI: 0.74 - 18.97) were shown to be independent predictors of RI ($p<0.05$). The best-fit predictive model for RI was as follows: RI (%) = 71.50 + 9.85×preoperative serum protein (g/dL) - 0.121×Vpre (mL) - 1.34×roundness_m (+ 27.75, if donor is female), where roundness_m = (roundness-0.780)×1,000.

CONCLUSION

Texture and shape parameters of the liver including Vpre and roundness were associated with liver regeneration. Preoperative CT texture and shape analysis of the future graft can be useful for predicting the rate of liver regeneration in recipients after LDLT.

CLINICAL RELEVANCE/APPLICATION

Preoperative CT texture and shape analysis of the future graft can help predict liver regeneration in recipients and assist in the surgical planning of LDLT.

SSJ09-06 Diffusion Kurtosis Imaging-Derived Histogram Metrics for Prediction of KRAS/NRAS Mutations in Rectal Adenocarcinoma: Preliminary Findings

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S403A

Participants
Yanfen Cui, Taiyuan, China (*Presenter*) Nothing to Disclose
Xiaotang Yang, Taiyuan, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Objective: To evaluate the potential role of diffusion kurtosis imaging (DKI)-derived parameters by using histogram analysis derived from whole-tumor volumes for prediction of the status of KRAS/NRAS mutations in patients with rectal adenocarcinoma.

METHOD AND MATERIALS

152 consecutive patients with rectal adenocarcinoma who underwent MRI examination including DKI (b values: 0, 700, 1400, and 2100 sec/mm2) were retrospectively evaluated. The quantitative parameters of D, K, and conventional apparent diffusion coefficient (ADC) were measured using whole-tumor volume histogram analysis. Student's t-test or Mann-Whitney U-test, receiver operating characteristic (ROC) curves, and Spearman's correlation were used for statistical analysis.

RESULTS

All the percentiles metrics of ADC and D values were significantly lower in the mutated group than those in the wild-type group (all $P< 0.05$), except for the minimum value of ADC and D (both $P > 0.05$), while K-related percentiles metrics were higher in the mutated group compared with those in the wild-type group (all $P< 0.05$). Regarding the comparison of the diagnostic performance of all the histogram metrics, K75th showed the highest AUC value of 0.866, and the corresponding values for sensitivity, specificity, PPV, and NPV were 67.57% and 92.31%, 89.29%, and 75.0%, respectively.

CONCLUSION

It was revealed that DKI metrics with whole-tumor volume histogram analysis, especially the K75th parameter, yielded more preferable AUC and specificity values for predicting KRAS/NRAS mutations than ADC and D values, and thus may potentially serve as an optimal imaging biomarker for the prediction of KRAS/NRAS/BRAF mutations for guiding targeted therapy.

CLINICAL RELEVANCE/APPLICATION

DKI metrics with whole-tumor volume histogram analysis, especially the K75th parameter, may potentially serve as an optimal imaging biomarker for the prediction of KRAS/NRAS mutations

SSJ10

Science Session with Keynote: Genitourinary (Quantitative Prostate MRI)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S502AB

BQ GU MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Hebert Alberto Vargas, MD, Cambridge, United Kingdom (*Moderator*) Nothing to Disclose
Antonio C. Westphalen, MD, Medina, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ10-01 Genitourinary Keynote Speaker: Update on Quantitative Prostate MRI - Challenges and Opportunities for Translation Into Clinical Practice

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S502AB

Participants
Nicola Schieda, MD, Ottawa, ON (*Presenter*) Nothing to Disclose

SSJ10-02 Application of a Novel High-Resolution, Accelerated Quantitative T2 Mapping Sequence at 3T for the Detection of Prostate Cancer

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S502AB

Participants
Andreas Bucher, MD, Frankfurt am Main , Germany (*Presenter*) Travel support, Guerbet SA;
Benjamin Kaltenbach, MD, Kelkheim, Germany (*Abstract Co-Author*) Nothing to Disclose
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Elisabeth Weiland, Erlangen, Germany (*Abstract Co-Author*) Nothing to Disclose
Tom Hilbert, Lausanne, Switzerland (*Abstract Co-Author*) Employee, Siemens AG
Thomas J. Vogl, MD, PhD, Frankfurt , Germany (*Abstract Co-Author*) Nothing to Disclose
Boris Bodelle, MD, Frankfurt am Main, Germany (*Abstract Co-Author*) Research support, General Electric Company; Research support, Siemens AG

PURPOSE

Quantitative measurements of the prostate have been shown to produce reliable differentiation of malignant prostate lesions in the peripheral zone in several small scale studies with previous generation T2 mapping sequences. We tested the reliability of a novel, fast, high-resolution T2 mapping prototype sequence with parallel imaging and model-based reconstruction (T2M) in the detection of malignant prostate lesions.

METHOD AND MATERIALS

A total of 46 multiparametric MRI datasets for suspected prostate cancer (pCA) at 3T were included. All examinations included T2M in addition to a standard multiparametric prostate protocol. Confirmed pCA were present in 22 cases. Quantitative T2 mapping was acquired axially (0.7x0.7x3.0 mm3, 16 echoes with delta TE 10.8 ms, TR 5000 ms). Region-of-interest measurements (ROI) were performed on the T2 maps in 3 slices for healthy prostate tissue of the peripheral and transitional zone (apex, midbase, base) with a minimum area of 10 mm2. Confirmed malignant lesions were traced in a separate ROI on the most representative slice. Average and minimum values of T2M relaxation time (T2) were recorded per ROI.

RESULTS

Diagnostic image quality was obtained in all patients. Average acquisition time for T2M was 4:37 mins. Mean T2 was 153.7±45.1 ms for healthy tissue in the peripheral zone, 96.2±22.7 ms in the transitional zone. Mean T2 was significantly reduced for pCA in the peripheral zone (71.6±13.3 ms, p=0.001). Differences of mean T2 of pCA and average tissue of the transitional zone were suffcient to differentiate between tumor infiltration and average healthy tissue of the transitional zone (p=0.001). Minimal values of T2 showed good differentiation between healthy tissue and pCA (healthy: 99.4±19.9 ms, malignant: 52.0±10.6 ms; p=0.001).

CONCLUSION

Quantitative measurements from T2 mapping sequences provide good differentiation between healthy and malignant prostate tissue and are feasible in an expanded standard porstate protocol at high-resolution in acceptable acquisition time.

CLINICAL RELEVANCE/APPLICATION

Accelerated T2 mapping sequences could be a feasible addition to standard multiparametric prostate MRI for detection of prostate cancer.

SSJ10-03 Efficacy of Quantitative Texture Parameters of 3T Multiparametric MRI for the Differentiation of Transition Zone Prostate Cancer Lesions from Benign Prostatic Hyperplasia Nodules with

Wholemount Histopathology as Reference

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S502AB

Participants
Sohrab Afshari Mirak, MD, Los Angeles, CA (*Presenter*) Nothing to Disclose
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Kyunghyun Sung, PhD, Los Angeles, CA (*Abstract Co-Author*) Research support, Siemens AG
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PURPOSE

To investigate the performance of different quantitative texture parameters of 3T multiparametric magnetic resonance imaging (3TmpMRI) for the differentiation of transition zone (TZ) prostate cancer (PCa) lesions from benign prostatic hyperplasia (BPH) nodules with wholemount histopathology as reference standard.

METHOD AND MATERIALS

This IRB approved, HIPAA compliant case-control study, included 77 patients. Regions of interest (ROI) for true positive TZ PCa lesions as well as the BPH nodules were contoured on 3TmpMRI axial T2-weighted images (T2WI), apparent diffusion coefficient (ADC) map of the diffusion weighted images (DWI) and dynamic contrast enhancement (DCE) MRI and the quantitative image analysis was performed. We generated 10 parameters including normalized T2WI signal intensity (SI) (calculated as mean T2WI signal intensity/ROI of obturator muscle), the shape of the histogram of T2WI SI (skewness and kurtosis), ADC minimum, ADC maximum, ADC skewness, ADC kurtosis, Ktrans (influx volume transfer coefficient), kep (efflux reflux rate constant) and Ve (the fractional volume of extracellular extravascular space). The quantitative parameters were compared between the TZ PCa and BPH nodules using paired sample t-test in SPSSv24. P-value<0.05 was considered as significant. The performance of the significant parameters were assessed using AUC for the ROC curves.

RESULTS

Mean patient age was 62.9±7.6 years with mean prostate specific antigen (PSA) 7.6±8.3 ng/ml. Compared to the BPH nodules, TZ PCa lesions had significantly higher T2WI SI (p=0.004), ADC skewness (p<0.001), Kep (p-value=0.026) and significantly lower ADC minimum (p<0.001) and ADC maximum (p=0.001). T2WI skewness, T2WI kurtosis, ADC kurtosis, Ktrans and Ve were not significantly different between cancerous and benign lesions (p>0.05). The highest AUC for the differentiation of TZ PCa from BPH was resulted from ADC skewness (0.998) followed by ADC minimum (0.891), ADC maximum (0.790), T2WI SI (0.625) and Kep (0.403) (figure 1).

CONCLUSION

3T mpMRI quantitative texture parameters, with higher performance of the parameters generated based on ADC maps, can be of significant value for the differentiation of TZ PCa from BPH nodules.

CLINICAL RELEVANCE/APPLICATION

Differentiation of transition zone prostate cancer from benign prostatic hyperplasia on 3T mpMRI can be difficult due to overlapping features, however mpMRI quantitative parameters may increase the performance.

SSJ10-04 PI-RADS-Based 3D Prostate Cancer Detection Using Residual Convolutional Neural Networks

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S502AB

Participants
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PURPOSE

Multi-parametric magnetic resonance imaging (mp-MRI) is playing an increasing role in prostate cancer assessment. Automated cancer localization as part of clinical decision support system can reduce inter-observer variability and time spent on image interpretation. This study evaluates the performance of a residual convolutional neural network (ResCNN) in the identification of potential areas of prostate cancer.

METHOD AND MATERIALS

A total of 337 cancer patients from the PROSTATEx dataset were analyzed in this study. Three radiologists segmented lesions that were PI-RADS v2 category three or higher using T2-weighted, ADC, and high b-value images. A 2D patch-based ResCNN was trained based on segmentations from the most senior radiologist. Volumetric predictions were generated using an adaptive threshold that controls the number of false positives. Sensitivity was measured by comparing network predictions to biopsy locations with clinically significant cancer using a distance criterion of 10 mm or less.

RESULTS

The network's sensitivity for detecting clinically significant cancer was 97% for all PI-RADS categories, whereas radiologists' sensitivities were 79±0.06%, 94±0.04%, and 99±0.02% for category 3, 4, and 5 lesions, respectively. The trade-offs for an increased network sensitivity were lesion volume overestimation (radiologists: 1.5cc, network: 3.2cc) and an increased number of false positives (PI-RADS 3: 29%, PI-RADS 4,5: 2%).

CONCLUSION

The proposed ResCNN was able to obtain similar sensitivity for detecting clinically significant cancer as the radiologists. This demonstrates the network's potential to assist radiologists in prostate cancer detection, especially for PI-RADS 3 lesions where the presence of clinically significant cancer is equivocal (sensitivity: network 97% vs radiologists 79%).

CLINICAL RELEVANCE/APPLICATION

We have demonstrated that a residual convolutional neural network trained on PI-RADS v2 protocol has the potential to assist radiologists in detecting clinically significant prostate cancers.

SSJ10-05 Radiomic Features from Prostate Bi-Parametric MRI Differentiate MRI-Invisible Lesions from Non-Tumor Region in the Peripheral Zone: A Preliminary Multi-Site Study

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S502AB

Participants
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PURPOSE

Approximately 12% of biopsy-confirmed prostate cancer (PCa) lesions cannot be detected on MRI, which are referred to as 'MRI-invisible' lesions (PI-RADS < 3 and Gleason Grade Group (GGG) >= 1). Radiomics derived from prostate multi-parametric MRI (mpMRI) have been shown to complement imaging in characterizing PCa. In this work, we explore radiomics from bi-parametric MRI (bpMRI) including T2-weighted MRI (T2WI) and apparent diffusion coefficient (ADC) maps to differentiate MRI-invisible lesions from non-tumor prostate tissue in the peripheral zone (PZ).

METHOD AND MATERIALS

In this study, a set of N = 100 PCa patients was included from 4 different institutions. Of these, 64 patients (N1) underwent 3T mpMRI prior to radical prostatectomy (RP) and 36 patients (N2) underwent 3T mpMRI with no abnormal signs followed by systematic biopsy that was negative. For N1, delineation of lesion regions of interest (ROIs) on bpMRI were obtained by mapping ROIs from corresponding RP surgical specimens and verified by an experienced radiologist. N = 39 visible lesions (VL) and N=25 invisible lesions (IL) were identified by the radiologist. Patients from N2 were used to obtain non-tumor (NR) ROIs within the PZ on T2WI and ADC maps. Training set (D1) consists of 15 NR, 15 IL and 18 VL, and the testing set (D2) consists of 21 NR, 10 IL and 21 VL. In D1, we identified stable radiomic features (test-retest and cross-site stability) that distinguished NR and IL, as well as NR and VL (to ensure their association with PCa). A logistic regression model (CL) was trained to separate NR and PCa lesions (IL + VL) in D1 and was then validated on D2 in terms of receiver operating characteristic (ROC).

RESULTS

Radiomic features including Co-occurrence of Local Anisotropic Gradient Orientations (CoLIAGe), Haralick features from T2WI; CoLIAGe and Laws features from ADC maps were found to distinguish NR and IL, VL. The area under the ROC curve (AUC) of CL on D2 is 0.93 (NR vs lesions), 0.97 (NR vs IL) and 0.91 (NR vs VL).

CONCLUSION

Radiomic features derived from prostate bpMRI were able to differentiate MRI-invisible lesions from non-tumor regions within the PZ.

CLINICAL RELEVANCE/APPLICATION

Radiomic based approaches might allow for non-invasive identification of PI-RADS invisible tumors and improve the lesion detection sensitivity of prostate MRI.

SSJ10-06 A Machine Learning-Assisted Decision Support Model with MRI Can Better Spare the Extended Pelvic Lymph Node Dissection at Cost of Less Missing in Prostate Cancer

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S502AB

Participants
Ying Hou, Nanjing, China (*Presenter*) Nothing to Disclose
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PURPOSE

To develop a machine learning (ML)-assisted model for identifying the candidates for extended pelvic lymph node dissection (ePLND) in prostate cancer by integrating clinical, biopsy and precisely defined MRI findings.

METHOD AND MATERIALS

248 patients treated with radical prostatectomy and ePLND or PLND were included. ML-based models were developed from 18 integrated features using a logistic regression (LR), support vector machine (SVM) and random forests (RFs) algorithm, respectively. The models were compared to a MSKCC nomogram using the receiver operating characteristic-derived area under the curve (AUC), calibration plot and decision-curve analysis (DCA).

RESULTS

Total 59/248 (23.8%) lymph node invasion (LNIs) were identified at surgery. After cross validation, the predictive accuracy of these ML-based predictors yielded similar AUCs (RFs: 0.906; 95% confidence interval [CI], 0.856-0.928; SVM: 0.891; 95% CI, 0.840-0.917; LR+: 0.886; 95% CI, 0.834-0.913), while higher than MSKCC nomogram (0.816, 95% CI, 0.762-0.862). The calibration of MSKCC tended to underestimate LNI risk across the entire range of predicted probabilities compared to RFs and SVM. The DCA demonstrated three ML-based models significantly improved risk prediction at risk threshold <= 80% compared to MSKCC. If ePLNDs missed was controlled < 3%, RFs resulted in higher positive predictive value (55/107 [51.4%] vs 56/139 [40.3%]), similar negative predictive value (137/141 [97.2%] vs 106/109 [97.2%]), and higher No. of ePLNDs spared (141/248 [56.9%] vs 109/248 [43.9]) compared to MSKCC.

CONCLUSION

Our ML-based model below 15% cutoff, superior to MSKCC nomogram, allows to 57% ePLNDs spared at the cost of missing < 3% LNIs.

CLINICAL RELEVANCE/APPLICATION

Preoperative identification of LNI is critical for appropriate treatment selection and planning.As precisely defining nodal stage is to allow surgeons to define which patients may benefit from ePLND or PLND during radical prostatectomy and which patients may safely avoid it.

Printed on: 10/29/20

SSJ11

Genitourinary (Evidence-Based Genitourinary Imaging)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S503AB

GU

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose
Mariano Volpacchio, MD, Buenos Aires, Argentina (*Moderator*) Nothing to Disclose

Sub-Events

SSJ11-01 What is the Value of Surveying the Kidneys during Pelvic Ultrasound Examinations? A Clinical Audit of 1000 Patients

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S503AB

Participants
Sheila Oh, MBBCh, Hamilton, New Zealand (*Presenter*) Nothing to Disclose
Orlaith Brennan, Hamilton, New Zealand (*Abstract Co-Author*) Nothing to Disclose
Martin Necas, Hamilton, New Zealand (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Pelvic ultrasounds are commonly performed for various clinical indications in female patients presenting to the hospital. A survey of the kidneys is routinely included as part of the examination, but there is limited justification for their inclusion in the assessment of every female presenting for a pelvic ultrasound1-4. There may be reasonable clinical rationale to extend the examination to survey the kidneys in select patients, i.e. large pelvic masses or lower abdominal pain necessitating review of the kidneys. However, most pelvic ultrasounds are performed for different reasons including heavy/irregular bleeding and characterisation of ovaries for polycystic morphology which provide no clinical justification for routine survey of kidneys. The prevalence of incidental renal findings in female patients presenting specifically for pelvic sonography is currently unknown. We aim to determine the incidence, spectrum and severity of renal findings in patients presenting for pelvic ultrasounds and clinical outcomes upon their discovery.

METHOD AND MATERIALS

A retrospective sequential audit of pelvic ultrasound examinations in 1000 non-pregnant female patients presenting to Waikato DHB Ultrasound service (Waikato Hospital & Thames Hospital) between 1 January 2017 and 14 July 2017. Examinations were identified using a sequential search of our PACS system. Ultrasound reports and outcomes were analysed. Renal findings were separated into clinically significant criteria (e.g.Bosniak 2F-4 cyst, new angiomyolipoma(AML), renal cell carcinoma(RCC) or new urolithiasis); and insignificant criteria (e.g.simple cyst, stable AML or known urolithiasis). Clinical outcomes of patients with significant renal findings were determined by reviewing patients' clinical records for one-year following the ultrasound.

RESULTS

A total of 1999 kidneys were examined from 1000 female patients (Mean age=43) who underwent pelvic ultrasound examination;1 patient had previous nephrectomy. No significant renal findings were found in 96% of pelvic ultrasound examinations. Of the 46 significant renal findings, 91% were clinically inconsequential. Only 4 patients had incidental findings of high clinical priority requiring specialist treatment; 2 patients were symptomatic from obstructive urolithiasis and 2 patients harboured asymptomatic RCC. Overall incidence of incidental renal findings of high clinical priority in asymptomatic patients was 2 in 1000 patients.

CONCLUSION

Prevalence of significant incidental renal findings was 4.6% but the vast majority (91%) were clinically inconsequential. Prevalence of incidental renal findings of high clinical priority was only 4 in 1000(0.4%); two were symptomatic. Indiscriminate uncritical screening of kidneys in women presenting for pelvic ultrasound is not evidence-based and represents a low-yield examination with extremely low rate of incidental findings of clinical significance.

SSJ11-02 Intrapatient Analysis of Effect of Oral and Intravenous Contrast Material on CT Diagnosis of Acute Pelvic Pathologies

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S503AB

Participants
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PURPOSE

Ultrasound is the initial modality to evaluate acute pelvic pathologies. However, when symptoms are poorly localized, patients can be evaluated by CT. Our objective was to compare the performance of computed tomography (CT) without and with oral and intravenous (iv) contrast for the diagnosis of acute pelvic pathologies in the same patients by using dual energy CT (DECT) contrast-enhanced and virtual non-contrast (VNC) images.

METHOD AND MATERIALS

In this retrospective analysis, we reviewed DECT studies with oral and IV contrast obtained for abdominal pain. We included patients with a radiological diagnosis of acute pelvic pathologies and control cases without evidence of acute pelvic pathology scanned between October 2018 and March 2019. In the first session, the virtual non-contrast scans were randomized and analyzed. In the second session, true contrast enhanced images were randomized and analyzed. Findings of acute pelvic pathologies and diagnostic certainty in percentage were noted. Diagnostic performance of VNC images were compared with contrast enhanced CT studies. Sensitivity, specificity and accuracy were calculated. Fischer's exact test and Wilcoxon signed-rank test were used for statistical analysis.

RESULTS

Cohort included 46 patients with 92 sets of CT images (patients with acute pelvic pathologies n=27, control cases n=19). Pelvic pathologies included: tubo-ovarian abscess/ hydrosalphinx (n=13), ovarian cyst rupture (n=8), hemorrhage within an ovarian cyst (n=2), large ovarian cyst (n=3), dermoid cyst rupture (n=1). Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of VNC images were 70.4% (95% CI= 49.8-86.3%), 94.7% (95% CI= 74.0-99.9%), 95% (95% CI= 73.5-99.2%), 69.2% (CI= 55.5-80.3%) and 80.4% (95% CI= 66.1-90.6%), respectively. Mean diagnostic certainty rate was significantly higher in true enhanced group when compared to VNC group (81.6% vs 100%, p=0.001).

CONCLUSION

When compared to contrast enhanced CT imaging, unenhanced images missed 30% of cases with acute pelvic pathologies. Also with contrast enhanced CT diagnostic certainty rate was significantly higher.

CLINICAL RELEVANCE/APPLICATION

The use of oral and intravenous contrast remains necessary in patients with suspected acute pelvic pathologies.

SSJ11-03 Suggestion on New Computed Tomography Criteria to Differentiate Pheochromocytoma from Adrenal Adenoma

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S503AB

Participants
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PURPOSE

To retrospectively investigate performance of new radiologic criteria to differentiate pheochromocytoma from adrenal adenoma using adrenal protocol computed tomography (CT).

METHOD AND MATERIALS

Consecutive 199 patients who underwent adrenal CT and surgically proven pheochromocytoma (n= 66) or adenoma (n= 133) were included. Patients were alternatively allocated to model development (n= 100) and validation (n= 99) groups, according to the order of surgical date. Two independent radiologists analyzed two CT criteria for pheochromocytoma. Conventional criteria were as follows: (a) lesion attenuation on unenhanced CT >10 Hounsfield unit (HU); (b) absolute percentage washout (APW) <60%; AND (c) relative percentage washout (APW) <40%. New criteria were as follows: (a) conventional criteria; OR (b) one of followings; (i) lesion attenuation on UCT >=40 HU; (ii) 1-min enhanced CT >=160 HU; or (iii) intralesional cystic degeneration seen on both 1-min and 15-min enhanced CT. Area under the curve (AUC) and inter-reader agreement were assessed.

RESULTS

Proportion of pheochromocytoma was similar between development and validation groups (26.0% versus 37.4%; p= 0.210). AUC of new criteria was consistently greater than that of conventional criteria for differentiating pheochromocytoma from adenoma (reader 1, 0.895 versus 0.755 for development group and 0.840 versus 0.724 for validation group; reader 2, 0.902 versus 0.799 for development group and 0.845 versus 0.724 for validation group) (p< 0.05 for all comparisons). Inter-reader agreement was excellent in interpreting any criteria (weighted kappa >0.800).

CONCLUSION

New radiologic criteria using adrenal protocol CT seem to improve diagnostic performance reliably in differentiating pheochromocytoma from adrenal adenoma.

CLINICAL RELEVANCE/APPLICATION

Conventional CT criteria have some overlaps in quantitative image finidngs between adrenal adenoma and pheochromocytoma. Thus, some of pheochromocytoma can be considered as adenoma radiologically. The present new criteria seem to allow more accurate prediction of pheochromocytoma by using adrenal protocol CT.

SSJ11-04 Establishing Normative Kidney Sizes for a Large Developing Country's Adult Population Using Big Data: A Study of 30,000 Ultrasound Scans Yields a Potential Gender and Age-Related Difference

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S503AB

Participants
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PURPOSE

There are no large-scale population level studies describing kidney size in normal adult population from this geography. Currently, radiologists rely on data from other countries or on limited data from small-scale studies specific to this geography. We studied kidney sizes of 30,000 patients with normal kidneys and compare our findings to currently established normal values.

METHOD AND MATERIALS

65,000 text reports of abdomen ultrasound scans done for patients presenting to 4 radiology clinics between June 2016 and December 2018 were extracted and anonymised. 35,064 reports were removed from the database since they either had some abnormality in the kidney (as determined by a filter-based text search mechanism) or were of paediatric population. Kidney sizes (length and breadth) were present in all 29,936 reports (48.6% females) and cortical thickness measurement was present in 1,624 reports (46.1% females). The sizes and cortical thickness for both kidneys were extracted using keyword-based mechanisms and summary statistics calculated.

RESULTS

The average age of females was 49.8 years and males was 52 years. The average length of the kidney was 10 cm (right) and 10.1 cm (left) in females and 10.3 cm (right) and 10.4 cm (left) in males. Average cortical thickness in females was 1.1 cm (left), 1.2 cm (right) and in males was 1.3 cm (left), 1.4 cm (right). However, the regression plots of kidney length vs. age, showed inflection points in females (38.2 y (right), 39.3 y (left)) to occur earlier when compared to that of males (43.2 y (right), 42.2 y (left)). This observed difference in inflection points might support the idea that kidney atrophy begins earlier in females than males. Additionally as compared to standard textbook kidney sizes and previous literature from this geography, our study values were slightly higher - study from 2014 reported sizes in males to be 9.7 cm (right) and 9.8 cm (left), and females to be 9.5 cm (right) and 9.7 cm (left).

CONCLUSION

The use of data-mining techniques can enable study of large datasets which currently reside unstudied in institutions across the world, giving insight into defining normative values across age-groups, populations and regions.

CLINICAL RELEVANCE/APPLICATION

Practising radiologists and clinicians can use age- and gender-specific normal sizes to improve their reporting and guide more appropriate clinical management.

SSJ11-05 Adherence to Appropriate Imaging Management per Published Guidelines for Incidental Adnexal Masses at a Level 1 Trauma Center

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S503AB

Participants
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PURPOSE

Evidence-based guidelines have been published to standardize management of incidental findings; however, there has been limited investigation of the adherence rates to these guidelines. We evaluate the appropriateness of radiologists' recommendations for follow-up imaging of incidentally discovered adnexal masses using published guidelines as the reference standard.

METHOD AND MATERIALS

Computerized tomography (CT) reports within the trauma registry were searched for 'ovary', 'ovarian' and 'adnexal'. 157 reports were used for this pilot study. 3 investigators independently assessed CT reports and generated recommendations for follow-up imaging as per American College of Radiology (ACR) guidelines. Discrepancies were reviewed among investigators for a consensus decision. Dictated reports were compared to published recommendations to assess for appropriate management, inadequate management, or over-management.

RESULTS

61 (39%) reports were excluded as they contained pertinent negative verbiage, expected physiologic findings, inadequate characterization or repeat examinations, leaving 96 for further analysis. 62 (65% [95% CI 56, 75]) had appropriate management, while 25 (26%) had inadequate management and 9 (9%) over-management. Of the inadequately managed reports, 11 had no recommendation provided when follow-up was indicated and 14 did not include a time interval when prompt follow-up imaging was

indicated. There was a significant association between appropriate management and age (<=50 years, 42/47 [89.4%] vs >50 years, 20/49 [51.9%], p<0.0001) and mass size (<=3 cm, 34/44 [77.2%] vs > 3cm, 28/52 [53.8%], p=0.01).

CONCLUSION

Adherence of radiologists to the ACR recommendations for adnexal masses was suboptimal; of note, we find that patient age > 50 years and mass size > 3 cm were associated with poorer adherence. A larger study is needed to validate these findings; however, these findings suggest a need to implement educational initiatives to promote the appropriate management of incidental adnexal findings.

CLINICAL RELEVANCE/APPLICATION

Proper management of incidental adnexal masses balances the goal for early detection of ovarian malignancy against unnecessary imaging of low-risk lesions.

SSJ11-06 Towards Reducing Overutilization of Prostate mpMRI: Using PSA Density to Predict Negative and Indeterminate MRI Scans

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S503AB

Participants
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PURPOSE

To assess the applicability of a prediction model based on clinical parameters to reduce the number of negative and indeterminate multiparametric MRI (mpMRI) scans in patients at risk for prostate cancer (PCa).

METHOD AND MATERIALS

In this retrospective research ethics board approved study, we evaluated 865 patients with no prior PCa diagnosis who underwent prostate mpMRI, classified according to PI-RADS v2.0. The following clinical risk factors were collected: age, prostate volume, PSA, PSA density (PSAd). Lesions reported as PI-RADS >= 4 were considered as suspicious for clinically significant (cs) PCa. The patient cohort was randomly split into training (n=605) and validation cohorts (n=260) for all analyses. We used univariate and multivariate logistic regression, and area under receiver operator characteristic (ROC) curve (AUC) to predict PI-RADS >= 4 findings. The optimal decision threshold to confidently rule out a PI-RADS >= 4 disease was determined in the training cohort and applied to the validation cohort. In total, 116 patients underwent biopsy following MRI, revealing 11 csPCas (>= Gleason Grade Group 2).

RESULTS

In univariate analysis, all variables were significant predictors of PI-RADS scores >= 4 (p<0.05). In multivariate analysis, only age, prostate volume, and PSAd were independent predictors of PI-RADS scores >= 4 (p<0.0001). PSAd (AUC=0.74) outperformed other single parameters in diagnostic accuracy (age: AUC=0.55, p<0.01; prostate volume: AUC=0.65, p<0.05; PSA: AUC=0.60, p<0.01) and yielded no significant difference compared to the multivariate model (AUC=0.73). At a PSAd cut-off value of 0.078 ng/ml2 sensitivity, specificity, positive and negative likelihood ratio were 93.62%, 28.64%, 1.31 and 0.22, respectively. This decision threshold would result in the omission of 25% (64/260) of mpMRI scans in the validation cohort, missing 6% of PI-RADS >= 4 findings (3/47). The number of subsequent biopsies could thus be reduced by a maximum of 33% (12/36), whilst missing only one csPCa.

CONCLUSION

In patients at risk for PCa, applying a PSAd cut-off level of 0.078 ng/ml2 would result in 25% fewer mpMRIs being performed while missing a minimal number of csPCas. Further prospective validation is required.

CLINICAL RELEVANCE/APPLICATION

We present a triage strategy for patients at risk for prostate cancer based on PSAd, which safely avoids a large proportion of prostate mpMRI scans with negative or indeterminate findings.

SSJ12

Health Service, Policy and Research (Education and Academics)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E260

ED HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ12-01 National Survey to Assess Gender Differences Among Radiology Residency Applicants Regarding Factors Impacting Program Selection

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E260

Participants
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PURPOSE

To investigate which program factors were considered most important by radiology residency applicants when ranking programs and to assess whether there was any significant difference by gender.

METHOD AND MATERIALS

Following IRB exemption, a web-based survey was distributed electronically to diagnostic radiology (DR) and interventional radiology (IR) residency programs in the US and Canada via the Association of Program Coordinators in Radiology (APCR) mailing list. The residents were asked to evaluate the importance of 30 factors during their evaluation of programs when applying for residency using a 5-point Likert scale (1=very negative/not important, 5=very positive/extremely important). Demographic information was also collected. The Mann-Whitney test was used to compare males and females for each factor on the survey and considered statistically significant at the $p<0.05$ level.

RESULTS

370 residents (95.4% DR and 4.6% IR) and 1 DR fellow (0.3%) completed the survey. Overall, the most important factors to respondents during residency program selection were program culture (4.42), geographic location (4.17), fellowship placement of graduates (4.14), and imaging and/or procedure volume (3.98). Of the respondents, 269 were male (72.5%) and 101 were female (27.2%). There was a significant difference between male and female respondents in the importance given to program culture ($p=0.002$), composition of current residents (marital status, age, race, gender, and children status) ($p=0.007$), percentage of current female residents ($p<0.0001$), program size ($p=0.047$), call schedule ($p=0.025$) and female faculty ($p<0.0001$), which female respondents ranked more highly and considered to be extremely important, very important or somewhat important.

CONCLUSION

Applicants consider many factors during residency program selection. Overall program culture, geographic location, fellowship placement and imaging and/or procedural volume were most important to applicants. There were significant gender differences in how applicants weighted the importance of several factors during residency program selection.

CLINICAL RELEVANCE/APPLICATION

Understanding factors considered by applicants during the residency program application process can help residency programs recruit applicants.

SSJ12-02 Are Women Disadvantaged in Academic Radiology?

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E260

Participants
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PURPOSE

There has been a persistent gender bias in Radiology preventing women from assuming leadership positions. This could lead to or result from women not ascending faculty rank. We sought to determine if 1) women are appropriately represented in the senior author positions in radiology journals compared with their first authored contributions 2) women's contribution to the radiology literature is proportional to their percentage growth in academia 3) whether there are gender differences in senior academic rank after accounting for factors known to influence academic advancement.

METHOD AND MATERIALS

We assessed the gender of 3,702 first and last authors of manuscripts published in 9 high-impact American radiology journals between 2002-2017. For the same years, we looked at the gender composition of academic faculty and ranks based on AAMC data. We calculated the proportion of faculty members with respect to gender and academic ranks over time. We also plotted the productivity rates for each gender over 16 years .Additionally the gender ratio of junior and senior faculty positions was plotted over time to see if the gender ratio of junior faculty who entered AAMC rosters 16 years earlier would be balanced to the gender ratio of senior faculy 16 years later.

RESULTS

Women's proportion as the first author grew from 26.9% to 37.4%, and from 15.7% to 23.9% as the senior author. Senior author contribution of women remained significantly lower than first authorship with no sign of narrowing the gap. Women were underrepresented in each faculty rank over 16 years. For a given year, the percentage of women associate professor and full-professor were 6.80% and 13.97% less than the mean percentage of female assistant professor. Mean manuscript productivity rate of women as junior faculty for 16 years was nearly equivalent compared to their male counterparts. The ratio of women in senior academic rank did not change with an increase in women authorship.

CONCLUSION

Although women have made inroads in their contribution to radiology literature over the years, this has not translated to improvement in the ratio of senior authorship and faculty positions versus men. Despite increased involvement of women in research over time, the remain disproportionately at junior faculty positions.

CLINICAL RELEVANCE/APPLICATION

Gender disparity has persisted over the years and led to the under-representation of women in senior authorship and higher academic ranks.

SSJ12-03 Analysis of Kinematic Differences in Hand Motion between Novice and Experienced Operators in Interventional Radiology

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E260

Participants
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PURPOSE

Kinematic hand motion analysis has been used to quantify refinements in learned tasks in surgery. Here, we compare the hand motion of attending physicians to trainees completing a basic simulated interventional radiology procedural task using electromagnetic sensor technology to determine if kinematic hand motion analysis can detect differences between experienced operators and trainees.

METHOD AND MATERIALS

5 attendings and 3 trainees (2 fellows, one resident) performed a simulated task of threading a wire through a sheath and removing the inner dilator over a wire while the motion of their dominant hand was recorded using electromagnetic motion sensor technology. All participants were right-handed. The task was repeated for 10 trials. The total distance the participant's hands traveled during the task (path length) and total time to complete the task were compared between attendings and trainees individually and as a group. The first trial path length and the last trial path length were compared to detect improvement with task repetition. Statistical analysis using paired t-tests and two sample t-tests were performed.

RESULTS

Total path length to complete the task for the attendings was shorter than that for the trainees (69±12 cm vs. 107±22 cm, $p<0.05$). The attendings also took a shorter time to complete the task (71±18s vs. 82±16s, $p<0.01$). The path length for all participants (attendings and trainees) decreased between the first attempt at the task and the last attempt (94±20 cm vs. 78±22 cm, $p<0.05$).

CONCLUSION

Electromagnetic motion tracking technology was able to discern kinematic differences in hand motion between attending physicians and trainees in a simulated interventional radiology task. Kinematic analysis also detected improvements with task repetition. Further exploration of this technology as a method to objectively measure performance of procedures in radiology is warranted.

CLINICAL RELEVANCE/APPLICATION

Kinematic differences between attendings and trainees represent an objective measure of performance. This element may be used to determine when a trainee can be deemed competent for a given procedure.

SSJ12-04 Research Involvement and Barriers in Radiology Residency Programs: Perceptions, Attitudes, Practice, and Impact Worldwide

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E260

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PURPOSE

To assess the opportunities and interest in academia amongst radiology trainees worldwide, and to identify barriers to research activities.

METHOD AND MATERIALS

A 35-question online survey was distributed to radiology trainees internationally using social media and support via email newsletters from 13 radiological societies. Feedback regarding length and setup of radiology residency programs, participation in research and barriers to academic activities were investigated. Fisher and Chi-squared tests were used to differentiate findings. A $p<0.05$ indicated a statistically significant difference.

RESULTS

In total, 749 participants (348 women, 392 men, 9 undisclosed) completed the survey. Research involvement amongst radiology trainees varied significantly, ranging from 36% (21/59) in South America to 79% (46/58) in North America. Research productivity (i.e. poster or scientific presentations and publications) varied significantly, with trainees involved in research from North America mostly publishing original articles (27/58, 27%), European trainees mostly publishing review articles (94/437, 22%) and South American trainees mostly publishing case reports (28/59, 47%). There was a lack of formal allocated time for research in 60% (451/749) of participants. When compared to participants with formally allocated time, there was a lower number of published original articles (31%, 138/451 vs. 42%, 126/298, $p<0.001$), review articles (13%, 58/451 vs. 20%, 60/298, $p=0.007$), and first author publications (31%, 140/451 vs. 40%, 120/298, $p=0.009$). Barriers to research included lack of allocated time (58%, 434/749) and mentorship (49%, 366/749). Some participants (18% (136/749)) declared a lack of personal interest as a barrier. Lack of funding was declared a major barrier by 50% (19/38) of participants from African countries.

CONCLUSION

Radiology research involvement amongst trainees varies worldwide, with many not formally involved in academia. Residency programs seeking to enhance research output should focus on providing protected time, training and mentorship.

CLINICAL RELEVANCE/APPLICATION

High quality research drives technological advances. Lack of involvement in academia and mentorship during residency may hamper the ability of radiologists to contribute to discoveries and improvements for patient care.

SSJ12-06 Breaking the Stereotype: Interventions Aimed at Changing Medical Student Misperceptions of Radiology and Increasing the Female Match Rate

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E260

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

The purpose of this project is to determine the effectiveness of the interventions implemented at a single medical school in disputing the common misperceptions of radiology and increase the number of female medical students pursuing radiology.

METHOD AND MATERIALS

1st (MSI) and 4th year medical students (MSIV) voluntarily participated in an online survey to assess whether the interventions implemented at one medical school corrected stereotypes about radiology, and to see if they increased the number of women going into radiology. The interventions included adding radiology into the preclinical curriculum, 3rd year electives in radiology, and a 'Women in Radiology Panel'. MSIs gave free text answers about their attitudes toward radiology, which were categorized into the '6 most common misperceptions': no patient contact, anti-social, dying field, spend all day in a dark room, good lifestyle, and other. MSIVs were asked why they did or did not choose radiology, and the answers were placed into the same 6 categories. We also looked at the impact the Women in Radiology Panel (WIRP) had on perceptions and whether attendees were more likely to consider radiology. We then looked to see if there has been an increase in the number of female students choosing radiology since implementation.

RESULTS

MSIV (N=64) response rates containing the '6 most common misperceptions' were decreased compared to MSIs (N=183), especially dark room (p=0.01), dying field (p=0.54), and antisocial (p=<0.0001). After the WIRP, attendees (N=18) rated their perception of patient contact (p=0.001) and work-life balance (p=0.33) higher. Attendees were also more likely to consider radiology (p=0.003). If exposed to 4 years of interventions there was a significant increase in the number of female students matching in radiology (p = 0.01).

CONCLUSION

Female students exposed to 4 years of interventions showed a significant increase in radiology match rate. The interventions also decreased the misperceptions about radiology. The WIRP was the most effective at changing misperceptions and resulted in a higher likelihood of considering radiology.

CLINICAL RELEVANCE/APPLICATION

Exposure to radiology early in medical school and the prescence of female radiologist role models can change misperceptions and increase the number of women choosing radiology.

Printed on: 10/29/20

SSJ13

Informatics (3D Printing, Augmented Reality, and Virtual Reality)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S501ABC

IN

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Christopher Morley, MD, New York, NY (*Moderator*) Co-founder, MediVis, Inc

Sub-Events

SSJ13-01 Implementing an In-House 3D Printing Service Across a Healthcare Enterprise

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S501ABC

Participants
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Erik Backlund, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Bon Ku, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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CONCLUSION

The creation of 3DP workflow tools and a management queue - via standard EMR integration - promotes access to 3DP and sets a new standard of care for providers across a healthcare enterprise. This development demonstrates a maturation of in-hospital 3DP service with the potential of scaling to other healthcare enterprises.

Background

Large clinical enterprises with multiple acute care hospitals and outpatient offices need to innovate scalable solutions to improve patient care. Integrated 3D printing (3DP) technology is emerging as a new standard of care, however the methods and workflows to implement this technology require demonstration. To meet growing demands, we established an in-house 3DP service involving a multi-disciplinary team of radiologists, clinicians, developers, designers, administrators, and students.

Evaluation

Leveraging multiple departments across our healthcare enterprise, we developed an entirely in-house 3DP service. Our software engineers developed an interface within the hospital's EMR along with a management system that allows clinicians to directly order 3D models and track their progress. Image segmentation, volume preparation, and printing are performed within a design lab staffed by clinicians, designers, and students with enterprise PACS access and expertise in 3D modeling and printing. Using the EMR 3D print interface, the team can collaborate with clinicians to validate models. At writing, we have 9 procedure specific 3D protocols in development with 6 surgical specialties across multiple hospitals. By integrating the 3DP process into EMR workflow, we have reduced friction to engage with this technology. Additionally, a data analytics team is able to extract measures and outcomes to be used for quality improvement.

Discussion

We have described the development of a streamlined in-house 3DP service that eliminates the need for outsourcing any step in the creation of patient care 3D models. By keeping the 3DP process in-house, we are able to reduce costs, create high quality custom models, remain HIPAA compliant, maintain quality control, and allow radiologists and other stakeholders to co-design and monitor the progress of the model.

SSJ13-02 Patient-Specific Metal Implants Using 3D Printing Technique for the Reconstruction of Skeletal Defect after Bone Tumor Resection

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S501ABC

Participants
Wanlim Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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CONCLUSION

Our study suggests that 3D printing technology can be useful to reconstruct patient-specific bone defect where functional reconstruction was not feasible with conventional methods. Future study to identify the optimum method of hybrid combination will be necessary.

Background

Reconstruction of the skeletal defect after resection of bone tumors is challenging because it can occur in various locations with a diverse bone defect. Prosthetic reconstruction is one of the most commonly used method, however pre-existing modular prosthesis system cannot fully accommodate the patient's specific defect and functional requirement. To overcome this shortcoming, we made a patient-specific metal implant that could be combined with pre-existing modular prosthesis using a 3D printer. Here, we describe our experiences on the patient-specific implant for the treatment of bone tumors.

Evaluation

This study involved 3 consecutive bone tumor patients who were treated between October 2018 and March 2019. Primary tumors consisted of osteosarcoma of the scapula, chondrosarcoma of the humerus, and giant cell tumor of the proximal radius. Conventional reconstructions were expected to be non-functioning for all those 3 patients, due to extensive bone destruction involving major joints. After we obtained 3D CT and MRI images, a rapid prototype was made to simulate bone defect. Then we designed a patient-specific metal implant that could be combined with pre-existing prosthesis in a STL file that could be printed. We evaluated the feasibility of hybrid reconstruction for the treatment of bone tumors using a 3D printing technology and functional outcome.

Discussion

All three tumors were resected as preoperatively planned, and there were four combination points between implants. Three of them were screw type combination and one was pressure-fit. Patient-specific implants were combined with pre-existing modular prostheses without difficulties. The mean range of motion (ROM) was 73% when compared to the preoperative ROM and all patients could perform independent daily activities.

SSJ13-03 Quality Assurance in 3D Printing: Gage R&R Study of Bone Model Creation

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S501ABC

Participants
April Krivoniak, MS, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
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CONCLUSION

Gage R&R analysis of Housdorff distances in a quick and accurate means of assessing model creation protocols and segmenters.

Background

As 3D printing for the creation of anatomic models grows, there is a pressing need to ensure quality of the model creation process. While most 3D printers have well-defined tolerances, the repeatability and reliability of the virtual model creation process is less studied. The ability to evaluate overall and individual segmenters' quality is vital to the creation of high-quality models. Here, we present the results of a Gage repeatability and reliability analysis of the model creation process.

Evaluation

Three segmenters created STL's for 5 patient femurs. Each patient was segmented 3 times by each segmenter. Images were randomized and deidentified. The segmenters included a biomedical engineer, CT technologist, and pediatric radiologist, each with at least 1 year of experience in 3D printing. Each patient was segmented by a radiologist/biomedical engineer with greater than 3 years of experience to serve as the reference for analysis. STL's were compared to the reference mesh and root mean square error (RMSE) was calculated with Hausdorff distances. Gage R&R analysis was performed for the RMSE. A total of 39 segmentations were performed. The overall RMSE [quartiles] was 0.47 mm [0.34, 1.03]. The RMSE Gage R&R variance was 16.5%. One operator consistently had higher RMSE for all models, while another operator had higher RMSE for 2 patients.

Discussion

The Gage R&R for RMSE, measured at 16.5% indicates that the variability among and within segmenters accounts for 16.5% of the variation in measurements. Ideally the value should be less than 10%. We plan to implement further training and a strict protocol for the segmentation of bony anatomy and repeating the analysis to assess for change in the two outlier segmenters. Our results show that Gage R&R analysis of image segmentation using Hausdorff distances is a quick, robust method to evaluate individual segmenters and overall model preparation protocols. Before segmenters can create models for clinical patients, we suggest performing a similar analysis to ensure high quality in the creation of anatomic models.

SSJ13-04 3D Printed and Augmented Reality Models: Initial Evaluation on Quantitative Outcomes for Patients Undergoing Robotic Assisted Radical Prostatectomy

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S501ABC

Participants

Nicole Wake, PhD, Bronx, NY (*Presenter*) In-kind support, Stratasys, Ltd; Consultant, General Electric Company
Andrew B. Rosenkrantz, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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Hersh Chandarana, MD, New York, NY (*Abstract Co-Author*) Equipment support, Siemens AG; Software support, Siemens AG; ;

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PURPOSE

The purpose of this study was to prospectively assess whether 3D printed and augmented reality (AR) prostate cancer models improve quantitative surgical metrics in patients undergoing robotic assisted radical prostatectomy (RARP).

METHOD AND MATERIALS

Patients with MRI-visible prostate cancer (PI-RADS v2 >=3) scheduled to undergo RARP were prospectively enrolled in our IRB approved study. Patients were randomized to one of three methods of pre-operative image data visualization: 1) imaging alone, 2) imaging and a 3D printed model, or 3) imaging and an AR model. Quantitative metrics including operating room time, blood loss, and positive surgical margins were measured. Continuous surgical metrics for all of the 3D groups were compared to the group with just imaging using an unpaired t-test and non-parametric outcomes were compared with the Cochran's Q test.

RESULTS

99 patients were enrolled: 45 had imaging only, 37 had pre-operative 3D printed models, and 17 had pre-operative AR models. Total operating time (minutes) was 222 ± 47 for imaging, 213 ± 42 for 3D printed models, and 225 ± 38 for AR models. Blood loss (mL) was 232 ± 114 for imaging, 227 ± 148 for 3D printed models, and 203 ± 38 for AR models. Ten patients (22.2%) with imaging only, 3 patients (8.1%) with 3D printed models, and 7 patients (41.2%) with AR models, had positive surgical margins ($p = 0.005$). There was a 9-minute reduction in operating time for the 3D printed model group as compared to the imaging group (213 ± 42 vs 222 ± 47 minutes). However, the unpaired t-tests showed no statistical significance between any of the continuous 3D surgical metrics as compared to imaging as the gold-standard.

CONCLUSION

In this cohort, use of 3D printed models decreased operative times and rates of positive surgical margins compared to imaging alone.

CLINICAL RELEVANCE/APPLICATION

3D printed and AR prostate cancer models can assist surgeons to plan procedures thereby potentially improving patient outcomes and decreasing cost.

SSJ13-05 Common Femoral Arterial 3D Printed Haptic Simulator with Co-Registered Augmented Reality Hologram

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S501ABC

Participants
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Abigail R. Cogman, DO, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Michael D. Weintraub, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Tyler A. Smith, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Gabriel C. Fine, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Edward P. Quigley III, MD,PhD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose

CONCLUSION

We provide a proof of principle for utilizing these tools to create a VR/AR teaching module for CFA access using 3D printing, the Microsoft HoloLens, and the co-registered haptic/virtual simulator using the Novarad Opensight Software.

Background

Common femoral artery (CFA) vascular access and subsequent closure for interventional procedures are commonly performed. Complications of CFA puncture include bleeding, dissection, thrombosis, pseudoaneurysm, neuropraxia, and injury to adjacent structures. To reduce the number of complications and ensure patient safety in an evolving training environment, simulators will likely be used with increasing frequency for interventional training. A growing body of evidence demonstrates simulators enhance user confidence, and decrease complications, procedural time, and radiation exposure. We developed a novel patient specific 3D printed haptic CFA simulator with coupled augmented reality (AR) anatomic hologram to provide tactile procedural practice and visuo-spatial reference.

Evaluation

We created osseous, vascular, and soft tissue models from anonymized CTA DICOM images. These were simultaneously 3D printed and displayed as an AR virtual model. We demonstrated overlay of the AR and haptic models of 3D patient CTA to be robust and accurate. For the haptic simulator, we printed osseous structures using polylactic acid, hollow vessel with Formlabs biomimetic elastic resin. These were embedded in a ballistic gel mold of soft tissues. Vessels were connected to pressurized fluid system and pump. US imaging of the haptic model faithfully reproduces patient's vascular anatomy. Successful puncture, catheterization, instrumentation, and closure of the CFA was achieved by trainees on initial attempts using US and using HoloLens AR platform.

Discussion

Simulators continually improve resident education in other medicine subspecialties, especially procedurally based simulations. We

have made a unique and adaptable CFA simulator that can be used to improve interventional procedural competency at all training levels. Critically, 3D printed haptic CFA simulator realistically approximates the appearance of vessels, bones, and soft tissue under both fluoroscopy and ultrasound.

SSJ13-06 DS U-Net: Deeply Supervised U-Net for Fetal Brain Extraction

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S501ABC

Participants
Jingjiao Lou, Jinan, China (*Presenter*) Nothing to Disclose
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Liang Sun, Nanjing, China (*Abstract Co-Author*) Nothing to Disclose
Gang Li, PhD,MS, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
Dinggang Shen, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

CONCLUSION

We propose an automatic brain extraction method for fetal MRI using 2D U-net with deep supervision. Moreover, we propose a multi-stage approach to first localize the brain, and then segment the brain, and finally further refine the segmented brain, thus achieving high accuracy. Experimental results demonstrate that the precision and robustness of our method outperforms the existing methods.

Background

Fetal brain extraction/segmentation is one of the most essential steps for prenatal magnetic resonance imaging (MRI) reconstruction and analysis. Due to maternal breathing and unpredictable fetal movement, it is a challenging task to extract fetal brains from sparsely-acquired imaging stacks typically with motion artifacts. To address this, we propose an automatic brain extraction method for fetal MRI using multi-stage 2D U-Net with deep supervision (DS U-net).

Evaluation

Since the fetal brain only occupies a small proportion of positive pixels in fetal MRI, we firstly employ a coarse segmentation derived from DS U-net to define a 3D bounding box for localizing the position of the brain. The DS U-net is trained with deep supervision loss to acquire more powerful discrimination capability. Then, another DS U-net focuses on the extracted region to produce finer segmentation. The final prediction results are obtained by performing refined segmentation. We validate the proposed method on 80 stacks of training images and 43 testing images. The experimental results demonstrate the precision of our method with average Dice coefficient of 91.69%.

Discussion

After several layers of down-sampling, the dimensions of the feature maps reduce gradually and become smaller than that of the ground-truth masks. This subsequently makes the error back-propagation ineffective, slows down the convergence rate, and reduces the discrimination capability of the network. The U-net trained with deep supervision loss has more powerful discrimination capability. Additionally, feature maps from adjacent slices can be selected as additional channels to improve the segmentation performance.

SSJ14

Molecular Imaging (Theranostics)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S504CD

MI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Christopher C. Riedl, MD, New York, NY (*Moderator*) Nothing to Disclose
Gabriel C. Fine, MD, Salt Lake City, UT (*Moderator*) Nothing to Disclose

Sub-Events

SSJ14-01 To Evaluate the Efficacy of 68Ga-DOTA-TOC and 18F-FDG PET/CT in the Follow-Up of Patients with Neuroendocrine Tumor Treated with the First Full Peptide Receptor Radionuclide Therapy Cycle

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S504CD

Participants
Sikandar M. Shaikh, DMRD, Hyderabad, India (*Presenter*) Nothing to Disclose

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PURPOSE

To evaluate the value of 68Ga-DOTA-TOC and 18F-FDG PET/CT for initial and follow-up evaluation of patients with neuroendocrine tumour (NET) treated with peptide receptor radionuclide therapy (PRRT).

METHOD AND MATERIALS

We evaluated 33 patients who were histologically proven NET.All these patients underwent both PRRT and three combined 68Ga-DOTA-TOC and 18F-FDG PET/CT studies. 68Ga-DOTA-TOC PET/CT was performed before PRRT, 3 months after completion of PRRT and after a further 6 - 9 months. 18F-FDG PET/CT was done within 2 months of 68Ga-DOTA-TOC PET/CT. Follow-up ranged from 11.8 to 80.0 months (mean 34.5 months).

RESULTS

All patients were 68Ga-DOTA-TOC PET-positive initially and at follow-up after the first full PRRT cycle. Overallx31 of the 99 18F-FDG PET studies (31 %) were true-positive in 19 of the 33 patients (58 %). Of the 33 patients, 14 (3 grade 1, 11 grade 2) were 18F-FDG-negative initially and during follow-up (group 1), 12 (3 grade 1, 6grade 2, 3 grade 3) were 18F-FDG-positive initially and during follow-up (group 2), 5 patients (1 grade 1, 3 grade 2, 1 grade 3) were 18F-FDG-negative initially but 18F-FDG-positive during follow-up (group 3), and 3 patients (all grade 2) were 18F-FDG-positive initially but 18F-FDG-negative during follow-up (group 4).18F-FDG PET showed more and/or larger metastases than 68Ga-DOTA-TOC PET in three patients of group 2 and two patients of group 3, all with progressive disease. In two patients with progressive disease who died during follow-up tumour SUVmax increased by 41 - 82 % from the first to the last follow-up investigation.

CONCLUSION

In known NET patients, the presence of 18F-FDG-positive tumours correlates strongly with a higher risk of progression. Initially, patients with 18F-FDG-negative NET may show 18F-FDG-positive tumours during follow-up. Also patients with grade 1 and grade 2 NET may have 18F-FDG-positive tumours. Therefore, 18F-FDG PET/CT is a complementary tool to 68Ga-DOTA-TOC PET/CT with clinical relevance for molecular investigation.

CLINICAL RELEVANCE/APPLICATION

Thus FDG PET-CT and Thus FDG PET-CT and 68Ga-DOTA-TOC PET-CT are complimentary to each other in evalaution and follow up after theraphy.

SSJ14-02 Inlaying Radiosensitizer onto the Polypeptide Shell of Drug-Loaded Ferritin for Imaging and Combinational Chemo-Radiotherapy

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S504CD

Participants
Jingwen Chen, Shanghai, China (*Presenter*) Nothing to Disclose
Qiuhong Zhang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Han Wang, MD, PhD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Ferritin with unique hollow cavity is an emerging protein-based nanoplatform for anticancer-drug delivery, but the in vivo

chemotherapeutic effectiveness is still unsatisfactory with such a monotherapy modality, which is urgently in need of improvement.

METHOD AND MATERIALS

Here a novel ferritin nanotheranostic with anticancer-drug doxorubicin encapsulated into its hollow interior and nanoradiosensitizer bismuth sulfide nanocrystals inlayed onto its polypeptide shell was synthesized for combinational therapeutic benefits. The formation mechanism of bismuth sulfide nanocrystals based on ferritin has been analyzed. The in vitro and in vivo treatment effects were carried out on HeLa cancer cells and tumor-bearing mice, respectively. The biocompatibility and excretion of the ferritin nanotheranostic have also been evaluated to guarantee their biosafety.

RESULTS

The polypeptide shell of ferritin provides nucleation sites for the bismuth sulfide nanocrystals through coordination interaction, and simultaneously inhibits the further growth of bismuth sulfide nanocrystals, rendering the bismuth sulfide nanocrystals like rivets inlaying onto the polypeptide firmly, which can not only strengthen the architectural stability of ferritin to prevent drug burst leakage during systemic circulation, but also act as excellent computed tomography contrast agents and nanoradiosensitizers for in vivo imaging-guided cancer combinational treatments.

CONCLUSION

The design concept of inlaying bismuth sulfide nanocrystals onto the polypeptide shell of doxorubicin-encapsulated ferritin significantly inhibits the tumor growth and simultaneously further broadens the application of ferritin in nanomedicine.

CLINICAL RELEVANCE/APPLICATION

The Bi2S3 nanocrystals onto the polypeptide shell can act as contrast agents for CT imaging, which can indicate the efficient tumor accumulation of Dox@AFBS through EPR effect after systemic administration, offering imaging guidance for in vivo cancer treatment.

SSJ14-04 A Fibronectin-Targeting Dual-Modal NIR-II Fluorescent and Photoacoustic Nanodots for Breast Cancer Imaging and Phototherapy

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S504CD

Participants
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Yanshu Wang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Dengbin Wang, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Metastasis is the primary cause of death in breast cancer patients. Early diagnosis of high-risk breast cancer, including metastasis, requires accurate imaging of tumor biomarker for tailoring appropriate interventional therapies. Increased fibronectin expression, a hallmark of epithelial-tomesenchymal transition, is associated with high-risk breast cancer and metastasis. A fibronectin-targeting dual-modal NIR-II fluorescent and photoacoustic nanoprobe is synthesised for breast cancer imaging and photothermal/photodynamic therapy (PTT/PDT).

METHOD AND MATERIALS

Organic NIR-II fluorescent squaraine dyes were achieved through an organic synthetic reaction. Encapsulation of the dyes in a polymer matrix yields nanodots showing a large absorptivity at 915 nm and an emission maximum near 1000 nm. Further decoration of the nanodots with a penta-peptide CREKA (Cys-Arg-Glu-Lys-Ala) yields targeted nanodots, SQ@DSPE, which binds to fibronectin that are abundant in the tumour microenvironment of fast-growing breast cancer.

RESULTS

The nanodots SQ@DSPE showed a large absorptivity at 915 nm and an emission maximum near 1000 nm. The large NIR absorptivity of the nanodots facilitates NIR-I photoacoustic imaging and NIR-II fluorescence imaging. We find that the targeted nanodots could be used as deep intravascular contrast and provides robust signal enhancement in high-risk breast cancer, including metastasis. The photothermal conversion behavior and photodynamic activity of the nanodots enables PTT/PDT of breast cancer.

CONCLUSION

We report the NIR-II fluorescent molecule for dual fluorescence and photoacoustic imaging. The formulated nanodots have been successfully used for dual NIR-II fluorescence and NIR-I photoacoustic imaging for precise noninvasive angiography. The synergetic bimodal imaging with targeting CREKA-decorated nanodots showed precise breast cancer-tumor diagnosis with good specificity and high sensitivity. Collectively, the bright nanodots hold great promise for monitoring and visualizing vascular and breast tissue abnormalities.

CLINICAL RELEVANCE/APPLICATION

This research demonstrates the promise of NIR-II molecules and nanodots in dual-modal NIR-II fluorescence and NIR-I photoacoustic imaging for early detection of high-risk breast cancer and metastasis.

SSJ14-05 Radiosynthesis and Initial Evaluation of [11C]AG-488: Novel Dual-Targeted Anti-GBM Agent

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S504CD

Participants
Patrick Carberry, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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Akiva Mintz, MD, PhD, Paramus, NJ (*Presenter*) Consultant, Regeneron Pharmaceuticals, Inc

PURPOSE

PET imaging plays a critical role in the diagnosis of disease. Our goal is to extend its use into the drug development arena by radiolabeling experimental therapeutics and studying their biodistribution in hard to reach malignancies like brain cancer. Glioblastoma (GBM) is malignant Grade IV brain cancer that is invariably fatal with a median survival of about 14 months. Chemotherapy and novel molecular strategies often fail due to the inability of drugs to pass through the BBB. Thus, PET offers a real-time tool to evaluate drug kinetics and tumor access. AG-488 (FLAG-003) is a novel ligand with established anti-angiogenetic and anti-microtubule properties in tumor cells and murine models of cancer. In preclinical models of GBM, AG-488 has been shown to reduce tumor volume and prolong survival and is in early stage clinical trials. The goal of this work is to radiolabel AG-488 with the positron emitter 11C and demonstrate BBB permeability of this novel drug.

METHOD AND MATERIALS

The radiochemical synthesis of [11C]AG-488 was optimized reacting [11C]CH3I in a GE FxMeI module. MicroPET/CT were obtained dynamically for 60 minutes following IV injection of 50-100µl of [11C]AG-488. Image analysis was performed on PMOD software.

RESULTS

[11C]AG-488 was obtained in high radiochemical purity (>98%) and specific activity (2.5+/-0.5 Ci/mmol) in 30+/-5% radiochemical yield, decay corrected to EOS. MicroPET imaging revealed distribution in the heart, lungs and liver as well as good BBB penetration, manifested by increased initial tracer uptake and significant retention in the brain over time, similar to what is seen in our previous work with microtubule-specific tracers.

CONCLUSION

[11C]AG-488 can be synthesized with a high purity and yield and significantly crosses the BBB. We anticipate using [11C]AG-488 to help expedite the development of this novel dual-target drug as well as a potential companion diagnostic. We are therefore planning on further studying [11C]AG-488 in various orthotopic GBM models.

CLINICAL RELEVANCE/APPLICATION

AG-488 is a novel dual action drug that is being tested on high grade glioma, a devestating disease. We succesfully synthesized [11C]AG-488 to demonstrate blood brain barrier penetration on PET imaging and are studying its use to diagnose and stratify GBM patients.

SSJ14-06 First-In-Human Imaging of 89Zr-Daratumumab for CD38 Targeted Imaging of Myeloma

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S504CD

Participants
Gary A. Ulaner, MD,PhD, New York, NY (*Presenter*) Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd; Research support, Novartis AG; Research support and Consultant, sanofi-aventis Group; Research support, sanofi-aventis Group
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Joe O'Donoghue, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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C Ola Landgren, New York , NY (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

CD38 is an established therapeutic target in multiple myeloma that is expressed at high density by almost all myeloma cells. Daratumumab is an FDA-approved therapeutic antibody that binds directly to CD38. Our objective was first-in-huma imaging with 89Zr-radiolabeled daratumumab for CD38-targeted imaging of myeloma.

METHOD AND MATERIALS

Ten myeloma patients received 2 mCi of intravenous 89Zr-DFO-daratumumab in 20 or 50 mg of total antibody mass. Each patient underwent 4 PET/CT scans over the next 8 days, as well as blood draws and whole-body counts, to determine tracer biodistribution, pharmacokinetics, and radiation dosimetry.

RESULTS

Phase I first-in-human 89Zr-DFO-daratumumab PET/CT imaging demonstrated distribution in the blood pool, liver and spleen. A total antibody mass of 20 or 50 mg provided successful immunoPET imaging, while 3 mg total antibody mass demonstrated excessive background accumulation of tracer in the bone marrow, liver, and spleen. Imaging on days 5-8 provided superior tumor-to-background ratios than on days 1-4. Focal 89Zr-DFO-daratumumab uptake was visualized in previously known as well as unknown sites of osseous myeloma, consistent with successful CD38-targeted immunoPET imaging of myeloma in human patients.

CONCLUSION

89Zr-DFO-daratumumab provides successful whole-body PET visualization of myeloma in a first-in-human phase I trial of myeloma patients.

CLINICAL RELEVANCE/APPLICATION

This novel PET antibody will be tested for its potential to provide sensitive detection of myeloma, determine minimal residual disease

This novel PET antibody will be tested for its potential to provide sensitive detection of myeloma, determine minimal residual disease (MRD) status after completion of therapy, predict the effectiveness of daratumumab therapy, and serve as the basis of theranostic constructs for patients with myeloma.

Printed on: 10/29/20

SSJ15

Musculoskeletal (Muscle, Tendon, and Nerve)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E353C

MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Theodore T. Miller, MD, New York, NY (*Moderator*) Nothing to Disclose
Antonio Barile, MD, L'Aquila, Italy (*Moderator*) Nothing to Disclose

Sub-Events

SSJ15-01 Quantitative Muscle Microstructural Changes Detected with Diffusion Tensor Imaging following Acute Hamstring Strain Injuries

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E353C

Participants
Christa Wille, Madison, WI (*Presenter*) Nothing to Disclose
Samuel A. Hurley, PhD , Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Nagesh Adluru, PhD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Rebecca Alcock, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Bryan C. Heiderscheit, PhD, Madison, WI (*Abstract Co-Author*) Research Consultant, Altec, Inc;
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PURPOSE

The purpose of this investigation was to quantify changes in muscle microstructure following acute hamstring strain injury (HSI).

METHOD AND MATERIALS

Collegiate athletes with an HSI (n=16) underwent a magnetic resonance image (MRI) exam of the bilateral thighs using a GE MR750 3.0T scanner and 32-channel torso coil at a mean of 4 (± 2.5) days following injury. MRI exam included coronal and axial fat-suppressed T2-weighted fat/water IDEAL scan (44 cm FOV, 256x256, 44 slices, 4 mm thk, 5 mm gap; TR/TE 7418/86.8 ms) to identify regions of edema and axial DTI sequences. Diffusion weighted images were acquired with b=500 s/mm2, 30 directions, 6 b=0 volumes (48 cm FOV, 160x160, 72 slices, 3 mm thk; TR/TE 5770/51.1 ms), and repeated with reversed phase-encode direction. Distortion, eddy current, and motion correction were performed using FSL TOPUP and EDDY (FMRIB Software Library). Axial parameter maps of fractional anisotropy (FA), mean diffusivity (MD), radial diffusivity (RD), and principal effective diffusivity eigenvalues (λ1, λ2, λ3) were created. Deterministic streamline tractography was performed using Euler integration with a step size of 0.1 mm (stopping criteria: 45° curvature and 0.20 FA thresholds). Mean DTI-parameters were identified for regions of injury within contractile muscle tissue using manual segmentation and compared to identical regions on the uninvolved limb with a Mann-Whitney-U test.

RESULTS

DTI-parameters demonstrate a significant decrease in FA ($p=0.046$) and significant increase in MD ($p=0.025$), RD ($p<0.01$), λ2 ($p=0.021$), and λ3 ($p<0.01$) in the region of injury compared to the mirrored region of normal muscle. Tractography from a selected subject demonstrates the effects of reduced FA on the involved limb (right) with fewer continuous fiber tracts present within the region of injury (purple) compared to the mirrored region of normal muscle on the uninvolved limb.

CONCLUSION

Significant muscle microstructural changes are detectable using DTI in athletes following an HSI. Decreased FA and increased diffusivity in regions of injured muscle indicate less restricted water diffusion, likely due to disruption of muscle fibers following injury.

CLINICAL RELEVANCE/APPLICATION

DTI-parameters can quantify microstructural changes in injured muscle and may have potential in guiding effective treatment following HSI.

SSJ15-02 Comparison of Quantitative MRI Parameters and Shear Wave Ultrasound Parameters of the Patellar Tendon in Subjects with Patellar Tendinopathy

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E353C

Participants
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PURPOSE

To compare quantitative MRI parameters and shear wave ultrasound parameters of the patellar tendon in subjects with patellar tendinopathy.

METHOD AND MATERIALS

The study group consisted of 15 subjects with clinically diagnosed patellar tendinopathy of a single knee with no current or past symptoms of patellar tendinopathy of the contralateral knee. Shear wave ultrasound of the proximal patellar tendon of both knees was performed. The difference in shear wave speed between the asymptomatic and symptomatic knee (DIFSWS) was used as a proxy for loss of mechanical stiffness of the symptomatic patellar tendon due to tendon degeneration. An ultra-short echo-time (UTE) T2* mapping sequence using 16 echoes between 0.03ms and 35ms was performed on the symptomatic knee on a 3T scanner (GE Healthcare, Waukasha, WI). Single-component T2* relaxation time (T2*Single) and multi-component T2* parameters including the fraction of the fast relaxing macromolecular bound water component (FF) and the T2* relaxation time of the fast relaxing macromolecular bound water component (T2*F) and the slow relaxing bulk water component (T2*S) were measured in the proximal patellar tendon. Pain and disabiility in the symptomatic knee was assessed using the Tegner-Lysholm questionnaire. Pearson correlation coefficients were used to detemine the association between quantitative MRI parameters and DIFSWS and Tegner-Lysholm score.

RESULTS

There was a significant positive moderate association between T2*Single and DIFSWS (rho=0.668 and p<0.01). There was a significant positive moderate association between T2*F and DIFSWS (rho=0.608 and p=0.01) and between T2*F and Tegner-Lysholm score (rho=0.525 and p=0.04) (Figure 1). There was no significant association between FF and T2*S and DIFSWS (rho=0.039-0.043 and p=0.89-0.91) and between T2*Single, FF, and T2*s and Tegner-Lysholm score (rho=0.061-0.447 and p=0.09-0.83).

CONCLUSION

Increases in T2*Single and T2*F of the proximal patellar tendon in subjects with patellar tendinopathy were associated with loss of tendon stiffness with increases in T2*F also associated with increased pain and disability.

CLINICAL RELEVANCE/APPLICATION

Increased T2* relaxation time of fast relaxing macromolecular bound water of the patellar tendon measured using quantitative MRI in subjects with patellar tendinopathy is associated with loss of tendon stiffness measured using shear wave ultrasound and increased pain and disability.

SSJ15-03 Spontaneous Anterior Interosseous Nerve Syndrome (AINS) is a Fascicular Disease of the Median Nerve

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E353C

Participants
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PURPOSE

To test the hypotheses that (1) hourglass constrictions (HGCs) are present within the anterior interosseous nerve (AIN) fascicular group of the median nerve near the humeral medial epicondyle (ME) and (2) there is no extrinsic compression of the AIN or median nerve within the arm or forearm.

METHOD AND MATERIALS

At 2 different sites, a radiologist and neurologist (each with 5-6 years of dedicated peripheral nerve imaging experience) analyzed MRI (n=22) and ultrasound (US, n=23) neurography exams, respectively, to evaluate the median nerve and AIN within the arm and forearm in patients with electrodiagnostically and/or clinically confirmed AINS. MRIs were acquired either at 3 T (n=18) or 1.5 T (n=4) with a 16-channel flexible receive-only coil using multiplanar T2-weighted fat suppression and proton density pulse sequences, including at least 1 axial plane orthogonal to the median nerve. US was performed by the interpreting neurologist with an 18-5 MHz transducer; the median nerve was scanned in cross-section from the wrist to axilla and in areas of abnormality, longitudinal scans were additionally obtained.

RESULTS

Fascicular HGCs of the median nerve proper were identified in all MRI cases, and constrictions and/or swelling were identified in 87% of US cases. On MRI, HGCs were located a mean of 2.4 cm proximal to the ME, at posterior/posteromedial (68%, mean 1.7 cm, expected location of the AIN fascicle), anterior/anteromedial (19%, mean 5.3 cm, expected location of pronator teres/flexor carpi radialis fascicle), posterolateral (5%, mean 1.0 cm), and anterolateral (8%, mean 3.4 cm) locations. On US, HGCs were located a mean of 4.5 cm proximal to the ME, at posterior/posteromedial (55%, mean 4.3 cm), medial (36%, mean 5.0 cm), and posterolateral

(9%, mean 4.0 cm) locations. No extrinsic compressive site or mass of the median nerve or AIN within the arm/forearm was identified.

CONCLUSION

HGCs of the AIN fascicular group of the median nerve are the hallmark imaging finding in AINS, demonstrating the same phenotype seen in other affected nerves in PTS. There is no imaging evidence of extrinsic compression of the median nerve or AIN in AINS.

CLINICAL RELEVANCE/APPLICATION

This study defines an anatomic range where fascicular HGCs of the median nerve are found in patients with anterior interosseous nerve syndrome, which will aid in its diagnosis and potential treatment.

SSJ15-04 High Resolution Ultrasound Evaluation of Peripheral Nerves in Patients with Diabetic Polyneuropathy

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E353C

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PURPOSE

To determine the role of high resolution ultrasound(HRUS) for screening of Diabetic polyneuropathy(DPN) by evaluation of nerve cross sectional area(CSA)

METHOD AND MATERIALS

In this IRB approved case-control study, thirty DPN cases and thirty matched healthy controls were taken. The diagnosis of DPN was based on at least one symptom/sign of neuropathy in type II diabetes patient and one abnormal nerve conduction study (NCS) parameter measured in two separate nerves. DPN severity was determined by the Toronto Clinical Neuropathy Score (TCNS). Using an 8-18 MHz ultrasound (US) transducer peripheral nerve CSAs were measured bilaterally in both the cases and controls. Four nerves were included in the study and their CSAs were recorded at specific sites; median nerve(MN) at three sites- carpal tunnel inlet(CrTI), 5cm proximal to wrist and at antecubital fossa(ACF), ulnar nerve (UN) at three sites-wrist, cubital tunnel inlet and cubital tunnel outlet (CbTO), tibial nerve (TN) at medial malleolus and sural nerve(SN) at midcalf. Statistical tests were applied to compare the nerve CSAs between cases and control groups. CSA was also compared in relation to TCNS and NCS parameters (conduction velocity, latency and amplitude).

RESULTS

The mean CSAs of MN at CrTI, UN at wrist and CbTO, TN and SN were significantly larger in DPN cases. CSAs ROC cut-offs for MN at CTI, TN and SN showed good accuracy (AUC> 0.80, sensitivity 83-96%, specificity 70-83%), and for UN at wrist and CTO was even higher (AUC>0.96, sensitivity 86-96%, specificity 90-96%). Significant correlation was obtained between nerve conduction velocities and CSAs of MN at forearm, MN at ACF and UN at wrist, with r values of -0.38, -0.37 and -0.36 respectively ($p<0.05$). Significant correlations were found between nerve amplitude and CSA of MN at CrTI ($r=-0.42$) and between TCNS and CSA of SN ($r=.52$), $p<0.05$ for both.

CONCLUSION

The nerve size in patients with DPN is significantly larger as compared to normal controls with ulnar nerve CSA showing the highest diagnostic accuracy. Significant correlation between nerve thickness and NCS parameters facilitates HRUS as an efficient screening tool for DPN.

CLINICAL RELEVANCE/APPLICATION

DPN is very common and HRUS may serve as a non-invasive and low- cost screening tool especially in patients with severe DPN where NCS is not helpful as the nerves may be unexcitable.

SSJ15-05 Tissue Characterization Using Quantitative Acoustic Radiation Force Impulse Elastography (ARFI) in Athletes with Different Experience in Self-Myofascial Release

Tuesday, Dec. 3 3:40PM - 3:50PM Room: E353C

Participants
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PURPOSE

Self-myofascial release using foam rolling (FR) has been developed into a popular preventive and recovery intervention and has been established in various sports disciplines. However, its effects on target tissue with regard to changes in stiffness properties are still poorly understood. The aim of this study was to investigate the role of foam rolling on muscle and ligament stiffness.

METHOD AND MATERIALS

Acoustic radiation force impulse elastography (ARFI) was performed in 40 volunteers (20 with more than 6 months of experience in

foam rolling and 20 without any experience) before and several times (0 min, 30 min, 60 min, 120 min, 12 h and 24 h) after a standardized foam rolling exercise of the lateral thigh. The exercise protocol included 5 sets, each with 45 seconds foam rolling on the lateral thigh (20 seconds of rest between each set). Tissue stiffness was assessed at different compartments of the lateral thigh including superficial and deep muscle tissue (vastus lateralis muscle, VL; vastus intermedius, VI) and connective tissue (distal insertion of the iliotibial band, ITB).

RESULTS

Tissue stiffness of the ITB revealed a significant decrease in experienced athletes directly after the intervention (p=0.02) and 30 min post-intervention (p=0.02). No significant changes at the ITB were observed in non-experienced athletes. For VL and VI no significant changes were detected at any time point in both groups.

CONCLUSION

A significant short-term decrease of connective tissue stiffness in experienced athletes is detectable with ARFI, which may have an impact on biomechanical output of the fascia. Recommendations for self-myofascial release with foam rolling therapy have to be taken in consideration of athletes' experience and whether decreased tissue stiffness is required.

CLINICAL RELEVANCE/APPLICATION

ARFI seems to be an applicable tool for systematic assessment of tissue stiffness of different physical therapy approaches, e.g. tissue stiffness of the ITB in patients with ITB-syndrome.

SSJ15-06 Permanent and Non-Permanent Changes of Skeletal Muscle Diffusion Properties in Triathletes and Non-Athletes Detected by Diffusion Tensor Imaging and T2 Mapping

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E353C

Participants
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PURPOSE

Diffusion tensor imaging (DTI) of the skeletal muscle gives quantitative information in various conditions such as aging, exercise injury, and training. The aim of this study was to quantify changes in the skeletal muscle microstructure caused by i) Daily endurance training of triathletes (timepoint 1) in comparison to gender-matched healthy controls. ii) Active exercise due to participation at a triathlon (timepoint 2) in a cross-over intrasubject comparison to quantitates of timepoint 1 (i).

METHOD AND MATERIALS

In total N=22 triathletes (male:female 16:6; age (SD) 43.2 (11.5) years) and N=23 controls (male:female 16:7; age (SD) 38.2 (14.4) years) were sampled. Out of these 22 triathletes, N=12 (m:f 8:4) participated in a post-triathlon MRI examination, which was performed within three hours after the race. The MRI scan was performed at 3 Tesla using a fat-suppressed single-shot SE-EPI sequence. The DTI-parameters mean diffusivity (MD), fractional anisotropy (FA), and eigenvalues (λ1-3), as well as T2 times, were calculated using Osirix (v9.5 DTImap plugin; v1.6 and T2 fit map). The muscle fat fraction (MFF) was calculated using axial 3D GRE modified two-point Dixon-based MRI (2pt-MRIDIXON). Regions-of-interests (ROIs) were chosen at midthigh level for rectus femoris (RF), biceps femoris (BF), adductor magnus (AM), semitendinosus (ST), and semimembranosus muscle (SM), avoiding areas of a suspected muscle strain on T2 images.

RESULTS

At timepoint 1 the T2 relaxation times of male triathletes were significantly increased in RF, BF, ST, and SM muscles and the MD and the eigenvalue λ2 and λ3 were significantly decreased in RF muscles compared to controls. At timepoint 2 the MD and one or two of the eigenvalues λ1 and λ3 were significantly increased in AM, BF, ST, and SM muscles of male triathletes compared to the baseline measurements at timepoint 1, the T2 times remained unchanged. Similar trends at both timepoints were observed in female triathletes, however without statistical significance.

CONCLUSION

The combined assessment of quantitative T2 and DTI parameters provides insight into changes of the muscle microstructure caused by endurance training and active exercise.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates that endurance-training and active exercise triggered, gender-specific effects in the skeletal muscle microstructure can be quantified by quantiative multiparametric MRI.

SSJ16

Musculoskeletal (Knee)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E353A

MR MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSJ16-01 Comparing Clinical and Semi-Quantitative Cartilage Grading in Predicting Outcomes After Arthroscopic Partial Meniscectomy

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E353A

Participants
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PURPOSE

Cartilage loss on preoperative knee MRI is a predictor of poor outcomes after arthroscopic partial meniscectomy (APM). Previous studies have used time-intensive MRI grading systems which are not amenable for routine clinical use. The ability to predict outcomes with a clinically used grading system has not been studied. This study's purpose was to compare the ability to predict outcomes after APM with cartilage loss graded using a clinically used modified Outerbridge system and a semi-quantitative MOAKS (MRI Osteoarthritis Knee Score) system.

METHOD AND MATERIALS

Cases were randomly selected meeting the following criteria: 1. Preoperative knee MRI performed within 6 months of APM surgery 2. Outcomes measured at the time of surgery and 1 year after surgery. Surgical failure was defined as a less than 10 point improvement in the Knee Osteoarthritis Pain Score (KOOSpain). Cases were independently evaluated by 2 musculoskeletal (MSK) radiologists and 1 radiology fellow using both grading systems. Accuracy of each system in discriminating success and failure was estimated using area under the ROC (AUC) with 95% confidence intervals. A Wald test was used to test non-inferiority of the clinical grading system to MOAKs. Inter-reader agreement of two grading systems in predicting outcomes was also compared.

RESULTS

80 cases from 78 patients (38 females and 40 males) with mean age of 56.6 years (range of 45-77) were studied. 21 patients (27%) were surgical failures. At least Grade 2 (< 50% cartilage thickness loss) ranged from 23.3% (lateral tibial plateau) to 52.5% (medial femoral condyle) of the observations. Prediction model using clinical grading (AUC = 0.695 [0.566, 0.824]) was non-inferior ($p = 0.047$) to MOAKS grading (AUC = 0.683 [0.539, 0.812]). Both MRI prediction models performed better than a model with only demographics (AUC = 0.667 [0.522, 0.812]. Inter-reader agreement with clinical grading (80.8%) was significantly higher ($P = 0.012$) than with MOAKS (65%).

CONCLUSION

Cartilage loss graded on MRI with a clinically used system has similar ability in predicting outcomes after APM compared to a semi-quantitative system with significantly better inter-reader agreement.

CLINICAL RELEVANCE/APPLICATION

The ability to use a clinical MRI cartilage grading system to predict outcomes after APM allows for the development of point of care prediction tools from routine MRI readings.

SSJ16-02 Deep Convolutional Neural Network-Based Detection of Meniscus Tears: Comparison with Radiologists and Surgery as Standard of Reference

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E353A

Participants
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PURPOSE

To evaluate a novel fully automated deep convolutional neural network (DCNN) for detection of meniscus tears.

METHOD AND MATERIALS

This retrospective study was approved by the local ethics committee. We included 100 patients, who had undergone MRI and arthroscopy of the knee in our institution. All MRI studies were evaluated for medial and lateral meniscus tears by two musculoskeletal radiologists independently and by the DCNN. The surgical reports served as the standard of reference. Statistics included sensitivity, specificity, accuracy and ROC curve analysis as well as kappa-statistics.

RESULTS

Fifty-seven percent (57/100) of patients had a tear of the medial and 24% (24/100) of the lateral meniscus, including 12% (12/100) of patients with a tear of both menisci. For medial meniscus tear detection, the sensitivity, specificity and accuracy were for reader 1: 93%, 91%, and 92%, for reader 2: 96%, 86% and 92%, and for the DCNN: 84%, 88% and 86%. For lateral meniscus tear detection, the sensitivity, specificity, and accuracy were for reader 1: 71%, 95% and 89%, for reader: 2 67%, 99% and 91%, and for the DCNN: 58%, 92% and 84%. Sensitivity for medial meniscus tear detection was significantly different between reader 2 and the DCNN ($p=0.039$), no significant differences existed for all other comparisons (all $p >= 0.092$). The AUC-ROC of the DCNN was 0.882, 0.781 and 0.961 for detection of medial, lateral and overall meniscus tear. Inter-reader reliability was very good for the medial (kappa 0.876) and good for the lateral meniscus (kappa 0.741).

CONCLUSION

Our DCNN has the capability to detect tears of the medial and lateral meniscus in a fully automated fashion and with similar performances than radiologists.

CLINICAL RELEVANCE/APPLICATION

Fully automated detection of meniscus tears may decrease workload for radiologists and reduce health care costs.

SSJ16-03 ACL Graft Remodeling Revealed by Serial UTE-T2* MRI

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E353A

Participants
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PURPOSE

Evaluate changes over time in UTE T2* MRI relaxation times of implanted ACL grafts during graft healing/remodeling over the first year after ACL reconstruction.

METHOD AND MATERIALS

10 patients (ages 14-45 years) who underwent primary ACL reconstruction (ACLR) with or without meniscal injury. UTE-MRI evaluation at 1, 3, 6, 9, and 12 months after surgery. High-resolution 3D T2 scan (slice thickness: 0.6mm, TR: 18.7ms; TE: 11.5ms); Quad-echo UTE-T2 sequence (slice thickness: 1mm, TR: 20ms; TE: 0.3, 3, 6, and 9ms). The ACL-reconstructed knee was scanned at all 5 time points (1, 3, 6, 9, and 12 months), and the contralateral knee was imaged at 1 month. The region of interest (ROIs) for the ACL-reconstructed knee include the central 2/3 of the intra-articular portion of the ACL graft The region of interest for the contralateral uninjured knee included the ACL, patellar tendon (PT), and semitendinosus tendon (SemiT). At the 1-month time point for both injured and uninjured knees, each ROI was manually segmented from the surrounding tissues on the 3D T2 images using Mimics software (Materialise, Inc.; Belgium) (Figure 1). The 1-month segmentation masks were co-registered with the 4-echo UTE images obtained at each subsequent time point to ensure voxel-to-voxel anatomic matching of each segmentation mask. T2* relaxation times were calculated by fitting an exponential curve to the signal intensity data from the 4-echo UTE sequences. Mean T2* values for each ROI were calculated from all voxels within each ROI. Custom software was created using Python to extract average UTE-T2* values underlying each segmented ROI.

RESULTS

Mean T2* relaxation times for the ACL graft (Figure 2) increased over time, from 3.5 ms at 1 month to 5.4 ms at 6 months, with a statistically significant increase between 1 and 3 months ($p < 0.05$). Qualitatively, T2* relaxation times increased from near the values of the native SemiT tendon (2.2 ms) to approach that of the intact (contralateral) ACL (4.9 ms). Serial changes in T2* were not uniform throughout the graft substance (Figure 3). Remodeling appears to have begun near the tibial insertion site and

progressed proximally towards the femoral insertion.

CONCLUSION

T2* values progressively increased over time, followed by regression towards the values of the intact native ACL.

CLINICAL RELEVANCE/APPLICATION

Early results show promise of UTE-T2 MRI for assessing ACL graft state.

SSJ16-04 Collagen Proton Fraction Estimated with Ultrashort Echo Time Magnetization Transfer (UTE-MT) MRI Modeling Correlates Well with Mechanical Properties of Cortical Bone

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E353A

Participants
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PURPOSE

To investigate the relationship between human cortical bone mechanics and the macromolecular proton fraction (MMF) obtained from ultrashort echo time magnetization transfer (UTE-MT) MRI modeling.

METHOD AND MATERIALS

156 cortical bone strips (~4×2×40 mm3) were harvested from the tibial and femoral midshafts of 43 donors (62±22 yo). Specimens were scanned using a 1-inch diameter T/R birdcage coil on a 3T clinical scanner (MR750, GE). The UTE-MRI scans involved: a) an actual flip angle imaging variable TR (AFI-VTR) sequence (AFI: TE=0.032; TRs=20, 100 ms; VTR: TE=0.032; TRs=20, 40, 100, and 150 ms; FA=45°) for T1 measurement (1), which is the prerequisite for the two-pool MT modeling, and b) a set of 3D-UTE-Cones-MT sequences (pulse power=400°, 600°, and 800°; frequency offset=2, 5, 10, 20, and 50kHz; FA=10°) for MT modeling (2-4). Other imaging parameters included: field of view=40×40mm2, matrix=160×160, slice-thickness=2mm. Afterwards, specimens were scanned using a Skyscan 1076 (Kontich, Belgium) µCT at 9 µm3 voxel size to measure bone porosity and bone mineral density (BMD). Finally, mechanical properties of the specimens were measured using 4-point bending tests. Pearson's correlation coefficients were calculated between MRI and µCT and mechanical properties.

RESULTS

Fig.1a shows the UTE-MRI image in axial plane at the middle of 20 bone strips with 4mm×2mm approximate cross-sections. Two representative specimens harvested from a 47-year-old male (I) and a 57-year-old female (II), respectively, are indicated with yellow rectangles. Fig.1b shows the corresponding µCT images. Figs.1c,d show corresponding MT modeling analyses. Figs. 1e-h show the scatterplots of Young's modulus, yield stress, ultimate stress, and failure energy on MMF, respectively. Young's modulus, yield stress, and ultimate stress demonstrated significant moderate correlations with MMF (R=0.60-0.61, $p<0.01$). MMF showed significant strong correlations with porosity (R=0.72) and BMD (R=0.71).

CONCLUSION

Significant correlations between bone MMF, mechanical properties, and microstructure suggest that the UTE-MT model can potentially serve as a novel tool to detect the variations of bone mechanics and microstructure.

CLINICAL RELEVANCE/APPLICATION

A UTE-MRI-based technique that correlates with bone mechanics and miscrostructure may be useful in future clinical studies for fracture risk estimation.

SSJ16-05 Reliability of a Novel Scoring System for Intraarticular Calcification of the Knee: BUCKS (Boston University Calcium Knee Score)

Tuesday, Dec. 3 3:40PM - 3:50PM Room: E353A

Participants
Mohamed Jarraya, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
Tuhina Neogi, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Describe and assess the reliability of a novel computed tomography (CT)-based scoring system, the BUCKS (Boston University Calcium Knee Score) method, for assessing the burden and determining the localization of intra-articular mineralization.

METHOD AND MATERIALS

We included both knees from subjects of the most recent visit of the Multicenter Osteoarthritis Study (MOST), an NIH-funded longitudinal cohort of community-dwelling older adults with or at risk of knee osteoarthritis (OA). All subjects underwent CT scans of bilateral knees. For each knee, a musculoskeletal radiologist assessed the presence and severity of mineralization in cartilage, menisci, capsule and ligaments. Readings of a sample of 31 participants by the same reader and a second reader were repeated 12 later. The BUCKS method assesses 14 cartilaginous subregions and 6 meniscal segments (each meniscus was subdivided into 3 segments: anterior horn, body and posterior horn), similar to WORMS system. Cartilaginous subregions and meniscal segments were assigned a score ranging from 0-3 (figure). The joint capsule, bilateral posterior meniscal roots, 2 cruciate (ACL/PCL) and 2 collateral ligaments (MCL/LCL) were each scored 0 or 1 for absence or presence of mineralization. Vascular calcifications were scored 0-3.

RESULTS

Thirty one subjects (61 knees) were included. Mean age was 72.3 years (SD= 6.7, range=63-86). Mean BMI was 31.0 kg/m2 (SD 5.2). Sixty one percent (n=19) were female. Intra-articular calcium crystals were present on CT images of 50 knees, with 38 having articular cartilage calcifications and 35 having meniscal calcifications. Of the 61 knees, tibio-femoral Kellgren and Lawrence Grades were K&L=0 in 18 knees, K&L=1 in 13 knees, K&L=2 in 14 knees, K&L=3 in 12 knees and K&L=4 in 3 knees. The intra-reader reliability (weighted-kappa) ranged from 0.93 for ligaments to 0.94 for cartilage, 0.97 for vessels, 0.98 for meniscus, and 1.0 for joint capsule. The inter-reader reliability (weighted-kappa) ranged from 0.92 for cartilage to 0.95 for meniscus and vessels, and 1.0 for joint capsule and ligaments.

CONCLUSION

We have designed and described a novel scoring system for intraarticular mineralization of the knee, BUCKS, which shows excellent intra- and inter-reader reliability.

CLINICAL RELEVANCE/APPLICATION

BUCKS is a potentially useful tool for the understanding of the role of calcium crystals in knee OA.

SSJ16-06 Efficacy of Knee Unloader Bracing Evaluated with Quantitative MRI

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E353A

Participants
Won C. Bae, PhD, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Unloader knee braces aim to shift the weight off the damaged compartment of the knee, and may offer pain reduction and delay time to surgery. Despite perceived benefits, the efficacy of bracing to reduce pain and preserve integrity of joint tissues, is under debate. The purpose of this study was to investigate if quantitative magnetic resonance imaging (qMRI) measures of bone marrow edema (BME; a pain correlate), cartilage, and meniscus are preserved after 9 months of unloader brace use in patients with osteoarthritis (OA).

METHOD AND MATERIALS

Patients with medial knee OA (n=4; 4 male; 50+/-13.4 yrs, mean+/-standard deviation) were imaged at 3T, before and 9 months after brace use. To evaluate BME, proton density fat suppressed images were processed to quantify the volume of high signal intensity within subchondral bone (Figure AB). To evaluate cartilage and meniscus, spin echo T2 map was acquired in sagittal plane, in the weight-bearing regions of lateral and medial tibiofemoral compartments. T2 values in tibial/femoral cartilage, and anterior/posterior meniscus, were determined (Figure C). Using repeated measures ANOVA, effects of brace use and knee compartment on BME and T2 values were assessed.

RESULTS

Initially, BME was found in 2 medial femoral condyles and all 4 medial tibial plateaus, with a mean volume of 1027+/-1103 mm3. After bracing, BME volume decreased by 82+9 % ($p = 0.081$). Changes in cartilage and meniscus T2 values are shown in Figure D. Femoral and tibial pooled cartilage T2 values (32.8+8 ms before, 32.6+5 ms after bracing) did not vary significantly with compartment ($p=0.14$) or bracing ($p=0.9$). Meniscus T2 values were initially higher ($p=0.01$) in the medial (17.4+5.4 ms) than lateral (12.8+3.5 ms) compartment but did not change after bracing ($p=0.24$).

CONCLUSION

In all patients, there was a decrease in BME volume without any new lesion development after 9 months of brace use. Despite small number of subjects, this data is promising, considering that without intervention, BME size may either decrease or increase.

CLINICAL RELEVANCE/APPLICATION

Combined with stable cartilage and meniscus T2 values, these results demonstrate the feasibility of using unloader brace to manage knee OA.

Printed on: 10/29/20

SSJ17

Nuclear Medicine (CNS Nuclear Medicine and PET)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S505AB

NM NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ17-01 Image-Based Deep-Learning Prediction of Amyloid Deposition Patterns Using Early Phase Imaging of Amyloid PET

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S505AB

Participants
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PURPOSE

This study is to develop an image-based deep-learning technique that generates predicted delay uptake patterns of amyloid PET using only early-phase images obtained after radiotracer injection.

METHOD AND MATERIALS

Deep-learning architecture was developed in a seven layer U-net convolutional neural network, units normalized by batch normalization, and activated by a rectified liner unit. [11C]PiB PET image sets were obtained from 259 subjects (age 67.3±8.0 yrs, 151 female) who underwent imaging at early (0-20 min) and delayed (50-70 min) time points. Additionally, an independent data set (20 subjects, age 67.4±8.7 yrs, 10 female) was used for testing the accuracy of future image prediction. The subjects included normal subjects, as well as Alzheimer's, Lewy body, and fronto-temporal dementias and mild cognitive impairment patients. Both volumetric PET images and NEUROSTAT/3D-SSP images were used for the analysis. By learning the relationship between the image at the early time point and the image at the delayed time point, the system performed the interpolation considering the relation and generated delayed images. In order to compensate for the small amount of data, a generative adversarial network (GAN) was used for learning.

RESULTS

The proposed technique achieved a root mean square percentage error (RMSPE) of 6.3%, peak signal-to-noise ratio (PSNR) of 21.8 dB, structural similarity index (SSIM) of 0.45 using NEUROSTAT/3D-SSP images to predict the delayed image based on the early image. These results shows that the predicted images are very similar to the real images.

CONCLUSION

This study has demonstrated the feasibility of an image-based deep-learning technique to predict delayed patterns of [11C]PiB PET uptake based on the early uptake. Such image-based prediction has not been well established in the past.

CLINICAL RELEVANCE/APPLICATION

This technique can predict delayed images from early images measured in a short time; hence it would contribute to saving measurement time and will benefit the patients, technicians and facilities.

SSJ17-02 Concordance between 18F-PI-2620 tau PET/MRI Imaging and Clinical Outcomes in Alzheimer Disease and Other Tauopathies

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S505AB

Awards
Trainee Research Prize - Resident

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PURPOSE

Primary pathology of Alzheimer disease (AD) includes both ß-amyloid and neurofibrillary tangles (NFT) of misfolded tau. Diagnosing tau pathology in vivo, and correlating pathology burden with clinical status, is crucial in diagnosing disease and in development of anti-tau therapy. The goal of this study was to 1) create a clinical protocol for evaluating a novel Tau PET ligand 18F-PI-2620 and 2) evaluate the concordance rate between radiologists and in comparison to clinical status.

METHOD AND MATERIALS

Per Braak staging, NFTs start in the entorhinal cortex in early stages (Braak 1-2), progress to the hippocampus (Braak 3-4) and lastly impact neocortex (Braak 5-6). Criteria for tau positivity was based on modified Braak staging, where Braak stages 1 & 2, 3 & 4, and 5 & 6 were collapsed into stage A, B, and C, respectively. Patients with no uptake were staged as 0. Tau positivity was determined based on visual uptake greater than off target regions. Two physicians were blinded to patient status, and independently evaluated the fused PET/MRI for 16 healthy older controls and 12 patients with mild cognitive impairment or dementia.

RESULTS

19, 2, 1, and 6 participants were classified as 0, A, B, and C, respectively. Using this staging, there was 89.2% agreement rate between readers (Cohen's kappa coefficient of 0.78, standard error=0.12). The greatest disagreement was for intermediate levels corresponding to Braak 3-4. Off target uptake included the substantia nigra, venous sinuses, the nasal sinuses, and choroid plexuses.

CONCLUSION

Overall, tau imaging with PI2620 is promising clinically, using modified Braak staging. Longitudinal imaging and confirmation with histopathology is needed to fully validate this tracer and understand whether Tau PET will be useful to track disease progression.

CLINICAL RELEVANCE/APPLICATION

As anti-tau therapy is developed for Alzheimer's and other tauopathies, 18F-PI-2620 PET/MRI seems a promising candidate for quantifying disease burden in vivo.

SSJ17-03 Hybrid PET-MR Imaging in Neurodegenerative Disorders: Are Age-Matched Controls Needed to Evaluate FDG Hypometabolism Patterns?

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S505AB

Participants
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PURPOSE

Neurodegenerative disorders demonstrate lobar patterns of parenchymal volume loss with associated decreased glucose metabolism. Limited data exists comparing semi-quantitative metabolic fluorodeoxyglucose (FDG) uptake on PET/MR imaging in patients with suspected dementia using an age-matched or non-age matched control brain atlas. This retrospective study compares semi-quantitative Z-scores provided by MIM Software in PET/MRI imaging of suspected dementia patients utilizing an age-matched versus non-age matched brain atlas.

METHOD AND MATERIALS

70 patients (37 female, 33 male, mean age 70) with suspected neurodegenerative disorder underwent hybrid FDG PET/MRI brain imaging. Patients were categorized by dementia subtype into Alzheimer's disease (AD), Frontotemporal dementia (FTD), and Lewy

Body Dementia (LBD). A Z score subset was obtained both in comparison with age-matched controls (minimum of 5 controls +/- 5 years of age) and a non-age matched control brain atlas which included a total of 43 individuals (19 female, 24 male; mean age 63.8 +/- 10 years). A two-tailed paired T-test was performed to compare the corresponding average Z scores.

RESULTS

26 patients with suspected AD (mean age 70) had mean parietal lobe Z-score values of -1.82 and -1.68, when compared to age-matched (AMC) and non-age matched controls (NAMC), respectively (p = 0.82); temporal lobe Z scores when compared to AMC and NAMC were -1.15 and -1.35, respectively (p = 0.69). 31 patients with suspected FTD (mean age 72) had mean Z-score values in the frontal lobes of -1.09 and -1.21 when compared to AMC and NAMC, respectively (p = .78); temporal lobe Z scores were -0.55 and -0.74 when compared to AMC and NAMC (p = 0.55). 13 patients with suspected LBD (mean age 66) had mean occipital, parietal, and temporal lobe Z scores of -2.61, -1.85, and -0.77 for AMC and -2.46, -1.98, and -0.943 for NAMC, respectively [p-values for AMC versus NAMC in the occipital, parietal, and temporal lobe were 0.54, 0.92, and 0.67 respectively].

CONCLUSION

Our semi-quantitative PET/MRI approach to recognize lobar patterns of brain hypometabolism in patients with neurodegenerative disorders demonstrates no significant difference when comparing patients to AMC or NAMC.

CLINICAL RELEVANCE/APPLICATION

Without the need for age-matched controls, a semi-quantitative approach to dementia can be more easily applied in the routine assessment of patients with underlying neurodegenerative disease.

SSJ17-04 18F-FDG PET/CT in Immunocompetent Patients with Primary Central Nervous System Lymphoma: Differentiation from Glioblastoma and Correlation with DWI

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S505AB

Participants
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Geng Daoying, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

18F-fluorodeoxyglucose (FDG) positron emission tomography (PET)/computed tomography (CT) is useful for the detection of cancerous lesions, and FDG uptake is related to the apparent diffusion coefficient (ADC) derived from diffusion-weighted imaging (DWI) of extracranial tumors. The purpose of our study was to investigate the ability of FDG PET/CT in distinguishing primary central nervous system lymphoma (PCNSL) from glioblastoma multiforme (GBM) and to explore the relationship between 18F-FDG uptake and the ADC in patients with PCNSL.

METHOD AND MATERIALS

We reviewed 92 patients (40 with PCNSL and 52 with GBM) who underwent FDG PET/CT scans at disease onset. The maximum standardized uptake value (SUVmax), tumor to normal contralateral cortex activity (T/N) ratio, SUVmean, metabolic tumor volume (MTV), and total lesion glycolysis (TLG) of tumor lesions were calculated. Receiver operating characteristic (ROC) curves were generated to determine the diagnostic performance for FDG PET-related parameters to differentiate PCNSL from GBM. Twenty-eight patients with PCNSL (with 34 lesions) also underwent diffusion-weighted imaging. Pearson's correlation analysis was used to assess the relation between SUV- and ADC-derived parameters.

RESULTS

The SUVmax, T/N ratio, SUVmean, and TLG values were significantly higher in PCNSL than in GBM. Comparative ROC analysis indicated that the SUVmax had a greater area under the curve (AUC) of 0.910 than the T/N ratio (0.905, P=.85), SUVmean (0.836, P=.0006), or TLG (0.641, P < 0.0001). The T/N ratio had the highest specificity (94.23%) for differentiating PCNSL from GBM, while the SUVmax had the most optimal sensitivity (92.31%). Further combined analysis of the indices did not significantly improve the AUC. Moderate inverse correlations between the SUVmax, SUVmean, TLG, and the ADC ratio (rADC) were found in PCNSLs (r=-0.526, P=.002; r=-0.504, P=.004; and r=-0.483, P=.006; respectively)

CONCLUSION

The SUVmax and T/N ratio may be reliable measures for differentiating PCNSLs from GBMs. Additionally, FDG metabolism indices were inversely proportional to the rADCs of PCNSL lesions.

CLINICAL RELEVANCE/APPLICATION

(dealing with PET CT) we found a potential benefit for combining PET and MRI scans for PCNSL lesions, as the ADC values on MRI and the intensity of 18F FDG uptake on PET may provide synergistic information on tumor aggressiveness and progno

SSJ17-05 Evaluation of 18F-trifluoromethylated D-cysteine as a Promising PET Tracer in Orthotopic C6 Glioma

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S505AB

Participants
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PURPOSE

To explore the potential application of 18F-trifluoromethylated D-cysteine (S-[18F]CF3-D-CYS), a new sulfur-containing amino acid

PET tracer in evaluating glioma in terms of tumor heterogeneity and boundaries.Further, compared its value with multiparametic MRI and 18F-FDG PET imaging.

METHOD AND MATERIALS

S-[18F]CF3-D-CYS was prepared from multi-step reactions. Small-animal PET imaging with S-[18F]CF3-D-CYS was performed on the same rats bearing orthotopic C6 glioma with 60-min dynamic scan and compared with 2-deoxy-2-[18F]fluoro-D-glucose ([18F]-FDG) and multiparametic MRI. The regions of interest were drawn on tumors and normal brain parenchyma. Further, we compared the imaging with histopathological examinations

RESULTS

Dynamic S-[18F]CF3-D-CYS PET imaging showed tumor uptake was at peak rapidly and then maintained plateau after 10 min p.i.. And there was an avid uptake in tumors and a much low uptake in normal brains in PET images with S-[18F]CF3-D-CYS, thus causing a high uptake ratio of tumor to control brain, which was higher than that in PET images with 18F-FDG (3.15 ± 0.37 vs 1.22 ± 0.05, $P < 0.0001$). S-[18F]CF3-D-CYS PET imaging also depicted clearer boundaries in glioma tumors than those 18F-FDG PET imaging depicted. The uptake extent of S-[18F]CF3-D-CYS was consistent with tumor cell density. Compared with multiparametic MRI, S-[18F]CF3-D-CYS PET imaging can give better differentiation between infiltrating tumor tissue and brain edema.

CONCLUSION

Compared with [18F]-FDG and MRI, S-[18F]CF3-D-CYS PET has an even clear tumor boundary and reflect the tumor heterogeneity. S-[18F]CF3-D-CYS PET might serve as a potential PET tracer with a good performance in diagnosis of glioma

CLINICAL RELEVANCE/APPLICATION

S-[18F]CF3-D-CYS PET is superior than [18F]-FDG and MRI in defining the glioma boundary and tumor heterogeneity and S-[18F]CF3-D-CYS might serve as a potential PET tracer for evaluating glioma.

SSJ17-06 Evaluation of the Potential Role of F-18 FDG PET as a Biomarker in Diagnosing Patients with Anti-Glutamic Acid Decarboxylase 65 (anti-GAD65) Associated Neurologic Disorders Including Stiff-Person Syndrome and Cerebellar Ataxia

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S505AB

Participants
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Lilja B. Solnes, MD, Baltimore, MD (*Abstract Co-Author*) Advisory Board, Progenics Pharmaceuticals, Inc

PURPOSE

To evaluate the role of F-18 FDG PET as a biomarker in anti-glutamic acid decarboxylase 65 (anti-GAD65) associated neurologic disorders including Stiff-person syndrome (SPS) and cerebellar ataxia (CA).

METHOD AND MATERIALS

30 patients with brain F-18 FDG PET who were diagnosed with Anti-GAD65 associated neurologic disorder were analyzed for brain uptake in 47 different clusters compared to 50 asymptomatic controls using NeuroQ™. Among the 30 patients, 19 had isolated SPS, 8 had isolated CA and 3 had co-existing SPS and CA. The whole-body F-18 FDG PET scans were used to subjectively evaluate muscular uptake for 50 patients with antiGAD65 neurologic disorders. ±1.65 was considered as the threshold for abnormal Z scores.

RESULTS

The Z scores calculated based on the average of the first scan of patients with FBP/RAMP-FBP protocol showed hypermetabolic activity in areas including brain stem, right medial temporal cortex, right lentiform nucleus, right caudate nucleus, bilateral superior lateral temporal cortices, bilateral associative visual cortices, and left superior parietal cortex, while areas including bilateral inferior lateral posterior temporal cortices, left lateral anterior temporal cortex, bilateral middle frontal cortices, bilateral primary visual cortex, bilateral inferior frontal cortices, showed hypometabolic activity. Patients with SPS phenotype showed lower uptake in cerebellum and thalamus and higher uptake in left parietal cortex, while those with CA revealed hypermetabolism in cerebellum and thalamus and hypometabolism in the bilateral parietal cortices. 62% of the patients showed increased muscular uptake. The most common pattern was symmetric shoulder girdle involvement.

CONCLUSION

Anti-GAD65 neurologic disorders comprise rare disorders with evolving diagnostic criteria. Our results showed that thalamus, as well as parietal and cerebellar cortices, are able to distinguish patients with CA vs. those with SPS phenotype. According to literature, normal musculature shows 12.5% increase in FDG PET uptake while our study showed 62% abnormal muscle uptake among these patients. FDG PET has the potential to become a diagnostic biomarker for patients with anti-GAD associated neurologic disorders.

CLINICAL RELEVANCE/APPLICATION

Anti-GAD65 neurologic disorders do not have definitive diagnostic criteria. F-18 FDG PET has the potential to become a diagnostic biomarker for these disorders based on the brain and muscle uptake.

SSJ18

Neuroradiology (Traumatic Brain Injury)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S406B

ER NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Bharathidasan Jagadeesan, MD, Minneapolis, MN (*Moderator*) Nothing to Disclose

Sub-Events

SSJ18-01 Detection of Cerebral Microbleeds in American Football Players Using SWI: A Comparison of 3T to 7T MRI

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S406B

Participants
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PURPOSE

American football players (AFP) experience repetitive brain trauma during their career and are at risk for developing a condition known as chronic traumatic encephalopathy. Cerebral microbleeds (CM) are a typical finding of repetitive brain trauma and diffuse axonal injury and show a frequency of about 9% in retired AFP (Casson IR et. al 2014). To our best knowledge all neuroimaging studies on CM in AFP have been performed on 1.5 or 3 T MRI. Ultrahigh field MRI with 7T shows significantly more CM in patients with diffuse axonal injury than 3 T SWI (Moenninghoff C et al 2015).The purpose of this study is to evaluate the diagnostic value of 7T SWI compared to 3T SWI for the detection of CM in AFP.

METHOD AND MATERIALS

Twelve professional AFP were enrolled in this prospective study (mean age: 23,4 years, range: 22-32 years, all male). All patients underwent a MRI scan with SWI imaging of the brain on 3T and 7T. Ultra-high field MR examinations were performed on a 7 T whole-body research system (Magnetom 7 T, Siemens AG, Germany). All examinations at 3 T were performed on a high-end clinical MR system (Magnetom Skyra, Siemens AG, Germany). Both MR systems were used in combination with 32-channel radiofrequency head coils. Image analyses were performed by two neuroradiologist in consensus reading on 3T MRI and on 7T MRI for number of CM and additional findings.

RESULTS

The readers identified a total of three CM in three different AFP in the 3T SWI (Fig. 1a). In the 7T SWI one of these CM was confirmed (Fig. 1b), moreover even two smaller adjacent CM were identified. The other two suspected CM at 3T in the other two AFP were identified at 7T as atypical small intracerebral veins (Fig. 1 c, d). As an additional finding a developmental venous anomaly (DVA) was found in one the AFP, which was well delineated in both 3T and 7T, whereas at 7T a more exact architecture of the DVA was definable.

CONCLUSION

7T SWI improves the depiction of CM. Moreover, 7T SWI allows a more accurate differentiation of lesions that were described as CM at 3T but identified as atypical venous blood vessels at 7T SWI.

CLINICAL RELEVANCE/APPLICATION

7T SWI could enable a more accurate detection of CM and help to understand pathophysiological processes in AFP, nevertheless larger studies at 7T are needed.

SSJ18-02 Influence of Callosal Microstructural Compromise on Interhemispheric Speed of Processing in Mild Traumatic Brain Injury

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S406B

Participants
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PURPOSE

The corpus callosum (CC) is at specific risk in Mild Traumatic Brain Injury (MTBI) and critical for interhemispheric communication. Here we test the hypothesis that microstructural compromise as measured by diffusion MRI affects performance on a novel interhemispheric speed of processing task (IHSPT).

METHOD AND MATERIALS

The study is approved by the institutional review board. 36 MTBI subjects (11 male, 25 female; mean age 36 years) within 4 weeks of injury and 27 controls were included (12 male, 15 female; mean age 37 years). IHSPT measures latency over 80 trials between visual word stimulus presentation to the right vs left visual hemifield. Patients with positive IHSPT values were included (indicating probable left language dominance, necessitating information crossing the CC). Diffusion MRI was performed on 3T (Skyra,Siemens) with 5 b-values (up to 2.5ms/m2 with 60 directions). Diffusion metrics of fractional anisotropy, diffusivity and kurtosis (mean, radial and axial; MD, RD, AD, MK, RK, AK) were calculated as well as compartment-specific white matter microstructure metrics, including axonal water fraction (f), a measure of axon density, intra-axonal diffusion (Daxon), reflective of axonal integrity, and extracellular diffusion along and perpendicular to the axis of the axon (Depar and Dperp), sensitive to glial and inflammatory changes, and changes in myelination, respectively. Region-of-interest analysis was done using freesurfer segmentation of the CC. Relationship between IHSPT performance and diffusion measures was assessed using Pearson's partial correlation in both MTBI and control groups.

RESULTS

In controls, we found correlations between IHSPT and several diffusion measures all localizing to the splenium (MD,RD, AK, and Deperp; $p<0.05$), lost in MTBI subjects. MTBI subjects, on the other hand, showed significant correlations between IHSPT and kurtosis diffusion measures in the genu of the CC (MK, AK, and RK) (Table 1).

CONCLUSION

In MTBI subjects, we find a relationship between CC body microstructural complexity and IHSPT not seen in controls. Furthermore, the normal relationships seen in controls between tissue microstructure and interhemispheric processing are lost after MTBI.

CLINICAL RELEVANCE/APPLICATION

Understanding how white matter injury affects cognitive performance is the critical next step for better assessing MTBI patients. Here we show altered relationships between CC microstructure and specific IHSPT between MTBI patients and controls.

SSJ18-03 Subject-Specific White Matter Abnormalities in Chronic TBI Assessed by Biophysical Modeling Using Simultaneous Multi-Slice Multi-Shell Diffusion MRI

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S406B

Participants
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PURPOSE

Conventional diffusion tensor imaging (DTI), assuming Gaussian distribution of water molecule diffusion, is not able to infer the microstructures cofounded by the effects of fiber crossings and orientation dispersion. Subject-specific analysis is crucial in traumatic brain injury (TBI) care and long-term follow up. The goal of this study is to demonstrate the feasibility of mapping subject-specific white matter abnormalities in chronic TBI using non-Gaussian diffusion MRI (dMRI) reconstruction techniques.

METHOD AND MATERIALS

Participants included 181 active service members diagnosed with possible TBI (M/F=180/1, age=35.40 ±7.88 years) and 43 non-TBI controls (M/F=31/12, age=40.35±5.99 years). 3T dMRI with inter-slice acceleration factor of 3 and inter-plane acceleration of 2 was prescribed using three shells (270 directions in each shell, diffusion gradients=3K, 2K, 1K, isotropic 1.7 mm) scheme. dMRI was preprocessed using TORTOISE package. Diffusion metrics were then reconstructed using several non-Gaussian dMRI models, including bi-tensor free water DTI, mean apparent propagator MRI, neurite orientation dispersion and density imaging model and multi-compartment microscopic diffusion model using the Spherical Mean Technique. For voxel-wise subject-specific analyses, the

group-wise means and the variances of the whole brain white matter of non-TBI controls were calculated after transforming to the MNI template and smoothing, and the Mahalanobis distance at each voxel was computed for the individual TBI subject, as well as leave-one-out approach for comparing individual control to the rest of controls.

RESULTS

Fig. 1 shows an example of the subject-specific analysis results of a mild TBI participant. There were no statistical difference of the total volumes of white matter anomalies between TBI and controls, though the TBI group tended to have a larger amount of anomalies.

CONCLUSION

Our results suggested that mapping microscopic features with methods that are not confounded by the effects of fiber crossings and orientation dispersion would have a better understanding of the complexity of axonal pathology in chronic TBI.

CLINICAL RELEVANCE/APPLICATION

Mapping subject-specific microstructural changes might help distinguishing the underlying pathology following brain injury, e.g. neuroinflammation vs axonal degeneration.

SSJ18-04 Relationship Of White Matter Microstructure To Working Memory Function As A Function Of Time-Since-Injury After Mild Traumatic Brain Injury: Diffusion MRI Study

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S406B

Participants
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PURPOSE

Cognitive complaints can be one of the most troubling and persistent symptoms after MTBI[1-2] and there is a need to better understand how working memory deficits[3] relate to detectable microstructural injuries. Here, we aim to discover robust biomarkers that allow for early identification of patients at highest risk of working memory impairments.

METHOD AND MATERIALS

We studied 19 MTBI(mean,30y.o) and 20 normal subjects(NC;mean,33y.o). Diffusion MRI was performed on 3T(Skyra,Siemens) with 5 b-values. Diffusion metrics of FA, diffusivity and kurtosis (mean/radial/axial) were calculated. Auditory-verbal working memory was assessed using WAIS-IV[4]:Digit Span Forward(DSF), Backward(DSB) and Sequencing(DSS), and Letter-Number Sequencing(LNS). Region-of-interest(ROI) analyses were performed to assess the relationship between diffusion measures and working memory performance using Pearson's partial correlation with age/sex as covariates(family-wise-corrected $p<0.05$). Subgroups were also defined according to their working memory performance and time-since-injury(Table2). Subgroup comparisons were done using MANCOVA with age as covariate.

RESULTS

There was a significant correlation between axial kurtosis(AK) and DSB in the right superior longitudinal fasciculus(SLF) in MTBI($r=0.69$), not present in NC(Table 1). In MTBI, we also found loss of the normal relationship between FA and LNS that was present in the right posterior corona radiata(pCR) in NC($r=0.67$). Time-since-injury and division of subjects into high/low performer groups(z-score=1) influenced some of the relationships between regional diffusion measures and performance on working memory(Fig.1).

CONCLUSION

We show differences in the relationship between diffusion measures and working memory performance in MTBI and healthy subjects. Furthermore, preliminary results suggest both time-since-injury and relative performance level on working memory provide additional insight into these relationships.

CLINICAL RELEVANCE/APPLICATION

Our study elucidates microstructural changes in relation to working memory after MTBI, and suggest the potential utility for early identification of patients with working memory deficits.

SSJ18-05 Region-Based Blood-Brain Barrier Disruption in Mild Traumatic Brain Injury: Quantification Using DCE MR Imaging and Automatic Segmentation Method

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S406B

Participants
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PURPOSE

To explore region-based blood-brain barrier disruption in mild traumatic brain injury (mTBI) patients with post-concussion syndrome

(PCS) using quantitative dynamic contrast-enhanced (DCE) MR imaging parameters and automatic segmentation method and to explore its clinical implications.

METHOD AND MATERIALS

Forty-one consecutive patients with PCS after mTBI and 29 controls, who had undergone MR imaging including DCE MR imaging at our institution between October 2016 and April 2018, were included in this retrospective study. After performing 3D T1-based brain segmentation with the FreeSurfer software package, mean Ktrans values from DCE MR imaging (derived using Patlak model) were analyzed at bilateral cerebral/cerebellar white matters, bilateral cerebral/cerebellar gray matters, corpus callosum, and brainstem. The Mann-Whitney U-test was performed to compare mean Ktrans between mTBI patients and controls. Ktrans values were correlated with neuropsychological test results using Mann-Whitney U-test and Spearman rank correlation in mTBI patients.

RESULTS

The median Ktrans (x10-1min-1) at bilateral cerebral gray matters was significantly higher in mTBI patients (0.010 [interquartile range: 0.008-0.013]) than in controls (0.008 [interquartile range: 0.007-0.012]) (P = .042). Ktrans tended to be higher in both the subgroup with the time interval between injury and MR imaging of 3 months or less and those with the interval longer than 3 months. Ktrans at bilateral cerebral gray matters was significantly higher in patients with atypical performance in auditory continuous performance test (commission errors) than in those with average or good performance (P = .041). In ROC analysis, Ktrans at bilateral cerebral gray matters had a sensitivity of 89% and a specificity of 70% for differentiating the two groups at a cut-off value of 0.009x10-1min-1. Ktrans at other regions were not significantly different between mTBI patients and controls.

CONCLUSION

BBB disruption was observed throughout bilateral cerebral gray matters in mTBI with PCS and the extent of BBB disruption as reflected by Ktrans was greater in patients with atypical performance in a neurocognitive test.

CLINICAL RELEVANCE/APPLICATION

DCE MR imaging can clearly depict BBB disruption in mTBI patients with PCS and is recommended as part of a MR study for the patients with otherwise normal conventional MR imaging findings.

SSJ18-06 The Application of Delayed-Contrast MRI (DCM) for Depicting Subtle BBB Disruption in TBI

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S406B

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PURPOSE

TBI is a highly complex disorder caused by primary and secondary injury mechanisms. Alternations in gliovascular signaling are not established as a key secondary injury. Moreover, little is known regarding the long terms effects of BBB disruption. Here we studied the feasibility for applying DCM for depicting subtle BBB disruption in TBI and the correlation with histology of blood vessels coverage by astrocytes (BVCA).

METHOD AND MATERIALS

24 mice were followed by DCM 1/8/29/64/98 and 133 days post closed head injury. BBB disruption maps were calculated from the MRIs and BBB disruption levels in the lesions vicinity were calculated. Extracted brains were sectioned and stained for astrocytes and vessels. The percent of BVCA was calculated from samples within the lesion vicinity. In addition, 10 TBI mice and 6 controls were scanned 15 months post TBI, and 5 patients were scanned 1 year post TBI.

RESULTS

Significant BBB disruption levels were depicted in the maps in the lesion vicinity in all mice post TBI. Lesion volumes as depicted in the BBB maps up to 1 week post TBI were x2.5 larger than the enhancing volume on T1-Gd ($p<0.02$). Disruption levels decreased linearly with time between days 1 and 133 ($r2=0.93$, $p<0.002$). Significant correlation was found between the disruption level calculated from MRI and BVCA for the different time points ($r2=0.77$, $p<0.05$). When scanned 15 months post TBI, disruption levels depicted in the ipsilateral ventricle were significantly higher for TBI mice vs control ($p<0.03$). Preliminary clinical results in 5 TBI patients show subtle BBB disruption, undetectable by standard MRI, depicted for all patients. Initial analysis suggests several possible disruption patterns (local disruption in the brain tissue and the midline, local blood-CSF disruption, subarachnoid, ventricular and wide-spread).

CONCLUSION

DCM enables depiction of significant BBB disruption, with higher sensitivity than T1-Gd, up to long times post injury. Correlation between MRI-based disruption levels and BVCA observed in the animal model may be explained by alterations in gliovascular signaling resulting from TBI.

CLINICAL RELEVANCE/APPLICATION

DCM may be applied for depicting subtle BBB disruption induced by TBI up to long times post injury. This may be used for prognosis and treatment monitoring. The correlation with BVCA may be used to study the mechanism of secondary damage.

Printed on: 10/29/20

SSJ19

Neuroradiology/Head and Neck (Image Analysis, Non-Artificial Intelligence)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S404CD

HN NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSJ19-01 Development and Evaluation of a High-Resolution Structural Template for Studies in Older Adults

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S404CD

Participants
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PURPOSE

Human brain structural MRI templates with low spatial resolution lack important fine details due to partial volume effects. The purpose of this work was to introduce a novel approach for high-resolution template construction based on principles of super-resolution, and using this technique, to develop a high-resolution structural template of the older adult brain.

METHOD AND MATERIALS

T1-weighted brain MRI data from 222 non-demented older adults (65-95 age-range, male:female=1:1) participating in the Memory and Aging Project were used in this work. The raw images (1mm isotropic) were rigidly and non-linearly aligned in a 0.5mm resolution space. The resulting non-linear deformations were utilized to map the image intensities of the rigidly transformed 0.5mm resolution images to exact physical locations in the 0.5mm template space, eliminating interpolations that occur in conventional template-building method. The final intensity in each voxel in template space was calculated as the weighted average of the intensities contained in that voxel using a Gaussian kernel. The new template, referred to as IIT-Aging_0.5mm, was quantitatively compared to other high-resolution templates of the older and younger adult brain, in terms of image quality and in terms of the spatial normalization accuracy achieved when they are used as references for alignment of structural images from a large number of older adults.

RESULTS

The IIT-Aging_0.5mm template has higher image sharpness, exhibited by larger high spatial frequency content in the normalized power spectra. Fine structures were resolved in IIT-Aging_0.5mm compared to MCALT_0.5mm and IIT-Aging. Visual inspection revealed atypical brain features (artifacts) in the cortex of MCALT_0.5mm (red circles), which are not present in the other templates. The accuracy of inter-subject spatial normalization was higher when using IIT-Aging_0.5mm. The IIT-Aging and IIT-Aging_0.5mm templates required lower deformation.

CONCLUSION

The IIT-Aging_0.5mm template is a high-quality, high-resolution structural template of the older adult brain that provides higher spatial normalization accuracy than other templates, even for normalization of lower resolution older adult data.

CLINICAL RELEVANCE/APPLICATION

The IIT-Aging_0.5mm template is a high-resolution template containing important fine details of older adult brain and allows higher spatial normalization accuracy for normalization of older adult data

SSJ19-02 T1w and DTI Templates of the Older Adult Brain in a Common Space: Development and Evaluation

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S404CD

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PURPOSE

The demand for multimodal MRI atlas of the older adult brain is increasing as large amounts of data are generated in aging studies. This work developed high quality T1-weighted (T1w) and diffusion tensor imaging (DTI) templates of the older adult brain in the same space through a proposed iterative multimodal template construction strategy.

METHOD AND MATERIALS

T1w and DTI data were collected on 202 non-demented older adults (50% male,65.2-94.9 yrs) from Rush Memory and Aging Project. DTI data were aligned to the raw T1w images. In the proposed approach, each iteration has two steps. In step1, a temporary T1w template is generated and the resulting transformations are also applied to the DTI data. In step2, a temporary DTI template is generated and the resulting transformations are also applied to the T1w data. The quality of the templates at each iteration was assessed by the average standard deviation of normalized T1w data, the average pair-wise Euclidean distance of tensors (DTED) and the coherence of primary eigenvectors (COH). The spatial matching between the two templates was assessed by the Spearman's rank correlation between the white matter tissue probability map and the FA map. The final templates were compared with other templates in terms of spatial normalization accuracy when used as a reference for normalization of data from older adults. The average cross-correlation and standard deviation of normalized T1w data and the DTED and COH of normalized DTI data were compared.

RESULTS

It is shown that the spatial normalization of the T1w and DTI data used to construct the templates improves($p<10^{-10}$) and the spatial matching between the T1w and DTI templates also improves($p<10^{-10}$), suggesting better quality of the templates with more iterations. The final T1w and DTI templates in this work allow higher spatial normalization accuracy of data from older adults compared to other available templates($p<10^{-10}$).

CONCLUSION

This work proposed a new multimodal templates construction approach and generated T1w and DTI templates of the older adult brain in the same space, which allow better spatial normalization of T1w and DTI data from older adults compared to other available templates.

CLINICAL RELEVANCE/APPLICATION

The templates developed in this work allow higher spatial normalization accuracy of both T1w and DTI data from older adults in common space.

SSJ19-03 Enhanced White Matter Connectome of the IIT Human Brain Atlas

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S404CD

Participants
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PURPOSE

The purpose of this work was two-fold: a) to enhance the white matter connectome of the IIT Human Brain Atlas through an improved tractography strategy and use of more precisely defined gray matter labels and b) to evaluate how representative the new connectome is of young adult participants of the Human Connectome Project (HCP).

METHOD AND MATERIALS

Data: i) the HARDI and DTI templates of the IIT Human Brain Atlas (v.4.1), ii) more precisely defined gray matter labels generated for the atlas and iii) the structural and diffusion MRI preprocessed data of 20 unrelated young adult HCP participants with balanced sex and age. Connectome construction: Whole brain anatomically-constrained tractography, spherical-deconvolution informed filtering (SIFT), and 84 Desikan-Killiany regions were applied on the IIT HARDI template and 20 HCP datasets to generate 21 connectomes, each containing 6972 edges. Connectome evaluation: The streamlines of the edges survived filtering of each connectome were transformed to the other 20 connectome spaces by DTI registration and the tract density images (TDI) were generated. F1 scores for each edge's spatial volumes between one connectome and the other 20 connectomes were computed. Pearson's correlation coefficients were also computed for TDI maps between all 20 pairs. These processes were repeated for each connectome in their spaces and the F1 scores and the Pearson's correlations were averaged. One sample t-tests were used to test the IIT connectome if the average F1 score and Pearson's correlation were significantly different than those of the HCP participants.

RESULTS

TDI and edge density images of the new IIT connectome has shown good correspondence with other studies. The IIT connectome has no significantly different average F1 scores and significantly higher average Pearson's correlations ($p<0.0001$) than those of the HCP group over the different numbers of survived edge, indicating that the IIT connectome is representative of individual HCP connectomes.

CONCLUSION

A new version of the IIT white matter connectome was developed and compared to those of 20 young adult HCP participants. It

was demonstrated that the IIT connectome is representative of individual HCP connectomes.

CLINICAL RELEVANCE/APPLICATION

The new IIT white matter connectome will facilitate atlas-based analyses of the whole brain connectome.

SSJ19-04 Multiscale Modeling of Intra-Regional and Inter-Regional Connectivities and Their Alterations in Major Depressive Disorder

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S404CD

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PURPOSE

Resting-state functional magnetic resonance imaging (rs-fMRI) studies have focused primarily on characterizing the connectivity among discrete brain regions. A major drawback is that it fails to provide a mechanistic understanding of brain cognitive function or dysfunction at cellular and circuit levels. To overcome this limitation, we developed a Multiscale Neural Model Inversion (MNMI) framework that linked microscale circuit interactions with macroscale network dynamics and estimated both local coupling and inter-regional connections based on blood oxygen-level dependent (BOLD) rs-fMRI.

METHOD AND MATERIALS

The fMRI data was obtained from a single-center, large-cohort first-episode, treatment-naïve MDD rs- fMRI database, consisting of 66 MDD adults and 66 matched normal controls (NC). We used biologically plausible Wilson-Cowan oscillators to model the dynamics of local neural circuits consisting of excitatory and inhibitory neural populations (Fig. 1). Different brain regions are connected via long-range fibers with initial strength estimated from their respective structural connectivity. The neural activity of each region was converted to BOLD signals with corresponding functional connectivity (FC) matrix using a hemodynamic model. The local and inter-regional connection parameters were optimized via stochastic optimization procedures to minimize the error between the simulated and the empirical FC matrices.

RESULTS

The recurrent excitation and inhibition within the dorsal lateral prefrontal cortex (dlPFC) were found to be reduced in MDD, consistent with the commonly accepted hypothetical model of MDD. In addition, recurrent excitation in the thalamus was found to be abnormally elevated, which may be responsible to abnormal thalamocortical oscillations often observed in MDD.

CONCLUSION

The MNMI framework was able to characterize potential intra-regional pathophysiological mechanisms of MDD, thus could be better than the conventional inter-regional FC analysis.

CLINICAL RELEVANCE/APPLICATION

Understanding impaired circuit dynamics via multiscale neural modeling helps to identify both biomarkers and pathologies of MDD, which is necessary to develop more effective diagnosis and treatment.

SSJ19-05 Carotid Plaque Vulnerability on Magnetic Resonance Imaging and Risk of Future Ischemic Events: A Systematic Review and Meta-Analysis

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S404CD

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PURPOSE

Magnetic resonance imaging (MRI) can characterize carotid plaque features, including intraplaque hemorrhage (IPH), lipid-rich necrotic core (LRNC), and thin-ruptured fibrous cap (TRFC), that have an increased tendency to cause future cerebrovascular ischemic events. We performed a systematic review and meta-analysis of studies evaluating the association of MRI-identified high-risk plaque features, including IPH, LRNC, and TRFC, with risks of subsequent ischemic events of stroke or transient ischemic attack

(TIA) over a follow up duration of >=3 months.

METHOD AND MATERIALS

Multiple databases were searched for relevant publications between January 2000 and December 2018. Studies reporting outcomes of future ischemic events of stroke or TIA for individual MRI-identified high-risk carotid plaque features over a follow up duration of >=3 months were included. Random effects meta-analysis was performed to estimate odds ratios (OR) and 95% confidence intervals (CI) comparing outcomes between MRI-positive and MRI-negative groups.

RESULTS

Fifteen studies including 2,350 patients were included (Figure). The annual rate of future ischemic events was 11.9% for MRI-positive IPH, 5.4% for LRNC, and 5.7% for TRFC. IPH, LRNC, and TRFC were associated with increased risk of future ischemic events (OR 6.37; 95%CI, 3.96 to 10.24), (OR 4.34; 95% CI, 1.65 to 11.42), and (OR 10.60, 95% CI 3.56 to 31.58); respectively.

CONCLUSION

The findings strengthen the assertion that MRI-positive 'high-risk' or 'vulnerable' plaque features, including IPH, LRNC, and/or TRFC can predict risks of future ischemic events of stroke or TIA.

CLINICAL RELEVANCE/APPLICATION

The current study findings lend support to the assertion that plaque morphological and compositional factors are extremely important in understanding the natural history of carotid atherosclerotic disease and should potentially be considered in guiding treatment for these patients.

SSJ19-06 Influence of Artifact Corrections on MRI Signal Intensity Ratios for Assessment of Gadolinium Brain Retention

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S404CD

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PURPOSE

To prospectively study the effect of flow artifact compensation and intensity inhomogeneity correction on brain signal intensity ratios in T1-weighted MR images in study participants who had previously received multiple doses of gadobutrol.

METHOD AND MATERIALS

This prospective study included 76 participants who received five or more gadobutrol-enhanced scans between 2007 and 2017. A control group of 25 participants without gadolinium-based contrast agent application in their history was included for comparison. Unenhanced brain MRI including two T1-weighted spin-echo sequences with and without flow artifact compensation was performed in all participants. Both sequences were reconstructed with and without intensity inhomogeneity correction and signal intensity ratios were assessed (dentate nucleus-to-pons and globus pallidus-to-thalamus ratios).

RESULTS

Using flow artifact compensation, a lower proportion of participants had to be excluded from the final analysis of the dentate nucleus-to-pons ratio due to flow artifacts (15 % versus 45 %, $p<0.001$). Without intensity inhomogeneity correction, a difference was found between the study and the control groups for the dentate nucleus-to-pons ratio ($p=0.004$), but not for the same sequence reconstructed with intensity inhomogeneity correction ($p=0.29$). For the globus pallidus-to-thalamus ratio, no difference was found between the study and control group.

CONCLUSION

The application of an intensity inhomogeneity correction algorithm has a significant impact on brain nucleus signal intensity ratios for the assessment of gadolinium brain retention.

CLINICAL RELEVANCE/APPLICATION

Differences in brain signal intensity ratios in T1-weighted MR images have beenreported as indicator of gadolinium brain retention.

SSJ20

Neuroradiology (Stroke 3)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S404AB

ER NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Brent D. Griffith, MD, Troy, MI (*Moderator*) Nothing to Disclose
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Sub-Events

SSJ20-01 Technical Outcomes and Early Experience of a Centrifugally-Trained Interventional Radiology Stroke Service

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S404AB

Participants
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PURPOSE

Despite level 1A evidence for efficacy, rapidly accessible IR stroke care is not universally available. Judicious establishment of new IR stroke centers is one approach to improve access to care. We describe the development of a centrifugally-trained IR stroke team and the initial year of independent practice.

METHOD AND MATERIALS

A team of interventional radiologists learned best practices for stroke intervention with on-site proctoring by an experienced neurointerventionalist who was flown by a helicopter-physician transport system to proctor each case performed during the training period. Patient eligibility for and appropriateness of endovascular thrombectomy (EVT) was determined using DAWN criteria. Technical success of EVT was assessed using the Thrombolysis in Cerebral Infarction (TICI) scale. Secondary endpoints included time metrics of workflow upon arrival to the ED, early neurologic recovery, 90-day mortality and intervention-related complications. We compared our outcomes of our study with those of the DAWN trial and HERMES meta-analysis.

RESULTS

30 total cases of EVT were retrospectively reviewed. TICI 3 or 2b technical success was achieved in 83%, not significantly different from the rate observed in HERMES when using two-tailed proportional analysis. No cases of intervention-related intraparenchymal hemorrhage, hematoma or arterial perforation/dissection occurred. Major early neurologic recovery was observed in 36% of cases compared to 50% in HERMES. 90-day mortality was observed in 10% of cases, similar to 15.3% in HERMES. The median interval from patient arrival to the ED to groin puncture was 104 minutes, compared to 109 minutes in the DAWN trial.

CONCLUSION

When comparing the performance of our centrifugally-trained IR stroke team with the HERMES meta-analysis, there was no significant difference in the technical efficacy of EVT nor any increased occurrence of intervention-related complications. There was also no significant difference in the median interval of time between patient arrival to the ED and groin puncture when compared to the DAWN trial.

CLINICAL RELEVANCE/APPLICATION

We describe a proof-of-concept model of a centrigully-trained IR stroke team as a possible approach to improve access to interventional stroke care.

SSJ20-02 Cost-Effectiveness of Thrombectomy for Ischemic Stroke Patients Presenting Beyond 6 Hours of Last Known to Be Well Based on the AURORA Meta-Analysis

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S404AB

Participants

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PURPOSE

The AURORA meta-analysis (Analysis of Pooled Data from Randomized StUdies of ThROmbectomy MoRe than 6 hours After Last Known Well) included patients that were randomized to endovascular thrombectomy (EVT) or to medical management (MM) presenting with large vessel occlusion stroke beyond 6 hours of symptom onset or last known to be well. Based on five pooled trials, EVT showed clear clinical benefits. We aimed to determine the cost-effectiveness of EVT in this context.

METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with EVT or MM (Figure 1). The analysis was performed in a United States setting from a societal perspective. Input parameters for the model were based on most recent and best available evidence (Table 1), including pooled outcome data from patients randomized in five trials (DAWN, DEFUSE 3, ESCAPE, REVASCAT, POSITIVE, Figure 2). Probabilistic sensitivity analyses (PSA) were performed using 10,000 Monte Carlo simulations to estimate uncertainty. Incremental costs (IC), incremental effectiveness (IE), and incremental cost-effectiveness ratios (ICER) were derived. Cost-effectiveness acceptability rates were determined for varying willingness-to-pay (WTP) thresholds.

RESULTS

Based on outcome data of 458 patients randomized within the AURORA meta-analysis, the base-case analysis identified EVT as the strategy that resulted in incremental QALYs and cost-savings over the projected lifetime compared to MM (IC: -$17,902; IE: +1.71 QALYs; ICER: EVT dominant). Adjusting for all input parameter uncertainty in PSA, EVT was the preferred strategy with acceptability rates of >99.9% at all WTP thresholds ranging from $10,000 to $150,000 per QALY (Figure 3). Simulations led to 94.46% dominant/cost-saving iterations (Figure 4).

CONCLUSION

EVT is projected to provide considerable long-term clinical benefit whilst also leading to considerable long-term cost-savings in the management of patients with large vessel occlusion stroke presenting beyond 6 hours of symptom onset or last known to be well

CLINICAL RELEVANCE/APPLICATION

The expanded EVT indication beyond traditional time windows increases the need for EVT. Based on the projected health and cost benefits, healthcare investments are justified to cover this new demand.

SSJ20-03 Correlation of ASPECTS with CT Perfusion Core Volume in Large Vessel Occlusion Ischemic Strokes: A Real World Experience

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S404AB

Participants
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PURPOSE

The Alberta Stroke Program Early CT Score (ASPECTS) and CT perfusion (CTP) are commonly used to predict the ischemic core in acute ischemic strokes (AIS). CT angiogram source images (CTA-SI) can also provide additional information to identify the extent of ischemia. Our objective was to investigate the correlation of non-contrast CT (NCCT) ASPECTS and CTA-SI ASPECTS with CTP core volumes and final infarct volumes (FIV).

METHOD AND MATERIALS

We utilized a single institutional, retrospective registry of consecutive patients with AIS with large vessel occlusion (LVO) between May 2016 and May 2018. We graded ASPECTS both on NCCT and CTA-SI blinded to CTP results, measured CTP core using automated RAPID software (CBF<30%) and calculated FIV using follow up CT/MRI within 5 days of stroke onset. We used Pearson's correlation coefficients to evaluate the correlation between continuous variables.

RESULTS

A total of 58 patients fit the inclusion criteria of LVO and imaging work up of NCCT, CTA, and CTP. The mean age was 64.1±16.1 years and 41.4% were female. The median NCCT ASPECTS was 7 (IQR, 6-9), CTA-SI ASPECTS was 5 (IQR, 4-7), and CTP core was 14.5 ml (IQR, 0-45 ml). There was a moderate correlation between NCCT ASPECTS and CTP core (correlation coefficient, R= -0.57, p<0.0001) and between CTA-SI ASPECTS and CTP core (correlation coefficient, R= -0.48, p=0.0002). The correlation coefficient between FIV and NCCT ASPECTS was -0.54 (p<0.0001), FIV and CTA-SI ASPECTS was -0.48 (p=0.0004), and FIV and CTP core

was 0.66 (p<0.0001). The optimal NCCT ASPECTS cutoff score to detect CTP core of 70 ml was 5 (sensitivity 0.57, specificity 0.84, Youden J 0.41) and the optimal CTA-SI ASPECTS was 4 (sensitivity 0.71, specificity 0.75, Youden J 0.46).

CONCLUSION

There was a moderate correlation between NCCT and CTA-SI ASPECTS in predicting CTP defined ischemic core and final infarct volumes.

CLINICAL RELEVANCE/APPLICATION

Our findings emphasize the need for further investigation into the use of CTA-SI ASPECTS for evaluating infarct extent in large vessel occlusions.

SSJ20-04 Successful Endovascular Thrombectomy Significantly Reduces Infarct Growth in both Early and Late Time Windows, but not for Patients with "Large" Admission Infarcts

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S404AB

Participants
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PURPOSE

Endovascular thrombectomy (EVT) of acute stroke patients with large vessel occlusion (LVO) and small infarcts (<50ml) has been proven to be of benefit up to 24-hrs post ictus. Our purpose was to investigate the relationship between degree of recanalization and infarct growth, stratified by admission infarct volume and time-post-ictus.

METHOD AND MATERIALS

We retrospectively studied 223 consecutive LVO patients who underwent EVT between 6/1/2012 and 12/31/2017. 92/233 met inclusion criteria including available admission MR-DWI and follow-up CT or MR 12-hrs to 5-days post-procedure. Infarct growth was calculated as [final-admission infarct volume] / [admission volume] * 100, (measured as L*W*H/2). Degree of recanalization was determined according to the AOL and TICI scores, as good (AOL 2B/3, TICI 3/4), poor (AOL 0/1, TICI 0-2), or intermediate (everything in-between). Patients were stratified according to admission infarct volume (< vs > 50 ml) and time-post-ictus at presentation (< vs > 6 hours).

RESULTS

92/233 patients; 53 men/39 women. Mean age 68. LVO location included 25 ICA, 84 M1, and 27 M2. Success of recanalization was 43/92 (47%) good, 19/92 (21%) intermediate, and 30/92 (32%) poor. There were 72/92 (78%) and 20/92 (22%) patients with admission infarct volume less than and greater than 50 ml, respectively. There were 68/92 (74%) and 24/92 (26%) patients treated less than and greater than 6-hrs post-ictus, respectively. Mean infarct growth was significantly different among the 3 recanalization groups (good 13.4 ml, 76%; intermediate 45.5 ml, 203%; and poor 102.1 ml, 482%; p<0.01). These differences remained significant when stratified by time-post-ictus (10.8 vs 42.7 vs 116.4 ml, and 81 vs 194 vs 498 %; p<0.01) in the early window group; and remained significant in the late window group (24.5 vs 56.0 vs 80.6 ml, and 58 vs 235 vs 464 %; p<0.01). These differences also remained significant when stratified by admission infarct volume (9.0 vs 46.4 vs 118.4 ml, and 87 vs 229 vs 630 %; p<0.01) in the <50 ml group; but did not remain significant in the >50 ml group (30.0 vs 40.7 vs 57.4 ml, and 37 vs 66 vs 63 %; p=0.4).

CONCLUSION

Successful, robust recanalization following EVT results in significantly less core infarct growth - compared to intermediate and poor recanalization - for both early (<6hrs) and late (>6 hrs) time-window patients. Similarly, intermediate recanalization results in less infarct growth compared to poor recanalization. There was no significant benefit of EVT for infarct growth, however, for the subgroup with large (>50 ml) admission infarct volumes.

CLINICAL RELEVANCE/APPLICATION

EVT has been proven to benefit stroke patients up to 24 hours post ictus in the DAWN and DEFUSE-3 trials. We have shown that the degree of core infarct growth is significantly impacted by the degree of recanalization, and that this effect is equally robust in both early and late time windows.

SSJ20-05 Multi-Phase CT Angiography Registration and Subtraction Optimization to Improve Distal Arterial Occlusion Detection in Acute Stroke

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S404AB

Participants
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PURPOSE

In the context of an ischemic stroke, subtracting multi-phase whole-brain CT-angiography images may reveal a delayed vessel sign. However, this operation results in noisy images and is prone to patient motion between acquisitions. The purpose of the study is to develop a post-processing pipeline that automatically reduces motion and noise resulting from multi-phase CT-angiography subtraction, thereby improving the detection of distal arterial occlusion.

METHOD AND MATERIALS

To minimize motion between acquisitions, multi-phase images must be registered. During this process, a similarity metric is computed iteratively by random sampling of voxels from a region of interest (ROI). We tested registration methods targeting different ROIs, namely, the head, the skull, the calvaria and the cochleae. To reduce noise, we applied a smoothing Gaussian filter and a color gradient to highlight the areas corresponding to delayed contrast opacification (i.e. subtraction image voxels with positive values). We tested noise-reduction methods with different sigma parameters and color gradient thresholds. The motion- and noise-reduction methods were tested on 35 anonymized studies with a clinical suspicion of stroke. Method performances were evaluated by four radiologists who were blinded to the method-specific parameters. Registration methods were further evaluated using Dice similarity coefficients (DSC).

RESULTS

The motion-reduction method using the calvaria registration ROI was the most effective according to radiologists' assessment ($p < 0.01$) and to DSC ($p < 0.05$). The noise-reduction method with a sigma of 1.5 and a threshold of 1 HU was most highly ranked by radiologists ($p < 0.01$). Based on the best post-processed subtraction image, radiologists were in moderate agreement for the presence of delayed perfusion ($\kappa = 0.59$).

CONCLUSION

We evaluated different methods to reduce motion and noise resulting from subtracting multi-phase CT-angiography images. This allowed us to design a post-processing pipeline to assist radiologists in detecting distal arterial occlusion in the context of an acute stroke.

CLINICAL RELEVANCE/APPLICATION

We developed a multi-phase CT-angiography post-processing pipeline based on optimized registration and images subtraction to improve distal arterial occlusion detection in acute stroke.

Printed on: 10/29/20

SSJ21

Physics (Diagnostic X-Ray Imaging)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: N228

PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Ingrid Reiser, PhD, Chicago, IL (*Moderator*) Spouse, Editor, IEEE Transactions on Communications
Bob Liu, PhD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ21-04 Weakly Supervised Learning for Classifying A Cardiomegaly Disease from Normal and Other Diseases on Chest Radiographs

Tuesday, Dec. 3 3:30PM - 3:40PM Room: N228

Participants
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PURPOSE

To develop a weakly supervised classification for screening of cardiomegaly disease with chest radiograph (CXR).

METHOD AND MATERIALS

We collected a total of 16,730 CXRs including normal (n = 6903), abnormal CXRs with cardiomegaly (n = 1184) and other five disease patterns including nodule, consolidation, pleural effusion, pneumothorax, interstitial opacity (n = 8619) from our institution. All CXRs were annotated by 5 - 10 years experienced thoracic radiologists. These datasets were randomly split into 70 percent for training, 10 percent for tuning, and 20 percent for final evaluation. To classify cardiomegaly, other disease patterns, and normal, we used densenet169 with convolutional neural network (CNN) for weakly supervised learning. When this algorithm was trained, normal and other disease patterns were randomly extracted from train datasets to balance the number of cardiomegaly. The performance of this classifier was evaluated with statistical analysis such as sensitivity, specificity, and accuracy.

RESULTS

In the test dataset, the algorithm showed 98.18% accuracy in classification of normal, cardiomegaly, and other diseases CXR. Sensitivity and specificity of CNN was measured at 81.85%, 93.06%, and 96.79%, and 95.45%, 94.35%, and 90.15% for cardiomegaly, other disease patterns, and normal CXRs, respectively.

CONCLUSION

Weakly supervised learning with deep CNN demonstrated high diagnostic performance in the classifying normal, cardiomegaly, and others disease patterns CXRs.

CLINICAL RELEVANCE/APPLICATION

Automated classifier with weakly supervision shows high diagnostic performance in classifying cardiomegaly from normal and others disease patterns CXRs, which could be used as a screening tool for cardiomegaly disease with CXR

SSJ21-01 Quantitative Flow Velocity Analysis of 1000 Frames Per Second (fps) High Speed Angiography (HSA) Image Sequences

Tuesday, Dec. 3 3:00PM - 3:10PM Room: N228

Participants
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PURPOSE

As minimally invasive image-guided endovascular interventions continue to replace invasive surgical procedures, quantification of parameters for impact evaluation such as blood velocity distributions and their changes due to the deployment of interventional devices become more important. We are developing a unique high spatial and high temporal resolution capability based on analysis of 1000 fps angiographic sequences for measuring such blood velocities in the intracranial vessels.

METHOD AND MATERIALS

A prototype system based on an Xcounter Actaeon photon counting detector (PCD) with 100 um pixels was used with a standard c-arm source set to 70 kVp, 100 mA to take a sequence of 1 ms exposures of a 3D-printed patient-specific aneurysm model connected to a pulsatile pump. Contrast was auto-injected into the phantom via a catheter maneuvered a short distance proximal of the aneurysm. Sequential frames were subtracted from one another creating a difference image where the contrast front would appear dark. Measurement of velocity from successive images was achieved by manually tracking the location of the center of mass of contrast fronts as they progressed through the phantom.

RESULTS

Over 200 individual points were sampled from the image sequence corresponding to different points of time and different locations throughout the phantom having varying vessel diameter. For this study, the average measured velocity for points sampled from the inflowing portion of the vessel was found to be 91.7 cm/s while for the outflow vessel the average velocity was 135.3 cm/s due to its reduced diameter. Points measured within the aneurysm sac had an average velocity of 80.0 cm/s, though directionality was highly dependent on location.

CONCLUSION

Detailed velocities of simulated intracranial blood flow as demonstrated here could be a valuable means of evaluating the impact of an interventional device deployment during planning, delivery, and post-deployment stages.

CLINICAL RELEVANCE/APPLICATION

A new way to measure intracranial vascular flow velocities with 1000 fps angiography has great potential to benefit the planning, conduct, and outcome of endovascular image guided interventions.

SSJ21-02 Analogous Lubberts Effect in Single Photon Counting Semiconductor Detectors

Tuesday, Dec. 3 3:10PM - 3:20PM Room: N228

Participants
Ke Li, PhD, Madison, WI (*Presenter*) Nothing to Disclose

PURPOSE

DQE loss due to depth (z)-dependent x-ray conversion gain and MTF in scintillator detectors was analyzed by G Lubberts half a century ago. The effect is associated with the spatial transport of optical quanta, which is not applicable to direct-conversion photon counting detectors (PCDs). However, mechanisms exist in PCDs to create variations of the MTF and the so-called x-ray multiplicity along z. The purpose of this work was study a Lubberts-like effect in PCDs and analyze the potential impacts on the detector design.

METHOD AND MATERIALS

Four major physical factors may contribute to depth-dependent PCD response: the escape fraction of K-fluorescent x-rays, height of voltage pulse generated by the motion of charge carriers, the lateral diffusion width of charge carriers, and the voltage (energy) threshold level. To analyze how the z-dependence of the PCD output is linked to each factor, a parallel + serial cascaded systems model of PCD was leveraged. Accuracy of the model in predicting DQE was experimentally validated using a CdTe-based PCD operated under 4 different radiation conditions and 40 threshold levels. Using the model as a theoretical tool, the impacts of each physical factor to the variation of PCD output along z was analyzed.

RESULTS

For a PCD with 2 mm CdTe, 3 μs mean electron lifetime, 20 keV low energy threshold, and 0.1 mm charge-collecting pixel electrode located at the back-end of CdTe, the Lubberts fraction (L) is 0.94 at zero-frequency and 0.91 at 5 lp/mm for a typical 120 kV CT spectrum. The Lubberts loss is primarily caused by the z-dependencies of K-escape fraction and electric (E) field; contribution of diffusion is negligible. When a front-end pixel design was used, an across-the-board improvement in L (>=4%) was achieved for the same input condition.

CONCLUSION

Compared with scintillator detectors, an improvement in the average Lubberts fraction was found in PCD, adding another benefit to this technology. The remaining small but non-negligible Lubberts loss is primarily caused by variations of K-escape fraction and E-field along z. Location of the pixel electrode needs to be optimized based on the input x-ray energy and pixel size in order to minimize the remaining Lubberts loss.

CLINICAL RELEVANCE/APPLICATION

As DQE is closely related to diagnostic image quality and dose efficiency, understanding the DQE-degrading Lubberts effect and engineering the corresponding remedy have direct clinical relevance.

SSJ21-03 Study of a Single-Shot Dual-Energy Flat Panel Detector with High Detective Quantum Efficiency

Tuesday, Dec. 3 3:20PM - 3:30PM Room: N228

Participants
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PURPOSE

Dual-energy (DE) imaging is well-known to aid in diagnosis by reducing anatomical noise and enabling material classification. Current approaches to DE imaging have trade-offs, such as motion artifacts due to the two exposures required or low sensitivity due to losses in a middle filter. Recently, a triple-layer flat panel detector (FPD) for use in single-shot DE imaging was proposed to address these trade-offs by eliminating motion artifacts while preserving high sensitivity. The purpose of this study is to evaluate the feasibility of such a detector by building and studying a prototype. Various image quality metrics are measured and clinical images are examined.

METHOD AND MATERIALS

An FPD prototype consisting of three stacked sensors each with its own cesium iodide (CsI) scintillator was used for all measurements. This detector generates three images per exposure: a digital radiography (DR) image -equivalent to one obtained with a conventional detector- and two tissue-subtracted (TS) images obtained through logarithmic subtraction: a bone and a soft-tissue image. To evaluate DR image quality, detective quantum efficiency (DQE) and modulation transfer function (MTF) were measured as per IEC 62220-1-1:2015 for multiple radiation quality (RQA) beams. The triple-layer detector's TS capabilities were qualitatively evaluated by studying three chest X-ray images obtained from an on-going clinical trial.

RESULTS

DQE and MTF on par with state-of-the-art single-layer DR detectors were observed across all RQA beams used, since the triple-layer design allows for a large total amount of CsI without increasing scintillator blur. The obtained clinical DE TS images showed good tissue separation and uniformity with no motion or alignment artifacts visible.

CONCLUSION

The high DQE and MTF measured indicate that the addition of DE capabilities is not detrimental to the main function of the triple-layer FPD as a DR detector, while the TS image quality indicates that it is a potential replacement to current DE technologies. We conclude that the triple-layer FPD design is promising for clinical use since both high-quality DR and DE images can be obtained in a single exposure.

CLINICAL RELEVANCE/APPLICATION

DE imaging is known to aid in diagnosis in certain clinical applications. The triple-layer FPD design is a compelling alternative to current technologies that could improve DE quality and adoption.

SSJ21-05 Comparison of Software for Retrospective Calculation of Applied Pressure in Mammography

Tuesday, Dec. 3 3:40PM - 3:50PM Room: N228

Participants
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Gerard J. den Heeten, MD,PhD, Amsterdam , Netherlands (*Abstract Co-Author*) Founder, SigmaScreening BV Scientific Advisor, SigmaScreening BV Patent Holder, SigmaScreening BV Stock options, Volpara Health Technologies Limited Medical Advisory Board, Volpara Health Technologies Limited

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CONCLUSION

The de Groot-script to calculate mean breast contact area is a useful tool for small datasets where obvious outliers can be removed after visual inspection, but should not be used in larger sets to prospectively predict the effect of the introduction of pressure-based compression in mammography.

Background

The subjectivity of 'appropriate' compression in mammography may cause concerns for variations in pain, dose and image quality. An objective compression guideline is possible by using a paddle with an indicator for the applied pressure (force per unit contact area). To study its impact on clinical practice, comparison with previously applied pressures is necessary. We compare two methods to retrospectively calculate pressure from mammogram pairs before (force-based) and after implementing the pressure-based paddle: Proprietary software (Volpara Analytics) and our own script (de Groot et.al., MedPhys 41: 023501).

Evaluation

Applied force was retrospectively obtained from the DICOM header of 826 randomly selected CC-view mammographic image pairs (2009: force-based, 2014: pressure-based). Mean breast contact area were calculated from all mammograms using Volpara and de Groot-script. Subsequently, applied pressure (force over contact area) was calculated. In both the force- and pressure-based group the applied pressure was higher with a much larger standard deviation when using de Groot-script compared to Volpara. (Force-based: Volpara 22.1±10.0 kPa, de Groot: 26.6±17.6 kPa, Pressure-based: Volpara 16.2±6.3 kPa, de Groot: 130.3±1888.0 kPa).

Discussion

The applied pressures as calculated with the de Groot-script in the pressure-based group were unrealistically high. In previous publication from our group, data obtained from de Groot-script were only used on small datasets after visual inspection of the results, something that is time-consuming in large datasets.

SSJ21-06 Material Characterization with Spectral Photon-Counting Radiography - An Experimental Approach

for Crystal Arthropathies

Tuesday, Dec. 3 3:50PM - 4:00PM Room: N228

Participants
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Spyridon Gkoumas, Baden-Daettwil, Switzerland (*Abstract Co-Author*) Employee, Dectris Ltd
Thomas Thuering, PhD, Taeferweg, Switzerland (*Abstract Co-Author*) Employee, Dectris Ltd
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PURPOSE

We aimed to assess whether spectral photon-counting radiography (SPCR) was able to differentiate the three most common crystals involved in crystal arthropathies, and secondly to compare SPCR with dual-energy CT (DECT).

METHOD AND MATERIALS

Industry-standard cylindrical solid rods of monosodium urate (MSU), calcium pyrophosphate (CPP) and calcium hydroxyapatite (HA) in three different clinically relevant concentrations (MSU: 200, 400 and 600 mg/ml, CPP and HA: 50, 100 and 200 mg/ml) were first imaged with SPCR, using a vendor X-ray tube and a prototype detector. Four energy thresholds were set at 15, 25, 30 and 35 keV. All samples were subsequently scanned with a dual-source dual-energy CT (DECT) of the latest generation. Respective attenuation values (AV), Hounsfield units (HU) and effective atomic numbers (Zeff) of the different rods were compared among each other and between imaging modalities.

RESULTS

MSU, CPP and HA showed statistically significant differences in AV, HU and Zeff with both imaging modalities (Zeff MSU: 6.52-6.96; CPP: 7.47-9.47; HA: 7.57-9.56). For each material, AV/HU/Zeff differed significantly among different concentrations (all $p < 0.001$; except between MSU at low vs. medium concentrations with DECT, $p = 1$). Mean Zeff measured with SPCR and DECT were comparable ($p = 0.9$). For each respective concentration, Zeff was significantly different between CPP and HA ($p <= 0.04$).

CONCLUSION

Characterization of the three most common crystals involved in crystal arthropathies is comparable between SPCR and DECT, with MSU clearly distinguishable from calcium-containing crystals. Zeff and attenuation values of CPP and HA show some overlap complicating their clear-cut differentiation. Future research should focus on findings in vivo.

CLINICAL RELEVANCE/APPLICATION

We present experimental results of a novel imaging technique approach for the characterization of crystalline compositions. This could impact the future diagnostic workup of crystal arthropathies, with inherent impact on patient management.

SSJ22

Physics (Photon Counting Detector CT)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: N226

CT PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sabee Y. Molloi, PhD, Irvine, CA (*Moderator*) Research Grant, Canon Medical Systems Corporation

Sub-Events

SSJ22-01 **Low Dose Ultra-High Resolution Sinus and Temporal Bone Imaging Using Photon-Counting Detector (PCD) CT and an Additional Tin Filter**

Tuesday, Dec. 3 3:00PM - 3:10PM Room: N226

Awards
Trainee Research Prize - Fellow

Participants
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PURPOSE

To reduce radiation dose while maintain high resolution in sinus and temporal bone (T-bone) CT scans using photon-counting detector (PCD) CT with an additional tin (Sn) filter.

METHOD AND MATERIALS

A head phantom was scanned on a clinical energy-integrating detector (EID) CT and a PCD-CT system. EID-CT scans were acquired using routine clinical protocols with120kV, 13.5 mGy for sinus, and 120kV, 49 mGy for T-bone exams which also employed a comb filter for ultra-high resolution (UHR) imaging. PCD-CT data were acquired using UHR mode (32x0.25 mm collimation), Sn-100kV, 10 mGy for both sinus and T-bone acquisitions. Patients referred for clinically indicated sinus and T-bone exams were scanned with PCD-CT following their clinical scans. Sinus scans were performed using 120kV, 95mAs, 13.6mGy for EID-CT, and Sn-100kV, 350 mAs, 7 mGy for PCD-CT. T-bone images were acquired using 120kV, 300mAs, 65mGy on EID-CT (comb filter-based UHR), and Sn-100kV, 500 mAs, 10 mGy on PCD-CT using UHR mode. Sinus images were reconstructed using H70 kernel, 0.75mm slice thickness, and T-bone images were reconstructed using a U70 kernel, 0.6mm slice thickness. Image contrast and noise were measured in uniform regions. Dose reduction was evaluated using the percentage change in image noise between EID-CT and PCD-CT for a given reconstruction kernel.

RESULTS

Sinus phantom results showed lower noise on PCD-CT (110 HU, 10mGy) compared to EID-CT (150 HU, 13.5mGy), yielding a total dose reduction of 72% if matched image noise is targeted. Phantom results using T-bone protocol showed lower image noise for PCD-CT (129 HU, 10 mGy) at 79% lower dose compared to EID-CT (148 HU, 49mGy). Sinus patient images showed lower noise on PCD-CT (129 HU, 7mGy) than EID-CT (152 HU, 13.6mGy) at 49% lower acquisition dose for PCD-CT without compromising spatial resolution. At matched image noise and kernel, this corresponds to a total dose reduction of 76%. Patient T-bone images showed comparable image noise between EID-CT (65mGy) and PCD-CT (10mGy) at six-fold reduced dose for PCD-CT.

CONCLUSION

We have demonstrated 72 to 84% dose reduction for sinus and T-bone imaging using PCD-CT with an additional Sn filter in comparison to the current clinical protocols.

CLINICAL RELEVANCE/APPLICATION

Using ultra-high resolution PCD-CT with additional tin filter, the image quality can be preserved while the patient radiation dose can be reduced to about one-fifth of the current clinical dose.

SSJ22-02 Comparison of Low Dose Image Quality in Conventional and Photon-Counting CT

Tuesday, Dec. 3 3:10PM - 3:20PM Room: N226

Participants
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PURPOSE

To compare the task-based performance of conventional (EID) CT and photon-counting CT (PCCT) in low dose imaging conditions.

METHOD AND MATERIALS

The largest section of a multi-tier phantom (Mercury Phantom, Gammex) was imaged using a prototype photon-counting CT scanner (Siemens, Germany) containing conventional and photon-counting subsystems. The largest section (36 cm diameter) was used to simulate the most difficult clinical imaging scenario. The phantom contains two sections: a uniform section for noise measurement and a section with five cylindrical inserts (8.5 mg/mL I, air, water, polystyrene (fat), bone) for resolution and detectability measurements. Images were acquired at matched low doses (1.7, 2, 2.5, 3, 4, 6 mGy CTDIvol) and reconstructed with a clinical protocol (medium-soft kernel (I40), 3 mm slices). An automated program was used to evaluate noise in the noise region and contrast, contrast-to-noise ratio (CNR), and detectability index (d') of bone and iodine inserts.

RESULTS

Noise was slightly higher in EID images (29.9-53.7 HU) than PCCT images (28.7-51.7 HU). Photon-counting images showed improved contrast in both bone (9.5%) and iodine inserts (12.9%) leading to improvements in CNR of 10.8% for bone and 14.0% for iodine. CNR improvement was found to be significant ($p < .01$) for both inserts. Detectability index improved for both bone (3.1%) and iodine (10.1%) with p-values of .05 and .01 respectively.

CONCLUSION

Photon-counting CT images had slightly lower noise and improved contrast compared to conventional CT at low doses. This further translated into improved contrast-to-noise ratio and detectability index for both iodine and bone.

CLINICAL RELEVANCE/APPLICATION

Photon-counting CT offers improved performance over conventional CT for low dose imaging tasks in terms of noise, contrast-to-noise ratio, and detectability index.

SSJ22-03 K-edge Photon Counting CT-Based Virtual Nonenhanced CT Imaging

Tuesday, Dec. 3 3:20PM - 3:30PM Room: N226

Participants
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PURPOSE

Virtual noncontrast (VNC) images derived from contrast enhanced dual energy CT (DECT) data can obviate the need for a separate noncontrast CT scan. An important premise of DECT-based VNC imaging is that the attenuation coefficient of an arbitrary material can be represented by a linear combination of two energy-dependent basis functions. However, this assumption is violated by the presence of iodine (I) K-edge. As a result, erroneous subtractions occur to calcium in the VNC images. The purpose of this work was to investigate the use of photon counting CT (PCCT) to accomplish K-edge PCCT imaging to improve the quantitative accuracy of VNC reconstruction.

METHOD AND MATERIALS

An experimental PCCT system was used to scan objects with known material types and concentrations: 50 and 25 mg/mL $CaCl_2$, 20 and 10 mg/mL iodine, and a mixture of $CaCl_2$ (25 mg/mL) and iodine (10 mg/mL). The energy bin width and position (bin 1: [15, 34] keV; bin 2: [34, 55] keV; bin 3: [55, 80] keV) were optimized to provide the highest overall accuracy for iodine and $CaCl_2$ concentration estimation. Similarly, the beam filtration (160 mg/cm2 of iodine) was optimized to achieve K-edge imaging. Three-material decomposition was performed using the multi-bin PCCT data. The CT number enhancement due to iodine was found from the iodine basis image, and was then subtracted from the full energy bin attenuation image to generate the final VNC image. These were then compared with VNC images from a commercial DECT system with projection domain material decomposition.

RESULTS

For the two objects that do not contain iodine (50 and 25 mg/mL CaCl2), their CT numbers were incorrectly reduced by 130±5 and 67±5 HU in DECT-based VNC images. The CT number errors for 20 and 10 mg/mL iodine, and the CaCl2-iodine mixture were -5±7, -3±5, and -74±7 HU, respectively, in DECT VNC images. In comparison, CT number errors of K-edge PCCT VNC images were -2±2 HU (50 mg/mL CaCl2), 3±13 HU (25 mg/mL CaCl2), -4±12 HU (20 mg/mL iodine), -4±4 HU (10 mg/mL iodine), and -3±8 HU (iodine-CaCl2 mixture).

CONCLUSION

K-edge PCCT-based VNC imaging effectively removes iodine signal while preserving the CT number accuracy of non-iodine structures such as bone and calcifications.

CLINICAL RELEVANCE/APPLICATION

VNC images derived from contrast enhanced PCCT can obviate the need for a separate noncontrast CT scan, reducing dose and scan time and providing important baseline tissue attenuation information.

SSJ22-04 Material Decomposition of Clinical Full-Field Photon Counting CT Data Using a 'One-Step' Direct Estimation Approach

Tuesday, Dec. 3 3:30PM - 3:40PM Room: N226

Participants
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PURPOSE

To demonstrate feasibility of material decomposition of clinical photon-counting head CT data using the constrained 'one-step' Spectral CT Image Reconstruction (cOSSCIR) method. The cOSSCIR method directly estimates the basis material images from the photon counts data, which allows constraints to be placed on the basis images to improve the decomposition.

METHOD AND MATERIALS

Head CT data of a human subject was acquired on a clinical full-field photon-counting CT prototype with silicon detectors (Prismatic Sensors, Sweden). Calibration data of a polyvinyl chloride (PVC) and polyethylene step wedge phantom was also acquired and used to estimate the effective spectra and a pileup correction for each energy bin. The cOSSCIR algorithm directly estimated the PVC and polyethylene basis material images from the photon-counts data using an optimization-based algorithm. The basis image were combined to form virtual monoenergetic images.

RESULTS

Basis material images of PVC and polyethylene were successfully reconstructed by the cOSSCIR algorithm, representing the composition of bone and soft tissue, respectively. Additional investigations are underway to evaluate the performance of cOSSCIR in correcting metal artifacts due to dental hardware and to compare the results to other material decomposition approaches

CONCLUSION

The results demonstrate feasibility of proposed cOSSCIR algorithm to reconstruct basis material images from clinical photon-counting head CT data.

CLINICAL RELEVANCE/APPLICATION

The cOSSCIR method previously demonstrated the ability to reduce metal artifacts in experimental photon counting images of phantoms. This study demonstrates the feasibility of using cOSSCIR for clinical head CT images, which can be degraded by dental metal artifacts.

SSJ22-05 Scan Protocol Design and k-Edge Imaging in a Clinical Whole-Body Photon-Counting CT

Tuesday, Dec. 3 3:40PM - 3:50PM Room: N226

Participants
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PURPOSE

To investigate the influence of threshold settings on the contrast-to-noise ratio (CNR) in a whole-body photon-counting (PC) CT system using potential novel high-Z contrast agents and to propose accordant scan protocols for clinical practice.

METHOD AND MATERIALS

Semi anthropomorphic phantoms of different sizes (XS=10×10 cm, S=20×30 cm, M=25×35 cm, L=30×40 cm) are measured at tube voltages between 80 kV to 140 kV using a prototype photon-counting CT system (SOMATOM CounT, Siemens, Germany). The phantoms are equipped with vials containing potential high-Z contrast agents (elements I, Gd, Yb, W, Bi). The PC detector intrinsically acquires data using two energy bins with the first bin covering an energy range of [20 keV, T] and the second bin covering [T, eU] with U being the tube voltage. The threshold T is varied in steps of 5 keV between the available 50 keV to 90 keV. The resulting bin images are combined in a statistically optimal manner to maximize the CNR of the contrast agent relative to the soft tissue background. The resulting CNR is evaluated as figure of merit in all bins and the combined images for all tube voltages, phantom sizes and contrast agents.

RESULTS

While CNR varies in individual bins as a function of threshold settings, the CNR in the combined images is nearly constant and independent of the thresholds used for image acquisition. This holds true for each given combination of patient size and tube voltage and is verified for all available contrast media in measurements and accompanying simulations. Furthermore, the effect of the agents' k-edges can be seen in the acquired data. Potentially, the remaining freedom to set T can be used to enable clinical k-edge imaging which is illustrated using Ytterbium.

CONCLUSION

An adaption of threshold settings for patient size or tube voltage is not required in clinical practice as an image with maximum CNR can always be provided by combination of bin images. Hence, the thresholds could be chosen on-demand to enable other applications, e.g. material decomposition with high-Z contrast agents exploiting k-edges of the elements used therein.

CLINICAL RELEVANCE/APPLICATION

Maximum CNR in PC-CT can always be provided independently of the thresholds. Hence, novel scan protocols can be designed enabling applications on-demand, e.g. using high-Z contrast agents.

SSJ22-06 Experimental Feasibility of Photon-Counting Spectral X-Ray Phase-Contrast Computed Tomography

Tuesday, Dec. 3 3:50PM - 4:00PM Room: N226

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PURPOSE

To evaluate the potential of the combination of photon-counting spectral CT and grating-based differential phase-contrast (gbDPC) CT.

METHOD AND MATERIALS

We propose a novel imaging approach, namely spectral differential phase-contrast CT, which merges the modalities of attenuation based and phase-contrast based imaging. Thereby, we introduce a new polychromatic forward-model for spectral phase-contrast imaging with multi-bin photon counting detectors, which uses spectral attenuation and phase-contrast information simultaneously by correlating the electron density determined by each modality. We performed a dual-energy gbDPC CT scan of a phantom containing tissue simulating materials. The data was acquired with a photon-counting detector (FliteX1, Direct Conversion AB, Danderyd, Sweden) equipped with two energy thresholds per pixel, which were placed at 23 and 64 keV. The phase contrast information was extracted by using a Talbot-Lau interferometer in step-and-shot mode. The phantom has been imaged with the following parameters: 140 kVp, 8000mAs, 1200 tomographic angles, 5 phase-steps per angle.

RESULTS

Similar to conventional spectral CT the inversion of the proposed forward-model yields basis-material line-integrals, which are reconstructed afterwards to obtain material specific volume data. Compared to conventional spectral X-ray imaging a considerably lower noise level in the basis-material images can be observed in experimental measurements. We observe a reduction of the variance by a factor of up to 3 for a constant radiation dose at the position of the sample without a significant loss in image resolution. Apart from basis-material images, the proposed method provides X-ray dark-field images, which arise due to small-angle scattering at microscopic structures.

CONCLUSION

Spectral differential phase-contrast CT yields material-specific images with strongly reduced image noise compared to conventional spectral CT. Different from conventional spectral CT an additional X-ray dark-field image is obtained.

CLINICAL RELEVANCE/APPLICATION

The basis-material images obtained in spectral CT suffer from noise amplification when compared to conventional CT images. Spectral differential phase-contrast CT is capable of diminishing this noise amplification, providing material specific images with

strongly reduced radiation dose delivered to the patient.

Printed on: 10/29/20

SSJ23

Physics (CAD/Machine Learning, Quantitative Imaging)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: N229

PH BQ AI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSJ23-01 Automatic Prediction of Coronary Heart Disease Events Using Coronary and Thoracic Aorta Calcium among African Americans in the Jackson Heart Study

Tuesday, Dec. 3 3:00PM - 3:10PM Room: N229

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PURPOSE

Coronary artery calcium (CAC) and thoracic aorta calcium (TAC) are predictors of CHD events. Given that CAC and TAC identification is time-consuming, methods for automatic quantification in CT have been developed. Hence, we investigate whether subjects who will experience a CHD event within 5 years from acquisition of cardiac CT can be identified using automatically extracted calcium scores.

METHOD AND MATERIALS

We included 2532 participants (age 59±11, 31% male) of the Jackson Heart Study without CHD history: 111 participants had a CHD event within 5 years from CT acquisition, defined by death certificates and medical records. For each subject a cardiac CT scan(GE Healthcare Lightspeed 16Pro, 2.5mm slice thickness, 2.5mm increment, 120kVP, 400mAs, ECG-triggered, no contrast) was available. Per-artery Agatston CAC scores (left anterior descending, left circumflex, right coronary artery) and TAC volume were automatically extracted with a previously developed AI algorithm. Scores were log transformed, combined with age and sex and all continuous variables were normalized to zero-mean and unit variance. We evaluated 3 models with 3-fold cross-validation where subjects were classified according to occurrence of CHD event using LASSO regression with 1) age, sex and CAC scores, 2) age, sex and TAC scores, and 3) all variables. Performance was evaluated with the area under the ROC curve (AUC).

RESULTS

In 1468 (58%) subjects no CAC and in 1240 (49%) no TAC was found. In remaining scans, median (range) CAC score was 78.7(1.6-5562.1): 49.5(0.0-4569.4), 0.0(0.0-2735.3), 3.9(0.0-3242.7) in the LDA, LCX and RCA, respectively. Median TAC volume was 116.8(4.7-7275.9). Prediction of CHD events using Model 1, 2 and 3 resulted in an AUC (95% CI) of 0.721(0.672-0.771), 0.735(0.686-0.785) and 0.727(0.678-0.776). Differences between the ROC curves were not significant (Model 1 and 2: p=0.80; 1 and 3: p=0.29; 2 and 3: p=0.76).

CONCLUSION

Identification of subjects at risk of a CHD event can be performed using automatically extracted CAC or TAC scores from cardiac CT.

CLINICAL RELEVANCE/APPLICATION

Prediction of CHD events from cardiac CT using TAC instead of CAC is feasible and may be advantageous in scans acquired without ECG-triggering or low image resolution.

SSJ23-02 Identifying Changes in Regional Autonomy of the Brain Using Resting State-Functional MRI in Patients with HIV-Associated Neurocognitive Disorder

Tuesday, Dec. 3 3:10PM - 3:20PM Room: N229

Participants
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PURPOSE

To evaluate a machine learning framework using Mutual Connectivity Analysis (MCA) for investigating changes in brain regional autonomy in patients with HIV-Associated Neurocognitive Disorder (HAND) using resting-state fMRI (rsfMRI).

METHOD AND MATERIALS

A total of 120 rsfMRI runs (3T, EPI sequence, TR=1.65s, 250 volumes, 3 runs per subject) were acquired in a cohort of 40 age-matched subjects (20 HIV+, 16 of whom had HAND symptoms, 20 HIV- controls). Regional activity was estimated by averaging voxels belonging to regions obtained using the Automated Anatomical Labeling atlas. Using MCA (DSouza et al, NeuroImage 2018), we investigate, if discernable changes exist in self-influence of brain regions, i.e. regional autonomy, once patients show HAND symptoms. MCA reveals non-linear measures of influence, which conventional correlation-based approaches cannot estimate. With these measures as features, a support vector machine classifier was trained to distinguish between healthy controls and subjects with HAND. Additionally, feature selection revealed regional connections that differed between the groups. For both feature selection and classification, strict data separation (90% train/10% test) was carried out in a 100-iteration cross-validation scheme. Area Under the receiver operator characteristics Curve (AUC) and accuracy (ACC) was used to quantitatively evaluate diagnostic quality.

RESULTS

Classification with MCA measures performed significantly better ($p<0.05$, Wilcoxon signed-rank test) with AUC=0.86±0.17 and ACC=0.78±0.16 than conventional correlation analysis with AUC=0.58±0.29 and ACC=0.57±0.18. Feature selection revealed regions of the frontal cortex, temporal pole, and default mode network affected by HAND, which is in line with other literature on HAND.

CONCLUSION

Our results suggest that an analysis capturing regional autonomy is more discriminative than conventional measures for imaging-based identification of patients with HAND, as MCA-derived nonlinear network measures significantly outperform correlation-based analysis in capturing relevant differences between patient groups. In addition, studying relevant features can identify specific brain regions affected by HAND-related activity changes.

CLINICAL RELEVANCE/APPLICATION

MCA is a novel method for investigating brain connectivity changes in HIV-related neurologic disease. Such changes can potentially serve as useful imaging biomarkers for therapy monitoring of HAND.

SSJ23-03 Independent Prospective Evaluation of a Quantitative MRI Biomarker for Early Response Prediction in Treatment of Multiple Myeloma

Tuesday, Dec. 3 3:20PM - 3:30PM Room: N229

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PURPOSE

Predicting early response to treatment of multiple myeloma (MM) is challenging. This study evaluated the generalizability of a MRI biomarker that we developed for this task using a prospective test set from an ongoing two-site study.

METHOD AND MATERIALS

With IRB approval and informed consent, 35 pairs of pre- and post-treatment spinal MR scans with an average interval of 2.4±1.1 months were prospectively collected from 35 MM patients who underwent a variety of therapeutic regimens in two hospitals in US and China. The MRI data were acquired with GE or Philips 1.5 T or 3.0 T scanners. We have previously developed a 3D dynamic intensity entropy transformation (DIET) method to transform MR signal to a voxelwise quantitative entropy enhancement value, from which predictor variables were derived and combined into a DIET response index (qERI) to assess treatment response. The qERI was trained in a retrospective data set with 64 MRI cases from patients who underwent bone marrow transplant, and achieved an area under the receiver operating characteristic (ROC) curve (AUC) of 0.89 in leave-one-case-out testing in our previous study. In this study, we applied our DIET method directly without re-training to the pairs of MRI scans of 35 new patients to predict clinical outcomes.

RESULTS

Of the 35 patients, 22 and 13 were clinically diagnosed as responders and non-responders, respectively, by using International Myeloma Working Group Uniform Response Criteria (URC) in more than 6-month fellow-up. Using a decision threshold previously chosen with the developmental set, the qERI correctly predicted 20 responders (90.9% sensitivity) and 10 non-responders (76.9% specificity) at an AUC of 0.79. Of 20 qERI-responders, URC initially determined 2 as non-responders at 3-month time point and re-assessed them as responders in 6-month follow-up. The agreement between the DIET method and the clinical outcome reached 0.86 (30 of 35) with a kappa value of 0.69.

CONCLUSION

The substantial agreement between qERI prediction and clinical outcomes demonstrated that qERI has the potential for early assessment of the clinical outcome of MM response, which usually requires longer-term follow-up, to a wide variety of treatment regimens.

CLINICAL RELEVANCE/APPLICATION

Quantitative MRI-based biomarker may improve the accuracy and efficacy for early assessment of treatment response for MM, allowing clinicians to optimize therapy of individual patients.

SSJ23-04 Standardization in Quantitative Imaging: A Multi-Center Comparison of Radiomics Feature Values Obtained by Different Software Packages on Digital Reference Objects and Patient Datasets

Tuesday, Dec. 3 3:30PM - 3:40PM Room: N229

Participants
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PURPOSE

Radiomics features are being increasingly proposed for clinical applications such as predicting patient response to therapy or prognosis. The purpose of this work was to investigate the agreement among these features when computed by several groups utilizing different software packages with standardized feature definitions and common image datasets designed to identify possible differences.

METHOD AND MATERIALS

Nine sites from the NCI's Quantitative Imaging Network PET-CT working group participated in this project. Nine common quantitative imaging features were selected for comparison including features that describe morphology, intensity, shape and texture. A standard lexicon developed by the International Biomarker Standardisation Initiative (IBSI) was adopted as the feature definition reference. The common image data sets were: (a) two sets of 3D Digital Reference Objects (DROs) developed specifically for this effort (200mm and 50 mm diameter objects): a uniform sphere, a sphere with intensity variations, and a complex shape object with uniform intensity; and (b) 10 patient image scans from the LIDC dataset using a specific lesion in each scan. To eliminate variation in feature values caused by segmentation differences, each object (DRO or lesion) was accompanied by a Volume of Interest (VOI), from which the features were calculated. Feature values for each object (DRO or lesion) were reported. The percent coefficient of variation (CV) was calculated across software packages for each feature on each object.

RESULTS

10 sets of results were obtained for the DROs. Six of the nine features demonstrated excellent agreement with CV < 1%. Larger variations (CV>= 13%) were observed for the remaining three features. Only 2 sets of results from patient datasets were obtained so far, but similar trends were observed with the exception being kurtosis, which showed higher CV than in the DROs.

CONCLUSION

By computing common radiomics features on a common set of objects using the same VOIs for each object, we have shown that while several features agree strongly across software packages, others do not. This highlights the value of feature definition standardization as well as the need to further clarify definitions for some features.

CLINICAL RELEVANCE/APPLICATION

Remaining disagreement in the community as to radiomic feature definitions and implementation details should be resolved before radiomic analysis becomes part of routine practice.

SSJ23-05 Participants

Liver and Lung Texture Feature Redundancy in Conventional and Photon-Counting CT

Tuesday, Dec. 3 3:40PM - 3:50PM Room: N229

Faraz Farhadi, Bethesda, VA (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate relative contribution of different acquisition and reconstruction protocols for the extraction of radiomics features of lung and liver, in photon-counting (PCCT) and energy integrated detector (EID) CT.

METHOD AND MATERIALS

A texture phantom containing lung and liver texture modules was imaged with a prototype photon-counting CT scanner (Siemens, Germany) using conventional and photon-counting subsystems. The phantom was scanned at 80 and 140 kV, matching clinical standards for lung and abdominal imaging respectively, and 5 different mAs values (14, 50, 100, 200, 274). Images were reconstructed with several different kernels appropriate for each clinical task, with uniform slice thickness and pixel size. Three 4.1 x 4.1 x 8 mm3 regions of interest (ROIs) were extracted from each image and analyzed for twenty texture features. Feature redundancy was defined as features presenting an intra-class correlation coefficient of >0.9.

RESULTS

For liver texture, all features extracted from EID data showed some redundancy while three features (Variance, Gray Level Non-Uniformity, Short Run High Gray Level Emphasis) extracted from PCCT data did not correlate with any other features. Fifteen of twenty features showed less (average: 33%) redundancy in PCCT data when compared to EID data, and 3 were more redundant (average 19%). For lung texture, all features extracted from both PCD and EID images showed some level of redundancy. Eleven features showed less (average 16%) redundancy while 8 had increased (average 20%) correlation with other features.

CONCLUSION

Radiomic features extracted from photon counting data showed less redundancy between individual texture features extracted from liver but not for lung.

CLINICAL RELEVANCE/APPLICATION

Sensitivity of radiomics features to CT acquisition and reconstruction parameters can introduce nonbiological differences to these values. Improvements in CT acquisition techniques could resemble more accurate representation of biologically important features.

SSJ23-06 Predictive Ability of Radiomic Features Calculated Using 2D versus 3D Region-of-Interest: A Multi-Energy CT Study of Lymphadenopathy in Head and Neck Cancer Patients

Tuesday, Dec. 3 3:50PM - 4:00PM Room: N229

Participants
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Martin Vallieres, PHD, Montreal, QC (*Abstract Co-Author*) Nothing to Disclose
Caroline Reinhold, MD, MSc, Montreal, QC (*Abstract Co-Author*) Nothing to Disclose
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Jan Seuntjens, PHD, Montreal, QC (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Examine the hypothesis that radiomic features calculated using entire tumor volume as region-of-interest (ROI) are more predictive than features based on the central tumor slice.

METHOD AND MATERIALS

This study concerns the use of primary tumor radiomic features for predicting cervical nodal metastases. Dual energy CT data from 87 patients with head-and-neck squamous-cell-carcinoma were reconstructed at 21 energies (40, 45... 140 keV). Each of the 94 matrix-derived texture features was calculated 64 ways (4 voxel sizes, 4 binning algorithms, 4 gray level discretizations), in 2D and 3D. A promising feature was defined as having absolute Spearman correlation > 0.3 with the outcome. The number of such features was plotted vs energy, for 2D and 3D. The correlation between the same feature in 2D and 3D was calculated, and the median correlation value for a feature set was plotted vs energy. Feature sets used were (a) all features, and (b) promising features in 2D/3D. Net improvement fraction (NIF) was defined as number of features more predictive in 2D minus number of features more predictive in 3D divided by total features. This was plotted vs energy. To evaluate the relation of performance to tumor size, the entire analysis was performed on 3 cohorts: (A) all 87 patients, (B) patients with fewer than median number of tumor slices, (C) patients with more than median number of tumor slices.

RESULTS

For cohorts (A) and (C), the number of promising features were greater in 2D than in 3D; the opposite was seen for (B). Correlation between 2D and 3D features was best for (A) and worst for (C). NIF was positive for (A) and (C), i.e., 2D better than 3D, but negative for (B). While some curves show energy dependence, the stated results are true for all energies.

CONCLUSION

For our dataset, 3D features only outperform 2D features for small tumors (fewer than median number of slices). For large tumors or all tumors considered together, 2D outperforms 3D. A possible explanation is that the heterogenous parts of the tumor are key for radiomic discrimination, reflecting the "tumor habitat", and for larger tumors, these are less well represented in the whole volume.

CLINICAL RELEVANCE/APPLICATION

Counter-intuitively, whole tumor volume radiomic analysis may not be the ideal approach. Central-slice-only analysis or sub-segmentation may be required for optimal radiomic biomarker development.

Printed on: 10/29/20

SSJ24

Radiation Oncology (Gastrointestinal Malignancies)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S402AB

GI RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Edward Y. Kim, MD, Seattle, WA (*Moderator*) Nothing to Disclose
Tarita O. Thomas, MD,PhD, Maywood, IL (*Moderator*) Nothing to Disclose

Sub-Events

SSJ24-01 Radiomics of Sulfur Colloid SPECT/CT to Predict Radiation-Induced Hepatotoxicity in Hepatocellular Carcinoma Patients

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S402AB

Participants
Stephanie K. Schaub, MD, Seattle, WA (*Presenter*) Nothing to Disclose
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PURPOSE

Wide variability exists in our ability to predict radiation-induced liver disease (RILD) in hepatocellular patients (HCC) treated with radiotherapy (RT). An unmet need exists for objective metrics to risk stratify patients, especially among those at highest risk with baseline Child-Pugh (CP)-B/C cirrhosis. We hypothesized that a radiomic signature derived from 99m-Tc sulfur colloid sulfur colloid (SC) SPECT/CT scans could inform on RILD risk prediction in HCC patients.

METHOD AND MATERIALS

92 consecutive HCC patients with underlying cirrhosis treated with RT (n=45 SBRT; n=47 proton RT) were retrospectively reviewed for clinical data including CP score, prior liver-directed therapy (LDT), vascular invasion, gross tumor volume (GTV), and RILD-specific death. Pre-treatment SC SPECT imaging of the uninvolved liver was mined to obtain 33 radiomic features. Univariate analysis was performed using Fine & Gray competing risk regression models to evaluate associations between radiomic features and RILD-death, with tumor progression, additional LDT, and non-RILD deaths treated as competing risks. Bonferroni multiple testing adjustment was applied such that a=0.05/33.

RESULTS

Patients had 33% CP-B/C class, 32% vascular invasion, 52% prior LDT, and median GTV was 33cc. During a median follow-up of 11 months, 8 RILD-related deaths occurred, all in patients with CP-B/C. 24/33 radiomic features were significantly associated with RILD-death ($p<0.0015$), with the strongest predictors being dissimilarity and zone percentage (both HR 0.1 per 1-SD increase), which measure image heterogeneity at the locoregional level. In contrast, the only clinical feature predictive of RILD-death was CP-B/C. Within the CP-B/C subgroup (n=30), 8 features retained statistical significance for RILD-death risk prediction, with kurtosis being the most significant (HR 1.4, $p<0.0001$). Among these patients, 6/15 with kurtosis above the median had RILD-death compared with 2/15 with kurtosis below the median. Further multivariate analysis was not performed due to few RILD-deaths.

CONCLUSION

Radiomic SC SPECT signatures may provide an objective biomarker for predicting RILD-specific death that may further stratify risk beyond Child-Pugh class.

CLINICAL RELEVANCE/APPLICATION

Radiomic signatures derived from pre-treatment sulfur colloid SPECT/CT may offer improved hepatotoxicity risk prediction in hepatocellular carcinoma patients treated with radiotherapy.

SSJ24-02 Recurrence and Patient-Related Factors in Hepatocellular Carcinoma Patients Treated with Stereotactic Body Radiation Therapy

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S402AB

Awards

Trainee Research Prize - Resident

Participants
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PURPOSE

Stereotactic Body Radiation Therapy (SBRT) is used in patients with HepatoCellular Carcinoma (HCC).In this study,we evaluate factors associated with failure.

METHOD AND MATERIALS

This is a retrospective analysis of HCC patients treated between 6/2007 and 1/2017. Failure was defined as: in-field (within 80% isodose line), out-field (outside 80% isodose line within the liver), and distant (outside the liver). Biological effective dose (BED) was calculated using alpha/beta = 10. Absolute lymphocyte count (ALC) nadir was defined as the lowest ALC within 2 months after SBRT and low ALC nadir was described as ALC <0.5 k cell/uL. Statistical analysis was done using chi-squared testing, logistic regression, and Kaplan-Meier methods.

RESULTS

113 patients with a median age of 63 years (IQR 57-69 years) were included. 71% were male; 72% had Child Pugh A, 61% had ECOG of 1 and 13.2% received liver transplant. The most common cause of HCC was hepatitis C (59%).The median tumor size was 25 mm (range 11-148 mm). The median dose of SBRT was 46.5 Gy (range 20-50 Gy) with median BED of 112.5 (range of 72-124.8). With median follow-up of 22 months (range 0-122), 26 (23%) of patients had failure: 5 (19%) were in-field, 16 (62%) were out-field, and 7 (27%) were distant metastases. 2 patients had concurrent in- and out-field failure. Progression free survival was 20.5 months (range 2-97 months) and the mortality rate was 36% and 54% in patients with any type of failure. In univariate analysis, pre-treatment alpha fetoprotein (AFP), on-treatment AFP and International Normalized Ratio (INR) were associated with risk of any failure (p=0.02, p=0.04 and p=0.04). 3-month post-treatment AFP was associated with risk of distant failure (p=0.03). Pre-treatment AFP was associated with any failure in multivariate analysis (p=0.01). BED or dose were not associated with any failure. Patient with low ALC nadir had lower overall survival (OS, 14.5 months versus 28 months, p-value=0.006). OS decreased to 9.5 months in patients with ALC nadir of <0.2 k cell/uL. In-field failure was associated with improved OS (p=0.03) and distant failure with higher rate of mortality (p=0.0001).

CONCLUSION

Pre-RT and on-treatment AFP in addition to INR can predict future failure. Survival can be impacted by low ALC nadir.

CLINICAL RELEVANCE/APPLICATION

Pre-RT AFP and INR can predict failure.Lower ALC nadir can impact survival in HCC patients treated with SBRT.

SSJ24-03 Developing a Prediction Model Based on MRI for Pathological Complete Response after Neoadjuvant Chemoradiotherapy in Locally-Advanced Rectal Cancer

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S402AB

Participants
Lijuan Wan, Beijing, China (*Presenter*) Nothing to Disclose
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PURPOSE

The aim of this study was to build an appropriate diagnostic model for predicting pathological complete response (pCR) after neoadjuvant chemoradiotherapy (nCRT) in patients with locally advanced rectal cancer (LARC) by combining magnetic resonance imaging (MRI) parameters with clinical factors.

METHOD AND MATERIALS

Eighty-four patients with LARC who underwent MR examination before and after nCRT were enrolled in this study. MRI parameters including cylindrical approximated tumor volume (CATV) and relative signal intensity of tumor (rT2wSI) were measured, corresponding reduction rates (RR) were calculated, as well as MR tumor regression grade (mrTRG) and other conventional MRI parameters were assessed. Logistic regression analysis with lasso regularization were performed and the appropriate prediction model for pCR was built up. An external cohort of thirty-six patients was used as the validation group for testing the model. Receiver operating characteristic (ROC) analysis was used to assess the diagnostic performance.

RESULTS

In the development and the validation group, 17 patients (20.2%) and 11 patients (30.6%), respectively, achieved pCR. Two CATV related parameters (CATVpost and CATVRR), one rT2wSI related parameters (rT2wSIRR), and mrTRG were the most important parameters for predicting pCR and were retained in the diagnostic model. In the development group, the area under the receiver-operating characteristic curve (AUC) for predicting pCR is 0.88 (95% CI 0.78-0.97, p<0.001), with a sensitivity of 82.4% and a specificity of 83.6%. In the validation group, the AUC is 0.84 (95% CI 0.70-0.98, p=0.001), with a sensitivity of 81.8% and a specificity of 76.0%.

CONCLUSION

A diagnostic model including CATVpost, CATVRR, rT2wSIRR, and mrTRG was useful for predicting pCR after nCRT in patients with LARC and can increase the confidence of the organ-preserving strategy.

CLINICAL RELEVANCE/APPLICATION

Our study dealt with building an appropriate diagnostic model for predicting pCR in patients with LARC. We proved that parameters like cylindrical approximated tumor volume (CATV) after nCRT (CATVpost) and reduction rate of CATV (CATVRR) are also useful in assessing pCR. These findings could contribute to the medical community by enabling prescription of a patient-tailored treatment.

SSJ24-04 Evaluation of Pre-Treatment MR Elastography for the Prediction of Radiation-Induced Liver Disease

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S402AB

Participants
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PURPOSE

MR elastography (MRE) is an established noninvasive imaging technique for quantifying liver stiffness for diagnosing fibrosis. The study purpose was to evaluate whether liver stiffness (LS) using MRE is associated with risk of developing radiation induced liver disease (RILD) in patients receiving radiation therapy (RT) for liver tumors.

METHOD AND MATERIALS

We identified patients who received RT (>=20 Gy) between 2010 and 2018 for primary liver cancer (hepatocellular or cholangiocarcinoma) or liver metastases, had an MRE exam <=6 months prior to RT, and had post-RT labs. LS was calculated as the mean across ROIs on 4 MRE slices. Based on previous studies, LS<3 kPa was considered normal and LS>=3.0 kPa as representing fibrosis. RILD was defined as an increase in Child-Pugh (CP) score of >=2 from baseline within 6 months of RT. Univariate Cox models were used to assess correlation.

RESULTS

95 patients were identified. Median age: 65 years, range [30,87]. 48 had primary liver cancer and 47 had liver metastases. Mean pre-RT LS was 3.9 kPa [1.8, 8.7]. Mean LS for patients with primary vs. metastatic tumors was 5.0 kPa vs 3.0 kPa (p<0.001). 19 patients (20%) developed RILD. Mean pre-RT LS was 5.1 kPa for patients who developed RILD vs. 3.6 kPA for patients who did not. Pre-RT LS>3.0 kPa was associated with increased risk of post-RT RILD (hazard ratio (HR) 9.3, 95% confidence interval (CI) 2.1, 40.4; p=0.003). Kaplan Meier analysis showed that 6-month survival-free of RILD for baseline LS<=3.0 kPa was 91% (95% CI: 76, 100) compared to 52% (95% CI: 35, 76) for LS>3.0 kPa. Additionally, BMI (HR 1.12 per 1 point BMI; 95% CI: 1.0, 1.2; p=0.005) and presence of cirrhosis (histologic or clinical evidence) (HR 4.9, 95% CI: 1.8, 12.0; p=0.002), were correlated with the development of post-RT RILD; whereas age, gender, CP score, gross tumor volume, and RT parameters (dose, fractions, or modality) were not significantly associated with risk of RILD.

CONCLUSION

Elevated pre-RT LS measured by MRE was associated with an increased risk of RILD in patients receiving high dose RT for liver tumors.

CLINICAL RELEVANCE/APPLICATION

Risk of radiation-induced liver disease (RILD) has limited the use of radiation therapy for management of liver cancer; MRE determined pre-RT liver stiffness may be a non-invasive predictor of RILD.

SSJ24-05 Early Results of Radiographic Response and Clinical Outcomes with 177Lu-DOTATATE in a Real-World Academic Clinical Practice

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S402AB

Participants
Sai Duriseti, MD,PhD, St. Louis, MO (*Presenter*) Nothing to Disclose
Michael C. Roach, MD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose
Hyun Kim, MD, Saint Louis, MO (*Abstract Co-Author*) Research Grant and Speakers Bureau, Varian Medical Systems, Inc; Research Grant and Speakers Bureau, ViewRay, Inc

PURPOSE

Treatment of advanced midgut neuroendocrine tumors with 177Lu-DOTATATE improves outcomes compared to octreotide alone as 2nd line therapy as demonstrated in the recent NETTER-1 trial. After its FDA approval, an increasing number of centers are implementing this therapy. Here we describe early efficacy of this treatment in the Department of Radiation Oncology at Washington University in St. Louis School of Medicine, including initial uptake verification, quantitative radiographic response, and early clinical outcomes with respect to patient clinical status and early serologic response.

METHOD AND MATERIALS

Patients were treated with 200 mCi of 177Lu-DOTATATE with a goal of delivering 4 infusions, each 2 months apart. After the 1st infusion, patents obtain an In-11 (111In) DOTATATE single photon emission computed tomography (SPECT) scan to verify uptake. After the 2nd infusion, we obtain a CT and/or MRI scan for response assessment. Depending on initial radiographic findings, we either continue with treatment, or reassess with a Fluorine-18 (18F) deoxyglucose or DOTATATE PET scan. Blood samples were collected between each treatment, as well as in the peri-infusion setting.

RESULTS

As of 4/1/2019, 39 patients have been treated at our institution. A total of 27 SPECT/CT scans were obtained after initial infusion or mid-treatment (after 2nd infusion) CT or MRI course of therapy. A total of 17 patients have completed all 4 treatments. 1 patient did not complete the full course of therapy. Of the 17 patients who completed therapy at time of analysis, follow up imaging was available for 16.

CONCLUSION

177Lu-DOTATATE delivery is feasible at a tertiary outpatient medical centers. Acute toxicities, distribution of uptake after infusion, and interval imaging at mid-way through treatment as well as at time of progression/failure will be reviewed. Early analysis of biomarkers and other factors predictive of clinical outcomes will be discussed as well.

CLINICAL RELEVANCE/APPLICATION

As the burden of patients surviving with metastatic tumors increase, the indications for targeted radiopharmaceuticals is expanding. Understanding real-world outcomes for novel radiopharmaceuticals helps refine these therapeutics.

SSJ24-06 Value of Contrast Enhanced Ultrasound with Perfusion Quantitative Analysis during Radiotherapy of Pancreatic Ductal Adenocarcinoma

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S402AB

Participants
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PURPOSE

To evaluate the value of contrast enhanced ultrasound (CEUS) with perfusion quantitative analysis in monitoring the therapeutic effect of pancreatic ductal adenocarcinoma (PDAC) during radiotherapy.

METHOD AND MATERIALS

From October 2017 to March 2019, 21 patients with histopathologically confirmed local advanced PDAC were included (15 men, 6 women; mean age, 65 years ± 2). All patients treated with chemoradiotherapy (CRT). The radiotherapy dose was 50.4Gy/28Fx with S-1 40mg bid orally taken in radiotherapy day. CEUS were performed before and 4 weeks after CRT. All ultrasound examinations were performed by an ACUSON Oxana 2 ultrasound equipment (Siemens Medical Solutions, USA) with a C6-1 convex array transducer (1-6MHz). Time intensity curves (TICs) were created with SonoLiver (TOMTEC Imaging Systems). Quantitative perfusion indexes were generated and compared inside the PDAC lesion with 5×5 mm region of interest (ROI), including maximum intensity (MI), rise time (RT), mean transit time (MTT) and time to peak (TTP).

RESULTS

While comparing before and after radiotherapy, no significant difference could be found by conventional B mode ultrasound. After created CEUS TIC with perfusion quantitative analysis, significant decrease could be found in MI before and after radiotherapy (41.78 ± 20.15 dB vs 24.79 ± 18.12 dB).

CONCLUSION

Depending on its unique advantages such as non-radiation, effective and convenient, CEUS with perfusion quantitative analysis may be useful to evaluate the therapeutic effect during the radiotherapy of PDAC patients.

CLINICAL RELEVANCE/APPLICATION

CEUS with perfusion quantitative analysis might be a potential imaging method during follow up and observe of the clinical radiotherapy therapeutic effect in PDAC patients.

SSJ25

Vascular/Interventional (Aortic Disease)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E352

IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Raisa J. Durrani, MD, New York, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSJ25-01 The Growth of Common Iliac Aneurysms (CIA) Coexisting with Abdominal Aortic Aneurysm (AAA): Correlation with AAA and Predictive Factors

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E352

Participants
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PURPOSE

Common iliac aneurysms (CIA) frequently coexist with abdominal aortic aneurysm (AAA), and expand over time with risk of rupture. Previous studies of CIA growth rely mostly on ultrasound, which may not be accurate and reproducible enough to characterize slowly growing CIAs. Intraluminal thrombus (ILT) has been studied as a marker of growth in AAA, but has not been studied in CIA yet. This study aims to examine the factors associated with growth of CIAs using serial CTA with multiplanar reconstruction (MPR).

METHOD AND MATERIALS

Data were collected from a single center from January 2000 to May 2018 in patients undergoing AAA surveillance. The maximal diameter of coexisting CIA was measured on CTA with MPR. Correlation of the baseline diameter and growth rate between CIA and AAA was evaluated. The presence of ILT in CIA and AAA was compared. Multivariate regression analysis was used to investigate the factors associated with CIA growth.

RESULTS

Seventy-one AAA patients (median age, 76 years old; all male) with 106 CIAs were identified, and were followed up for a median of 2.2 years (range, 0.6-9.2 years). The CIAs had baseline diameter of 2.3±0.6 cm with growth rate of 0.9±1.3 mm/year. CIA growth was positively correlated with AAA growth ($r=0.43$, $P<0.01$), whereas the baseline diameter of CIA and AAA were not significantly correlated ($P=0.88$). The presence of ILT in CIA was associated with that in AAA ($P<0.01$). Multivariate regression analysis showed that CIA baseline diameter, AAA baseline diameter, and smoking were positively related to CIA growth. In CIAs with diameters of 2-3cm ($n=60$), which consisted the largest subgroup (56.7%), the growth rate of CIA with ILT was more than double that of CIAs without ILT (1.6 mm/year vs. 0.7 mm/year, $P=0.017$).

CONCLUSION

CIA baseline diameter, AAA baseline diameter, and smoking are predictive of CIA growth. In CIAs of 2-3cm, presence of ILT predicts faster aneurysm growth and this important feature should be described in the radiology report so that shorter-interval surveillance can be considered.

CLINICAL RELEVANCE/APPLICATION

CIA baseline diameter, AAA baseline diameter, and smoking are predictive of CIA growth. In CIAs of 2-3cm, presence of ILT could be a risk factor for fast growth and may prompt earlier follow-up.

SSJ25-02 Diagnostic Imaging Using Contrast-Enhanced Ultrasound (CEUS) in Comparison to Other Non-Invasive Imaging Strategies in the Management of Patients with Possible Endoleak Type I/III after Endovascular Aortic Repair: A Cost-Effectiveness Analysis

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E352

Participants
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Dirk-Andre Clevert, MD, Muenchen, Germany (*Abstract Co-Author*) Speaker, Siemens AG Speaker, Koninklijke Philips NV Speaker, Bracco Group Speaker, Samsung Electronics Co, Ltd

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PURPOSE

To evaluate the cost-effectiveness of contrast-enhanced ultrasound (CE-US) in comparison to noninvasive imaging strategies in patients with possible type I or type III endoleak after endovascular aortic repair (EVAR).

METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with the imaging strategies contrast-enhanced ultrasound (CE-US), Duplex ultrasound (DU-US), contrast-enhanced computed tomography angiography (CE-CT), and contrast-enhanced magnet resonance imaging angiography (CE-MR). United States healthcare data were used for analysis. Model input parameters were based on best available and most recent evidence (Table 1). Starting age was 70 years. The prior probability of a type I / III endoleak was set at 12.8 %, the reported frequency of type I / III endoleaks in literature. Probabilistic sensitivity analyses (PSA) were performed using 30,000 Monte Carlo simulations to estimate model uncertainty. The percentage of cost-effective iterations was determined for different willingness-to-pay (WTP) thresholds.

RESULTS

The base-case analysis showed that CE-US is dominant over CE-CT and CE-MR in the proposed model. CE-US led to increased lifetime QALYs compared to DU-US (9.56 QALYs vs. 9.53 QALYs) at slightly higher lifetime costs ($20,050 vs. $19,868). Therefore, CE-US was the optimal strategy in the base-case analysis for a WTP threshold of $100,000/QALY. In PSA, CE-US was the strategy with the highest percentage of cost-effective iterations if the WTP threshold was set higher than $10,000/QALY. In accordance with contemporary WTP thresholds and adjusting for model uncertainty, CEUS was determined as the most cost-effective strategy.

CONCLUSION

In patients undergoing endoleak surveillance after EVAR, CE-US is a cost-effective strategy for the detection and evaluation of type I and type III endoleaks.

CLINICAL RELEVANCE/APPLICATION

CE-US should be considered as surveillance imaging modality of choice in patients after EVAR.

SSJ25-03 Thoracic Endovascular Aortic Repair or Medical Treatment in Patients with Acute Uncomplicated Type B Aortic Dissection

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E352

Participants
Dongqiao Xiang, MD, Wuhan, China (*Presenter*) Nothing to Disclose
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PURPOSE

The purpose of this retrospective study was to further assess the early and long-term (10-year) outcomes of thoracic endovascular aortic repair (TEVAR) in patients with acute uncomplicated type B aortic dissection (TBAD) compared with those receiving best medical treatment (BMT).

METHOD AND MATERIALS

Between February 2008 and March 2018, 357 patients with acute uncomplicated TBAD were retrospectively identified and divided into 2 groups, the TEVAR group (n = 191) and the BMT group (n = 166). Information about baseline characteristics and details of medical and endovascular management, in-hospital clinical events, length of stay, and in-hospital mortality were collected from the electronic medical record database. Initial diagnostic and follow-up computed tomography angiography images were retrieved from the imaging archiving system. The anatomic characteristics, extent of the dissection, thrombosis status of the false lumen and postoperative complications were retrospectively evaluated and documented. The final survival state was determined via the review of hospital admitting notes or telephone follow-up.

RESULTS

Clinical history was similar between groups. Although there is no significantly difference in in-hospital/30-day mortality rate, patients in TEVAR group had significantly higher early event rates than those in the BMT group (12.0% vs. 3.0%; p = 0.001). Late event rates were significantly higher in the BMT group compared with the TEVAR group (p = 0.004). Kaplan-Meier estimates demonstrated that patients in the BMT group had significantly more rupture and aortic enlargement than those in the TEVAR group (p = 0.014; p= 0.030, respectively). The cumulative survival rates from all causes of death at 1, 3, 5 years were 96.8%, 96.0%, 90.0% in the TEVAR group and 93.7%, 87.9%, 82.4% in the BMT group. Log-rank tests revealed a significantly higher all-cause mortality rate in the BMT group versus the TEVAR group (p = 0.020).

CONCLUSION

Despite more early complications, TEVAR has proven to be an effective treatment for acute uncomplicated TBAD in this study, with lower late event rates and mortality than BMT during the long-term follow-up.

CLINICAL RELEVANCE/APPLICATION

(dealing with acute uncomplicated type B aortic dissection) 'TEVAR has an advantage in stabilizing the dissected aorta, inducing aortic remodeling processes and promoting false lumen thrombosis, and it is recommended to consider it when formulating a treatment plan.'

SSJ25-04 Aortic Changes Following Acute Uncomplicated Medically-Managed Stanford Type B Aortic Dissection

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E352

Participants
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PURPOSE

To characterize longitudinal changes in the descending thoracic aorta following acute uncomplicated medically-managed Stanford Type B aortic dissection (SBAD).

METHOD AND MATERIALS

Longitudinal study of medically-managed SBAD after index admission to a single center between 1995-2015. Repeated measurements of the descending thoracic aorta were made using centerline oblique reformats of CT and MR imaging. Aorta-related events were captured including death, descending thoracic aorta aneurysm (max total diameter >40 mm), rupture, repair/fenestration, and intimomedial flap changes. Joint modelling was used to study the relationship between changing aortic anatomy and hazard of an aorta-related event.

RESULTS

There were 94 patients identified with medically-managed SBAD. Of those, 74 (79%) survived the index hospitalization and had imaging available. The median [IQR] radiological follow-up was 3.1 years [1.1-7]. Measurements were taken from 442 studies (399 CT, 90%). At index admission, 11 (16%) had a complex intimomedial flap, 47 (64%) a totally patent false lumen, and the median maximum total aortic diameter was 42 mm [37-47]; this was located in proximity to the left subclavian artery origin (zone 3) for 42 patients (57%). The growth velocity of the maximum total aortic diameter over 0-6 months was 2 mm/month [95%CI: 1.3-2.6], 6-12 months was 0.4 mm/month [-1-1.8], and 1-5 years was 0.1 mm/month [0-0.2]. In follow-up, 49 patients (66%) had an aorta-related event [18 aneurysmal degenerations (36.7%), 2 ruptures (4%), 22 repairs (45%), 4 flap changes (8.2%), 3 deaths (6.1%)] with event-free-survival of 70% at 6 months [61-81], 57% at 1 year [47-69], and 34% at 5 years [24-47]. Joint modelling demonstrated univariate association between risk of aorta-related event and maximal total descending aortic diameter (HR [95%CI]: 1.026 [1.02-1.031], p<0.0001), true lumen diameter at point of maximal total diameter (0.983 [0.968-0.998], p=0.03), and maximal false lumen diameter (1.013 [1.003-1.022], p=0.009).

CONCLUSION

For medically-managed SBAD, changes in the descending thoracic aorta over time, including maximum total, false lumen, and true lumen diameters, were associated with the hazard of aorta-related event.

CLINICAL RELEVANCE/APPLICATION

This study relates changing aortic anatomy to clinically-relevant outcomes for medically-managed Stanford Type B aortic dissection which can be used to inform management decisions.

SSJ25-05 Prediction of Abdominal Aortic Aneurysm Growth Rate Using Radiomic Feature Analysis of FDG PET-CT

Tuesday, Dec. 3 3:40PM - 3:50PM Room: E352

Participants
Pratik Adusumilli, MBChB, Leeds , United Kingdom (*Presenter*) Nothing to Disclose
Mohammed Waduud, MRCS, Leeds, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Marc Bailey, MRCS, Leeds, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Radiomics allows objective and quantitative assessment of medical images by analysing distribution and relationships of pixel grey levels. The technique has been used extensively to study tumours, however, the potential use for prediction of growth of abdominal aortic aneurysms (AAA) has not been established. The aim of this study was to explore the correlation between radiomic features extracted from FDG PET-CT and AAA growth.

METHOD AND MATERIALS

Patients with an unrepaired AAA who underwent FDG PET-CT between January 2009 and December 2016 for malignancy evaluation were selected from an institutional database. Patients underwent subsequent AAA surveillance with serial ultrasound. Radiomic feature analysis was performed with LIFEx software. Regions of interest were drawn over the AAA and blood pool within the aortic arch on the PET scan. Ratio of AAA SUV to blood pool (BP) activity was calculated along with 40 radiomic features. Bivariate Pearson correlation was calculated with Bonferroni correction for multiple testing. A control group of patients without AAA were also analysed. AAA growth rate was calculated using initial and final aortic calibre measurements for the trial group and normal aortic growth rates in the control group.

RESULTS

50 patients (mean age 74 years, 40 male) were included in the study. A correlation was considered significant if it had a p value of < 0.001 in the trial group and no correlation in the control group. There was no correlation between AAA:BP SUV ratio and

aneurysm growth. Significant correlations were found between AAA growth rate and GLCM Homogeneity (a measure of local homogeneity), GLCM Contrast (a measure of local variation) and GLCM Dissimilarity (a measure that defines the variation of grey level pairs in an image). The Pearson correlation and significance for these features were .483; 0.001, -.428; 0.0001 and -.462; 0.001 respectively.

CONCLUSION

Radiomic features extracted from AAA at FDG PET-CT may provide useful risk stratification metrics which could be used to identify patients at higher risk of rupture. Further evaluation in a larger prospective cohort with a more advanced method of estimating AAA growth is required to validate these initial findings.

CLINICAL RELEVANCE/APPLICATION

Radiomic features extracted from AAA at FDG PET-CT might be considered as a risk stratification tool in future studies to predict aneurysms at higher risk of significant expansion.

SSJ25-06 Investigation of the Quality Reserve Provided by Digital Variance Angiography in Fenestrated and Branched Endovascular Aortic Aneurysm Repair Setting

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E352

Participants
Eric Verhoeven, MD,PhD, Nuremberg, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Kinetic imaging is a novel image processing algorithm providing enhanced image quality in X-ray angiography setting. The algorithm produces so;called Digital Variance Angiography (DVA) images. The study objective was to assess the quality reserve of DVA images by comparing the performance to standard digital subtraction angiography (DSA) in fenestrated and branched endovascular aortic aneurysm repair (F/B-EVAR) setting.

METHOD AND MATERIALS

Retrospective evaluation of image data of 30 patients undergoing F/B-EVAR at our institution without any preselection. The signal-to-noise ratio (SNR) of DSA and DVA images was measured and compared. The same raw image data were used to generate dynamic DSA and DVA runs. The videos were compared by six experts in a randomized blinded questionnaire. Fleiss' Kappa-test was used to determine interrater agreement.

RESULTS

DVA images provided 1.49 times higher SNR than DSA (median value, Q1-Q3 interval 1.14-1.81). Evaluators preferred DVA over DSA images in 85.9% of comparisons. The interrater agreement was 91.3% and Fleiss's kappa was 0.21 ($p<0.001$).

CONCLUSION

DVA-imaging enhances angiographic image quality compared to DSA-imaging in F/B-EVAR setting. The observed quality reserve of DVA provides opportunities to reduce both radiation-dose and the amount of contrast agent. A prospective study based on these results could confirm the achievable amount of dose reduction without significant image quality loss.

CLINICAL RELEVANCE/APPLICATION

Digital Variance Angiography (DVA) is a novel medical image processing method that significantly improves the image quality of X-ray angiograms compared to Digital Subtraction Angiography The quality reserve of DVA may allow a substantial amount of radiation dose reduction in the F/B-EVAR setting without affecting the quality and diagnostic value of angiograms. Further prospective research is necessary to determine the precise refinement of dose protocols.

SSJ26

Vascular/Interventional (Biliary and Portal Hypertension)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: E350

GI IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Mona B. Ranade, MD, Brookfield, WI (*Moderator*) Nothing to Disclose
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Sub-Events

SSJ26-01 Clinical Effectiveness of Percutaneous Endoscopic Holmium Laser Lithotripsy for Symptomatic Intra/Extrahepatic Biliary Stones

Tuesday, Dec. 3 3:00PM - 3:10PM Room: E350

Participants
Riccardo Muglia, MD, Pieve Emanuele , Italy (*Presenter*) Nothing to Disclose
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PURPOSE

To retrospectively assess the efficacy, safety and follow-up of percutaneous endoscopic holmium laser lithotripsy for symptomatic intra/extrahepatic biliary stones.

METHOD AND MATERIALS

We retrospectively evaluated 28 patients (M:F=19:9, median age=68.5 years) with intrahepatic and/or extrahepatic biliary stones, undergoing 43 percutaneous, transhepatic lithotripsies with holmium laser from 2012 to 2018 in a single center.Data collected were: patient characteristics; location and amount of stones; post-procedural symptoms and complications; length of hospital stay; clinical success rate.Endoscopic retrograde cholangiopancreatography was precluded due to bilio-enteric anastomosis in 12/28 (43%) patients, distal gastrectomy in 5/12 (18%), and for prior biliary interventions followed by a fistula, ultimately leading to biliary stenosis in 11/28 (39%).

RESULTS

Twenty patients (71%) received one only lithotripsy, three (11%) underwent two procedures, five (18%) had 3 or more lithotripsies.Multiple interventions were scheduled due to the elevated amount of stones to treat (13/15, 87%) or for new symptomatic biliary stones (2/15, 13%) during follow-up.Stones were localized in intrahepatic ducts (21/43, 49%), extrahepatic ducts (15/43, 33%) or both in intra- and extrahepatic ducts (8/43, 18%).Treatments lasted averagely 115 minutes; we fragmented 1 to 3 stones in 12 treatments (28%) and more than 3 stones in 31 (72%).After lithotripsy, 15 patients (53%) had sepsis with positive hemoculture treated with antibiotics, 2 (7%) had mild intrahepatic bleeding, treated conservatively. Only 1/15 septic patient was admitted in the intensive care unit and discharged after 26 days.Median hospital stay was 5.5 days (range 2-42).Our cohort was followed up for a median time of 17.5 months (0-66) from the first treatment.Twenty-two patients (79%) reached clinical success after lithotripsy, while six (21%) experienced further cholangitis and were readmitted for antibiotic therapy (3/6) or ERCP (3/6).

CONCLUSION

Percutaneous endoscopic holmium laser lithotripsy is effective in treating symptomatic intrahepatic and extrahepatic biliary stones, though burdened by a high incidence of postoperative sepsis.

CLINICAL RELEVANCE/APPLICATION

Percutaneous endoscopic holmium laser lithotripsy could be considered an option for first-line treatment of symptomatic intrahepatic and extrahepatic biliary stones, when ERCP is precluded.

SSJ26-02 Comparison of Percutaneous Endobiliary Radiofrequency Ablation with Stent Placement versus Stent Placement Alone for Treating Malignant Biliary Obstruction: Is There an Added Benefit?

Tuesday, Dec. 3 3:10PM - 3:20PM Room: E350

Participants
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PURPOSE

To retrospectively compare the outcomes of endobiliary radiofrequency ablation and stent placement (RFA-Stent) with stent placement alone (Stent) in treating unresectable malignant biliary obstruction (MBO).

METHOD AND MATERIALS

The study was approved by the institutional review board, and the requirement to obtain informed consent was waived. Seventy patients (mean age, 61.4 years; 45 men [64.3%]) who underwent RFA-Stent and 63 (mean age, 65.6 years;34 men [54.0%]) who underwent Stent for unresectable MBO from June 2013 to June 2018 were included. Overall survival (OS), primary and secondary stent patency (PSP, SSP), complications were compared according to level of biliary obstruction (subgroup): Type A (distal, Bismuth Types I and II biliary obstruction) and Type B (Bismuth Types III and IV biliary obstruction). Survival curves were calculated by performing the Kaplan-Meier method and compared by using the log-rank test and Cox regression models.

RESULTS

PSP and SSP were significantly longer for the RFA-Stent group than the stent group (PSP: 8.5 months vs. 4.5 months, P < 0.001; SSP: 9.0 months vs. 5.1 months, P < 0.001), but with OS being comparable (6.0 months vs. 4.5 months, P = 0.160). In subgroup analysis, RFA-Stent showed significant OS (8.0 months vs. 5.0 months; P = 0.026) benefits compared to Stent in patients with Type A MBO, but with comparable outcomes in patients with Type B MBO (5.0 months vs. 3.2 months; P = 0.962). The PSP and SSP was improved in both subgroups (Type A, PSP: 8.5 months vs. 4.5 months; P= 0.002; SSP: 9.0 months vs. 5.0 months, P < 0.001; Type B, PSP: 8.0 months vs. 6.0 months, P = 0.045; SSP: 12.0 months vs. 6.0 months, P = 0.005, respectively). The rate of complication was comparable for the RFA-stent group when compared to the stent group (all P > 0.05). In Cox analysis, RFA-Stent modality, performance status score 0, A type of biliary obstruction, total bilirubin<=166.8μmol/L and total bilirubin decrease value after stent placement procedure greater than 21.5μmol/L were favorable prognostic factors for OS. RFA-Stent modality, total bilirubin<= 166.8μmol/L were favorable prognostic factors for PSP. RFA-Stent modality, age older than 65 years, total bilirubin <= 166.8μmol/L were favorable prognostic factors for PSP (all P < 0.05).

CONCLUSION

In this retrospective study, RFA-Stent was associated with improved stent patency in patients with MBO. In addition, RFA-Stent may be associated with improved survival in patients with Type A MBO.

CLINICAL RELEVANCE/APPLICATION

RFA-Stent was associated with improved stent patency in patients with MBO. In addition, RFA-Stent may be associated with improved survival in patients with Type A MBO.

SSJ26-03 Effect of Intra-Gastric Satiety-Inducing Device on Food Intake, Body Weight Gain, and Satiety-Related Hormones in Rat Model

Tuesday, Dec. 3 3:20PM - 3:30PM Room: E350

Participants
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Xiao Li, PhD, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the effect of an intra-gastric satiety-inducing device (ISD) on food intake, body weight gain, and satiety-related hormones in a rat model.

METHOD AND MATERIALS

The institutional animal care and use committee approved this study. Thirty-two male Sprague Dawley rats weighing 250-300g were randomly divided into four groups of eight each. The ISD (constructed in-house) used was comprised of a 4-mm-diameter 1.5-cm-length straight nitinol stent for the lower esophagus, and one (single-disk) or two (double-disk) 2.5-diameter flat star-shaped nitinol disks for the fundus of stomach. Single-disk and double-disk group rats underwent peroral placement of a single- and double-disk ISD, respectively, and control group rats underwent peroral placement of an ISD with no disk. To prevent migration, the stent part of the ISD was surgically fixed to the esophageal wall using sutures. All operations were performed under direct visualization *via* a laparotomy with fluoroscopy assistance. Sham group rats underwent sham operation. All rats were supplied with food and water ad libitum and were euthanized 4 weeks after the operation.

RESULTS

Technical success was achieved in all rats. One rat in double-disk group died 2 weeks after the operation due to gastric perforation. The remaining rats survived until the end of the study without any complications. The mean food intake over the 4 weeks after the operation was significantly different between the four groups (all $P < .05$). Specifically, the mean food intake was significantly lower in both ISD groups than it was in the control and sham groups (all $P < .05$) but was not significantly different between the single- and double-disk ISD groups ($P > .05$) and the control and sham groups ($P > .05$). The mean body weight gain 4 weeks after the operation was significantly different between the four groups ($P < .05$). Specifically, the mean body weight gain was significantly lower in the double-disk ISD group than it was in the single-disk ISD, control, and sham groups (all $P < .05$), and was significantly lower in the single-disk ISD group than it was in the sham group ($P < .05$), but was not significantly different between the single-disk ISD and control groups ($P > .05$). The mean fasting serum ghrelin and leptin levels 2 and 4 weeks after the operation were not significantly different between the four groups ($P > .05$).

CONCLUSION

ISD could reduce food intake and body weight gain but does not affect satiety-related hormones in a rat model.

CLINICAL RELEVANCE/APPLICATION

ISD might be an effective treatment for obesity which can overcome existing problems. (This is a proof-of-concept animal study.)

SSJ26-04 Non-Invasive Assessment of Portal Hypertension in HBV-Related Liver Cirrhosis with Spectral CT Iodine Density: A Correlation Study with HVPG

Tuesday, Dec. 3 3:30PM - 3:40PM Room: E350

Participants
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PURPOSE

To investigate the feasibility of spectral CT iodine density in evaluation of portal hypertension by correlation with hepatic venous pressure gradient (HVPG) in patients with liver cirrhosis.

METHOD AND MATERIALS

Thirty-one patients (F/M,13/18, mean age 44.2 ± 7.8 years old) with liver cirrhosis were recruited in this study, and they were all performed three phases contrast enhanced spectral CT within 1 week before TIPS, with HVPG recorded during the interventional surgery. All CT raw data were reconstructed at 1.25 mm slice thickness, and liver and spleen volume were measured in venous phase images. Iodine density (in milligrams per milliliter) were measured on iodine-based material decomposition images. Multiple regions of interest (ROIs) in liver parenchyma, aorta and portal vein were selected from three slices of images with portal vein trunk as the central one, and mean liver parenchymal iodine density from arterial phase, venous phase and delayed phase were recorded. Quantitative indices of iodine density (ID) of liver (IDLAP) and spleen (IDSAP) parenchyma for arterial phase, venous phase (IDLVP) and (IDSVP), ID of portal vein in venous phase (IDPVP) were measured and correlated with HVPG, with statistical significance as $P<0.05$.

RESULTS

For Child-Pugh stage in 31 patients, 12 were grade A, 15 grade B, and 4 grade C. Correlation of quantitative indices with HVPG were as following: (1) no correlation was found between liver and spleen volume, IDLAP, IDSAP, IDSVP and IDLVP with HVPG; (2) IDPVP was found to be independently correlated with the HVPG ($P<0.01$); (3) With threshold set as 54.3, IDPVP demonstrates 69.5% sensitivity, 62.1% specificity, 72.6% positive predictive value and 64.7% negative predictive value in the diagnosis of clinically significant portal hypertension (HVPG >=12mmHg), respectively.

CONCLUSION

Spectral CT Iodine density demonstrates feasibility in evaluation of clinically significant portal hypertension in liver cirrhosis as a noninvasive imaging modality.

CLINICAL RELEVANCE/APPLICATION

It is possible to evaluate clinically significant portal hypertension with quantitative index of iodine density in spectral CT noninvasively.

SSJ26-05 Intravascular Ultrasound (IVUS) Guided Transjugular Intrahepatic Portosystemic Shunts (iTIPS): One-Year Clinical Outcomes

Tuesday, Dec. 3 3:40PM - 3:50PM Room: E350

Participants
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PURPOSE

Use of intravascular ultrasound (IVUS) to guide portal vein puncture for transjugular intrahepatic portosystemic shunts (iTIPS) has increased in recent years, showing improved procedural metrics such as procedure time, contrast, and radiation doses over conventional techniques. Here we aim to evaluate the one-year clinical outcomes of patients undergoing iTIPS placement at our institution.

METHOD AND MATERIALS

All patients having undergone iTIPS placement between January 2016-March 2018 with 1-year clinical follow up were retrospectively analyzed. Medical records were reviewed for TIPS indication, clinical and demographic data, procedural details, clinical outcomes, and need for TIPS revisions. Clinical success was defined as requiring a decrease need or discontinuation of paracentesis/thoracentesis or absence of variceal bleeding for those respective primary indications. Technical success, 30-day complication rate, and need for TIPS revisions through one year post procedure were evaluated.

RESULTS

A total of 43 patients underwent iTIPS for refractory ascites (58%), control or secondary prevention of variceal bleeding (38%), or other (4%) with median Na-MELD of 14 (range 7-25). Technical success rate was 98%, with only one procedure having been aborted due to unfavorable anatomy and presence of portal vein thrombus, and was successfully reattempted with IVUS 1 month later. Complications within 30 days were only seen in 2 patients (4.7%) consisting of acute respiratory failure and heart failure decompensation. There were no bleeding complications. The clinical success rate at one year was 88.4%. 13 patients (30%) underwent revision(s) within one year. However, of these revisions only 4 (9%) had clinical evidence of TIPS malfunction (3 with reaccumulated ascites burden and 1 with variceal rebleed).

CONCLUSION

Use of IVUS for TIPS placement is highly technical successful with low 30-day complication rates and provides durable 1 year efficacy in controlling ascites and variceal bleeding. While the revision rate over 1 year was 30%, only a minority of these manifested with clinical signs of TIPS malfunction.

CLINICAL RELEVANCE/APPLICATION

iTIPS not only provides improved procedural metrics as previously reported, but shows durable 1-year clinical success, acceptable revision rates, and low 30-day complications.

SSJ26-06 Creation of a Haptic 3D Printed Simulator for TIPS Training in Augmented and Virtual Reality

Tuesday, Dec. 3 3:50PM - 4:00PM Room: E350

Participants
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PURPOSE

TIPS creates artificial channel within the cirrhotic liver from inflow portal vein to outflow hepatic vein. TIPS morbidity and mortality is high due to patient risk factors and complex anatomy.

METHOD AND MATERIALS

Our developments in 3D printing biomimetic haptic simulators coregisters patient specific anatomy to produce a realistic VR/AR environment. Patient CTA images (Siemens, Germany) are converted to 3D objects using Mimics (Materialis, Belgium). Individual models of liver, portal, hepatic, caval veins, arteries, and bones were used to create multicolor virtual models of operative field. Each model components are individually 3D printed. Osseous structures are printed using fused deposition modeling on Fusion 3D and Ultimaker 3 printers, using polylactic acid (PLA). Hollow vessels were made in Formlabs elastic resin and connected to 3D printed manifolds and pumps. Liver is molded into 3D printed reusable liver mold. VR model, patient CT abdomen images are coregistered and overlaid upon haptic simulator using the Novarad Opensight software (Novarad Corporation, South American Fork, UT) and Microsoft HoloLens augmented reality platform (Microsoft Corporation, Redmond, WA.

RESULTS

Trainees in AR/VR/MR environment can see virtual model while doing TIPS on realistic 3D-printed haptic model. Prior to patient procedure, they can practice critical skills: TIPS creation, stent deployment, TIPS remodeling.

CONCLUSION

Virtual reality/augmented reality (VR/AR) is a critical training tool for patient-specific image-guided procedures such as TIPS. Training VR/AR simulation environments prior to performing TIPS enhances user confidence, decrease complications, procedural time, and radiation exposure. We demonstrate an ideal TIPS teaching model utilizing 3D printed haptic simulator, the Microsoft HoloLens, and the co-registered haptic/virtual simulator using the Novarad Opensight Software.

CLINICAL RELEVANCE/APPLICATION

To create 3D printed patient specific transjugular intrahepatic portosystemic shunt (TIPS) simulators fused with virtual reality (VR) and augmented reality (AR) to improve trainee performance, decrease procedure time, radiation dose, and clinical morbidity and mortality.

SSK01

Breast Imaging (Tomosynthesis Screening)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E451B

BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSK01-01 Interval Breast Cancer Following Use of Digital Breast Tomosynthesis in a Population-Based Screening Program for Breast Cancer

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E451B

Participants
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PURPOSE

To compare rates and characteristics of interval breast cancer among women screened with digital breast tomosynthesis in combination with synthetic mammograms (DBT) and women screened with standard digital mammography (DM), in a population-based screening program for breast cancer.

METHOD AND MATERIALS

The national screening program for breast cancer is population-based, offering women aged 50-69 biennial mammographic screening. Our study population included 94,075 women screened 2014-2015; 35,303 women screened with DBT (study group) and 58,772 women screened with DM (control group). The rates of screen-detected breast cancer were 9.4/1000 and 6.1/1000, respectively. The women in the study population were followed for interval breast cancer two years after their screening examination. Rates and histopathological data (tumor type, histologic grade, diameter, lymph node status and ER/PR/Her2/Ki67 status) were analyzed. We used chi-square test and t-test to test for statistical significance. A p-value of <0.001 was considered statistically significant after the Bonferroni correction.

RESULTS

We observed an interval breast cancer rate of 2.0/1000 (68/35,303) in the study group and 1.5 (88/58,772) in the control group (p=0.115). No statistical significant differences were observed in histopathological tumor characteristics between the study and the control group.

CONCLUSION

Despite of a higher rate of screen-detected breast cancer among women screened with DBT compared with DM, we observed no statistical significant differences in rates or histopathological tumor characteristics of interval breast cancer between the groups.

CLINICAL RELEVANCE/APPLICATION

Despite an increased rate of screen-detected breast cancer for screening with DBT compared with DM shown in studies, no difference in rates of interval breast cancer was observed.

SSK01-02 Interval Cancers after Tomosynthesis plus Digital Mammography or Digital Mammography Breast Cancer Screening: The Reggio Emilia Tomosynthesis Randomized Trial

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E451B

Participants
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PURPOSE

The RETomo trial was a two-arm test-and-treat randomized controlled trial comparing digital breast tomosynthesis (DBT) plus digital mammography (DM) versus DM alone for breast cancer screening. We present interim analysis on interval cancers after the first round.

METHOD AND MATERIALS

Women (45-70 yo) presenting for a screening mammography, and previously screened with DM, were asked to participate and, if willing, randomised to the experimental arm (DBT+DM) or to the control arm (DM), both with two projections and double reading (NCT02698202). Women were assessed according to the decision at DBT+DM. Detection rate, recall rate, and interval cancer are reported. All women were followed up to 30 months from recruitment or up to second round.

RESULTS

From March 2014 to March 2016, 9779 women were recruited to the DM+DBT arm of the study, and 9787 women were recruited to the DM arm. Recall rate was 3.5% in both experimental and control arm; detection rate, including ductal carcinoma in situ (DCIS), was 8.6 per 1000 (84) and 4.5 per 1000 (44), respectively (relative detection rate 1.68, confidence interval [CI]: 1.22-2.30). Interval cancers were 17 in both arms, corresponding to an overall rate of 1.8/1000 (95% CI 1.1-2.9), including 1 DCIS in the DM+DBT arm and 2 in the DM arm. Among women younger than 50yo, followed with annual mammography, the interval cancers were 2 (rate of 0.7/1000; 95% CI 0.1-2.4) and 6 (rate of 2.1/1000; 95% CI 0.8-4.5) in the experimental and control arm, respectively.

CONCLUSION

These are the first results from a randomised trial reporting interval cancer intervals after DM+DBT compared to DM alone screening. The introduction of DBT to DM in screening strongly increased the detection rate, but had no impact on interval cancer rate, suggesting that screen detected and interval cancers come from different populations of lesions with different growth speed, but also imkplying that high sensitivity can lead to overdiagnosis.

CLINICAL RELEVANCE/APPLICATION

Our results suggest caution in introducing DBT in screening before health benefits have been demonstrated. Only pooling data on advanced cancer incidence and mortality from all ongoing trials can answer.

SSK01-03 Early Performance Measures Among Women Screened with DBT after a Prior DBT or a Prior DM, in a National Screening Program

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E451B

Participants
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PURPOSE

To investigate performance measures among women screened with digital breast tomosynthesis including synthesized mammography (DBT) after prior screening in a randomized controlled trial (RCT) with either DBT or standard digital mammography (DM).

METHOD AND MATERIALS

TB-2 (Tomosynthesis in X) is a prospective cohort study offering DBT to all women attending the screening unit in X. TB-2 is being performed in the consecutive screening round of TB-1, a RCT evaluating DBT versus DM. The studies are being performed as a part of BreastScreen Y, a population based program offering mammographic screening to women aged 50-69 biennially. During the first year of TB-2 (2018), 4657 women were screened with DBT after DBT, and 4659 with DBT after DM. Frequencies and proportions of consensus, recall, screen-detected breast cancer (invasive and ductal carcinoma in situ), and positive predictive values of recalls (PPV-1) and biopsies (PPV-2) were analyzed. One-sided Z tests were used to test whether the proportions within the DBT after DBT arm differed from those observed within the DBT after DM arm. A p-value of <0.05 was considered statistically significant

RESULTS

A total of 8.3% (387/4757) of the DBT after DBT screening exams were discussed at consensus compared to 8.5% (397/4759) for DBT after DM (p=0.36). The percentage of recalled women was 4.5% (211/4547) for DBT after DBT versus 5.0% (232/4758) for DBT after DM, (p=0.15). The number of breast cancers was 0.69% (32/4757) for DBT after DBT and 1.03% (48/4759) for DBT after DM (p=0.0364). PPV-1 and 2 were 20.7% (48/232) and 38.1% (48/126) for DBT after DBT, and 15.2% (32/221) and 20.7% (32/101) for DBT after DM (PPV-1: p=0.07; PPV-2: p=0.16).

CONCLUSION

Screening with DBT after DM yielded a high number of screen-detected breast cancers, which is in keeping with results from previous studies. Whether this increased detection is beneficial for women and society remains unclear.

CLINICAL RELEVANCE/APPLICATION

DBT detected more breast cancer than standard DM. Further studies investigating the tumor characteristics and aggressiveness of

DBT detected more breast cancer than standard DM. Further studies investigating the tumor characteristics and aggressiveness of these extra cancers are needed to offer women personalized treatment.

SSK01-04 Implementation of Digital Breast Tomosynthesis (DBT) in a Large Academic Oncology Center: Analysis of Screening Mammography Performance Metrics

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E451B

Participants
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PURPOSE

To evaluate screening mammography performance metrics of digital breast tomosynthesis (DBT) compared to 2D full field digital mammography (FFDM) in patients' with prior history of breast cancer at a large academic oncology center.

METHOD AND MATERIALS

This HIPAA compliant, retrospective study consisted of consecutive female patients with a personal history of breast cancer treated with lumpectomy with or without radiation or mastectomy who underwent screening FFDM from October 2014-September 2016 or screening DBT from February 2017-December 2018 at an academic oncology center. An institutional breast cancer registry identified cancer diagnoses. Primary outcomes of recall rate (RR), cancer detection rate (CDR), and positive predictive value (PPV1) were compared between FFDM and DBT groups. Natural language processing was used to obtain patient and image characteristics including breast density, current or prior imaging findings from the most recent prior imaging examination, and BI-RADS category of the current screening examination.

RESULTS

There were 7282 examinations in the FFDM cohort and 4913 examinations in the DBT cohort during their study periods. Screening mammography performance metrics for FFDM included 9.7% (704/7282) recall rate, 6.3% (44/704) PPV1, and 6.0/1000 (44/7282) CDR and for DBT included 7.5% (369/4913) recall rate, 7.0% (26/369) PPV1 and 5.3/1000 (26/4913) CDR. There was a significant decrease in RR with DBT (p=0.0004) but no significant change in PPV1 (p=0.61) or CDR (p=0.59) between groups.

CONCLUSION

In patients' with a personal history of breast cancer, DBT significantly reduced recall rates while maintaining CDR and PPV1s.

CLINICAL RELEVANCE/APPLICATION

Integration of DBT in screening of breast cancer survivors can reduce recall rates while maintaining other screening mammography performance metrics.

SSK01-05 Digital Breast Tomosynthesis Slab Thickness: Impact on Reader Performance and Interpretation Time

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E451B

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PURPOSE

To evaluate the impact of digital breast tomosynthesis (DBT) slab thickness on reader performance and interpretation time.

METHOD AND MATERIALS

This IRB-approved, HIPAA compliant prospective reader study was performed at an NCI-Designated Cancer Center. Four fellowship-trained breast imagers (R1-R4) interpreted 122 DBT patient exams containing standard MLO and CC views with no prior exams or clinical history. Cases were presented using a standard protocol (10 mm slabs, 1 mm planes, synthetic 2D) and an experimental protocol (6 mm slabs, synthetic 2D) with a crossover design and 6-week washout period between sessions. Interpretation times were harvested from the workstation. Comparisons were made using t-tests or non-parametric tests for continuous variables, chi-square tests or Fisher's exact tests for categorical variables, and ROC curves for diagnostic performance.

RESULTS

Eleven exams were unilateral. Among 233 breasts, mammographic findings and final diagnoses included 45 masses (25 IDC, 1 DCIS,

19 benign), 22 groups of calcifications (3 IDC, 9 DCIS, 10 benign), 18 architectural distortions (11 IDC, 3 ILC, 1 DCIS, 3 benign), 14 asymmetries (2 IDC, 12 benign), and no finding in 134. Intrareader differences for observed findings were not significantly different between standard and experimental protocols (p>0.83). For detection of malignancy, area under the ROC curve (with 95% CI) was similar using standard and experimental protocols for all 4 readers: R1 [0.71 (0.65, 0.77) vs 0.69 (0.61, 0.76); p=0.81], R2 [0.82 (0.73, 0.90) vs 0.79 (0.70, 0.87); p=0.69], R3 [0.86 (0.79, 0.92) vs 0.90 (0.85, 0.96); p=0.52], and R4 [0.80 (0.71, 0.88) vs 0.82 (0.75, 0.90); p=0.79]. Mean reduction in interpretation time using the experimental protocol was 0.45 minutes or 11.2% (4.0 + 1.7 min vs 3.6 + 1.5 min; p<0.0001), and was statistically significant for 3/4 readers (p<0.005).

CONCLUSION

An experimental DBT reconstruction protocol using 6 mm slabs without 1 mm planes was associated with similar perception of specific findings and unchanged overall diagnostic performance compared with the standard protocol, and required less interpretation time.

CLINICAL RELEVANCE/APPLICATION

DBT is associated with longer interpretation time than 2D mammography. As DBT use increases, alternate reconstructions may help shorten interpretation time while maintaining reader performance.

SSK01-06 Effect of Age, Race and Screening Frequency on Recall Rates by Screening Mammogram Modality: Findings from a Learning Health System

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E451B

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PURPOSE

Health systems seeking to maximize screening efficiency and optimize effectiveness need to balance the benefits of screening mammography (cancer detection) with recall and false positive rates. This analysis examines the effect of age, race and screening frequency on recall rates in a large US cohort.

METHOD AND MATERIALS

A big data platform was used to integrate EMR, RIS, and tumor registry data into a learning health system. This analysis included 575,180 screens from 257,597 women, performed 2015-2017, at 58 facilities across 3 large healthcare organizations. Women were defined as 2+ screens if they had 2 or more screens that were at least 9 months apart. Women were defined as 1-screen if they had no evidence of a screening mammogram in the one year prior to and at any time after the first observed exam; women with index screening mammograms within 12 months of the end of the study period were excluded. Women in 1-screen cohort include both prevalent and incident exams and thus represent screeners without an apparent recent prior exam. EMR records were used to identify women as either African American (AA), Caucasian (C), Asian (A) or Other (O).

RESULTS

Nearly a quarter of the women (N=57,418; 22.3%) met criteria for 1-screen and 200,179 for 2+ screens. Recall rates were significantly higher among women with 1-screen compared to 2+ screens, both overall and within each age and race category. There was a dramatic decrease in recall rate in the 2+ screen group vs the 1-screen group, particularly for DBT vs DM, after adjustment for age, breast density and institution (p<0.01), across all races (except O) and ages: 2+ screen groups (AA:7.00 vs 7.78%, C:7.38 vs 7.61%, A:7.33 vs 8.90%, O:6.75 vs 7.25%, Overall=7.31 vs 7.68%) vs 1-screen (AA:15.28 vs 18.14%, C: 15.43 vs 17.33%, A: 16.43 vs 21.64%, O:12.45 vs 15.45%, Overall=15.33 vs 17.62%).

CONCLUSION

While age and race are strong determinants of recall rates, screening frequency and screening modality have an even greater total impact. Initiatives to encourage compliance with annual screening mammography in women ages 40 and older, particularly with DBT, may help health systems optimize breast cancer screening programs while minimizing harms.

CLINICAL RELEVANCE/APPLICATION

Adherence to routine screening, and use of digital breast tomosynthesis, reduces recall rates and minimizes potential harms associated with screening mammography, across all strata of age and race.

SSK01-07 How to Resolve Tomosynthesis-Detected Architectural Distortion to Avert Biopsy

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E451B

Participants
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PURPOSE

Architectural distortion (AD) is a feature raising suspicion of malignancy. Superimposed tissue may obscure AD on 2D, that is unmasked on a 1-mm DBT slice. After conversion to DBT, our recalls for AD have increased. With concern for overdetection, our purpose was to investigate how DBT detected AD can potentially be resolved on diagnostic examinations to avoid biopsy.

METHOD AND MATERIALS

After IRB approval, our proprietary database was used to map imaging findings (IF) that prompted a recall (11/2014-01/2017). Then we compared 3 month before and after transition to DBT. To study AD after transition, we identified all DBT screening-recalled diagnostic studies with AD as the main IF. Two breast imagers reviewed examinations to determine whether AD was seen on one or both DBT screening views, had US correlatives, and was resolved on diagnostic. For all biopsied AD, path reports were reviewed. For all resolved AD, FN rate w/in a 2 year timeframe were determined.

RESULTS

Comparing 10,387 screens before with 11,170 after transition to DBT, AD recalls accounted for a relative increase of 45.6%. After transition, we identified 40 cases w/ AD as the main IF recommended for biopsy. 15/40 (38%) screen-detected ADs, were one view only (7 CC and 8 MLO), and 7/15 (47%) w/ US correlates. Histologies were: 2 (5%) ILC, gr. 1 (1 w/ US corr.); 1 (2%) DCIS, gr. 2; 13 (32%) RSs, 6/13 (46%) w/ US corr. and 2 (15%) RS with atypias (1 w/ ADH and FEA, and 1 w/ FEA and LCIS); and 18 (45%) benign histologies of fibrosis, sclerosing adenosis, columnar cell change, apocrine metaplasia, and PASH. 6/13 (46%) RSs were excised with no upgrades. Classic LCIS was found in 2 cases. None of the diagnostic resolved cases were FN in a 2 year time period.

CONCLUSION

An increase in AD-recalled screening cases after transition to DBT may result from greater conspicuity of AD on DBT. No cancers were found in one-view-only AD w/o an US correlate. Fibrosis may be a possible concordant response to inflammation or trauma explaining subtle AD perceived on DBT. In diagnostic AD resolved cases no FN were found. With increasing DBT experience, breast imagers may need to reevaluate the management of AD to judge the need for biopsy, to determine concordance, and possibly to influence a decrease in FP while maintaining CDR.

CLINICAL RELEVANCE/APPLICATION

Determining the ways how to resolve DBT detected AD on diagnostic examinations may decrease the biopsy rate without affecting CDR.

SSK01-08 Screening Downstages Breast Cancer at Detection for Most Women but Some Need More Intensive Screening Regimen

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E451B

Participants
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PURPOSE

To explore clinical and imaging characteristics of screening detected vs. symptomatic female breast cancer.

METHOD AND MATERIALS

We included 231 consecutive female breast cancer (BC) cases: 142 screening detected and 89 symptomatic BC (lump 81%, focal pain 9%, nipple discharge 6%, skin changes 4% cases) between April 2017 and March 2018. All screening mammography employed Digital Breast Tomosynthesis (DBT). Diagnostic mammography used DBT and Full-field Digital Mammography. Diagnostic ultrasound was performed as appropriate. BC was diagnosed via ultrasound-guided or DBT-guided vacuum-assisted core needle biopsy (CNB). Demographic, imaging and pathology (CNB and surgical) data were collected and analyzed using the independent samples T-test and Pearson Chi-square.

RESULTS

Women with screening detected BC were not significantly (p=ns) different from women with symptomatic BC in the following: Age (mean age, 62.8 vs. 61.3 years), Mammographically dense breasts (49% vs. 55%). Compared with symptomatic BC, cases of screening detected BC had a significant (p<.05) association with: Smaller invasive tumors (13.5 vs. 24.2 mm) and more minimal cancers (60% vs. 18%), Lower grade tumors (32% vs. 13% G1; 33% vs. 47% G3), Fewer node positive cases (11% vs. 49%), Longer interval from prior mammogram (33 vs. 17.7 months), Prior mammogram within past 11-24 months (70% vs. 21%). Women older than 40 years with symptomatic BC were more likely to have never had a mammogram compared to those with screening detected BC (36% vs. 1.4%, p<.05). 17% of symptomatic BC were diagnosed within 10 months of a prior negative mammogram (interval BC). Interval BC had a tendency to be larger and higher grade compared with all other cancers, however the differences

did not reach statistical significance due to a small sample size.

CONCLUSION

Screening detected BC had more favorable prognostic features than symptomatic BC, and the latter was associated with a shorter interval from a prior mammogram, including interval BC diagnosis.

CLINICAL RELEVANCE/APPLICATION

Routine screening DBT allows for detection of majority of BC at an earlier stage prior to symptoms. However, 17% of symptomatic BC diagnosed as interval BC (within 10 months of negative DBT) suggests that certain women may benefit from more intensive screening regimen. Further sudy of this population is warranted.

SSK01-09 The Potential Impact on Dose When Digital Breast Tomosynthesis (DBT) is Used in the Diagnostic Workup of Asymmetric Densities at Screening Assessment

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E451B

Participants
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PURPOSE

Digital Breast Tomosynthesis (DBT) as a screening tool has improved the cancer detection rate and reduced the false positive rate. We wanted to assess the impact of DBT on dose when assessing asymmetric densities.

METHOD AND MATERIALS

All women recalled following an abnormal screening mammogram were asked to participate. All had triple assessment performed which involves clinical examination, additional mammographic views and targeted ultrasound of the breast and a biopsy if required. Performed between 13/11/2015 and 29/07/2016, this was an IRB approved prospective study. The DBT study was read within 6 weeks of the assessment clinic. The number of additional mammographic views and dose in mGy was recorded. The dose of the DBT examination was recorded. Statistical analysis: Dose was analysed in a mixed design, 2 x 2 ANOVA looking at dose with and without DBT (within cases).

RESULTS

1,470 women attended for screening assessment and 835 women consented to take part. 810 cases had complete data on dose & screening outcome. 248 cases were recalled for an asymmetric density in 247 women. 11 cancers were identified. There was a significant effect of the use of DBT, $F(1,246) = 69.17$, $p < .0001$, $\omega = .53$ (within cases): mean dose without DBT ($M = 8.0$, $SD = 5.3$) was higher than with DBT ($M = 5.9$, $SD = 3.0$). There was an interaction between the use of DBT and whether or not a biopsy was taken $F(1,246) = 12.96$, $p < .0001$, $\omega = .22$. When a biopsy was taken but Tomosynthesis/Ultrasound investigation indicated a biopsy was not necessary, mean dose was also higher without DBT ($M = 11.1$, $SD = 7.3$) than dose with DBT ($M = 5.5$, $SD = 1.6$). However, when a biopsy was taken that Tomosynthesis/Ultrasound investigation agreed should have taken place, there was no significant difference in dose without DBT ($M = 9.8$, $SD = 5.5$) and dose with DBT ($M = 9.1$, $SD = 5.1$).The reduction in the number of films used, associated with the use of DBT, was analysed in a one way, between cases ANOVA looking at whether cases were biopsied or not. The overall reduction in the number of films used, associated with the use of DBT, was 4.3 ($SD = 2.1$). .

CONCLUSION

DBT in assessment has the potential to reduce the dose and number of additional mammographic images required in the diagnostic work up of asymmeric densities.

CLINICAL RELEVANCE/APPLICATION

DBT in the diagnostc work up of asymmetric densities results in a reduction in the dose and number of biopsies performed.

SSK02

Breast Imaging (Ultrasound)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E450A

BR US

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSK02-01 A Novel Imaging Biomarker for Monitoring Response to Neoadjuvant Chemotherapy

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E450A

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PURPOSE

PET and MRI studies have shown that imaging biomarkers can be used to characterize response of tumors to Neoadjuvant chemotherapy (NAC) and predict pathological outcomes. However, serial PET and MRI exams are time consuming, carry high cost and are associated with risks such as exposure to Gadolinium or radiation. Our previous studies have shown that tissue sound speed, derived from ultrasound tomography (UST) measurements, is an imaging biomarker that can be used to track tumor changes in the breast. Since ultrasound is relatively inexpensive, the purpose of this study was to evaluate sound speed as a reliable and cost-effective imaging biomarker for assessing NAC.

METHOD AND MATERIALS

Twenty-one patients undergoing neo-adjuvant chemotherapy for invasive breast cancer, were serially examined with UST throughout their treatment. The two parameters measured were the volume (V) and the volume averaged sound speed (VASS) of the tumor. Response curves of VASS and V were plotted for each study participant. Pathology results were used to classify participants as complete or partial responders based on whether they achieved complete pathologic response (pCR) or not. The response curves were then averaged together within each group. The trend in the data was assessed by determining the Spearman correlation coefficient for changes in VASS and V. A t-test was used to determine if the response curves were statistically different between the two groups.

RESULTS

In the partial response group, VASS and V showed a gradual change with time while the complete response group showed a much steeper change with time (Figure 1). The difference between the two groups was significant ($p<0.01$) for all parameters. Furthermore, large drops in V and VASS in the first 3 weeks of treatment appeared to be predictive of pCR, though this finding was not prospective.

CONCLUSION

Our study demonstrates that UST can be used to monitor NAC and that the partial vs complete responders could be separated based on how V and VASS changed with time. A future larger study will test the predictive power of UST prospectively.

CLINICAL RELEVANCE/APPLICATION

UST has potential for non-invasive, rapid identification of partial vs complete responders in women undergoing NAC without the use of either a radiotracer or gadolinium. Clinical decision making would improve by transitioning non-responders to alternative treatment quickly and by demonstrating effective response to NAC.

SSK02-02 Precision Imaging: Early Ultrasound Evaluation (US) to Identify Excellent Responders to Neoadjuvant Chemotherapy (NAC) in Patients (pts) with Triple Negative Breast Cancer (TNBC)

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E450A

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PURPOSE

TNBC is a heterogeneous disease with distinct molecular subtypes that convey diverse clinical behavior and response to chemotherapy. The aim of this study is to determine if early US after two cycles of NAC has the potential to identify excellent responders to standard NAC averting need for costly genomic profiling and selecting patients with lower likelihood to achieve pathologic complete response (pCR) for targeted therapeutic trials.

METHOD AND MATERIALS

107 patients enrolled in "A randomized triple Negative Breast Cancer Enrolling Trial to Confirm Molecular Profiling Improves Survival" (ARTEMIS; NCT02276443) had US with three-dimensional measurements at baseline and after 2 cycles of Adriamycin-based NAC. Pathologic response was assessed at the time of surgery after completing anthracycline/taxane-based NAC. The relationship between pCR and primary tumor volume reduction (PTVR) by US was evaluated using recursive partitioning and ROC analysis.

RESULTS

Overall, 40% (43/107) of pts achieved pCR. Recursive partitioning showed that in patients with PTVR after 2 cycles >=73% pCR was 23/31 (74%). If the PTVR was < 73%, only 20/76 (26%) pts had pCR. In pts with <73% PTVR, the baseline volumetric size of the primary tumor (BTVS) further influenced pCR. If BTVS was < 35cm, 32% (19/59) had pCR, and if >=35 cm, only 6% had pCR (1/17) ($P < 0.0001$). The percentage of TVR after 2 cycles was also predictive of pCR (AUC = 0.79, 95% CI = 0.70, 0.88, $p < 0.0001$).

CONCLUSION

Early US exam after 2 cycles can identify the subgroup of TNBC with excellent response to standard NAC. Reduction in percent tumoral volume may predict patients with higher likehood to achieve pCR. An exploratory cut point of 73% PTVR will be tested in a validation study.

CLINICAL RELEVANCE/APPLICATION

Early US exam after 2 cycles can identify the subgroup of TNBC with excellent response to standard NAC, eliminating need for expensive genomic profiling and avoiding toxicity of investigational targeted therapy.

SSK02-03 Predicting Pathologic Complete Response with Ultrasound Tumor Characteristics in Triple Negative Breast Cancer Patients

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E450A

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PURPOSE

To investigate which pretreatment and midtreatment ultrasound breast tumor characteristics are predictive of pathologic complete response (pCR) status in triple negative breast cancer (TNBC) patients treated with neoadjuvant chemotherapy

METHOD AND MATERIALS

As a substudy of an active, single-institution, IRB-approved clinical trial of Stage I-III TNBC patients, this imaging analysis included the first 125 patients who underwent surgery. Ultrasound was performed on all patients before (pretreatment) and after (midtreatment) completion of four cycles of AC (Adriamycin and cyclophosphamide) chemotherapy. Patients subsequently received taxane-based chemotherapy or an investigational therapy as guided by midtreatment response. Review of ultrasound images was performed while blinded to pathology results (i.e., pCR versus non-pCR) from definitive surgery. Tumor size was based on the largest dimension on ultrasound. Tumors with a nonmass finding of abnormal, altered echotexture compared to surrounding breast tissue were described as 'infiltrative'. The appearance of the tumor at midtreatment was designated as 'mass', 'architectural distortion', 'flat tumor bed', or 'clip only/no visible tumor bed'. Midtreatment response pattern was described as 'complete', 'concentric shrinkage', 'fragmented', 'stable' or 'progression'. Logistic regression analyses were performed with p values less than 0.05 considered statistically significant.

RESULTS

Mean patient age was 53 years, range 27-77. Fifty-five of 125 patients (44%) achieved pCR while 70 of 125 (56%) had non-pCR. On pretreatment ultrasound, tumors that were <= 5 cm in size (p=0.029) or tumors that did not have an associated infiltrative/nonmass appearance (p=0.0081) were more likely to achieve pCR. On midtreatment ultrasound, tumors which no longer had the appearance of a space-occupying mass (p<0.0001) or tumors that showed a complete or concentric shrinkage response pattern were more likely to result in pCR (p=0.010).

CONCLUSION

Ultrasound pretreatment tumor size, associated nonmass/infiltrative component assessed at pretreatment, midtreatment tumor appearance and tumor response pattern at midtreatment are variables that may be useful to predict pCR in TNBC.

CLINICAL RELEVANCE/APPLICATION

Ultrasound can be an accessible, informative tool during pretreatment and midtreatment to identify TNBC patients who are less likely to achieve pCR and may benefit from investigational therapies.

SSK02-04 Screening Ultrasonography-Detected Category 4A Breast Masses with a Decision-Making Support Software Based on Deep Learning as an Alternative to Biopsy

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E450A

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PURPOSE

To evaluate the additional value of a decision-making support software based on deep learning (S-DetectTM) in B-mode ultrasonography (US) for analyzing screening US-detected breast masses.

METHOD AND MATERIALS

This Institutional Review Board approved retrospective review of three institutional databases identified 246 women (median age: 45 years; range 20-83 years) with clinically and mammographically occult screening US-detected breast masses scheduled for biopsy. The masses were examined by an ultrasound machine (RS80A with Prestige, Samsung Medison, Co., Ltd.) equipped with S-DetectTM. BI-RADS final assessment categories on B-mode, and the quantitative scores of each descriptor on a continuous scale of 0 to 1 on S-DetectTM were collected. The area under the receiver operating characteristic curves (AUCs) of each descriptor of S-DetectTM were analyzed, and the added values of combining S-DetectTM to B-mode with respect to AUCs, sensitivity, and positive predictive value (PPV) were assessed.

RESULTS

Among 246 breast masses, 205 were benign and 41 were malignant (30 IDC, 7 DCIS, 2 ILC, 1 mucinous, 1 adenoid cystic carcinoma). There were 205 category 4A, 20 category 4B, 14 category 4C, and 7 category 5. The PPVs for category 4A, 4B, 4C,

and 5 on B-mode alone were 6.8%, 40.0%, 85.7%, and 100%, respectively. In differentiating benign and malignant masses using the S-DetectTM software, quantitative scores of not-circumscribed margin, irregular shape, and not-parallel orientation showed higher AUC values (0.754-0.800) than those of echogenicity and posterior features (0.544-0.692). Furthermore, by downgrading BI-RADS 4A masses with a not-circumscribed margin score < 0.000228, irregular shape score < 0.031686, or not-parallel orientation score < 0.000092 to BI-RADS 3, 50 false-positive biopsies could be avoided, without losing sensitivity. The PPV of category 4A increased to 9.0% after adding quantitative information.

CONCLUSION

The quantitative scores of not-circumscribed margin, irregular shape, and not-parallel orientation were important in analyzing US-detected masses, and adding this information to B-mode US could decrease unnecessary benign biopsies.

CLINICAL RELEVANCE/APPLICATION

The quantitative values measured by S-DetectTM of the morphological characteristics of masses on B-mode could decrease false-positive biopsies caused by screening US, although validation is needed.

SSK02-05 Added Value of Vascular Index Using Superb Microvascular Imaging for Evaluation of Breast Masses: Comparison with Grayscale Ultrasound

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E450A

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PURPOSE

The purpose of this study is to evaluate the added value of vascular index using superb microvascular imaging for evaluation of breast masses in comparison with grayscale ultrasound (US).

METHOD AND MATERIALS

This prospective study was approved by the institutional review board, and informed consent was obtained. Between August 2018 and December 2018, a total of 70 breast masses (36 malignant and 34 benign) in consecutive 70 patients were evaluated with grayscale US and superb microvascular imaging (SMI). Two breast radiologists analysed grayscale US alone and combination of grayscale US and SMI using BI-RADS scale. They also independently measured the vascular index based on SMI. Diagnostic performance of grayscale US alone and combination of grayscale US and SMI was reported and compared. Vascular index was compared between benign and malignant masses and the optimal cut-off value was determined. We also assessed the interobserver variability in imaging analyses and vascular index between radiologists.

RESULTS

Interobserver variability in imaging analyses and vascular index was almost perfect (range of intraclass correlation coefficients, 0.932-0.947). Vascular index was higher among the malignant breast masses than benign lesions, with statistical significance (P<0.001). The optimal cut-off value of vascular index in discriminating between malignant and benign breast masses was 2.95 with a sensitivity of 86.1% and a specificity of 91.2%. The diagnostic performance of grayscale US alone and combination of grayscale US and SMI were 0.824 and 0.912 for reader 1 (P=0.028), and 0.795 and 0.853 for reader 2 (P=0.101), respectively.

CONCLUSION

Vascular index using SMI showed better diagnostic performance in distinguishing malignant from benign breast masses, with high interobserver variability.

CLINICAL RELEVANCE/APPLICATION

Our study indicates that the combined use of grayscale US and SMI with vascular index can improve the characterization of breast masses.

SSK02-06 Can We Learn Easier Breast Tumor Differentiation with Quantitative Speed-of-Sound Biomarkers? Comparison of Deep Learning of B-mode and Speed-of-Sound Images Using Conventional Ultrasound

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E450A

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PURPOSE

Speed of Sound (SoS) is a quantitative diagnostic biomarker (meters per second) which correlates with tissue microstructure. Current SoS systems are dedicated and require breast immersion in a water bath. Our purpose is to obtain SoS maps from a conventional pulse-echo ultrasound (US) system, and to use a deep learning software (DLS), based on SoS texture, to correctly classify benign and malignant breast tissues.

METHOD AND MATERIALS

As part of an on-going HIPPA-compliant study, 27 women with histologically proven solid breast lesions (13 carcinoma, 14 benign) were examined. SoS were compared with 308 healthy breast segments in 106 women without abnormal findings. A laptop US system with a linear probe was used for B-mode and SoS-US imaging (UF-760 AG, Fukuda Denshi). Local phase aberrations in intrinsic reflections (speckle) of breast tisuse were measured with images acquired from different angular directions, and SoS images were reconstructed. SoS and B-mode texture was analyzed with a DLS (ViDi Suite v2.0.) trained with 60% of the images, and classification accuracy was evaluated in the remaining images.

RESULTS

A significant SoS increase ($p<0.001$) is observed in malignant lesions (carcinoma) with respect to benign lesions (79% fibroadenoma, 21% other). A SoS increase cut-off value of 42 m/s provided Accuracy (Ac) =81.5% for malignant/benign lesion differentiation, and Ac=96.0% for carcinoma and breast segments without lesions of different ACR densities (64% a&b, 36% c&d). The SoS differences between benign lesions and lesion-free segments were not significant ($p>0.05$). In comparison SoS texture analysis with DLS achieves Ac=83.4% for differentiation of benign/malignant lesion, Ac=99.0% for malignant lesion/lesion-free segments and Ac=98.0% for benign lesion/lesion-free. In comparison, B-mode DLS for the same region of interest respectively achieved Ac=50%, Ac=100%, Ac=100%. Malignant lesions that were not correctly classified with a SoS cut-off (e.g. a mucinosis carcinoma) were correctly classified with SoS DLS.

CONCLUSION

DLS of quantitative SoS maps improves differentiation of breast tumors with respect to a single cut-off value. For a reduced lesion dataset, DLS texture analysis of SoS was superior to B-mode ultrasound.

CLINICAL RELEVANCE/APPLICATION

Breast cancer differentiation with B-mode ultrasound is currently based on subtle geometric and texture features, which require extensive sonographic training experience or large lesion datasets for machine learning. On the other hand, SoS-US is a quantitative imaging modality, which provides an objective lesion assessment with reduced training data (or even a single image). The integration on SoS-US as an add-on feature on clinical ultrasound systems has potential to improve and facilitate breast diagnostics.

SSK02-07 Analysis of the Preoperative Axillary Ultrasound in 685 Women with T1 Breast Cancer: Can We Move Away from Sentinel Lymph Node Biopsy in Women with Early Breast Cancer?

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E450A

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PURPOSE

The involvement of axillary lymph nodes is critical for appropriate treatment of breast cancer, and its evaluation is currently a hot topic of controversy across breast units. We aim to evaluate the negative predictive value (NPV) and specificity of axillary ultrasound (AUS) in the exclusion of metastatic axillary lymph node in study participants with early breast cancer.

METHOD AND MATERIALS

Preoperative AUS was performed in women with T1 breast cancer, enrolled in our Institute, as a part of a multicenter randomized prospective trial. NPV and specificity were calculated for different histologic groups: all histologic evidence of tumor including micrometastases and isolated tumoral cells (ITC), then only those with metastases, and next only those with metastases >3 mm.

RESULTS

Preoperative AUS in 685 consecutive study participants (mean age: 49±10 years) resulted in 33/685 (4.8%) of false positive and 53/343 (15.5%) of false negative, which is reduced to 28/343 (8.1%) excluding ITC and micrometastases and to 17/343 (4.9%) considering only metastases >3 mm. Overall NPV was 597/650 (92%, 95%CI, 90-94%) including all cases of positivity to histopathological examination. Excluding ITC and micrometastases, the NPV was 620/650 (95%%, 95%CI, 94-97%). Finally, including metastases that can be detected by AUS (namely, metastases >3 mm) alone, the NPV was 628/650 (97%, 95%CI, 95-98%). Specificity of AUS in our population was 628/685 (95%, 95%CI, 93-97%).

CONCLUSION

Our results show that in women with early breast cancer, the AUS may represent an effective, non-invasive diagnostic tool for axillary staging. Considering the high NPV and specificity, AUS allows to select those women who could benefit from observation

alone as a treatment approach.

CLINICAL RELEVANCE/APPLICATION

Currently, the oncological community moves away from sentinel lymph nodes biopsy and our results confirmed the role of AUS as a non-invasive, low-cost, easily available and accurate modality for preoperative staging of the axilla, in women with early breast cancer.

SSK02-08 Adjunctive Automated Breast Ultrasound Has Better Diagnostic Performance for Breast Cancer than Hand-Held Ultrasound

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E450A

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PURPOSE

Adjunctive ultrasonography improves diagnosis of breast cancer. Automated breast ultrasound system(ABUS) can overcome the operator dependency and lack of standardization of Hand-held ultrasound(HHUS). We aimed to evaluate and compare the clinical value of adding HHUS or ABUS to mammography(MG) in the diagnostic workflow of breast cancer among Chinese women.

METHOD AND MATERIALS

1266 female outpatients aged 40 to 69 years old were enrolled in this hospital-based multi-center study. All the women underwent HHUS, ABUS and MG, Breast Imaging-Reporting and Data System(BI-RADS) was used to imaging interpretation and mammographic breast density assessment. Lesions classified as BI-RADS 4 or 5 by any of three modalities were defined as suspicious findings and were referred to biopsy for diagnosis. Clinical performance of different strategy was compared in terms of sensitivity, specificity and area under the curve(AUC) of receiver operating characteristics, using McNemar's test and nonparametric Z test.

RESULTS

323 breast cancer cases were detected in our study. 958 out of 1266 women were classified as having dense breast. Increased sensitivity and AUC as well as decreased specificity were observed when adding HHUS or ABUS to MG(all P<0.001). Compared with the combination of MG and HHUS, the combination of MG and ABUS had almost same sensitivity (0.988v.s. 0.985, p=1.000), higher specificity (0.876 v.s. 0.857, p=0.003) and higher AUC(0.932 v.s. 0.921, p=0.018). Same trend was observed when HHUS or ABUS was only added to women with dense breast(p=1.000, 0.004 and 0.011, respectively). In addition, compared with adding ABUS to all participants, adding ABUS to women with dense breast decreased the sensitivity(0.969 v.s. 0.988,p=0.031) while increased the specificity (0.884 v.s. 0.876, p=0.008), leading to a nonsignificant increase in AUC(0.927 v.s. 0.932, p=0.213).

CONCLUSION

Adding ultrasonography to MG can improve breast cancer diagnosis. Adjunctive ABUS have significant better diagnostic performance compared with adjunctive HHUS.

CLINICAL RELEVANCE/APPLICATION

The sensitivity of mammography in women with dense breast is limited in clinical practice. Adding ulrtasonography, especially ABUS, can improve diagnosis, and overcome the operator dependency.

SSK02-09 Efficiency of Technologist-Performed Hand-Held Whole Breast Ultrasound for Screening Women with Dense Breast Tissue

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E450A

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PURPOSE

Technologist-performed hand-held screening whole breast ultrasound (WBUS) has been performed at our institution since 2009 in

women with dense breast tissue. With new federal breast density notification legislation in the United States, more facilities will be interested in offering this service to patients. The purpose of this study was to understand the workflow details around this practice in terms of time requirement for both technologists and radiologists and final outcome of cases.

METHOD AND MATERIALS

For a one month period (2/1/19 - 2/28/19) WBUS performed following a normal tomosynthesis screening mammogram at four sites (tertiary cancer center and 3 out-patient satellite offices) were prospectively recorded. Twenty-seven mammography technologists cross-trained in breast sonography performed all exams. Dedicated breast radiologists were present on-site to check cases and re-scan if necessary. Technologists recorded images of four quadrants, the retroarerolar area, and axilla as well as documented any findings of interest. Data recorded for each exam included technologist scanning time, need for re-check by radiologist, radiologist scanning time, reason for re-check, and final BI-RADS score. Technologists identifiers were not recorded to reduce bias.

RESULTS

616 exams were performed: 602 bilateral and 14 unilateral. The average scanning time for bilateral exams was 12.5 minutes (range 4-34), and for unilateral exams was 5.1 (range 2-7). A re-check was performed in 67 cases (10.8%) and radiologist scanning time averaged 3.3 minutes (range 1-10). Reasons for re-check included complicated cyst/fibrocystic changes (18), mass/masses (13), normal fibroglandular tissue/artifact (12), suspicious mass (5), scars/prior biopsy (4), prominent lymph nodes (3), fat necrosis (1), recheck prior finding (1), implant rupture (1), improved image capture (1) and unrecorded (8). Final BI-RADS was BI-RADS 1/2: 96.6%, BI-RADS 3: 2.6%, BI-RADS 4/5: 0.8%.

CONCLUSION

Technologist-performed hand-held WBUS is time efficient, requiring just over 12 minutes scanning time per case. As the majority of cases are normal and do not require re-check, radiologist time involvement is minimal.

CLINICAL RELEVANCE/APPLICATION

Technologist-performed hand-held WBUS is an efficient method to provide adjuvant screening to women with dense breast tissue.

Printed on: 10/29/20

SSK03

Cardiac (Coronary Atherosclerosis)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E351

CA CT

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Suhny Abbara, MD, Dallas, TX (*Moderator*) Royalties, Reed Elsevier; Institutional research agreement, Koninklijke Philips NV; Institutional research agreement, Siemens AG
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Sub-Events

SSK03-01 Calcium Scoring in Denoised Ultra-Low Dose Chest CT

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E351

Participants
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PURPOSE

To assess the effect of a denoising method (D) for ultra low-dose CT (ULDCT) on calcium scoring.

METHOD AND MATERIALS

52 consented patients, referred for an outpatient chest CT, underwent 2 scans: a normal dose CT (NDCT), 120 kVp and automatic current modulation, with or without contrast media, immediately followed by an ULDCT, 120 kvp and fixed current at 10 mA for bmi <29 and 20 mA for bmi>=29. Consecutively, each ULDCT was denoised using a locally-consistent non-local-mean (LCNLM) algorithm to obtain a high signal to noise ratio (SNR) version of the ULDCT. The LCNLM algorithm leverages large databases of image patches extracted from high-SNR chest CT scans to denoise ULDCTs while enforcing local spatial consistency to preserve fine details and structures in the image. Blinded to all clinical information, a chest radiologist separately assessed the NDCT, ULDCT, and denoised ULDCT (D), documented findings, assigned an Agatston score for each of the scans and classified the severity of the calcifications in the coronary arteries (H). To account for the influence of strong dose reduction on Agatston scores, a 2nd order polynomial correction function between ULDCT and NDCT Agatston scores was computed and applied in a leave-one-out cross-validation scheme to each case. The same was done between ULDCT and D scores. The correction function was applied to the ULDCT and D scores obtained in the experiments.

RESULTS

Using ULDCT reduced the radiation for patients with a BMI > 29 by an average of 93% and for those with a BMI of up to 29 by an average of 96%. For patients with a BMI > 29 the average effective radiation dose for ULDCT was 0.41 mSv, whereas for those with a BMI of up to 29 it was 0.24mSv. All 14 patients with severe calcifications (Agatston>400) were classified correctly in the denoised ULDCT, while only 12 were classified as severe in the ULDCT. Also, all 6 patients with moderate calcifications (100<=Agatston<=400) were classified correctly in both ULDCT and the denoised ULDCT.

CONCLUSION

Interpretation of ULDCT may cause errors in calcium scoring, but implementation of the LCNLM algorithm for denoising improves ULDCT images so that calcium scoring results are similar to those obtained in normal dose scans.

CLINICAL RELEVANCE/APPLICATION

Denoising ULDCT with the LCNLM algorithm enables correct calcium scoring with dose reductions greater than 90%.

SSK03-02 Individualized Coronary Artery Calcium Scoring at Any Tube Voltage Using a kVp-independent Reconstruction Kernel

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E351

Participants
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PURPOSE

Low kV-scanning lowers radiation at many CT applications, yet is not currently used for coronary artery calcium scoring (CACS) as the Agatston convention is defined at 120kV. We prospectively investigated an automated tube voltage selection (ATVS)-based protocol, using a software-based correction algorithm and a kVp-independent kernel, for the accurate derivation of Agatston calcium scores from cardiac CT data acquired at any kV-level.

METHOD AND MATERIALS

With IRB approval, 24 patients (50% male, 60.2 ± 10.5 years) underwent conventional clinical CACS at 120 kVp and an additional research CACS acquisition using an individualized, body habitus-adjusted tube voltage between 70 and 130 kVp, based on the ATVS selection. Datasets of the additional CACS scans were reconstructed using a kVp-independent kernel that enables using the Agatston scoring convention without changing the weighting threshold of 130 HU, regardless of the original tube voltage chosen for image acquisition. Agatston scores and radiation dose estimates derived from the different ATVS-based coronary calcium scoring studies were compared with the standard acquisition at 120 kVp.

RESULTS

Median Agatston scores derived from the standard 120 kVp, 28.5 (IQR, 0.25 - 346.3), and the patient-tailored kVp-independent protocol, 32.1 (IQR, 0 - 348.7), showed no significant differences ($p = 0.17$). We found an excellent correlation for Agatston scores derived from the two different protocols with a Pearson's correlation coefficient of $r = 0.99$. Additionally, 96% of patients were classified into the same risk category (0, 1-10, 11-100, 101-400, or >400) using the patient-tailored kVp-independent protocol. The CT dose-length-product was 27.7 ± 8.6 mGy×cm using ATVS protocol and 30.0 ± 8.3 mGy×cm using the standard 120 kVp protocol, resulting in a significantly lower effective radiation dose with the kV-independent approach (0.39 ± 0.12 mSv vs. 0.42 ± 0.11 mSv) ($p < 0.001$).

CONCLUSION

ATVS-based CACS using a kVp-independent kernel enables Agatston calcium scoring in excellent correlation compared to the standard 120 kVp scanning. Additionally, radiation dose parameters were significantly reduced using the ATVS-based protocol.

CLINICAL RELEVANCE/APPLICATION

Using the ATVS with a kVp-independent reconstruction kernel allows the CACS protocol to be individualized to each patient, resulting in an optimal compromise between radiation dose and high diagnostic reliability.

SSK03-03 Smoking, but Not Other Risk Factors, Predicts High-Risk Plaque in Low Calcium Score 1-99 AU: Implications for Patient Management

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E351

Participants
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PURPOSE

The American Heart Association 2018 cholesterol guidelines recommend statin therapy in patients with a coronary calcium score (CCS) >100 AU as Class IIa, while in low CCS (1-99 AU), an "individual risk estimation" is adviced, leaving the clinician in a greyzone for decision making. High-risk plaque criteria are novel promising coronary computed tomography angiography (CTA) biomarkers for prection of major cardiac events.Hence, the objective of this study was to define predictors of high-risk plaque by coronary computed tomography (CCTA) in patients with a low CCS.

METHOD AND MATERIALS

6473 low-to-intermediate ASCVD-risk patients (60±12.51 years; 40.11% females) who underwent CCTA and CCS were prospectively enrolled. CCTA analysis included (1) stenosis severity CADRADS 0-4 and (2) high-risk plaque (HRP) criteria: low attenuation plaque (LAP) quantified by HU, napkin-ring (NR), spotty calcifications (SC) or positive remodeling (PR). Multiple multivariate binary logistic regression models were created for prediction of the different HRP-criteria by the major risk factors (nicotine, arterial hypertension, positive family history, dyslipidemia, diabetes mellitus).

RESULTS

997 patients had a low CCS (age 60.6±9.3, 40.12% female), among them 279 (28%) smokers. 35.6% of smokers had at least one HRP (min.2 criteria) versus only 26.9% of non-smokers (p=0.014). NRS was found more often in smokers (16.2% vs 9.2%, p=0.04). On multivariate linear regression, smoking but not the other risk factors predicted HRP (OR 1.56; 95% CI 1.10-2.20; p=0.012), napkin-ring (OR 2.05; 95% CI 1.12-3.74, p=0.02) and PR (OR 1.81; 95% CI 1.18-2.77 p= 0.006). There was a trend between LAP<30 HU and diabetes (p=0.09), and LAP<60 HU and <90 HU with dyslipidemia (p=0.069; p=0.035, respectively), but there was no correlation of any other risk factors with any other HRP criteria.

CONCLUSION

Active smoking predicts the presence of high-risk plaque, especially napkin-ring and positive remodeling in patients with a CCS between 1 and 99 AU, but not the other major cardiovascular risk factors.

CLINICAL RELEVANCE/APPLICATION

Although a CCS between 1-99 AU categorizes these patients as low-risk, a history of smoking should incite the physician to further investigate whether the patient has high-risk plaque, and manage LDL more restrictively, e.g by initiating or intensifying statin treatment, and/or aiming a lower target LDL.

SSK03-04 Coronary Calcium Scoring at 100 kV with Tin Filtration Using a kV-independent Reconstruction Kernel

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

This study aimed to investigate the feasibility of a protocol for coronary artery calcium scoring (CACS) at 100 kV with tin filtration (Sn100 kV) to provide accurate Agatston scores, as well asses its potential for radiation dose reduction, using a software-based correction algorithm and a kV-independent kernel compared to the standard 120 kV acquisition.

METHOD AND MATERIALS

With IRB approval, we analyzed image data of 114 patients (66 men, 61.8 ± 9.6 years) who underwent a clinically-indicated CACS acquisition using the standard 120 kV protocol and an additional Sn100 kV CACS scan, as part of a research study. Datasets of the Sn100 kV scans were reconstructed using a kV-independent kernel. The kV-independent kernel produced images with Hounsfield unit (HU) values equivalent to 120 kV for bone and calcium. This enables Agatston scoring without changing the original weighting threshold of 130 HU, regardless of the original tube voltage chosen for image acquisition. The Agatston scores and radiation dose values were calculated and compared between the two different protocols.

RESULTS

Median Agatston scores derived from the standard 120 kV and the Sn100 kV protocol with the kV-independent kernel were 24.7 (IQR, 0-171.1) and 21.4 (IQR, 0-173.8), respectively, without significant differences (P = 0.18). We found an excellent correlation for Agatston scores derived from the two different protocols with a Pearson's correlation coefficient of r = 0.99. The dose-length-product was 11.4 ± 4 mGycm using the Sn100 kV and 50.4 ± 24.9 mGycm using the standard 120 kV protocol (P < 0.01), resulting in a significantly lower effective radiation dose by 77% (0.16 ± 0.06 mSv vs. 0.7 ± 0.35 mSv, P <0.01) for scanning at Sn100 kV. Additionally, 99% of patients were classified into the same risk category (0, 1-10, 11-100, 101-400, or >400) using the Sn100 kV protocol.

CONCLUSION

CACS at Sn100 kV using the kV-independent kernel is feasible and shows a high correlation compared to standard 120 kV scanning. Furthermore, the radiation dose was significantly reduced using the low-kV protocol.

CLINICAL RELEVANCE/APPLICATION

The use of a Sn100 kV protocol with a kV-independent kernel allows for a significant reduction of the radiation dose to the patient and simultaneously achieves a high diagnostic reliability.

SSK03-05 Determining Calcifications in Coronary Arteries Using Non-Gated Chest CT with 256-Detector Row in Comparison with Dedicated Calcium-Scoring CT

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

To investigate the reliability and accuracy of determining coronary artery calcifications (CAC) using non-contrast, non-gated chest CT with 256-detector row.

METHOD AND MATERIALS

This was an institutional review board approved study and all participants gave written informed consent. A total of 1318 patients for chest examination were enrolled to undergo both non-gated chest CT and dedicated calcium-scoring CT (CSCT) on a 256-detector row CT scanner. The chest CT was scanned in fast-helical mode with 8cm collimation, 0.28s rotation speed and pitch 0.992:1 to cover entire chest. CSCT used single prospective ECG-triggered cardiac axial mode with 0.28s rotation speed covering only the heart. Both scans used 120kV and automatic tube current modulation for obtaining a preset noise index of 20HU at 2.5cm slice thickness.Two reviewers evaluated the subjective image quality of the ungated chest CT in terms of the detection and display of calcifications in coronary arteries. CAC scores (Agatston, Mass and Volume) were determined using both image sets and were statistically compared.

RESULTS

It took less than 0.5s to cover the heart in the ungated chest CT and all cardiac images were acceptable for detecting and displaying calcifications in coronary arteries. Sensitivity and specificity of non-gated chest CT for determining positive CAC was 94.8% (182/192) and 100%, respectively. The agreement in assessing the quantitative Agatston, Volume and Mass scores between the non-gated chest CT and CSCT was almost perfect, with the Intra-class correlation coefficient (ICC) values of 0.998, 0.999 and 0.999, respectively. Additionally, there was a good agreement in CAC quantification between the non-gated chest CT and dedicated CSCT with small coefficient of variation: Mass score (9.0%), Volume score (9.5%) and Agatston score (12.6%).

CONCLUSION

non-gated chest CT with 256-detector row is a reliable imaging mode for detecting and quantifying calcifications in coronary arteries and the calcium mass score is the most accurate parameter compared with dedicated calcium-scoring CT.

CLINICAL RELEVANCE/APPLICATION

Non-gated chest CT on a 256-detector row CT with fast scan speed may be used to reliably detect and quantify calcifications in the coronary arteries.

SSK03-06 Deep Learning-Based Automated CT Coronary Artery Calcium Scoring

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E351

Participants
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PURPOSE

As the determination of coronary artery calcium scores (CACS) is labor-intensive and time-consuming, a more automated workflow is desirable to reduce the need for human interaction. The purpose of this study was to evaluate an artificial intelligence (AI)-based automated coronary artery calcium scoring application for electrocardiogram (ECG)-gated non-contrast cardiac computed tomography (CT).

METHOD AND MATERIALS

We analyzed a fully automated calcium scoring application that is composed of multiple deep learning models, including voxel segmentation and computing the likelihood of a voxel being coronary calcium. The software automatically identifies the coronaries and calcified lesions, whereas aortic plaques are excluded from the calculations using a model for aorta segmentation. This algorithm was trained on about 2000 annotated ECG-gated cardiac CT scans. Then, the application was evaluated on 511 consecutive patients (mean age, 56.4±10.2 years; 211 men) undergoing dedicated calcium scoring CT. Results were compared to CACS obtained via standard manual assessment by independent cardiovascular imagers.

RESULTS

CACS values revealed no significant differences between the automated algorithm and the reference standard (P=0.282). CACS using the automated application showed an excellent correlation with the reference standard (Pearson, r=0.97). In addition, the fully automated software classified 476 of 511 (93.2%) patients into the same risk category (0, 1-10, 11-100, 101-400, or >400) as the human observers, whereas 35 (6.8%) patients were misclassified into a different category. Overall, 15 (2.9%) patients were downgraded to a lower category and 20 (3.9%) patients were upgraded to a higher category.

CONCLUSION

AI-based automated calcium scoring for non-contrast ECG-triggered cardiac CT shows high accuracy when compared to manually obtained reference scores. The use of this fully automated software application may reduce the need for human user interaction and interpretation time.

CLINICAL RELEVANCE/APPLICATION

The use of this AI-based fully automated software application may reduce the need for manual input and interpretation time and thus enhance workflow efficiencies for this growing CT application.

SSK03-07 Deep Learning for Calcium Scoring in Radiotherapy Treatment Planning CT Scans in Breast Cancer Patients

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E351

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PURPOSE

Cardiovascular disease (CVD) is an important cause of mortality in breast cancer patients. Coronary artery calcification (CAC) and thoracic aorta calcification (TAC) are strong and independent risk factors for CVD and can be detected and quantified in radiotherapy treatment planning (RTTP) CT. Manual quantification of CAC and TAC is a tedious and time-consuming task. Therefore, we evaluated the performance of an AI system, developed for automatic calcium scoring in low-dose chest CT, in RTTP CT.

METHOD AND MATERIALS

We included 1409 breast cancer patients (age 56±7 years), who participated in the UMBRELLA cohort and underwent a RTTP CT (Philips Brilliance Big Bore CT, 120kVp, no ECG-triggering, no contrast, 3.0mm slice thickness). In a first step, CAC and TAC were manually annotated in these scans. In a second step, a deep learning algorithm was applied for automated detection of CAC and TAC. A baseline system was trained with 1181 low-dose chest CTs (all major CT vendors, 120/140kVp, no ECG-triggering, no contrast, 1.0-3.0mm slice thickness) from the National Lung Screening Trail (NLST). A RTTP-specific system was trained with the NLST scans and additionally 568 RTTP scans. The remaining 841 RTTP scans were used for evaluation. CAC was quantified as Agatston and volume scores; TAC as volume scores only. Agatston score was stratified into five risk categories: 0, 1-10, 11-100, 101-400, >400. Reproducibility between manual and automatic scores was evaluated with linearly weighted κ (categories) and Intraclass Correlation Coefficient (ICC, volume scores).

RESULTS

For the baseline system, ICCs were 0.85 (95% CI 0.83-0.87) and 0.98 (0.97-0.98) for CAC and TAC volumes, respectively. ICCs for the RRTP-specific system improved to 0.92 (0.91-0.93) and 0.99 (0.98-0.99) for CAC and TAC volumes, respectively. The baseline and RTTP-specific systems achieved a κ of 0.85 (0.80-0.90) and 0.89 (0.85-0.93).

CONCLUSION

An AI system trained on low-dose chest CTs allows accurate automatic CAC and TAC scoring in RTTP CT, which improves further upon RTTP-specific training.

CLINICAL RELEVANCE/APPLICATION

Accurate, fully automatic CVD risk assessment in breast cancer patients from readily available RTTP scans allows cost-effective identification of patients who may benefit from preventive treatment.

SSK03-08 Preliminary Exploration and Analysis of Coronary Artery Plaque Characteristics in HIV-Infected Patients Based on Radiomics

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E351

Participants
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PURPOSE

To analyze the difference of coronary artery plaque characteristics between HIV infected patients and non-infected patients by using radiomics technique, and screen the features related to different types of plaques.

METHOD AND MATERIALS

From March 2017 to March 2019, 206 patients (97 HIV infected patients and 109 uninfected patients) with positive coronary artery plaque confirmed by coronary computed tomography angiography(CCTA) were included in this study. The plaque types were artificially divided into calcium plaque, non-calcified plaque and mixed plaque by two experienced radiologists, and the regions of interest (ROI) were manually drawn on the CCTA images. 1029 radiomics features were automatically extracted from each plaque. The minimum redundancy and maximum correlation features were selected using analysis of variance(ANOVA) and the least absolute shrinkage and selection operator (LASSO) method of 10-fold cross-validation, and two-sample t-test was also performed to disply the difference of the selected features.

RESULTS

A total of 364 plaques including 58 (71), 34 (43) and 79 (79) patients with calcified plaques, mixed plaques and non-calcified plaques respectively in the HIV-infected group (non-infected group) were analyzed. The mixed plaques were significantly different between the two groups, and the clustering effect of calcified plaques and non-calcified plaques were poor. 24 radiomics features of mixed plaques were selected by ANOVA and LASSO, and the coefficients in the LASSO method were shown in Fig. a. The selected features of mixed plaques from HIV-infected group was significantly different from the non-infected group by t-test (all p values<0.05). Hierarchical clustering was used in order to display the differences of the selected features between HIV-infected group and non-infected group, and the radiomics heat map was shown in Fig. b.

CONCLUSION

Radiomics features showed significant difference between HIV-infected and non-infected patients with coronary artery mixed plaque. But no significant difference between calcium plaque and non-calcified plaque were found.

CLINICAL RELEVANCE/APPLICATION

HIV infection may affect the formation of mixed coronary plaque in patients, suggesting that patients with HIV infection of coronary heart disease may need different treatment methods.

SSK03-09 Calcium Scoring on Emergency Aortic Dissection CT Scans: A Missed Opportunity for Radiologists to Impact Clinical Management of Acute Chest Pain Patients

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E351

Participants
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Kenny Ye, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

CT aortography (CTAo) is routinely performed in the emergency setting for acute chest pain patients. Previous studies show that the diagnostic yield of CTAo is very low. Most patients are sent home shortly after a negative scan without directed cardiovascular follow up. This study assesses these patients' long term clinical outcomes and investigates the potential prognostic value of coronary artery calcium (CAC) scoring from CTAo.

METHOD AND MATERIALS

A cohort of patients who received emergency CTAo from 2007-2012 was assembled using a quality-improvement medical record survey tool. The time period allowed for long term follow up (5-10 years). Clinical events included death, aortic dissection (AD), myocardial infarction (MI), cerebrovascular accident (CVA), and pulmonary embolism (PE). Visual CAC scores were computed from original images utilizing a validated, 12-point ordinal method. Kaplan-Meier Estimator and Cox regression were used for survival analysis.

RESULTS

1662 patients had CTAo, of which 599 (36%) had at least one subsequent documented clinical event (227 [13.7%] deaths, 86 [5.2%] AD, 119 [7.2%] MI, 96 [5.8%] CVA, 71 [4.3%] PE). Survival analysis showed a strong association between CAC score and mortality with hazard ratios (HR) increasing with higher CAC scores when age and gender were included as covariates. Eight year mortality for patients without coronary calcium (CAC of 0) was 13%, for those with low calcium (CAC 1-3) was 25% (HR 1.88), for those with moderate calcium (CAC 4-6) was 41% (HR 2.74), and for those with high calcium (CAC 7-12) was 57% (HR 3.68). CAC scores were highly predictive of major adverse cardiac events - MI, CVA, and death (p<2e-16). CAC score, however, was neither predictive of occurrence of PE (p=0.98) nor AD (p=0.24). AD and PE occurred earlier (median 517 and 578 days) than major cardiovascular events (medians 852-1191 days).

CONCLUSION

CAC scores in patients undergoing CTAo strongly predict long-term all-cause mortality and major adverse cardiovascular events. Including a CAC score in CT aortogram reports has a potential role in directing subsequent patient management by highlighting high risk patients for cardiovascular risk assessment and treatment.

CLINICAL RELEVANCE/APPLICATION

Visual CAC scores from emergency CT aortograms can provide additional value by identifying patients with high long-term cardiovascular risk who may benefit from aggressive risk factor management.

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SSK04

Science Session with Keynote: Cardiac (Great Vessels)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E352

CA VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSK04-01 Cardiac Keynote Speaker: Imaging of Aortitis

Wednesday, Dec. 4 10:30AM - 10:50AM Room: E352

Participants
Daniel Ocazionez-Trujillo, MD, Houston, TX (*Presenter*) Nothing to Disclose

SSK04-03 Ascending Aortic Diameter, Pulmonary Artery to Ascending Aorta Ratio, and Cardiovascular Death in the National Lung Screening Trial (NLST)

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E352

Participants
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PURPOSE

Older heavy smokers undergoing lung cancer screening CT are at high risk of cardiovascular (CV) death. Ascending aortic (Ao) diameter and a pulmonary artery to Ao diameter (PA/Ao) ratio >=1 have been associated with death in non-lung screening populations. We sought to determine normal ranges for Ao diameter and PA/Ao ratio and their association with CV death in heavy smokers from the National Lung Screening Trial (NLST).

METHOD AND MATERIALS

In 994 randomly selected NLST participants having non-contrast non-ECG gated low-dose lung screening CT, Ao and PA diameters were measured at the level of the PA bifurcation. Uni- and multivariable Cox regression models were used to estimate hazard ratios (HR) for Ao diameter and PA/Ao ratio >=1 for CV death. Multivariable models were adjusted for age, sex, smoking status, and body surface area. Inter-observer reproducibility for Ao diameter and PA/Ao ratio were assessed in 30 participants by 2 independent observers.

RESULTS

In 994 participants (age 61.5±5.2 yr; 43% female), 2% (20/994) suffered CV death over median follow up of 6.7 years. Mean Ao diameter was 34.0±3.7 mm. Ao diameter was significantly associated with CV death (CV death; 36.6±4.3 mm vs. no CV death; 34.0±3.7 mm, p=0.007), with an unadjusted HR of 2.5 per 5 mm increase (95% CI: 1.6-3.7, p<0.001). Ao diameter remained an independent predictor of CV death after adjustment (adjusted HR; 2.5 per 5mm increase, 95% CI: 1.2-3.7, p=0.009). The mean PA/Ao ratio was 0.8±0.1. In unadjusted analysis, there was borderline significant association between PA/Ao ratio >=1 with CV death (10% (2/20) vs. 2% (24/972), p=0.037 and unadjusted HR 4.3 (0.99-18, p=0.052). After adjustment, there was insufficient evidence to suggest a PA/Ao ratio >=1 is associated with CV death (HR 1.3, 0.18-10.3, p=0.78). Inter-observer reproducibility for Ao diameter and PA/Ao ratio was good (ICC: 0.95 and 0.91).

CONCLUSION

Greater Ao diameter, but not greater PA/Ao ratio, was associated with CV death after adjusting for risk factors.

CLINICAL RELEVANCE/APPLICATION

Larger ascending aortic diameter is a risk factor for cardiovascular death in persons having lung screening CT.

SSK04-04 Assessment of Disease Activity in Takayasu Arteritis: A Quantitative Study with Computed Tomography Angiography

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E352

Participants
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PURPOSE

Identifying disease activity in Takayasu arteritis (TAK) is challenging. The aim of this study was to investigate the value of quantitative characterization with computed tomography angiography in the assessment of disease activity in patients with TAK.

METHOD AND MATERIALS

We retrospectively analyzed the data on 162 aortic CT angiography from 140 TAK patients. Patients were categorized based on disease activity according to National Institutes of Health criteria into two groups: active disease group (n = 65) and inactive disease group (n = 97).

RESULTS

Patients with active TAK had a thicker wall compared with patients with inactive TAK (5.2 ± 2.4 mm vs. 2.5 ± 0.8 mm, $p < 0.001$). The ratio of mural CT attenuation over that of the paravertebral muscle was higher in active TAK than in inactive TAK (1.5 ± 0.3 vs. 1.1 ± 0.2, $p < 0.001$). Given a thickness cutoff of 3.3 mm, sensitivity for active-phase TAK was 83.1%, specificity 89.7%, positive predictive value 84.4%, and negative predictive value 88.8%. With enhancement ratio cutoff of 1.2, sensitivity for active-phase TAK was 89.2%, specificity 76.3%, positive predictive value 71.6%, and negative predictive value 91.3%. In receiver-operating characteristic curves comparison, wall thickness and enhancement ratio were superior to C-reactive protein and erythrocyte sedimentation rate for determining active phase disease ($p < 0.05$).

CONCLUSION

Quantitative characterization with CT angiography was a useful tool to assess disease activity in TAK patients. Arterial wall thickness and enhancement have a high sensitivity and specificity for detecting TAK activity.

CLINICAL RELEVANCE/APPLICATION

Takayasu Arteritis (TAK) is a primary granulomatous large vessel vasculitis, affecting predominantly young women with substantial morbidity and mortality. Assessment of disease activity is crucial in the management of TAK. We analyzed the data on 162 aortic CT angiography from 140 TA patients. We described the quantitative utility of wall thickness and enhancement in the discrimination of active and inactive TAK and proposed a cutoff value for wall thickness and enhancement ratio. This will provide a quantitative reference, giving more valuable information to discriminate better active inflammation from quiescent disease, thereby aiding the decision to clinical management.

SSK04-05 Comparison of a Novel Compressed Sense Accelerated 3D Non-Contrast Modified REACT MRA with Standard Contrast-Enhanced MRA in Patients with Connective Tissue Diseases or Other Aortic Pathologies

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E352

Participants
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PURPOSE

Patients with connective tissue diseases (CTD) require repetitive vascular imaging such as magnetic resonance angiography (MRA). Potential effects of gadolinium retention are ambiguous. This study investigated the use of a novel Compressed SENSE (Philips Healthcare) accelerated (factor 10) ECG- and respiratory-triggered 3D modified Relaxation-Enhanced Angiography without Contrast and Triggering (REACT) (non-CE-MRA) in comparison to standard non-ECG-triggered 3D contrast-enhanced MRA (CE-MRA) for imaging of the thoracic aorta.

METHOD AND MATERIALS

Retrospective analysis independently conducted by two radiologists in 30 patients with CTD (25 of 30 patients) or other aortic diseases on non-CE- and CE-MRA using a manual (Multiplanar-Reconstruction, MPR; Agfa HealthCare) and a semiautomatic (Advanced Vessel Analysis, AVA; Philips Healthcare) measurement tool on seven dedicated points (inner edge): Aortic annulus, aortic sinus, sinotubular junction, mid-ascending aorta, high-ascending aorta, aortic isthmus, descending aorta. Image quality was evaluated on a four-point scale and evaluation time for each measurement technique was noted (min).

RESULTS

There was a high agreement ($r>0.9$) and no significant interobserver difference between non-CE-MRA and CE-MRA using both tools with smaller differences for non-CE- than CE-MRA. However, descending aorta showed the highest difference without being clinically significant (mean 2.21% between non-CE- and CE-MRA using MPR). For non-CE-MRA, average acquisition time was 6:34 min. Non-CE-MRA showed significant better image quality from aortic annulus to mid-ascending aortae ($p<0.05$), at the distal points, no significant difference was noted ($p>0.05$). Regarding time requirement, no statistical significance was found between both measurement techniques ($p=0.08$).

CONCLUSION

Compressed SENSE accelerated (factor 10) 3D modified REACT allows for fast and reliable imaging of the thoracic aorta using a manual and semiautomatic measurement approach with higher image quality in the aortic root and mid-ascending aorta than CE-MRA without contrast agent and its disadvantages. This is of particular relevance for patients requiring repetitive imaging.

CLINICAL RELEVANCE/APPLICATION

Patients with connective tissue diseases require repetitive vascular imaging. Therefore, modified non-CE-MRA REACT may be an alternative since it lacks the disadvantages of contrast agent and shows high diagnostic accuracy.

SSK04-06 Inter-Examination Reproducibility of Phase-Specific Systolic Aorta Segmentation: 4D Flow MRI in Healthy Volunteers

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E352

Participants
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PURPOSE

Hemodynamic aorta parameters can be derived from 4D flow MRI and requires lumen segmentation. The aim of this study was to determine the inter-examination reproducibility of phase-specific aorta segmentation of 4D flow MRI in healthy volunteers.

METHOD AND MATERIALS

Ten volunteers (26.5±2.6years) underwent 4D flow MRI at 3T MRI (Ingenia, Philips Healthcare) twice. The 4D flow acquisition parameters were: respiratory navigator-gated, retrospective ECG-gated, velocity encoding: 200cm/s, isotropic spatial resolution: 2.5mm, temporal resolution: 35.1-36.1ms and field of view: 350x250x75mm. Thoracic aorta was segmented at five systolic phases using CAAS MR 4D flow v1.1 (Pie Medical Imaging). By positioning six perpendicular planes on the segmentation's centerline the aorta was divided into five segments; proximal and distal ascending aorta, aortic arch, proximal and distal descending aorta (pAAo, dAAO, AoA, pDAo and dDAo respectively). To evaluate the inter-examination variability the image analysis was performed for both 4D flow examinations. Finally, the centerline length (CL) and mean diameter (MD) were determined for each segment using an in-house developed tool. The paired T-test (TT), absolute mean difference (DIFF), coefficient of variation (COV) and interclass correlation coefficient (ICC) were calculated between both examinations.

RESULTS

The TT showed no significant ($p<0.05$) group difference between both examinations, except for AoA MD at the fifth phase ($p=0.03$). The inter-examination analysis showed for MD low DIFF (0.1-1.2mm), low COV (1.6-8.8%), with good-to-excellent ICC (0.78-0.99) over all phases, excluding pAAo which had moderate-to-good ICC (0.53-0.77). For CL low DIFF (0.0-1.6mm), intermediate-to-low COV (7.5-15.2%) with good-to-strong ICC (0.71-0.91) were found over all phases, excluding pAAo which had a poor ICC (0.36-0.48).

CONCLUSION

In general, for MD and CL a good-to-excellent reproducibility was found for all segments and phases, except for pAAo. This observation can be explained by ease-of-use image analysis within the applied software, resulting in DIFF well below the spatial acquisition resolution. The reduced reproducibility of pAAo is most likely related to pronounced systolic stretching and lumen distension in the ascending aorta.

CLINICAL RELEVANCE/APPLICATION

Good-to-excellent inter-examination reproducibility of phase-specific aorta segmentation based on 4D flow MRI was found in healthy volunteers.

SSK04-07 A 3D Deep Convolutional Neural Network for Automatic Segmentation and Measurement of Type B Aortic Dissection

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E352

Participants
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PURPOSE

This study aimed to develop an automatic aorta segmentation and measurement method based on 3D convolutional neural network in aortic computed tomography angiography (CTA) of the patient with type B aortic dissection (TBAD).

METHOD AND MATERIALS

149 patients with TBAD underwent CTA at initial presentation were consecutively included in this study. Areas and volumes of true and false lumen were measured at eight levels relevant to preoperative planning and postoperative evaluation with the centerline technique based on automatic centerline analysis and vessel straightening. The measurements of three blinded radiologists as the standard references. Deep learning based on 3D Unet combined intersection over union tracing algorithm was used for automatic lumen segmentation. Splitting the data into training set and test set (87% VS 13%) randomly. Data between the test set and standard reference were compared using Bland-Altman and paired Student t test. Reliability of measurement was determined using intra-class correlation analyses and the excellent agreement was defined as an ICC coefficient of > 0.8.

RESULTS

The proposed model achieved a mean dice similarity score of 0.948, 0.941 and 0.963 for the true lumen, false lumen and entire aorta respectively. Measurement derived from the proposed model showed excellent agreement with the reference standard, with mean difference 0.0620 ± 0.6715, 95% limits of agreement -0.0119 to 0.1358. Correlation coefficient between deep learning and standard reference was 0.997 (P < 0.001), and ICC coefficient was 0.999. As for manual method, however, mean difference was 0.3881 ± 2.0769 with statistical significance (P = 0.001), 95% limits of agreement 0.1596 to 0.6165. Correlation coefficient between manual method and standard reference was 0.975 (P < 0.001), and ICC coefficient was 0.987. Proposed deep learning method was more efficient (3.16±0.47min) than radiologists (2±0.4h) in generating the centerlines and measurement on each case (P<0.01).

CONCLUSION

This study showed that our proposed model had good accuracy in automatic segmentation of the aorta and time saving.The accuracy and repeatability of the quantitative parameters measurement were better than manual measurement results.

CLINICAL RELEVANCE/APPLICATION

With deep learning, the accurate, uniform and efficient measurement of aorta in CTA can be obtained, can benefit individualized preoperative planning and predict survival risk in the future.

SSK04-08 Sexual Dimorphism in the Association between Coronary Plaque Burden and Ascending Aorta 4D Deformation

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E352

Participants
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Jatin R. Matta, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To develop and implement automatic 4D deformation analysis for Ascending Aorta (AA) and investigate the significance of sex difference on the association between AA deformation and coronary plaque burden as measured by Coronary Computerized Tomography Angiography (CCTA). The purpose is to provide an objective estimation for the 4D AA image-based surrogates of the plaque burden in asymptomatic subjects with low/intermediate risk (Framingham score (FrS) of coronary artery diseases (CAD).

METHOD AND MATERIALS

CCTA was obtained in 50 asymptomatic adults after signing informed consent. FrS, coronary calcification, and plaque burden score were obtained for all subjects. Automatic in-house AA 4D deformation algorithm and analysis were performed to assess time to peak distensibility (TPD). Univariable and multivariable generalized nonlinear regression modeling were performed to investigate the association of FrS, and TPD, with coronary plaque burden (segment involvement score (SIS) >5). Receiver Operator Curves (ROC) and Area Under the Curve (AUC) were obtained for FrS, TPD and combined for the detection of SIS>5.

RESULTS

Males subjects (n=31) were age and BMI matched to the female subjects. TPD individually, was significant predictor of SIS > 5 (regression coefficient (ß = -0.15034), P-value = 0.008). Additionally, sex was a significant effect modifier of TPD, with a stronger statistically significant association with women (ß = -0.0311, P-value = 0.030). ROC showed significant improvement (p=0.001) in the performance of FrS when combined with TPD for the detection of SIS>5.

CONCLUSION

In low/intermediate CAD risk asymptomatic women, there is strong association between TPD and substantial of coronary plaque burden beyond and independent of tradition CAD risk factors. AA 4D deformation analysis may supplement traditional risk scores for CAD risk stratification in women. This is in line with previous studies that demonstrated the suboptimal performance of CAD risk score models for women compared to men.

CLINICAL RELEVANCE/APPLICATION

AA 4D deformation analysis (also attainable by other imaging modalities) can be used as an independent surrogate for subclinical atherosclerosis in low /intermediate FrS asymptomatic women. This method reduces subjectivity for CCTA analysis as an additional quantitative objective measurement for CAD risk stratification, life style modification and therapy of CAD particularly in women.

SSK04-09 Dual-Energy CT in Patients with Suspect Acute Pulmonary Embolism: A Diagnostic Accuracy Systematic Review and Meta-Analysis

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E352

Participants
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PURPOSE

To review the diagnostic performance of dual-energy CT (DECT) in diagnosing acute pulmonary embolism (PE).

METHOD AND MATERIALS

No IRB approval was needed, the study protocol was registered on PROSPERO and reported according to PRISMA. In February 2019, a systematic search was performed on MEDLINE/EMBASE, for articles reporting the diagnostic performance of DECT in diagnosing acute PE. Pooled sensitivity, specificity, positive and negative likelihood ratios (LR) and diagnostic odds ratio (DOR) were calculated according to the approach by Reitsma. A summary receiver operating characteristics (sROC) curve was constructed. Data were reported as estimate and 95% confidence interval (CI). The pooled effective radiation dose for the chest was calculated using the random effect model and the impact of year of publication was evaluated through meta-regression analysis. Risk of publication bias was assessed using the Egger test.

RESULTS

Of 159 initially retrieved articles, 14 studies were identified, including 23 independent study parts, for a total of 993 patients. Patients' median age ranged from 40 to 68 years. Twelve studies used a dual-tube/dual-detector DECT, while 2 used rapid-kV switching DECT. Lower voltages ranged from 80 to 100 kVp, while high voltages ranged from 135 to 140 kVp. Pooled sensitivity was 84.1% (95% CI 78.3-88.6%), pooled specificity was 88.6% (95% CI 83.9-92.1%), positive LR was 7.52 (95% CI 5.21-10.60), negative LR was 0.18 (95% CI 0.13-0.25), DOR was 42.8 (95% CI 24.2-70.3). The sROC curve had an area under the curve of 0.93. Effective radiation dose to the chest showed high heterogeneity (I2=97%), and its pooled estimate was 4.52 mSv (95% CI 3.68-5.36 mSv). At meta-regression analysis, year of publication did not significantly impact on radiation dose (coefficient .152, *P=.703). A significant risk of publication bias was found (Egger's test reporting P=.006).*

CONCLUSION

The diagnostic performance of DECT in acute PE is substantially comparable to that of single-energy CT, in presence of a comparable effective radiation dose to the chest.

CLINICAL RELEVANCE/APPLICATION

DECT may be used instead of single-energy CT in patients with suspect of acute PE. This may be especially useful, since DECT has been shown to provide more information with regards to lung ventilation and tissue characterization than single-energy CT, thus leading to a more accurate, comprehensive evaluation of the lungs.

Printed on: 10/29/20

SSK05

Chest (Lung Cancer Screening)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: N229

CH CT OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Jane P. Ko, MD, New York, NY (*Moderator*) Research collaboration, Siemens AG
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Sub-Events

SSK05-01 Cancer Risk in Subsolid Nodules in the National Lung Screening Trial

Wednesday, Dec. 4 10:30AM - 10:40AM Room: N229

Participants
Mark M. Hammer, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose
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PURPOSE

Subsolid nodules, comprising pure ground glass (GGN) and part-solid (PSN) nodules, have a high risk of indolent malignancy. Lung-RADS management guidelines are based on expert opinion and lack independent validation. The purpose of this study is to evaluate Lung-RADS for its ability to estimate the malignancy rates of subsolid nodules, using nodules from the National Lung Screening Trial (NLST). Lung-RADS was also compared to the NELSON trial volumetric classification.

METHOD AND MATERIALS

Two hundred nodules from each of the following categories were selected from the NLST: GGN < 10 mm, GGN <= 10 mm, and PSN > 6 mm. A thoracic radiologist reviewed the baseline and follow-up CT images and measured the nodules. The primary outcome for each nodule was the development of a cancer in the same lobe. Analyses were weighted by the higher prevalence of the GGN < 10 mm category. Nodules were classified by either the Lung-RADS or NELSON trial systems.

RESULTS

A total of 434 nodules were true subsolid nodules. At baseline, Lung-RADS 2 comprised 282 (73%) of nodules, with a malignancy rate of 3%, greater than the reported 1% in the Lung-RADS document (p=0.0081). The malignancy rate for GGN < 10 mm (1.5%) was significantly smaller than that for GGN measuring 10 - 19 mm (7%), p=0.02. Lung-RADS 3 comprised 89 nodules (17%), with a malignancy rate of 13%, greater than the reported 2% in the Lung-RADS document (p<0.001). The area under the receiver operating characteristic curve for Lung-RADS at baseline was 0.715, compared to 0.668 for NELSON.

CONCLUSION

Subsolid nodules in Lung-RADS categories 2 and 3 have a higher risk of malignancy than reported, and GGN 10 - 19 mm have a risk that is closer to Lung-RADS 3 than Lung-RADS 2. There does not appear to be an advantage to using volumetric (NELSON) compared to linear measurement (Lung-RADS) classification schemes.

CLINICAL RELEVANCE/APPLICATION

The malignancy risk of subsolid Lung-RADS 2 and 3 nodules in lung cancer screening is higher than expected, which may require revision of management guidelines.

SSK05-02 Are We on the Same (Web) Page for Lung Cancer Screening? A Comprehensive Content Analysis of United States Lung Cancer Screening Program Websites

Wednesday, Dec. 4 10:40AM - 10:50AM Room: N229

Participants
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PURPOSE

To assess the scope and quality of patient educational content of United States Lung Cancer Screening (LCS) program websites.

METHOD AND MATERIALS

A Google searches for "lung cancer screening", "low dose CT screening", and "lung screening" performed September 15, 2018 yielded 269 LCS program websites. 258 unique websites were equally divided and randomly assigned to 9 Thoracic Radiologists for analysis. Each radiologist reviewed text, images, videos, and PDF attachments for a random subset of sites using a standardized checklist. All main landing pages for LCS sites, along with linked pages from the institution directly dealing with LCS were included in the analysis. Information on links external to the LCS institution were not included in the content analysis. Content areas for which websites were analyzed included (1) LCS eligibility criteria, (2) monetary costs and insurance coverage, (3) benefits and (4) risks of lung cancer screening.

RESULTS

While most sites mentioned eligibility for screening (98%), 13% reported ages 55-74, 42% ages 55-77, 17% ages 55-80, and 19% gave multiple ranges. A quarter of websites did not address monetary costs of screening; out-of-pocket costs as a result of screening were rarely mentioned. Many (93%) mentioned the possibility of early detection of lung cancer and the use of low-dose CT, but 39% of sites did not mention the magnitude of the benefit, and 47% made no mention of the U.S. National Lung Cancer Screening Trial. More than half of the websites (53%) did not address any risks related to screening. Categories of risks discussed included radiation (38%), false positives (37%), and further tests (40%). Fewer sites included false negatives (20%), overdiagnosis (12%), procedural complications (10%), and anxiety/worry (20%).

CONCLUSION

There is inconsistency in the information provided to patients about lung cancer screening. Stated ages for eligibility, while commonly reported, vary widely. Health care costs are a large concern for many and yet a quarter of webpages do not address cost. In addition, the majority of LCS sites fail to address the risks of screening.

CLINICAL RELEVANCE/APPLICATION

Radiology practices should increase efforts to offer updated, standardized LCS information on websites to improve public knowledge of this imaging-based cancer screening tool and help alleviate some patient concerns.

SSK05-03 Lung Cancer Screening in NLST Eligibles: Tailoring Annual Low-Dose Computed Tomography by Post-Test Risk Stratification

Wednesday, Dec. 4 10:50AM - 11:00AM Room: N229

Participants
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PURPOSE

To calculate the risk of lung cancer (LC) in 1 and 3 years after baseline low-dose computed tomography (LDCT), in screenees selected by National Lung Screening Trial (NLST) criteria

METHOD AND MATERIALS

For the aim of this post-hoc analysis, screenees from a prospective lung cancer screening (LCS) trial were retrospectively selected: age>=55years, pack-years>=30.Pre-test metrics: baseline demographics, medical interview, and pulmonary function test.Post-test

metrics: retrospective LDCT reading by FDA-approved workstation for LCS, featuring computer aided diagnosis (CAD) and advanced semi-automatic algorithm for volumetric segmentation of nodule. Solid nodules were classified into 3 categories: 1)no nodule or nodule 1-112mm^3; 2)nodule 113-260mm^3; 3)nodule>260mm^3. Subsolid nodules were assigned either category 2(non-solid or part-solid nodules with solid component>5mm) or category 3(solid component>=5mm).The highest category was used for screenee-wise risk assessment.The primary outcome was LC diagnosis at 1 year or 3 years; the secondary outcome was the stage of LC. The Chi squared test was used to test the association between metrics and the primary outcome at 1 or 3 years.The risk of LC in 1 or 3 years was calculated by univariate and multivariate models

RESULTS

In 1,248 NLST-eligible screenees, LC frequency was 1.2% at 1 year and 2.3% at 3 years. At 1 year, category 3 was the only predictor of LC risk in multivariate model (odds ratio 79.84 p<0.001), confirming that early follow up by LDCT (e.g.3months) is needed for characterisation of such nodules. At 3 years, LC risk was predicted by category 2 (OR5.99 p=0.009) and 3 (OR26.55 p<001), Tiffeneau<70% (OR 2.75 p=0.024). LCS simulation with triennial screening rounds for category 1 and selective annual round for category 2 and 3 (29% in our population) showed 35% reduction of LDCT through 3 years

CONCLUSION

Annual LCS could be selectively offered to 30% of NLST eligible screenees, while longer interval might be safe in those with category 1. Validation of volumetric thresholds is granted through multiple software vendors

CLINICAL RELEVANCE/APPLICATION

LCS strategy can be optimised by tailoring annual LDCT to a minority of subjects at high risk, while longer screening intervals could be a safe strategy for low risk subjects yielding substantial reduction of LDCT burden (radiation and cost).This model is being prospectively tested in a LCS trial with LDCT every 3 years

SSK05-04 Impact of Significant Coronary Artery Calcification Reported on Lung Cancer Screening Low Dose CT

Wednesday, Dec. 4 11:00AM - 11:10AM Room: N229

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PURPOSE

Coronary artery calcification (CAC) is a common and important incidental finding in low dose CT lung cancer screening (LD-LCS). Our objective were to determine the incidence of significant coronary artery calcification (CAC) reported on LD-LCS and to determine the impact of its reporting on subsequent diagnostic and therapeutic interventions.

METHOD AND MATERIALS

In this IRB approved retrospective study, we queried our lung cancer screening database for reports of LD-LCS performed between January 2016 and September 2018. All reports with significant findings designated with the "S" modifier for any LungRADS category were reviewed, and those with the "S" modifier pertaining to significant CAC were selected. The grading of CAC was extracted from the reports and compiled into four groups: moderate, severe, other non-standard descriptors (e.g. extensive, dense, etc.), or unspecified. From the electronic medical record, we reviewed and recorded baseline clinical characteristics of included patients and subsequent changes in management that resulted from the report of significant CAC. Paired Student's t-test and Fisher's exact test were used to compare subsets of patients.

RESULTS

Out of the 3110 patients who underwent LD-LCS, 756 (24.3%) patients (mean age: 67 +/-6.4 year; M=466, 61.6%: F=290, 38.4%) were reported to have significant CAC. Of these, 236 patients (31.2%) had established, documented coronary artery disease at baseline. A change in management was noted in 155 patients (20.5%). The most common changes in management were medication regimen change (n=114/155, 73.5%), stress testing (n=65/155, 41.9%), and cardiology specialist referral (36/155, 23.2%). Percutaneous (3/155, 1.9%) and surgical (3/155, 1.9%) coronary interventions were infrequent. In those without known CAD, those whose CAC were semi-quantified as moderate, severe, or other nonstandard modifier were more likely to have a change in management compared to those whose CAC were unspecified (35% vs. 25%, p=0.02).

CONCLUSION

Coronary artery calcification is a common significant finding in LD-LCS. The reporting and semi-quantitative assessment of CAC in patients without established coronary artery disease resulted in change in management.

CLINICAL RELEVANCE/APPLICATION

Routine and standardized reporting of significant CAC found on LD-LCS has the potential to change patient management and may contribute to improved cardiovascular outcomes in this high-risk population.

SSK05-05 Interobserver Agreement for Lung-RADS Categorization in Subsolid Nodule-Enriched Lung Cancer Screening CT's

Wednesday, Dec. 4 11:10AM - 11:20AM Room: N229

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PURPOSE

To evaluate the interobserver agreement for Lung-RADS categorization in subsolid nodule-enriched low-dose screening CTs.

METHOD AND MATERIALS

A retrospective review of the low-dose screening CT reports from 2013 to 2017 using keyword search for subsolid nodules found 54 baseline CTs. A total of 162 CTs, including 108 negative screening CTs as controls, were classified into Lung-RADS categories by two fellowship-trained thoracic radiologists in a consensus manner. We randomly selected 60 scans (20 in Category 1/2 and 3, 10 in Category 4A and 4B) to ensure a balanced representation of all lung-RADS categories. Five radiologists reviewed the 60 CT scans and classified each CT scans into Lung-RADS categories. Rates of concordance, minor and major discordance were calculated, with the major discordance defined as at least six months of management discrepancy. We analyzed the agreement of five observers using Cohen's kappa statistics.

RESULTS

Averaged correct categorization was achieved by five radiologists for 60.3% (181 of 300) in all cases and 45.0% (90 of 200) in positive screens. Minor and major discordance rate was 29.7% and 10.0% in all cases and 41.5% and 13.5% in positive screens, respectively. Pairwise interobserver agreement (weighted k) was 0.535 (range, 0.353-0.686; 95% confidence interval, 0.406, 0.664).

CONCLUSION

The accuracy of radiologists in the categorization of screening CTs with subsolid nodules varied and the interobserver agreement was only moderate in the retrospective study. This inconsistency may affect management recommendations in lung cancer screening.

CLINICAL RELEVANCE/APPLICATION

Lung-RADS categorization of low-dose screening CTs with subsolid nodules varies among radiologists and the inconsistency may affect management recommendations.

SSK05-06 Update on Lung Cancer Screening Utilization: Results from the 2017 Behavioral Risk Factor Surveillance System Cross-Sectional Survey

Wednesday, Dec. 4 11:20AM - 11:30AM Room: N229

Participants
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PURPOSE

Lung cancer screening with low dose chest CT (LCS) reduces lung cancer mortality. Despite favorable recommendations from the USPSTF for LCS in 2013 and coverage by public and private payors since 2015, initial studies reported that only <5% of eligible patients are being screened. Despite increasing insurance coverage, public awareness, and availability of LCS nationwide, few studies have evaluated recent LCS utilization. Our purpose was to estimate LCS utilization using nationally representative cross-sectional survey data from the most recent Behavioral Risk Factor Surveillance System Survey (BFRSS) survey.

METHOD AND MATERIALS

BRFSS is a nationally representative, cross-sectional phone survey of adults in the United States. The 2017 survey included questions about LCS eligibility and utilization in 11 states (Florida, Georgia, Kentucky, Maryland, Missouri, Nevada, Oklahoma, Vermont, Wyoming, Kansas, Maine). Primary outcome was the proportion of patients ages 55-79 with at least a 30 pack year smoking history who reported undergoing LCS. Multivariable logistic regression models were used to evaluate the association between self-reported LCS usage and sociodemographic characteristics, adjusted for potential confounders and accounting for complex survey design elements.

RESULTS

30,362 participants were included of whom 27.8% reported at least 30 pack year smoking history. Among participants with at least a 30 pack year smoking history between the ages of 55-79, 12.2% (95% CI 10.7, 13.7) reported obtaining a chest CT scan specifically to evaluate for lung cancer. In our multiple variable analyses, age, education category, income category, health insurance status, race, marital status, and employment status were not associated with statistically significant differences in self-reported receipt of LCS ($p > 0.05$).

CONCLUSION

Overall, utilization of LCS remains low (12%) among eligible participants, however comparison with previously published studies suggests improvements in LCS utilization.

CLINICAL RELEVANCE/APPLICATION

LCS uptake among eligible patients is low. Provider education, public awareness campaigns, and continued improvements in health insurance coverage are required to save more lives with LDCT.

SSK05-07 Impact of Multidisciplinary Review of Lung Cancer Screening CT on LungRADS Score and Follow-Up Recommendations

Wednesday, Dec. 4 11:30AM - 11:40AM Room: N229

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PURPOSE

There is evolving consensus that positive lung cancer screening CT scans should be reviewed by a multidisciplinary panel. We assessed the impact of multidisciplinary review of lung cancer screening CTs initially coded as LungRADS (LR)-3, LR-4a, or LR-4b.

METHOD AND MATERIALS

From 1/2017-12/2018, 872 patients underwent lung cancer screening CT at 4 sites within an integrated health care system. A designated radiologist at each site interpreted CTs according to LR criteria. CT scans coded as LR-3 (n=71, 8.1%), LR-4a (n=33, 3.8%), or LR-4b (n=32, 3.7%) were reviewed by a multidisciplinary team of radiologists, interventional pulmonologists, and thoracic surgeons. Following multidisciplinary review, CTs were given a final LR score and follow-up recommendations were provided.

RESULTS

136 patients were coded as LR-3, LR-4a, or LR-4b by the site radiologist. After multidisciplinary review, 23 (16.9%) patients had the LR score changed. Baseline characteristic were similar between patients with a change in LR score compared to those with no change in LR score. 12 CTs (52%) had the LR score upcoded and 11 CTs (48%) were downcoded. Reasons for change in LR coding are described in Figure 1. CT scans not following LR assessment categories were more likely to be upcoded (p=0.03), whereas findings considered to be infectious/inflammatory/scarring were more likely to be downcoded (p=0.04). After LR upcoding, follow-up recommendations were changed to biopsy (n=4), PET/CT (n=4), or 3-month follow-up CT (n=4). LR downcoding resulted in follow-up recommendations being changed to 6 month follow-up CT (n=6), 12 month low dose CT (n=4), and PET/CT (n=1). LR upcoding facilitated early detection of lung cancer in one patient (4.3%), whereas downcoding resulted in a potential delay in cancer diagnosis in one patient (4.3%).

CONCLUSION

Multidisciplinary review of LR-3, LR-4a, and LR-4b CTs results in LR reclassification in 16.9% of patients within an integrated health care system. Lung nodules not coded according to LR assessment categories, or CT findings ascribed to infection/inflammation/scarring, were significantly more likely to have the LR score changed. Further studies should examine the impact of multidisciplinary review on CT screening outcomes.

CLINICAL RELEVANCE/APPLICATION

Multidisciplinary review of LR-3, LR-4a, and LR-4b cases results in LR reclassification and changes to follow-up recommendations in a significant minority of cases.

SSK05-08 Variability among Expert Readers in Low-Dose CT Lung Cancer Screening: Comparison of Readings between Individual Institution and Central Review in a Nationwide Lung Cancer Screening Project

Wednesday, Dec. 4 11:40AM - 11:50AM Room: N229

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PURPOSE

Computer-aided detection and volumetry is known to reduce interobserver variability but its potential in a real world setting has rarely been reported. This study aimed to evaluate the variability among experts in a nationwide lung cancer screening project.

METHOD AND MATERIALS

We evaluated 1647 consecutive baseline screening CT scans obtained during one month period of December 2017 from a nationwide lung cancer screening project (K-LUCAS) in which 14 institutions participated. Chest radiologists of each institution assessed CT scans using a thin-client system equipped with semi-automated nodule segmentation and computer-aided detection software based on Lung-RADS (institutional reading). One chest radiologist retrospectively reviewed all these CT scans while minimizing modification of segmentation results and minimizing rejecting tiny nodules (central review). Reading results between institutional reading and central review were compared. Positive rates of central review using Lung-RADS and NELSON criteria were also compared.

RESULTS

The average per-case positive rate was significantly higher in central review (24.9% [410/1647; 11.1-32.7% across institutions] vs. 19.3% [319/1647; 5.6-30.0% across institutions]; P<.001). The number of detected nodules was significantly larger in central review (3.04 vs. 1.17 nodule/case; P<.001), while variability in positive rates among institutions were significantly lower in central review (coefficient of variability, 21.9% vs. 40.2%; P=.044). Manual measurements while rejecting segmentation results occurred in 1.6% (80/5008) of nodules at central review and in 17.8% (342/1920) nodules at institutional reading. Positive rate with Lung-RADS is higher (24.9%) compared with that of NELSON criteria (3.9%) but lower than indeterminate scan rate defined by NELSON criteria (33.4%) which requires additional scanning.

CONCLUSION

There is considerable variability among expert readers in reading of lung cancer screening CT mainly by discarding tiny nodules and modifying or rejecting segmentations results. NELSON criteria do not reduce the number of additional scanning in nodule management compared with Lung-RADS.

CLINICAL RELEVANCE/APPLICATION

Even in a situation where computerized tools are adopted, there is considerable variability among readers. The value of reducing variability by applying stricter rules should be further investigated.

SSK05-09 An Observer Study Comparing Radiologists with the Prize-Winning Lung Cancer Detection Algorithms from the 2017 Kaggle Data Science Bowl

Wednesday, Dec. 4 11:50AM - 12:00PM Room: N229

Participants
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PURPOSE

The 2017 Kaggle Data Science Bowl challenge awarded 1 million dollars in prize money to develop computer algorithms for predicting, on the basis of a single low-dose screening CT scan, which individuals will be diagnosed with lung cancer within one year of the scan. Participating teams received a training set of around 1500 low-dose CT scans to develop and train their algorithms and final performance was measured on a test set of 500 scans, containing 151 lung cancer cases. Over 2000 teams submitted results. The best 10 algorithms all used deep learning and are freely available as open source code. To gain insight into how the performance of these algorithms compares to radiologists, we conducted an observer study including 11 readers who read 150 cases from the test set.

METHOD AND MATERIALS

We randomly extracted 100 benign cases and 50 lung cancer cases from the test set of the challenge. Each algorithm scored each test case with a score between 0 (low) and 1 (high) for harboring a malignancy. We developed a web-accessible workstation in which human experts could review chest CT scans. The web workstation included the common tools found in a professional medical viewing workstation. We invited 11 readers, a mix of radiologists and radiology residents, to read these 150 CT cases and assign a score between 0 (low) and 100 (high) whether the patient will develop a lung cancer within one year of the presented scan. ROC analysis was used to compare the performance of the human readers with the algorithms. The primary outcome was area under the ROC curve. 95% confidence intervals were computed by 1000 bootstrap iterations and are reported between brackets.

RESULTS

The mean area under the ROC curve for the human readers was 0.90 [0.85-0.94]. The mean area under the ROC curve for the algorithms was 0.86 [0.81-0.91]. The mean human reading time per case varied between 96 and 275 seconds.

CONCLUSION

The top 10 algorithms from the Kaggle Data Science Bowl 2017 showed promising performance, but were still inferior to human readers. Future analysis will focus on understanding the strengths and weaknesses of the computer algorithms and the human readers and how these can be optimally combined.

CLINICAL RELEVANCE/APPLICATION

Fully automatic algorithms using deep learning developed in a large-scale challenge show promising performance for lung cancer detection in chest CT, but performed inferior to radiologists in this subset of the test set.

SSK06

Science Session with Keynote: Emergency Radiology (Pulmonary Emboli - Current Cutting Edge, and the Future)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S103AB

CH ER

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Michael N. Patlas, MD,FRCPC, Hamilton, ON (*Moderator*) Speaker, Springer Nature
Jamlik-Omari Johnson, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SSK06-01 Emergency Radiology Keynote Speaker: Pulmonary Emboli: Current Clinical Picture

Wednesday, Dec. 4 10:30AM - 10:50AM Room: S103AB

Participants
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SSK06-03 Radiation Dose, Subjective and Objective Image Quality of Two Dual-Source CT Scanners in Acute Pulmonary Embolism: A Comparative Study

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S103AB

Participants
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PURPOSE

To compare radiation dose, mean acquisition time, objective and subjective image quality of two Dual Source CT scanners in the evaluation of acute pulmonary embolism (PE), operating in dual energy mode.

METHOD AND MATERIALS

Total of 221 scans on the 2nd generation SOMATOM Definition Flash CT scanner (the Flash) and 354 scans on the 3rd generation SOMATOM Force (the Force) were included, after adjusting the acquisition parameters to be the same.In a randomized blinded design, two radiologists independently reviewed both sets of scans in two settings (5-week interval) for subjective image quality using a 5-point Likert scale. Dose length product (DLP), CTDIvol and effective dose (ED) were calculated along with objective parameters such as image noise, Signal to Noise ratio (SNR), Contrast to Noise ratio (CNR) and dose-independent Figure of Merit (FOM= CNR2/ED).

RESULTS

Mean acquisition time was significantly lower in the Force in comparison to the Flash (2.81s +/-0.1 in comparison to 9.7s +/- 0.15 [mean+/- SD] respectively; p< 0.0001) with the Force 3.4 times faster than the Flash. The mean image quality score was found to be 4.33/5 and 4/5 for the Force and the Flash respectively with statistical significance (p <0.0001 on the unpaired t-test; 95% CI= 0.17-0.49). Interobserver reliability for image quality indicates strong agreement on both, the Force (K= 0.83, P<0.005) and the Flash-generated scans (K= 0.85, P<0.005). DLP, CTDIvol and ED were significantly lower in the Force than the Flash (175.6 +/- 63.7; 5.3 +/-1.9 and 2.8 +/- 1.2 in comparison to 266 +/- 255; 7.8 +/-2.2 and 3.8 +/-4.3 [mean +/- SD] respectively). Noise was significantly lower in the Force (p<0.01). SNR, CNR and FOM were significantly higher in the Force than the Flash (33.5 +/-23.4; 29.0 +/-21.3 and 543.7 +/-1037 in comparison to 23.4 +/- 17.7; 19.4 +/- 16.0 and 170.5 +/-284.3 [mean +/- SD] respectively).Study limitations includes retrospective design and Berkson's selection bias as the Force was routinely used for emergency patients while the Flash was used for inpatients.

CONCLUSION

Objective and subjective image quality is significantly higher on the Force with significantly lower mean acquisition time and radiation dose in comparison to the Flash.

CLINICAL RELEVANCE/APPLICATION

The improved image quality and speed of the Force could be very useful in emergency radiology setting with large patient volume while maintaining lower radiation dose.

SSK06-04 Diagnostic Accuracy of Dual-Energy CT in Detection of Acute Pulmonary Embolism: A Systematic Review and Meta-Analysis

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S103AB

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PURPOSE

To calculate sensitivity, specificity and diagnostic accuracy of Dual-Energy CT (DECT) in the detection of acute pulmonary embolism (PE) through meta-analysis framework (PROSPERO registration Number: CRD42019120143).

METHOD AND MATERIALS

We searched Medline (via PubMed), EBSCO, Web of Science, Scopus and the Cochrane Library for relevant published studies. We selected clinical trials assessing the accuracy of DECT in the detection of PE. Quality assessment of bias and applicability was conducted using the Quality of Diagnostic Accuracy Studies-2 tool. The sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, and the diagnostic odds ratio were recorded. The summary receiver operating characteristic curve was drawn to get the Cochran Q-index and the area under the curve.

RESULTS

Seven studies with high homogeneity were included in our systematic review. The pooled sensitivity was 87.9% (95% confidence interval [CI]: 80.1- 93.4%), specificity was 93.3% (95% CI: 85.1- 97.8%), and diagnostic odds ratio was 51.59 (95% CI 17.28-153.98). The pooled PLR was 8.72 (95% CI: 4.10- 18.54) and NLR was 0.20 (95% CI: 0.11- 0.39). Cochran-Q was 0.8794 and Area Under the Curve (AUC) was 0.9416 in the sROC curve.

CONCLUSION

DECT shows high sensitivity, specificity and diagnostic accuracy in the detection of acute PE. However, studies with larger sample size are still needed to support these findings.

CLINICAL RELEVANCE/APPLICATION

This meta-analysis shows the high diagnostic accuracy of dual energy CT (DECT) in diagnosis of acute PE. Astonishingly, a few studies have been published in the literature to discuss the value of DECT in this particular diagnosis. Hence, studies with larger sample size are still needed to support these findings.

SSK06-05 Pulmonary Embolism during Pregnancy: A 17-Year Single-Center Retrospective MDCT Pulmonary Angiography Study

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S103AB

Participants
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PURPOSE

To determine the prevalence of pulmonary embolism (PE) and alternative diagnoses in pregnant women requiring computed tomography pulmonary angiography (CTPA); to assess the evolution of qualitative image quality and radiation dose over time.

METHOD AND MATERIALS

We retrospectively included all pregnant women referred to CTPA for clinically suspected PE over 17 years. Four different scanners were successively in use during the inclusion period, starting with a 4-MDCT system, then 16-MDCT, 64-MDCT, and finally 256-MDCT. Two blinded radiologists reviewed each CTPA in consensus regarding PE, alternative diagnoses and qualitative image quality. Radiation dose metrics, associated clinical and laboratory parameters were retrieved. Subgroup comparison was performed (Wilcoxon and Kruskal-Wallis tests).

RESULTS

After the exclusion of 8 (1.7%) patients due to inadequate technical CTPA quality, we analyzed 229 patients (mean age 31.7 years) with a mean gestational age of 28±7weeks. Qualitative image quality was similar across the four different CT systems used

over time (p=0.28). Sixteen (7%) patients had PE, 69 (30.1%) had an alternative diagnosis, and 144 (62.9%) had no radiological findings. Alternative radiological diagnoses in case of PE-negative CTPA included consolidation (n=14), other pulmonary infiltrates (n=33), pleural effusion (n=29), and basal atelectasis (n=43). Gestational age, symptoms and D-dimer levels were not significantly different between patients with or without PE (all p-values >0.05). We observed a 30% decrease in radiation exposure (dose-length product) over time (p<0.001), with a concomitant 4-fold increase of examinations per year.

CONCLUSION

In pregnant women, CTPA is rarely positive for PE and more often shows alternative diagnoses than PE. The use of CTPA in pregnancy has risen notably over 17 years, but radiation dose exposure has decreased by one third over the same period without a change in qualitative image quality.

CLINICAL RELEVANCE/APPLICATION

The use of CTPA in pregnancy has steadily risen over the last 17 years, and thanks to recent technical improvements, radiation dose exposure inherent in CTPA has considerably decreased while diagnostic image quality remains identical. In pregnant women, CTPA is rarely positive for PE and more often shows alternative diagnoses than PE.

SSK06-06 Attenuation Gradients Across Thoracic Vasculature on CT Pulmonary Angiography Predict Mortality Following Pulmonary Embolism

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S103AB

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PURPOSE

Early risk stratification of pulmonary emboli (PE) has important clinical value in emergency and inpatient settings. While the PE Severity Index (PESI) is a well-validated prognostication tool for this purpose, its derivation requires multiple variables and has weak positive predictive value (PPV) in identifying high-risk patients. CT for pulmonary angiography (CTPA) captures the distribution of intravenous contrast across thoracic vasculature based on hemodynamic status. We hypothesize attenuation differences across this vasculature may be independently predictive of 30-day mortality, and improve the PPV of PESI score.

METHOD AND MATERIALS

We retrospectively identified 1000 consecutive patients who had positive CTPA studies between 1/1/2017 and 2/12/2019. The primary outcome was 30-day mortality following CTPA. Patient demographics and admission information were used to calculate PESI class. CTPA studies were performed with a fixed delay of 22 sec and injection rate of 4 cc/s. For each patient, densities (HU) were measured in the superior vena cava [SVC], main pulmonary artery [PA], left atrium [LA], and descending aorta [AO] on a single mid-thoracic transaxial slice. Density differences, PESI scores, and their combination were compared between groups.

RESULTS

We identified 1000 consecutive patients with positive CTPA studies within the study period. Compared to surviving patients (n=907, 90.8%), patients who died within 30 days (n=92, 9.2%) exhibited higher attenuation in the PA (446±164 vs 377±128 HU, p<0.001). The absolute density change from PA to AO (PA-AO) was associated with 30-day mortality (OR 1.002, 95%CI 1.001-1.004, p=0.001). This effect did not persist after adjusting for PESI score. With a threshold PA-AO difference of 150 HU, the combined PESI/PA-AO score had greater PPV for 30-day mortality than either independently (Combined 18.7% vs PESI 15.0% vs PA-AO 13.5%).

CONCLUSION

This study provides a simple, novel approach to identify high-risk PE patients by measuring vessel densities on a single transaxial CTPA image. Odds of high-risk PE increased with greater attenuation differences between the PT and AO, with a difference of 150 HU serving as a useful threshold that improves the predictive value of the PESI score.

CLINICAL RELEVANCE/APPLICATION

Vessel density changes on standard CTPA protocol may be used to improve identification of 30-day mortality following pulmonary embolism.

SSK06-07 Estimating Quantitative Lobar and Zonal Pulmonary Perfusion from Dual Energy CT Pulmonary Angiography: Accuracy and Applications in Pulmonary Embolism

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S103AB

Participants
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PURPOSE

To assess accuracy and variations in lobar and zonal pulmonary perfusion on dual energy CT (DECT) pulmonary angiography in patients with and without pulmonary embolism with deep learning-based prototype and Lung AnalysisTM for automatic lung segmentation and quantitative perfusion on dual energy CT.

METHOD AND MATERIALS

Our IRB approved retrospective study included 88 adult patients (M:F=38:50; mean age= 56±19 years) who underwent DECT-PA on a 384-slice, third generation dual source CT (Siemens Somatom Force). Amongst these, 40 patients had pulmonary embolism (PE) and 48 had no PE. All CT exams were reviewed for location and distribution of PE. Transverse thin (1-1.5mm) DECT images (80kV;150kV) were exported and processed on a stand-alone prototype for automatic lung lobe segmentation (RUL, RML, RLL, LUL, LLL). The mean iodine concentration was normalized to main pulmonary artery. The mean attenuation numbers (M-HU), contrast amount (CA in mg) and normalized iodine concentration (NIC) were derived. The zonal volumes (RUZ, RMZ, RLZ, LUZ, LMZ, LLZ) and mean enhancement (M-HU) were derived from Lung Analysis (Siemens SyngoViaTM). Descriptive statistics and ANOVA were performed.

RESULTS

The deep learning-based automatic lung lobe segmentation was accurate in all DECT-PA (88;100%). Both lobar and zonal perfusions were significantly lower in patients with PE as compared to those without PE ($p < 0.0001$). The mean M-HU, CA and NIC for PE negative and positive affected were: RUL (29,700,0.11; 23,556,0,08); RML (24,283,0.09;19,194,0.07); RLL (26,709,0.10; 20,471,0.07), LUL (26,776,0.10; 18,534,0.06) and LLL (26,628,0.09; 18,402,0.06) ($p<0.0001$). The zonal M-HU for PE negative and positive cases were: RUZ (32; 27), RMZ (30; 20), RLZ (29; 23), LUZ (31; 23), LMZ (29; 21) and LLZ (29; 20) ($p<0.0001$).

CONCLUSION

Accurate lung lobe segmentation and quantitative lobar lung perfusion can be obtained with application of deep learning-based segmentation tool on DECT pulmonary angiography.

CLINICAL RELEVANCE/APPLICATION

Quantitative parameters can improve diagnostic accuracy and may help predict patient outcome for pulmonary embolism on DECT pulmonary angiography.

SSK06-08 Can Pulmonary Embolism Rule-Out Criteria Replace the Need for D-Dimer Testing among Patients with Low Clinical Probability in the Emergency Department?

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S103AB

Participants
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PURPOSE

The Pulmonary Embolism Rule-Out Criteria (PERC) rule has been suggested as an alternative to D-dimer testing in patients with low riisk in pretest Pretest probability clinical scoring systems. This study looked at whether the PERC rule could safely replace the use of D-dimer in patients suspected of PE.

METHOD AND MATERIALS

Retrospectively we reviewed 350 patients with a suspected pulmonary embolism and had computed tomography pulmonary angiography (PCTA) and a blood sample for D-dimer level taken. PERC was retrospectively calculated for all patients and the diagnostic performance of the PERC rule was compared with a standard D-dimer level in the detection of PE

RESULTS

Of the 350 patients, 56 had positive CTPA and 294 had a negative scan. In these patients, the sensitivity of the PERC rule for detecting PE was 98.2% [95% confidence interval (CI): 90.45% to 99.95%], with a negative likelihood ratio of 0.16 (95% CI: 0.02 to 1.18). However, the negative predictive value of the PERC rule was 96.97 % % (95% CI: 81.70% to 99.57%). In comparison, the sensitivity for the standard D-dimer test was 98.21%% (95% CI: 90.45% to 99.95%), with a negative likelihood ratio of 0.24 (95% CI: 0.03 to 1.73). The negative predictive value for the standard D-dimer test was 95.65 % (95% CI: 75.17% to 99.38%).

CONCLUSION

The PERC rule has a high negative predictive value for excluding PE in patients presenting with suspected PE to the emergency department.

CLINICAL RELEVANCE/APPLICATION

Pulmonary embolism (PE) is a common and potentially fatal cardiovascular emergency. Pretest probability clinical scoring systems are used to stratify patients a suspicion of pulmonary embolism into low risk and high risk for PE. Patients with low risk for PE usually undergo D-dimer testing. A negative D-dimer in this low-risk group rules out PE with a high degree of certainty because of its high sensitivity. The D-dimer is, however, a poorly specific test and positive results often lead to unnecessary radiological imaging.

SSK06-09 Machine Learning Based Prediction of Pulmonary Embolism in the Emergency Department

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S103AB

Participants
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PURPOSE

Pulmonary embolism (PE) is a challenging diagnosis, often not recognized in timely fashion. The Wells score, based on specific anamnestic questions and clinical signs, is a known clinical decision tool for performing D-dimer blood test or CTA for suspected PE. Validation studies showed area under the curves of (AUC) of 0.75-0.80 for the Wells score. Our goal was to develop a machine-learning model for raising suspicion of PE without using specific anamnestic information or D-dimer results.

METHOD AND MATERIALS

An institutional review board granted approval for this retrospective study. We retrieved data for consecutive patients (1/2012 to 12/2018) who performed CTA in our ED for suspected PE. Clinical variables included demographics, vital signs, chief complaint, background medical history coded using ICD10 coding, chronic medications and blood tests other than D-dimer (complete blood count, chemistry panel). Number and time to previous ED visits and hospitalizations were also computed as variables. We verified PE presence in the scans using ICD10 coding. We evaluated the AUC of single variables to predict PE. We used a gradient boosting machine learning model (CatBoost) to predict PE. The model was trained on years 2012-2017 data and tested on year 2018 data. We evaluated the AUC of the model and used Youden's index to find the model's optimal sensitivity and specificity.

RESULTS

Overall, 4,701 patients were included in the study. From them, 367 patients (7.8%) were diagnosed with PE. Single variables with highest AUC for prediction of PE included: days from previous ED visit (0.69), chief complaint (0.69), oxygen saturation (0.68), Creatine Phosphokinase (CPK) (0.68), albumin (0.65), days to previous hospitalization (0.64), number of background diseases (0.63), heart rate (0.62), C reactive protein (CRP)(0.61) and number of previous hospitalizations (0.61). The machine learning model showed an AUC of 0.80 (95% CI: 0.765 - 0.845) for predicting PE. Using Youden's index, the model showed a sensitivity of 98.6% and specificity of 46.6% for predicting PE.

CONCLUSION

Readily available clinical and laboratory variables can be used to train a machine learning model for raising suspicion of PE in the ED setting with accuracy similar to the Wells score.

CLINICAL RELEVANCE/APPLICATION

Machine learning model can be used to flag patients with high probability for having PE, for performing D-dimer in these patients.

SSK07

Gastrointestinal (Focal Liver Lesions Non-HCC)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S501ABC

GI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSK07-01 Diagnostic Performance of LR-M Criteria and Imaging Spectrum of Primary Hepatic Malignancies

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S501ABC

Participants
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PURPOSE

To evaluate diagnostic performance of LR-M criteria for differentiating hepatocellular carcinoma (HCC), intrahepatic mass-forming cholangiocarcinoma (iCC), and combined hepatocellular-cholangiocarcinoma (cHCC-CC) and to compare the imaging features of each type

METHOD AND MATERIALS

In this retrospective, case-control study, 110 patients with surgically proven iCC (n=67) and cHCC-CC (n=43) between June 2013 and June 2018 were enrolled as a case group. Another 110 patients with size-matched HCC were selected as a control group. Two independent readers evaluated imaging findings of preoperative MRI based on LI-RADS version 2018 and assigned LI-RADS category without knowing postsurgical histopathology. Diagnostic performance of LR-M criteria was evaluated and imaging features of iCC, cHCC-CC, and HCC were compared.

RESULTS

In the case group, 91 patients were categorized into LR-M and 15 patients into LR-5 (83% and 14%, respectively), while 13 patients of the control group were categorized into LR-M and 88 patients into LR-5 (12% and 80%, respectively). When more than two features of LR-M criteria were present, it suggested iCC or cHCC-CC with the specificity of 94.5%. Among the case group, findings of LI-RADS major criteria were more frequently seen in patients with cHCC-CC, while those of LR-M criteria were more prominent in those with iCC. Among the lesions with peripheral arterial phase hyperenhancement, enhancing rim was evenly uniform in 38 patients with iCC (out of 52 patients, 73.1%), while 14 patients with cHCC-CC showed irregularly thickened area of enhancing rim (out of 25 patients, 56%; p=0.022).

CONCLUSION

Diagnostic performance of LR-M criteria is desirable, and combination of imaging features is helpful for differentiating LR-M from HCC. The presence of irregularly thickened area of enhancing rim may suggest cHCC-CC rather than iCC.

CLINICAL RELEVANCE/APPLICATION

The presence of more than two LR-M findings is highly suggestive of iCC or cHCC-CC. Combination of imaging features may be helpful for differentiating primary liver malignancies.

SSK07-02 Pre-Operative Prediction of MVI in Liver Primary Tumors: Value of LI-RADS v2018 in Combination with Non-LI-RADS MR Features

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S501ABC

Participants
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PURPOSE

To investigate whether a combination of LI-RADS v2018 MR features, non-LI-RADS MR features, and AFP can pre-operatively predict microvascular invasion (MVI) in primary liver cancers.

METHOD AND MATERIALS

This retrospective single-center study was approved by our institutional review board with waived informed consent requirement. Between 2014 and 2018, 188 patients had pre-operative MRI within 1 month before hepatectomy for surgically confirmed primary liver cancers. LI-RADS and non-LI-RADS (non-smooth tumor margin, two-trait predictor, and peritumoral enhancement) MR features were retrospectively assessed by two radiologists in consensus. In patients with multifocal tumors, only the largest tumor was evaluated. LI-RADS v2018 categories were assigned based on major features. MVI was assessed by a liver pathologist on resected tumor specimens. Pre-operative AFP was recorded. Univariate and multivariate analyses were used to assess MVI predictors. Sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV) of a multivariate prediction model were estimated.

RESULTS

173 (92.0%) patients had hepatocellular carcinoma, 11 (5.9%) had intrahepatic cholangiocarcinoma, and 4 (2.1%) had combined hepatocellular and cholangiocarcinoma. MVI was present in 85/188 (45%) patients. Pre-operative LI-RADS categories of LR-3, LR-4, LR-5 and LR-M were assigned in 5 (2.7%), 9 (4.8%), 154 (81.9%), and 20 (10.6%) patients, respectively. LR-M (OR: 5.258, P=0.005), mosaic architecture (OR: 3.159, P=0.002), and non-smooth tumor margin (OR: 2.410, P=0.009) were independent predictors of MVI (Table 1, Figure 1). The sensitivity, specificity, accuracy, PPV, and NPV of the prediction model were 5.9%, 98.1%, 56.4%, 71.4%, and 55.8%, respectively.

CONCLUSION

This single-center, retrospective study indicated combining LR-M, mosaic architecture, and non-smooth tumor margin can predict MVI with high specificity. Multi-centric, prospective studies are needed to confirm the accuracy of the model for predicting MVI in primary liver cancers.

CLINICAL RELEVANCE/APPLICATION

This retrospective single-center study showed the potential value of combining LI-RADS v2018 and non-LI-RADS MR features in predicting MVI in primary liver cancers. Further studies are warranted.

SSK07-03 Differentiating New Hepatic Metastases from Focal Hepatopathy in Patients during Treatment for Malignancy

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S501ABC

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PURPOSE

To differentiate between liver metastases versus benign focal hepatopathy (FH) that develops over the course of medical or surgical treatment of malignancy.

METHOD AND MATERIALS

Between 2010 and 2018, there were 1179 consecutive biopsies (1069 patients) of hepatic lesions suspicious for malignancy. 924 were True Pos, 169 True Neg (TN), 43 False Neg and 43 lost to follow up. Among the TN were 22 FHs defined as new lesions following oncologic treatment and histologically as steatosis, sinusoidal and biliary congestion/obstruction or inflammation. Cirrhotic patients, primary hepatic tumors and abscesses were excluded. Patients with FH and metastases were matched for age, malignancy-type and treatment regimen. 3 abdominal radiologists (1, 1, 3 y post-fellowship) blinded to pathology reviewed pre-biopsy MR (40 malignant: 13 FH) and CT (53: 12); 3 FH pts had both MRI and CT. A 5-point Likert scale (1: definitely benign, 5: definitely malignant) and imaging characteristics were assessed. A training data set for readers was provided to introduce a common lexicon. Univariate analyses (Chi-Sq, T-test), logistic regression and inter-rater reliability (kappa, spearman, ICC) were performed.

RESULTS

Characteristics of patients with FHs included: pancreatobiliary malignancies (68%), hepatobiliary/GI surgery or stent (77%) and chemotherapy within 1y prior to biopsy (50%). Results for MR: Likert 2.3-2.5 for FH vs 3.6-4.4 for metastases (p<.05, correlation=.49). Compared to FH, metastases were associated with multiplicity (>3 lesion/liver), larger size, arterial rim-enhancement, portal venous rim-enhancement/central hypoenhancement and restricted diffusion (P< 0.05, all readers, univariate, k=.48-.81 except arterial rim k=0.22, ICC=.91). Lesion multiplicity was associated with metastasis on multivariate analysis. For CT: Likert 2.3-4.0 for FH vs 3.8-4.9 for metastases (p<.05, correlation .47-.58). Only non-spherical shape was associated with FH (p<.05, all readers, k=.33-.89 except arterial rim .08-.22, ICC .97-.99).

CONCLUSION

Multiplicity, size, enhancement and diffusion characteristics may be helpful to distinguish FH from metastases on MR whereas only non-spherical shape was helpful on CT.

CLINICAL RELEVANCE/APPLICATION

Identification of FH could increase confidence in radiologic-pathologic correlation and limit biopsies following the medical-surgical treatment of malignancy. MRI may be more helpful than CT in distinguishing FH from metastases.

SSK07-04 Does Volumetric Functional MRI Improve Fudan Clinical Prognostic Scoring System for Unresectable Intrahepatic Cholangiocarcinoma Treated with Systemic Chemotherapy?

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S501ABC

Participants
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PURPOSE

To assess the incremental value of volumetric functional MRI-derived parameters over Fudan clinical prognostic scoring system in patients with intrahepatic cholangiocarcinoma (ICCA) treated with systemic chemotherapy.

METHOD AND MATERIALS

This retrospective, HIPAA compliant and IRB approved study included 68 patients with unresectable ICCA (age, 65±14 yrs; 27 men [40%]). Patients underwent systemic chemotherapy after baseline MRI (including contrast-enhanced and DWI with ADC mapping). Single largest tumor was assessed by a single experienced abdominal radiologist for anatomic and functional (viable tumor volume, percentage viable tumor volume [100 × viable tumor volume/whole tumor volume], viable tumor burden [100 × viable tumor volume/whole liver volume], and ADC) parameters. Cox regression was used to identify the strongest functional predictor of overall survival. Prognostic scores were calculated for each patient using the established Fudan score (utilizing serum alkaline phosphatase level, carbohydrate antigen 19-9 level, tumor margin type, tumor size, and number of intrahepatic tumors), as well as modified Fudan score (with functional MRI parameter replacing subjective tumor margin). The performance of both the scores was measured by C-index and assessed by comparing Kaplan-Meier survival estimates in different risk groups. Predictive accuracy of both scoring systems was compared. P<0.05 was considered significant.

RESULTS

Among the volumetric functional MRI parameters, ADC (>1350x10-6mm2/s vs. <=1350) showed the strongest association with overall survival (HR, 6.0; 95% CI, 3.0-11.9; P<0.001). Both Fudan and modified Fudan score (replacing the tumor margin [subjective] with ADC [quantitative]) provided prognostic prediction with differences in OS among intermediate vs. high vs. very high-risk groups (Fudan, P=.04; modified Fudan, P=0.001). C-index of the modified Fudan score for predicting survival was 0.82 (95% CI, 0.74-0.90), higher (P=0.006) than the C-index of the original Fudan score (0.67[95% CI, 0.55-0.79]).

CONCLUSION

Supplementing Fudan model with ADC provided more accurate prognosis for ICCA patients undergoing systemic chemotherapy, improving the survival prediction performance by 15%.

CLINICAL RELEVANCE/APPLICATION

Volumetric MRI can increase accuracy of the only available prognostic scoring system for ICCA treated with systemic chemotherapy by replacing the highly subjective tumor margin with more objective ADC.

SSK07-05 Diagnostic Performance of the Liver Imaging Reporting and Data System Version 2018 for Intrahepatic Cholangiocarcinoma

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S501ABC

Participants
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PURPOSE

To evaluate the diagnostic performance of the Liver Imaging Reporting and Data System version 2018 (LI-RADS v2018) for Intrahepatic Cholangiocarcinoma (ICC).

METHOD AND MATERIALS

A total of 78 primary liver cancer with either ICC (n = 39) or hepatocellular carcinoma (HCC) (n = 39) were retrospectively reviewed. ICCs and HCCs were one-to-one matched according to age, tumor size and background disease of liver. All the patients were at high risk for HCC according to LI-RADS v2018 and performed manetic resonance imaging (MRI) examination before surgery or biopsy. The MRI protocols included routine MRI sequences, diffusion-weighted imaging (DWI) and dynamic imaging. Two readers blinded to pathology findings independently evaluated the MR images for each lesion and assigned LI-RADS categories, scoring major and ancillary features according to LI-RADS v2018. Interobserver agreements of LI-RADS category assignment and the diagnostic performance of LI-RADS v2018 in categorizing ICC were analyzed.

RESULTS

The LI-RADS categories of the 39 IMCCs by reviewer 1 include LR-4 (n=5), LR-TIV(HCC) (n=3), LR-M (n=27) and LR-TIV(M) (n=4). In the HCC group, the LI-RADS categories by reviewer 1 include LR-4 (n=7), LR-5 (n=28), LR-TIV(HCC) (n=1) and LR-M (n=3). In the results of reviewer 2, the LI-RADS categories of ICC include LR-4 (n=4), LR-TIV(HCC) (n=2), LR-M (n=26) and LR-TIV(M) (n=7); the LI-RADS categories of HCC include LR-4 (n=3), LR-5 (n=30), LR-TIV(HCC) (n=2) and LR-M (n=4). Interobserver agreements of LI-RADS category assignment were excellent (Kappa= 0.815;95% CI:0.711-0.919;P<0.001). Regarding LR-M and LR-TIV(M) categories as positive, LR-4, LR-5 and LR-TIV(HCC) as negative, the sensitivity, specificity and accuracy of LI-RADS v2018 in categorizing ICC as LR-M or LR-TIV(M) were 79.5%, 92.3%, 85.9% (reviewer 1) and 84.6%, 89.7%, 87.2% (reviewer 2) respectively.

CONCLUSION

LI-RADS v2018 performs high sensitivity, specificity and accuracy in categorizing ICC as LR-M or LR-TIV(M). However, a small part of ICC and HCC may present atypical imaging features, resulting in wrong LI-RADS categories.

CLINICAL RELEVANCE/APPLICATION

LI-RADS v2018 performs high sensitivity, specificity and accuracy in categorizing ICC as LR-M or LR-TIV(M). However, a small part of ICC and HCC may present atypical imaging features, resulting in wrong LI-RADS categories.

SSK07-06 Gd-EOB MRI for Subtype Differentiation of Hepatocellular Adenomas

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S501ABC

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PURPOSE

Evaluate MRI Gd-EOB enhancement characteristics to differentiate between subtypes of hepatocellular adenomas (HCA).

METHOD AND MATERIALS

48 patients with 79 histopathologically proven HCA who underwent gadoxetic acid-enhanced MRI were enrolled (standard of reference: surgical resection). Quantitative (lesion to liver enhancement) measurements and qualitative imaging features were evaluated by two blinded radiologists. Inter-reader variability was tested. Additionally, voxel heterogeneity was evaluated using texture analysis (pyradiomics).

RESULTS

Overall, 24%(19/79) HHCA, 47%(37) IHCA, 6.5%(5) bHCA and 22.5%(18) UHCA were anayzed. In the hepatobiliary phase (hbp) 87.5%(69/79) of all adenomas were rated as hypo- to isointense. 66%(52/79) showed a heterogeneous Gd-EOB-uptake. 100% of all IHCA and 80% of all bHCA were rated with a heterogenous uptake of at least 0-25%($p<0.05$) (HHCA: 26%(5/19); UHCA: 33% (6/18); $p>0.05$), while 63%(24/37) of all IHCA showed a heterogeneous uptake of at least 50% or more ($p<0.001$). Quantitative ROI based analyses showed no significant difference between the subtypes ($p>0.05$). Volume-based analyses showed a significant increased voxel heterogeneity for IHCA /variance of mean SI: 6465.48; $p=0.038$) when divided into IHCA and other (vs. 2681.8).

CONCLUSION

Gd-EOB MRI imaging has an additional value for subtype differentiation of HCA, the typical heterogeneous hbp-uptake IHCA can be identified reliably. Furthermore, when combing typical morphologic MR-appearances of the other HCA-subtypes and their Gd-EOB behavior sensitivity increases significantly.

CLINICAL RELEVANCE/APPLICATION

Potential of a noninvasive MRI subtype differentation of HCA to avoid unnessecary surgical resection and/or intervention and to provide evidence in terms of guidelines for benign liver lesions.

SSK07-07 MDCT Imaging Feature Related with Histopathologic Growth Pattern to Predict Response of Bevacizumab-Based Chemotherapy in Patients with Colorectal Liver Metastases

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S501ABC

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PURPOSE

To investigate the performance of MDCT imaging features related with histopathological growth patterns (HGPs) in predicting response of Bevacizumab-based chemotherapy and the 1-year progression free survival (PFS) in patients with of colorectal liver metastases (CRLMs).

METHOD AND MATERIALS

The study was designed as a two-step protocol. In the first-step, between January 2007 and December 2018, patients who had chemo-naïve resected CRLMs and preoperative MDCT were included. HGPs of each resected CRLMs were retrospectively reviewed. Multivariate logistic regression based on clinical, pathological and MDCT imaging factors were used to construct a model in predicting HGPs. The second step included patients who had unresectable CRLMs and were treated with the Bevacizumab-based chemotherapy between January 2012 and January 2018. The factors related with HGPs were used to build a model to predict the objective response rate (ORR) and the 1-year PFS by multivariate analyses.

RESULTS

A total of 95 resected CRLMs with desmoplastic (n=52) and replacement (n=43) HGP lesions were assessed in the first-step study. The enhanced rim on portal venous phase (PVP) was identified as the only independent predictor in distinguishing the desmoplastic HGP with the AUC of 0.761(95%CI: 0.661-0.860, P<0.001). In the second-step study, 50 CRLM patients with Bevacizumab-based chemotherapy were included. The enhanced rim on PVP was identified as the only independent significant predictor of ORR and 1-year PFS by using the multivariable analyses.

CONCLUSION

The enhanced rim on PVP of the baseline MDCT images, which related with the desmoplastic HGP of CRLM, was identified as the independent prognostic predictor of good outcome for CRLM patients with Bevacizumab-based chemotherapy.

CLINICAL RELEVANCE/APPLICATION

The HGP of CRLMs is capable of predicting response to Bevacizumab treatment and long-term survival. However, the diagnosis of HGP could only be made via histopathological analysis and the clinical application is restricted. In this present study, the baseline MDCT imaging feature of enhanced rim on portal venous phase, related with the desmoplastic HGP, was identified as the independent prognostic predictor of good outcome for CRLM patients with Bevacizumab-based chemotherapy. This imaging feature could be a potential biomarker in patient selection of target agent treatment, as well as the outcome predicting in patient with CRLMs.

SSK07-08 Prediction of Histopathologic Growth Patterns of Colorectal Liver Metastases with a Noninvasive Imaging Method

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S501ABC

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PURPOSE

This study was to predict histopathologic growth patterns (HGPs) in colorectal liver metastases (CRLMs) with radiomics model.

METHOD AND MATERIALS

Patients with chemotherapy-naive CRLMs who underwent abdominal contrast-enhanced MDCT followed by partial hepatectomy between January 2007 and January 2018 were included in this retrospective study. Hematoxylin- and eosin-stained histopathologic sections of CRLMs were reviewed, with HGPs defined according to international consensus. Lesions were divided into training and validation datasets based on date of treatment. Radiomic features were extracted from pre- and post- contrast (arterial and portal venous) phase MDCT images, with review focusing on the segmented tumor-liver interface (TLI) zones of CRLMs. Minimum redundancy maximum relevance (MRMR) and decision tree (DT) methods were used for radiomics modeling. Multivariable logistic regression analyses and ROC curves were used to assess the predictive performance of these models in predicting HGP types.

RESULTS

A total of 82 CRLMs with histopathologic-demonstrated desmoplastic (n = 54) or replacement (n = 28) HGPs were assessed. The radiomics signature consisted of 20 features of each phase selected. The fused arterial and portal venous phase radiomics signature demonstrated the best predictive performance in distinguishing between replacement and desmoplastic HGPs (AUCs of 0.962 and 0.870 in the training and validation cohorts, respectively). The radiomics model showed good discrimination (C-indices of 0.974 and 0.765 in the training and validation cohorts, respectively).

CONCLUSION

A radiomics model derived from MDCT images may effectively predict the HGP of CRLMs, thus providing a basis for prognostic stratification and therapeutic decision-making.

CLINICAL RELEVANCE/APPLICATION

1. Radiomics model derived from MDCT images may effectively predict the HGP of CRLMs.2. Radiomics can supplement radiologists' visual interpretation in morphologically similar tumors.

SSK07-09 Evaluation of Pre and Post-Treatment LI-RADS Categories as Predictors of Overall Survival in HCC Patients Undergoing Transarterial Embolization

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S501ABC

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PURPOSE

LI-RADS treatment response (LR-TR) algorithm has recently been proposed for the assessment of HCC response to locoregional therapy. The aim of our study was to evaluate associations between pretreatment (preTx) and posttreatment (postTx) LR-TR categories with overall survival (OS) in patients with HCC after transarterial embolization (TAE).

METHOD AND MATERIALS

In this IRB approved retrospective single center study, consecutive patients between December 2003 and December 2017 were included if they had 1 or 2 lesions and underwent TAE +/- ablation, with no prior therapy nor subsequent liver transplantation. Two radiologists (R1 and R2) reviewed preTx and postTx imaging to assign preTx LI-RADS diagnostic and postTx LR-TR categories, with agreement measured by kappa statistics. Associations with OS were examined on preTx and postTx variables, including tumor size, preTx LR categories and LR-TR categories (Viable, Equivocal, Nonviable) using Kaplan-Meier method and Cox proportional hazard regression.

RESULTS

88 patients (median 71 yo, 71 M, 17 F) were included, the majority having a single lesion (n=79, 83.2%) and either A or B BCLC stage (n=56, 63.6%). Median OS from first embolization was 35.5 months (95%CI: 26.4 - 50.2). For both readers, preTx tumor size (Hazard ratio (HR) R1 1.099 (95% CI: 1.030-1.172), R2 1.083 (95% CI: 1.016-1.154)) and LR-TIV vs LR-5 (HR R1 3.511 (95% CI: 1.617-7.625), R2 2.174 (95% CI: 1.010-4.682)) were associated with OS ($p<0.05$). PostTx tumor size (HR R1 1.158 (95% CI: 1.079-1.243), R2 1.135 (95% CI: 1.054-1.223)) and LR-TR Viable vs Nonviable category (HR R1 3.181 (95% CI: 1.766-5.728), R2 2.701 (95% CI: 1.498-4.872)) were associated with OS ($p<0.005$). Median OS for LR-TR Viable patients were 22.91 (R1, 95% CI: 17.85-31.96) and 25.64 months (R2, 95% CI: 18.58-35.70), compared to 64.21 months (R1 and R2, 95% CI: 42.71-92.45 and 36.30-94.09, respectively) for Nonviable patients. Interreader agreements were moderate for preTx LR categories (k=0.567 95% CI: 0.359-0.775) and substantial for postTx LR-TR categories (0.691 95% CI: 0.568-0.815).

CONCLUSION

Both preTx LI-RADS categories and postTx LR-TR categories were associated with OS in HCC patients following TAE.

CLINICAL RELEVANCE/APPLICATION

LI-RADS treatment response categories show potential as a surrogate endpoint for overall survival in HCC patients treated by transarterial embolization. Further validation is needed in larger multi-center studies.

Printed on: 10/29/20

SSK08

Gastrointestinal (Dual-energy CT)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S502AB

BQ CT GI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

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Sub-Events

SSK08-01 Extracellular Volume Quantification of Liver Using Dual-Energy CT: Utility for Prediction of Liver-Related Events in Cirrhosis

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S502AB

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PURPOSE

To determine whether quantification of liver extracellular volume fraction (fECV) using dual-energy CT allows prediction of liver-related events (LRE) in patients with cirrhosis.

METHOD AND MATERIALS

This retrospective study included 305 patients with cirrhosis who underwent dual source dual-energy liver CT and had serum markers within 2 weeks of initial CT imaging. The fECV score was measured using iodine map of equilibrium phase images obtained 3 minutes after contrast injection at 100 kVp and Sn140 kVp. Association of fECV score and serum markers with LRE was investigated. A risk model combining fECV score (<27 versus = or >27%) and albumin level (<4 versus = or >4 g/dL) was constructed for predicting LRE.

RESULTS

Increased fECV score (odds ratio, 1.27; 95% confidence interval (CI), 1.15, 1.40) was independently associated wtih decompensated cirrhosis at baseline (n = 85) along with Model for End Stage Liver Disease score (odds ratio, 1.32; 95% CI, 1.07, 1.63). In patients with compensated cirrhosis, 10.5% (23 of 220) experienced LRE during a median follow-up period of 2.0 years (decompensation, n =14; hepatocellular carcinoma, n = 9). fECV score (hazard ratio, 1.40; 95% CI, 1.22, 1.62) and albumin level (hazard ratio, 0.26; 95% CI, 0.09, 0.73) were independently predictive of LRE. Mean times to LRE in patients at high (16.5 months, n = 18), intermediate (25.6 months, n = 44), and low (30.5 months, n = 158) risk of LRE were significantly different (p < 0.0001).

CONCLUSION

The fECV score derived from dual-energy CT images allows prediction of LRE in patients with cirrhosis.

CLINICAL RELEVANCE/APPLICATION

The fECV score derived from iodine map of dual-energy CT can predict hepatic decompensation or hepatocellular carcinoma in cirrhotic patients. Dual-energy scanning is recommended as a part of liver CT during the follow-up of cirrhotic patients.

SSK08-02 Assessment of Peritoneal Carcinomatosis Using Iodine Overlays from Spectral Detector Computed Tomography

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S502AB

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PURPOSE

Peritoneal carcinomatosis (PC) is a prognostically relevant metastatic condition which can be difficult to differentiate from postoperative peritoneal alterations, particularly in early stages. The purpose of this study was to determine whether PC could be distinguished more accurately from benign peritoneal alterations when using spectral detector CT (SDCT)-derived iodine overlays (IO) in addition to conventional images (CI) compared to CI only.

METHOD AND MATERIALS

60 oncologic patients, 30 with PC confirmed by histopathology and 30 with non-malignant peritoneal alterations confirmed by follow-up or PET-CT who received clinically indicated portal-venous phase SDCT scans of the abdomen were retrospectively included. Two experienced and two less experienced radiologists blinded towards patient group and clinical information evaluated presence of PC for each patient and rated conspicuity and diagnostic certainty for up to 5 individual lesions per patient using 5-point Likert scales. Patients were randomized and the subjective assessment was conducted in a session that comprised solely conventional images and a second one which additionally included color-coded iodine overlay images between which a latency period of 6 weeks was administered to minimize recognition bias.

RESULTS

In less experienced readers, IO led to an increased sensitivity / specificity (CI: 0.78 / 0.83 vs. CI+IO: 0.82 / 0.88) for PC. Experienced radiologists showed a higher specificity when employing IO as well, which was however accompanied with a lower sensitivity (Sensitivity / Specificity: CI: 0.92 / 0.80 vs. CI+IO: 0.73 / 0.82). In the subgroup of patients with history of abdominal surgery, the rise in specificity averaged over all readers was even higher (CI: 0.78 vs. CI+IO: 0.91). Median Likert scores for lesion conspicuity were significantly higher for the combination of CI and IO (4 (3-5)) compared to CI only (3 (3-4); $p<=0.05$) while diagnostic certainty was comparable (4 (3-5)).

CONCLUSION

Iodine overlays are instrumental in distinguishing benign from metastatic peritoneal lesions, particularly in patients who underwent abdominal tumor surgery and for less experienced radiologists.

CLINICAL RELEVANCE/APPLICATION

Iodine overlays should be employed as a supplement rather than a surrogate for CI and the additional information on iodine uptake should not outweigh conventional image features suggestive for PC as this might result in lower overall sensitivity.

SSK08-03 The Utility of a Dual-Energy CT Protocol for Acute GI Bleeding (AGIB) in Patients with Recent Overt GI Bleeding

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S502AB

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PURPOSE

To examine the benefit and utility of a two-phase, dual-energy (DE) CT protocol for acute GI bleeding protocol (DE-AGIB-CT) in recent overt GI bleeding.

METHOD AND MATERIALS

Consecutive patients underwent clinically-indicated two-phase DE-AGIB-CT (arterial and portal phases). A gastroenterologist reviewed all clinical information during hospitalization (endoscopy, angio, surgery) to create the reference standard. The clinical radiologist report was used to determine site and presence of active extravasation or other findings (e.g., varices, tumor) causing GI bleeding. After reconciliation, performance of DE-AGIB-CT was estimated. To ascertain the contribution of portal phase and DE images, 3 GI radiologists evaluated all patients with active bleeding, and an equal number of negative exams chosen randomly. Radiologists rated confidence in site and imaging evidence of GI bleeding using only mixed kV arterial images, then with mixed kV portal phase images, and then with dual energy images (50 keV, iodine maps, VNC).

RESULTS

176 patients underwent DE-AGIB-CT for the evaluation of suspected acute GI bleeding. Reference standard identified a cause for active GI bleeding in 56 patients (31.8%). 31 DE-AGIB-CT exams were positive for active extravasation (29% colon, 26% jejunum/ileum, 26% stomach, 19% other). The sensitivity, specificity, positive and negative predictive values of DE-AGIM for correct identification of imaging evidence of GI bleeding was 61% (95%CI:46%-74%), 91% (84%-95%), 74% (58%-86%), and 85% (78%-90%). Sensitivity of active extravasation for cause of AGIB is 30 % (18.37%-43.78%). Out of 31 cases with active contrast material extravasation, in 10 cases (33%), 2/3 radiologists increased confidence in presence of active bleeding by >= 10% by evaluating portal phase images in addition to mixed kV CTA images. Dual energy reconstructions did not increase confidence in any cases.

CONCLUSION

The sensitivity of a dedicated protocol for GI bleeding was less than previously reported, even when imaging criteria were extended beyond luminal extravasation to include identification of causes of GI bleeding. Portal phase imaging increased confidence for GI bleeding.

CLINICAL RELEVANCE/APPLICATION

Physicians should take into consideration the possibility of limited sensitivity of CTA when they rely on this modality in the diagnosis and triaging of patients with acute GI bleeding. Portal phase images improve reader confidence.

SSK08-04 Can Dual-Energy CT Replace Perfusion CT in Monitoring Tumor Therapeutic Response and Predicting Outcomes in Rabbit VX2 Liver Tumors?

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S502AB

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PURPOSE

To investigate whether dual-energy CT (DECT) can replace perfusion CT (PCT) for monitoring and predicting tumor response to antiangiogenic treatment in rabbit VX2 liver tumors.

METHOD AND MATERIALS

In 54 VX2 liver tumor-bearing rabbits, a optimal contrast-enhanced DECT protocol during the arterial phase (AP) and portal phase (PP) was used to reconstruct images from PCT data obtained from the same scan based on time-attenuation curves. The rabbits were randomized into the control group(n=18),low (n=20) and high dosage(n=16) treated group. The normalized iodine concentrations(nIC) and PCT parameters of tumor at different time points (baseline, 2, 4, 7, 10, and 14 days after treatment) were compared among the three groups. Animals were assessed for survival, tumour size and spread, and tumour and immunohistological markers at 14 days and after 90 days.

RESULTS

There was no statistical difference in the diagnostic performance for respondents and nonrespondents differentiation between nIC and PCT parameters at 2 days and 4 days (area under the receiver operating characteristic curve, 0.73-0.76 vs.0.83-0.86) in the treated group. Radiologic parameters including BF, PEI, nICAP and nICPP at 2 days were positively correlated with the 14-day tumor size change and immunohistological markers(All P values <0.05). The overall survival days correlated with tumors with higher baseline mean transit time values on PCT(P=0.023) but not with nIC in both AP and PP.

CONCLUSION

DECT-derived nIC enabled monitor early antiangiogenic treatment effects but could not predict outcome at the end of treatment of rabbit VX2 liver tumors as compared with PCT parameters.

CLINICAL RELEVANCE/APPLICATION

Dual-energy CT can replace perfusion CT for monitoring tumor response and predicting short-term efficacy to tumor anti-angiogenic therapy but cannot predict outcome at the end of treatment .

SSK08-05 The Influence of Liver Iron Deposition on the Quantification of the Liver-Fat Fraction Using Spectral CT Imaging and Material Decomposition Technique: A Vitro Experiment Study

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S502AB

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PURPOSE

Our first goal was to build in vitro liver fat-iron deposition model in order to provide a phantom for fat content quantification in study. The second goal was to investigate whether iron deposition has an effect on the quantification of the liver-fat fraction using spectral CT imaging and material decomposition technique.

METHOD AND MATERIALS

Liver-fat-iron mixture samples were prepared as described. A total of 9 samples of 3 groups of homogeneous liver-fat mixed samples with fat volume percentage of 0%, 10%, 20% and 30% were prepared (group A, B and C, added iron with iron concentration of 10,

20 and 30mg/mL, respectively). All samples were scanned on a GE Revolution CT scanner using GSI mode with rapid tube voltage switching between 80-140 kVp, and with tube current 320mA, pitch 1.375mm. After the CT scan reconstructed imaging data were processed with GSI imaging analysis software package for material decomposition and characterization. Fat concentration (on fat-water bases) measured with consistent ROIs placed in the tube center with a diameter of 8mm. Each sample was recorded at 4 different regions for average and statistical analysis. A linear regression was performed using SPSS 19.0 software to analyze the relationship between the measured fat concentration and the liver fat concent (LFC).

RESULTS

(1) We had successfully developed liver iron-fat models in vitro for fat content quantification. With the designed fat volume percentage, the gradient range covered clinical fat content in liver, and the iron concentration of 20, 30 and 40mg/mL simulated the moderate and severe liver iron overload respectively. (2) The model showed good linear relationship between the measured fat concentration and LFC. And the linear correlation equation of group A, B and C were y=0.037+61.85(R^2 = 0.998, P=0.0.02), y=0.134x+263(R^2 = 0.991, P=0.043), and y=0.074x+195(R^2 = 0.998, P=0.02).

CONCLUSION

The presence of iron underestimated of liver fat concent by using spectral CT imaging and material decomposition technique in vitro experiment.

CLINICAL RELEVANCE/APPLICATION

This study demonstrated the feasibility of using CT spectral imaging and material decomposition techniques to precisely quantify the fat concentrations under the condition of simultaneous fat deposition and iron deposition, and the presence of iron was a confounding factor, leading to the underestimation of liver fat content.

SSK08-06 Crohn's Disease Activity Quantified by Iodine Density Obtained from Dual-Energy CT Enterography

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S502AB

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PURPOSE

To assess the utility of bowel wall iodine density obtained from dual source, dual-energy CT enterography (DECTE) as a biomarker of Crohn's disease (CD) activity.

METHOD AND MATERIALS

Twenty-two patients with CD imaged with DECTE from 2/2016-5/2018 were retrospectively identified by departmental report search. Iodine maps were created with commercial software (Syngovia®). Iodine content was normalized to the aorta and then manual region of interest cursors were placed over the visibly assessed maximal and minimal iodine density segments of involved and unaffected small bowel. The maximum (Imax) and minimum iodine density (Imin) were recorded. A weighted iodine density (Iweighted) was calculated. Hounsfield units from the blended (50% 150/50% 80kVp) DE images were recorded (mixed HU). The clinical assessment of disease activity using ESR, CRP, fecal calprotectin, colonoscopy/endoscopy and surgery were the reference standard. The CD activity index (CDAI) was used as a separate additional reference standard.

RESULTS

Average Imax and Imin of affected bowel were 4.27±1.11(2.4-7.4)mg/mL and 2.71±0.51(2.2-3.9)mg/mL, respectively. Iodine density of normal-appearing small bowel was 1.40±0.26(0.9-1.9)mg/mL. The Imax and Imin of affected bowel differed significantly from normal bowel (P<0.0001). Mixed HU (101.82±27.5) also statistically differed (46.33±19.62) (P<0.0001). Significant heterogeneity in the affected segments was present on iodine maps. Using overall clinical assessment as the reference standard, all patients with Imin>2.6mg/mL, Iweighted>3.3mg/mL, or Imax>4.7mg/mL had clinically active disease. Using CDAI as the reference standard, all patients with Imin>2.7mg/mL, Iweighted>3.6mg/mL or Imax>5.4mg/mL had clinically active disease. The median effective dose was 4.64±1.68(2.03-8.12)mSv.

CONCLUSION

Iodine density obtained from DECTE highlights regions of maximal activity within affected bowel segments. An iodine density of 2mg/mL appears to be a threshold between normal bowel and those involved with active CD. Iodine density thresholds Imin>2.7mg/mL, Iweighted>3.6mg/mL and Imax>5.4mg/mL appear to indicate clinically active disease.

CLINICAL RELEVANCE/APPLICATION

Because CD activity is heterogeneous, more specific targeting of affected segments can pinpoint therapeutic intervention.

SSK08-07 Can Advanced Tumor Analysis with DECT Iodine Quantification and Radiomics Help Characterize Focal Liver Lesions?

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S502AB

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PURPOSE

We assessed a machine learning-based Dual Energy Tumor Analysis (DECT-TA) prototype (Siemens Healthineers) for semiautomatic segmentation and radiomics analysis of benign and malignant liver lesions seen on contrast-enhanced dual-energy CT (DECT).

METHOD AND MATERIALS

Our IRB-approved study included 103 adult patients (mean age 65 ± 15 years; 53 men, 50 women) with benign (n= 60) or malignant (n= 43) hepatic lesions on contrast-enhanced dual-source DECT (Siemens Force or Flash). Most malignant lesions had histologic proof; benign lesions were either stable on follow-up CT or had characteristic benign features on MRI. Low and high kV datasets were de-identified, exported offline, and post-processed with the DECT-TA for semiautomatic segmentation of the volume and rim of each liver lesion. For each segmentation, contrast enhancement and iodine concentrations, as well as 585 radiomics features were derived for different DECT image series. Statistical analyses were performed to determine if DECT-TA radiomics can differentiate benign from malignant liver lesions.

RESULTS

Iodine concentration, normalized iodine concentrations, mean iodine in the benign and malignant lesions were significantly different ($p < 0.0001$-0.0084; AUC: 0.695 - 0.856). Iodine quantification and radiomics features from lesion rims (AUC up to 0.877) had higher accuracy for differentiating liver lesions as compared to the values from lesion volumes (AUC up to 0.856). Random forest classification yielded higher accuracy for differentiating liver lesions with both the DECT iodine quantification (AUC= 0.91) than DECT radiomics (AUC= 0.90).

CONCLUSION

The DECT-TA prototype enables accurate differentiation between benign and malignant hepatic lesions based on iodine quantification and radiomics features.

CLINICAL RELEVANCE/APPLICATION

DECT segmentation, iodine quantification and radiomics can be used for characterizing focal liver lesions.

SSK08-08 Dual-Energy CT Improves Radiologist Confidence in Diagnosing Acute Bowel Ischemia Compared with Conventional CT

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S502AB

Participants
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PURPOSE

The diagnostic performance of dual-energy CT (DECT) and confidence level of radiologists making the diagnosis on DECT in suspected acute bowel ischemia (ABI) in comparison with conventional CT were assessed. CT viewing times for conventional CT and DECT were evaluated.

METHOD AND MATERIALS

This retrospective study included 89 patients with clinically suspected ABI, who underwent Dual-energy CT imaging over 4 years in a large teaching institution. Clinical, laboratory, operative and biopsy findings were recorded as reference standard. Two radiologists who were blinded to the reference standard independently assessed conventional CT images to look for ABI, and subsequently, assessed DECT images. Diagnosis, confidence levels and CT reading times for both conventional CT and DECT were compared. The readers expressed their confidence levels in assessing bowel ischemia on 5 point Likert scale.

RESULTS

ABI was detected in 13 patients among 89 patients with clinical suspicion. The confidence level of Reader 1 to make the diagnosis increased by one level in 51.3% after reviewing DECT images; increased by two levels in 10.2%, and remained the same in 35.9%. For Reader 2, the confidence level increased by one level in 29.2% of patients, increased by two levels in 5.5%, unchanged in 48.6%, and decreased by one level in 15.3%. The mean reading time for conventional CT by Reader 1 was 104.6 ± 57.23 sec, and the mean additional time to read DECT was 63.5 ± 38.55 sec. The corresponding CT viewing times for Reader 2 were 67.4 ± 33.39 sec, and 51.1 ± 28.99 sec, respectively.

CONCLUSION

DECT increases the confidence of radiologists in diagnosing ABI with comparable diagnostic accuracy and reasonable extra-viewing time, as opposed to interpreting conventional CT alone. Hence, DECT is a promising imaging technique for routine clinical use in suspected ABI.

CLINICAL RELEVANCE/APPLICATION

Acute Bowel Ischemia (ABI) is a clinical emergency, warranting prompt intervention or surgery, and this study aims to assess if dual-energy CT (DECT) could play a valuable role in evaluation of ABI.

SSK08-09 Non-Invasive Assessment of Liver Cirrhosis with Multiphasic Dual Energy CT Using Iodine Quantitation: Correlation with Model of End-Stage Liver Disease Score

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S502AB

Participants
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PURPOSE

To determine whether contrast-enhanced multiphasic dual-energy (DE) CT iodine quantitation correlates with severity of chronic liver disease.

METHOD AND MATERIALS

This single-center, IRB-approved and HIPAA compliant retrospective study involved 28 patients with (15M; median age, 62 (58-68) years) and 22 patients without cirrhosis (8M; median age, 67 (51-75) years) who underwent a multiphasic liver protocol DECT. All three (arterial, portal venous (PVP), and delayed) phases were performed in DE mode. Patient demographics, MELD scores, and cirrhosis diagnosis were based on electronic medical records. A radiologist obtained Iodine concentration (mg I/ml) by manually placing ROIs in the caudate, left and right hepatic lobe, aorta, common hepatic artery (CHA), and portal vein (PV) on all 3 phases. ROI size and position were constant in all phases. Absolute iodine values were divided by those from the aorta for each phase to derive normalized Iodine quantitation (I). Iodine slopes (λ) were calculated as follows: Idelayed-arterial/ time(180 seconds) and Idelayed-PVP/ time(180 seconds). Slopes were correlated with MELD scores and the area under the curve of the receiver operating characteristic (AUROC) was calculated to distinguish cirrhotic and non-cirrhotic patients.

RESULTS

Cirrhotic and non-cirrhotic patients had significantly different λdelayed-PVP for caudate (λ = 1.350 vs. 2.350, P< .0001), left (λ = 1.383 vs. 2.200, P< .004), and right (λ = 1.063 vs. 1.913 , P< .0001) lobe. λdelayed-arterial were significantly different for CHA (λ = 2.450 vs. 11.250, P< .023) and PV (λ = 2.750 vs. 3.750, P= .013). A statistically significant correlation was found between MELD scores and λdelayed-PVP of caudate, left and right lobes (rho =0.340, P=.034; rho=0.393, P=.005; rho=0.368, P=.034, respectively). AUROC for caudate, left, and right lobe λdelayed-PVP in differentiating cirrhotics from non-cirrhotics were 0.794, 0.739, 0.908, respectively.

CONCLUSION

Multiphasic DECT iodine quantitation over time is significantly different between cirrhotics and non-cirrhotics and correlates with MELD score.

CLINICAL RELEVANCE/APPLICATION

Multiphasic DECT iodine quantitation could serve as a non-invasive measure of cirrhosis and disease severity with high diagnostic accuracy.

SSK09

Gastrointestinal (Colon and Appendix)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S504AB

GI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Gaurav Khatri, MD, Irving, TX (*Moderator*) Nothing to Disclose
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Harmeet Kaur, MD, Houston, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSK09-01 Intravoxel Incoherent Motion Diffusion-Weighted Imaging of Primary Rectal Carcinoma: Distinguish the Malignant or Benign Lymph Node

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S504AB

Participants
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PURPOSE

The aim of this study was to evaluate the difference between the malignant or benign lymph node by IVIM and to determine the optimal parameter of IVIM.

METHOD AND MATERIALS

We retrospectively enrolled 98 patients with pathologically proven rectal adenocarcinoma. All patients underwent routine MR examination and IVIM sequence. A total of 246 lymph nodes were harvested and subjected to histological analysis. The IVIM maps were automatically generated. The t test, Mann-Whitney U test, and receiver operating characteristic curves was used for statistical analysis.

RESULTS

All IVIM parameters demonstrated the difference between metastatic lymph nodes and the normal lymph nodes (PD<0.01; PD*=0.01; Pf<0.001). For metastatic lymph nodes, f value of poorly differentiated rectal carcinoma were lower than well/moderately differentiated carcinoma, the significant difference was found (Pf=0.03). In addition, D value of mucinous carcinoma were higher than non-mucinous carcinoma (P<0.01) and D* values were on the contrary (P<0.01). D* showed a relatively higher area under the curve (AUC)(0.905) and higher sensitivity(94.48%) and specificity(85.33%) than other percentiles for differentiation of benign or malignant lymph nodes (LNs).

CONCLUSION

The IVIM parameters may distinguish between the malignant and benign lymph node during the primary staging of rectal carcinoma. D* appears to be a valid and promising parameter to indicate the quality of LNS.

CLINICAL RELEVANCE/APPLICATION

The IVIM parameters can demostrate the malignant or benign lymph node of primary staging of rectal carcinoma. D* is recommended as part of a MR study prior to tumor removal.

SSK09-02 Dual-Energy CT Colonography: Increasing Reader Performance and Confidence in a Spectral Colon Phantom

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S504AB

Participants
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PURPOSE

To investigate if Dual-Energy CT (DECT) improves polyp detection compared to conventional CT (CCT) at CT Colonography (CTC) for different fecal tagging levels in an anthropomorphic phantom model.

METHOD AND MATERIALS

A 30 cm diameter colon phantom containing 60 polyps of different shapes (spherical, ellipsoid, flat) and size groups (5-9 mm; 11-15 mm) was serially filled with simulated feces tagged with 4 different iodine concentrations (1.26, 2.45, 4.88, and 21 mg I/ml). The artificial colon wall, polyps, feces and surrounding fat were tailored to match the spectral properties of human tissue. Low-dose scans (CTDIvol: 4.5 mGy) were performed on a dual-layer spectral CT with and without an additional outer 6 cm fat-ring (total diameter 42 cm). The phantom was divided into 336 segments, 276 without and 60 with polyps. Two abdominal radiologists independently reviewed CCT and DECT images (40 keV monoenergetic) images to record the presence of polyps in each segment and confidence (3-point Likert-scale.) Sensitivity and specificity between CCT and DECT were compared using McNemar's test, corresponding ROC AUCs were compared using DeLong's test; reader confidence was compared using Wilcoxon test.

RESULTS

Interrater agreement was substantial (κ=0.736). Overall sensitivity was higher at DECT than for CCT (59% versus 42%, respectively, p<0.001), including scans with the fat-ring (sensitivity: 48% vs 31%, respectively, p<0.001), while overall specificity was high for both (99.6% and 99.7%, respectively). Greater fecal tagging correlated with higher sensitivity for polyp detection both CCT and DECT (lowest vs highest tagging, 11 vs 76 % and 28 vs 85%, respectively, both p<0.001). At corresponding tagging levels, DECT showed higher sensitivity and specificity, resulting in superior ROC AUCs (p<0.003 for all levels). Reader confidence increased significantly with DECT compared to CCT (1.77 vs 1.54, p<0.001).

CONCLUSION

DECT improves polyp detection sensitivity and confidence in CTC exams, especially with low level fecal tagging. Effects were seen irrespective of polyp size or shape, and for larger phantom diameter. Study of clinical DECT colonography is warranted.

CLINICAL RELEVANCE/APPLICATION

DECT improves polyp detection sensitivity and confidence in a CTC phantom. Clinical DECT CTC studies to reduce cathartic bowel preparation or to salvage suboptimal tagged exams are warranted.

SSK09-03 Role of CT Colonography and Texture Analysis in Differentiating Sigmoid Cancer versus Chronic Diverticular Disease

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S504AB

Participants
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PURPOSE

To retrospectively evaluate morphological findings of chronic diverticular disease and sigmoid carcinoma at computed tomography colonography (CTC) and to evaluate texture analysis potential in order to differentiate them.

METHOD AND MATERIALS

We included in our IRB-approved retrospective study 95 consecutive patients with histologically proven chronic diverticular disease (n = 53) or sigmoid carcinoma (n = 42). Two radiologists retrospectively analyzed CTC studies unaware of the histological diagnosis. One reader scored each exam according to presence or absence of potential discriminators (Length, Wall thickness, Shouldering phenomenon, Thickening type, Growth pattern, Diverticula, Fascia thickening, Fat tissue edema, Loco-regional lymph nodes, Mucosal pattern) and performed volumetric texture analysis on the colonic tissue in both groups.

RESULTS

The Findings that suggest carcinoma diagnosis were: absence of diverticula in the affected segment (sensitivity 87.9%; specificity 90.5%); straightened growth pattern (sensitivity 71.4%; specificity 90.9%); shouldering phenomenon (sensitivity 90.5%; specificity 81.8%); complete distortion of mucosal folds (sensitivity 95.2%; specificity 75.8%). Considering mass-like lesions, growth pattern and mucosal folds distortion lose their diagnostic value. The only morphological finding with higher diagnostic value is absence of diverticula in the examined segment; its combination with shouldering phenomenon increases carcinoma diagnosis specificity. Regarding texture analysis parameters, kurtosis (first order feature, HISTO, p<0.001), correlation (second order feature, GLCM, p=0.0037) and contrast (second order feature NGLDM, p=0.0079) resulted to be significantly different between the two groups.

CONCLUSION

Carcinoma is best differentiated from chronic diverticular disease in CTC by the absence of diverticula in the affected segment and the presence of shoulder phenomenon. Texture analysis can provide an additional tool in differentiating the two entities when

considering HISTO kurtosis, GLCM correlation and NGLDM contrast, but further studies are needed

CLINICAL RELEVANCE/APPLICATION

Distinguishing colonic carcinoma from chronic diverticular disease at CTC is fundamental due to the extremely different prognosis and treatment of the two pathologies. CTC is able to do that and texture analysis can be helpful in this diagnostic process.

SSK09-04 Use of CT Encounters to Improve Colon Cancer Screening Utilization Rates: Cross-Sectional Survey Results from the National Health Interview Survey

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S504AB

Participants
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PURPOSE

Millions of patients undergo cross-sectional imaging examinations using CT every year. These imaging encounters may represent opportunities to improve colorectal cancer screening rates with CT colonography among patients who have not received recommended colon cancer screening. Using a nationally representative cross-sectional survey, the purpose of this study was to estimate the proportion of patients who have undergone CT examinations among those who have not received recommended colon cancer screening.

METHOD AND MATERIALS

Survey respondents from the 2015 National Health Interview Survey (NHIS), a nationally representative federal cross-sectional survey, were analyzed. Participants aged 50-75 without history of colorectal cancer were included. The proportion of patients who have not received recommended colon cancer screening who underwent CT examinations was estimated. Multiple variable logistic regression analyses were performed to evaluate the association between sociodemographic characteristics and colorectal cancer screening adherence. Stata survey procedures were used with NHIS-provided sampling weights to account for complex survey sampling design and to obtain statistically valid estimates for the civilian, non-institutionalized US population.

RESULTS

13,602 survey respondents met inclusion criteria. 46.8% (45.5, 48.1) reported having ever received a CT scan and 72.1% (70.4, 73.7) of those were eligible for CRC screening. Among those who previously had CT scans, Asian race participants (OR 0.47, 95% CI - 0.31, 0.72, p = 0.001) and participants without health insurance coverage (OR 0.48, 95% CI - 0.34, 0.70, p < 0.001) had lower odds of adherence, while increasing household income (OR 1.01, 95% CI 1.00 - 1.01, p < 0.001) and education (OR 1.30, 95% CI 1.10 - 1.54, p = 0.002) were associated with higher odds of adherence. Among participants who did not receive CRC screening, 35.2% (33.3%, 37.2%) reported having a CT scan, representing an estimated 10,904,722 people across the United States.

CONCLUSION

Among patients who have not received recommended colorectal cancer screening, approximately 1 out of 3 report having undergone a CT examination.

CLINICAL RELEVANCE/APPLICATION

Radiology encounters with patients undergoing CT exams may represent opportunities to improve colorectal cancer screening rates and utilization of CT colonography across the US.

SSK09-05 Radiomics-Based LN Staging after Neoadjuvant Chemoradiotherapy in Locally Advanced Rectal Cancer by Features from the Primary Tumor and One Automatically Selected Lymph Node

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S504AB

Participants
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PURPOSE

This study aims to predict N stage after neoadjuvant chemoradiotherapy (NCRT) by combining the features of primary tumor and the features of one lymph node (LN) selected through a radiomics approach.

METHOD AND MATERIALS

229 patients were included in this study, chronologically divided into the discovery cohort (n=183) and validation cohort (n=46). T2-weighted images were scanned in an oblique direction perpendicular to the intestinal tube with following parameters: repetition time (TR) = 5700 ms, echo time (TE) = 110 ms, echo number = 25, field of view (FOV) = 180 mm. 41 features were extracted from the primary tumor and all visible LNs delineated on both pre-NCRT and post-NCRT MRI images. Pathological N stage after excision is used as ground truth. The LN that has the minimum or maximum value for each feature is selected and combined with the features of primary tumor to construct a Radiomics model in the discovery cohort by logistic regression with L1 regularization. The model is tested in the validation cohort and compared with several models.

RESULTS

The average LN number and standard deviation for one patient is 13.4±5.1 in pre-NCRT scanning and 6.7±4.1 in post-NCRT scanning. The optimal way of LN selection is by using the maximum cluster prominence. The area under receiver operative curve (AUC) is 0.840 (95%CI: 0.778-0.890) for discovery cohort and 0.864 (95%CI: 0.731-0.947) for validation cohort. For the model that only uses tumor features, AUC is 0.580 (95%CI: 0.505-0.653) for discovery cohort and 0.669 (95%CI: 0.515-0.801) for validation cohort. For the model that uses tumor features and the LN that has the largest volume, AUC is 0.801 (95%CI: 0.736-0.856) for discovery cohort and 0.839 (95%CI: 0.701-0.931) for validation cohort. For the model that uses tumor features and average LN features, AUC is 0.741 (95%CI: 0.671-0.803) for discovery cohort and 0.539 (95%CI: 0.386-0.687) for validation cohort. For subjective evaluation, AUC is 0.650 (95%CI: 0.576-0.719) for discovery cohort and 0.756 (95%CI: 0.607-0.870) for validation cohort.

CONCLUSION

Radiomics model combining tumor features and features from LN with the maximum cluster prominence shows increased accuracy in predicting LN metastasis after NCRT for locally advanced rectal cancer (LARC) patients.

CLINICAL RELEVANCE/APPLICATION

Identification of lymph node (LN) status is crucial for assigning patients with LARC to appropriate treatments.

SSK09-06 The Diagnostic Performance of MRI for Detection of Extramural Venous Invasion in Colorectal Cancer: A Systematic Review and Meta-Analysis of the Literature

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S504AB

Participants
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PURPOSE

To perform a systematic review and meta-analysis regarding the diagnostic performance of MRI for detection of extramural venous invasion (EMVI) in patients with colorectal cancer.

METHOD AND MATERIALS

MEDLINE and EMBASE were searched up to November 9th 2018. We included diagnostic accuracy studies that used MRI for EMVI detection in patients with colorectal cancer, using pathology as the reference standard. The methodological quality was assessed using QUADAS-2. Sensitivity and specificity were pooled and plotted in a hierarchical summary receiver operating characteristics plot. Meta-regression analysis using several clinically relevant covariates were performed.

RESULTS

Fourteen studies (n = 1751 patients) were included. Study quality was generally moderate. Pooled sensitivity was 0.61 (95% CI 0.49-0.71) and specificity was 0.87 (95% CI 0.79-0.92). There was substantial heterogeneity: Cochran's Q-test ($p<0.01$), Higgins I2 (98% and 95% for sensitivity and specificity, respectively). Publication bias was present ($p = 0.01$). Higher prevalence of advanced T stage, high-resolution MRI and antispasmodic drugs were significant factors affecting heterogeneity ($p <0.01$). Location of primary tumor, preoperative treatment status, study design, definition of reference standard, magnetic field strength, and use of functional MRI sequences were not statistically significant ($p = 0.17$-0.92).

CONCLUSION

MRI demonstrates moderate sensitivity and good specificity for detection of EMVI in colorectal cancer. Using high-resolution MRI may improve diagnostic performance.

CLINICAL RELEVANCE/APPLICATION

MRI demonstrates moderate sensitivity and good specificity for detection of EMVI in patients with colorectal cancer. Preoperative MRI would benefit patients with coloretal cancer for correct staging and subsequent setting of optimal treatment. Furthremore, this study would provide rationale for future studies evaluating the role of MRI-detected EMVI without pathologic confirmation.

SSK09-07 Characteristic Radiographic Patterns of Biopsy-Proven Immune-Related Colitis in Melanoma Patients Treated with Cytotoxic T-Lymphocyte Antigen-4 (CTLA-4) Inhibitors

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S504AB

Participants
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PURPOSE

To investigate the radiographic signature of biopsy-proven immune-related colitis in patients treated with CTLA-4 inhibitors.

METHOD AND MATERIALS

We retrospectively reviewed medical records of 692 cancer patients treated at our institution who received at least 1 course of an immune checkpoint inhibitor between 2011 and 2018. Among them, 100 (14%) had biopsy-proven colitis and of those, 97 (97%) had concomitant imaging. In order to characterize the radiographic features of colitis associated with CTLA-4 inhibitors, we limited our cohort to patients treated with a CTLA-4 inhibitor who underwent at least 1 baseline and on-treatment abdominal CT. Abdominal CTs were reviewed by a single radiologist for the presence and imaging characteristics of colitis.

RESULTS

We identified 20 patients with melanoma treated with either ipilimumab (17) or tremelimumab (3) (mean age 69 yrs) who subsequently developed biopsy-proven colitis. Of those 20 patients, 18 (90%) had radiographic evidence of colitis a mean of 14.6 wks after starting CTLA-4 therapy. Radiographic patterns noted were pancolitis (10 patients, 56%), segmental colitis (7, 39%), segmental colitis associated with diverticulosis (SCAD, 6, 33%), enterocolitis (3, 17%), and enteritis alone (1, 6%); several patients had multiple features. Most common CT features of colitis included bowel wall thickening (16 patients, 89%), fluid-filled colon (14, 78%), fat stranding (14, 78%), mesenteric vessel engorgement (12, 67%), and mucosal hyperenhancement (10, 56%). Among the 6 patients with classic SCAD pattern, 3 (50%) also had concomitant involvement of the hepatic flexure, a novel radiographic finding. Colitis prompted interruption of treatment and initiation of steroids in 6 patients and steroids/infliximab in 12 patients.

CONCLUSION

CTLA-4 inhibitor mediated biopsy-proven immune-related colitis has radiographic findings ranging from segmental colitis to pancolitis on CT. Bowel wall thickening was the most prevalent finding. A subset of patients with SCAD pattern may have a predilection for involvement of the hepatic flexure, reported here for the first time. These findings should be prospectively validated in additional cohorts.

CLINICAL RELEVANCE/APPLICATION

Given the expanding role of immune checkpoint blockade including CTLA-4 inhibition, radiologists should be aware of the imaging features of immune-related colitis.

SSK09-09 Retrospective Diagnostic Model Development and Validation Study: Differentiation of Complicated from Uncomplicated Appendicitis in Adolescents and Young Adults Using CT and Clinical Predictors

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S504AB

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PURPOSE

To develop and validate a diagnostic model comprising CT and clinical/laboratory features for differentiation of complicated from uncomplicated appendicitis.

METHOD AND MATERIALS

This retrospective study included 1153 adolescent and young adults (mean age ± standard deviation, 30 ± 8 years) with suspected appendicitis on CT. We used the data from a previous pragmatic multi-center randomized controlled trial that compared 2-mSv CT and conventional-dose CT for the diagnosis of appendicitis in 20 teaching hospitals. We included 804 patients from 12 sites for model development, and 349 patients from eight sites for external validation. The outcome of interest was complicated appendicitis (perforated or gangrenous appendicitis). Complicated appendicitis was surgically or pathologically confirmed in 300 and 121 patients in the development and validation set, respectively. We constructed diagnostic models using logistic regression from candidate predictors comprising eight CT features and 13 clinical/laboratory features. The final model was selected using the Bayesian information criterion. A simplified rule was derived at a cut-off score targeting 95% sensitivity in the development set. For external validation, sensitivity and specificity were measured in the validation set, using the detailed model and its simplified rule targeting 95% sensitivity.

RESULTS

Six predictors comprising 5 CT features (contrast-enhancement defect of the appendiceal wall, abscess, periappendiceal fat stranding, appendiceal diameter, and extraluminal air) and the percentage of segmented neutrophil were included in our model. In the validation set, the sensitivity and specificity were 95.9% (90.6%, 98.6%) and 19.3% (14.4%, 25.0%) using the detailed model; and 95% (90%, 98%) and 16% (11%, 21%) using the simplified rule.

CONCLUSION

We propose highly sensitive prediction model for complicated appendicitis, which may contribute to reducing the number of unnecessary appendectomies performed for uncomplicated appendicitis.

CLINICAL RELEVANCE/APPLICATION

For physicians who are willing to attempt conservative management of appendicitis while minimizing the risk of treatment failure, our model can be used with expected percentage of false negatives to be less than 1.5%.

Printed on: 10/29/20

SSK10

Genitourinary (PI-RADS v2.0 and v2.1)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: N227B

GU

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSK10-01 PIRADS Score 2 Misses Significant Prostate Cancer Foci on MRI

Wednesday, Dec. 4 10:30AM - 10:40AM Room: N227B

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PURPOSE

To evaluate cancer suspected areas in multiparametric MRI (mpMRI) of the prostate which were classified as PIRADS 2 lesions using scientifically proved MRI criteria of cancer by an experienced reporting investigator

METHOD AND MATERIALS

In 2012-2017 328 out of 929 patients with suspicion of prostate cancer that underwent mpMRI were categorized as PIRADS 2 by a radiologist with more than 7 years' experience, 198 of them underwent an 18-core TRUS guided biopsy added by 3 additional samples of the MRI suspected areas. Since 2015 suspicious lesions were evaluated with respect to well-known tumor criteria in literature. In 2012-2014 suspicious lesions were retrospectively categorized as PIRADS 2. In 61 of 198 patients with PIRADS 2 score suspicious lesions were found (study group).The negative predictive value (NPV) of PIRADS 2 was assessed.Chi-square-test was performed to evaluate a possible difference between the number of significant carcinomas in patients with suspicious lesions and in men with PIRADS score 2 criteria alone.

RESULTS

In the study population cancer was found in 13 of 61 men (21%), significant cancer (Gleason score > 6 or Gleason score 6 with PSA > 10 ng/ml or tumor areas in both prostate lobes) in 10 patients (16%). 11 of 13 cancer foci showed a good correlation between the suspected areas in MRI and the biopsy sides. In the control group 25 carcinomas were detected (18%), 16 of them significant (12%). PIRADS score 2 showed a NPV for significant carcinomas of 87 % in the whole population, 84% in the study group and 88% in the control group. The number of significant carcinomas detected in the study population was not significant higher than in the control group.

CONCLUSION

PIRADS scoring provides accurate reproducible reports in interpreting prostate MRI, especially in unexperienced investigators. Reported weaknesses of the PIRADS system are the straight recommendations of interpreting the different zones of the prostate with priority to first and second line sequences in diagnosis weighting. Including proved tumor criteria in MRI as early contrast enhancing foci in the transitional zone or low signal intensity areas in the peripheral zone on T2-weighted images tends to indicate prostate carcinoma beside PIRADS criteria.

CLINICAL RELEVANCE/APPLICATION

PIRADS 2 lesions could comprise significant prostate cancer foci and should require further diagnostic assessment with additionally scientific proven tumor MRI criteria.

SSK10-02 Factors that Predict Clinically Significant Prostate Cancer Among Prostate Imaging Reporting and Data System (PI-RADSv2) Category 3 Lesions Using Histopathology as a Reference

Wednesday, Dec. 4 10:40AM - 10:50AM Room: N227B

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PURPOSE

This study aimed to identify clinical and magnetic resonance imaging (MRI) factors that predict clinically significant prostate cancer (CSC) in patients with Prostate Imaging Reporting and Data System version 2 (PI-RADSv2) category 3 lesions using histopathology as a reference.

METHOD AND MATERIALS

This retrospective study included 339 consecutive PI-RADSv2 category 3 lesions that were identified by multiparametric prostate 3T MRI during the January 2009 to December 2018 study period. Transitional and peripheral zone lesions were also included. Histopathologic diagnosis was determined via radical prostatectomy in 232 lesions (68.4%), and by MRI-guided biopsy in 107 lesions (31.6%). CSC was defined as a Gleason score equal to or greater than 3+4. Imaging parameters, quantitative measurement, and PI-RADSv2 category were analyzed by an experienced board-certified radiologist. Univariate and multivariate logistic regression analyses were performed to identify factors significantly associated with CSC.

RESULTS

Of the 339 included lesions, 124 (36.6%) were CSC, and 215 (63.4%) were benign or non-CSC. Univariate analysis showed prostate volume ($p=0.005$), prostate specific antigen density ($p=0.049$), UCLA score ($p<0.001$), mean apparent diffusion coefficient (ADC) ($p<0.001$), ADC ratio ($p<0.001$), Ktrans ($p=0.012$), base, mid, and apex levels ($p<0.001$), and index lesions ($p<0.001$) to be significantly associated with CSC. Multivariate analysis revealed prostate volume (logistic regression coefficient [Coef.]=-0.032, 95% confidence interval [CI]: -0.05 to -0.02, $p<0.001$), ADC ratio (Coef.=1.478, 95% CI: 0.83-2.13, $p<0.001$), apex location (Coef.=1.731, 95% CI: 0.57-2.89, $p=0.003$), and index lesions (Coef.=1.755, 95% CI: 1.14-2.37, $p<0.001$) to be independent predictors of CSC. These findings were used to develop a nomogram for assessing the probability of CSC among PI-RADSv2 category 3 lesions as shown in Figure 1.

CONCLUSION

Prostate volume, ADC ratio, apex level, and index lesions were identified as the MRI parameters and quantitative measurement factors that independently predict CSC in PI-RADSv2 category 3 lesions.

CLINICAL RELEVANCE/APPLICATION

MRI parameters and quantitative measurement factors can predict the probability of CSC in PI-RADSv2 category 3 lesions.

SSK10-03 Patients Assigned to PI-RADS Category 4 and Subsequent Targeted Negative Biopsy: How To Deal With?

Wednesday, Dec. 4 10:50AM - 11:00AM Room: N227B

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PURPOSE

To comprehensively characterize patients assigned to MRI category PI-RADS 4 and guide clinical management in the case of negative biopsy.

METHOD AND MATERIALS

This prospectively enrolled, single center cohort study includes 931 consecutive patients after mp-MRI (T2WI,DWI,DCE) at 3T for prostate cancer detection. 193 patients with PI-RADS assessment category 4 and subsequent targeted MRI/US fusion-guided plus systematic 12-core TRUS-guided biopsy as reference standard were finally analyzed. The primary endpoint was prostate cancer (PCa) detection of MRI-subgroups in PI-RADS 4 cases (S1-S3: highly likely clinically significant PCA, overlaying prostatitis, or overlaying stromal hyperplasia). Secondary endpoints were analyses of clinical data and detection of targeted biopsy cores.

RESULTS

PCa detection rate was 62% (119/193) including 48% clinically significant PCa (csPCa; Gleason score >=3+4=7). 95% of the index lesions of MRI-subgroup S1 had PCa, whereas lesions of subgroup S3 had csPCa only in 4%. 7% of the patients targeted biopsy cores missed the csPCa index lesion. PSA density (PSAD) was significantly higher in PCa patients.

CONCLUSION

Small csPCa can reliably be detected with mp-MRI by experienced readers, but can be missed by targeted biopsy alone. Re-biopsy of PI-RADS-4-lesions within subgroup S1 is recommended after negative targeted biopsy. Negatively biopsied PI-RADS-4-lesions within subgroup S3 can be followed-up without early re-biopsy. In uncertain cases PSAD should be considered for biopsy decision.

CLINICAL RELEVANCE/APPLICATION

Re-biopsy of PI-RADS-4-lesions with negative primary biopsy might be adjusted to lesion location, image appearance and PSAD. No all patients need timely re-biopsy.

SSK10-04 Dirty Peripheral Zone in Patients with Suspicious Prostate Cancer: Evaluation with PI-RADS v2 Followed by MRI-Guided Biopsy

Wednesday, Dec. 4 11:00AM - 11:10AM Room: N227B

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PURPOSE

Interpretation of dirty peripheral zone (PZ) using PI-RADS v2 is a challenge because of unclear criteria in the term between 'indistinct' in diffusion-weighted imaging (DWI) score 2 and 'focal' in DWI scores 3-5. We aimed to investigate the detection rates of prostate cancer (PCa) in dirty PZ (dirty group) and to identify any differences between dirty and non-dirty control groups.

METHOD AND MATERIALS

266 patients (dirty group = 139; control group = 127) with suspicious PCa were enrolled in this retrospective study. All patients underwent prebiopsy 3-T MRI and subsequent MRI-guided targeted biopsy and concurrent systemic biopsy. Dirty PZ was defined as >= three lesions of wedge-shaped, ill-defined or linear hypointensity in the PZ on apparent diffusion coefficient (ADC) maps. Biopsy-based definition of clinically significant cancer (CSC) was Gleason score >= 3 + 4. Detection rates of all PCa and CSC were compared between the two groups. Inter-reader agreement for PI-RADS v2 scoring was evaluated.

RESULTS

In 266 patients, detection rates of all PCa were 41.7% for dirty group and 50.4% for control group, respectively (P = 0.157); dirty group had significant lower detection rates of CSC than control group (19.4% versus 33.1%, P = 0.011). In all 326 target lesions (dirty group = 176; control group = 150), detection rates of all PCa were 43.8% for dirty group and 50.7% for control group, respectively (P= 0.222); dirty group had significantly lower detection rates of CSC than control group (21% versus 34.7%, P = 0.0063). Regarding remote lesions from target lesions based on systemic biopsy, detection rates of all PCa and CSC in dirty group versus control group were 18.7% versus 32.8% (P = 0.027) and 26.9% versus 19.1% (P = 0.731), respectively. For PI-RADS v2 score >= 4 or not, a substantial inter-reader agreement was seen for control group (κ = 0.723), while a poor inter-reader agreement was seen for dirty group (κ = 0.063).

CONCLUSION

In patients with suspicious PCa, dirty PZ appears to contain approximately 20% CSCs, with fewer detection rates of CSCs than non-dirty PZ. Furthermore, dirty PZ reveals a poor inter-reader agreement for PI-RADS v2 scoring.

CLINICAL RELEVANCE/APPLICATION

When performing a MRI-guided targeted biopsy, we need a cautious approach for dirty PZ because it may harbor approximately 20% CSCs. However, dirty PZ demonstrates fewer detection rates of CSCs compared with non-dirty PZ.

SSK10-05 Does the PI-RADS Prostate MRI Definition of Sextant Regions Adequately Correspond with Transrectal Ultrasound to Direct Non-Fusion TRUS Biopsy of Suspicious MRI Masses?

Wednesday, Dec. 4 11:10AM - 11:20AM Room: N227B

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PURPOSE

To determine if prostate sextant anatomical nomenclature is consistent between multiparametric MRI (MP-MRI) and transrectal ultrasound (TRUS) biopsy.

METHOD AND MATERIALS

50 patients (age 60.9±7.2 years, prostate volume 52±29cm^3, prostate specific antigen 8.0±4.2 ng/mL) underwent MR-TRUS fusion biopsy. Standard 12-core sextant biopsies were also performed purely under TRUS guidance and the biopsy core locations relative to the MP-MRI were recorded. A radiologist sectioned each MP-MRI into base, mid-gland and apex regions as defined by the Prostate Imaging Reporting and Data System version 2 (PI-RADS). Each TRUS-guided biopsy core location was compared to 3D reconstructions of the MP-MRI sextant regions to determine the length of the biopsy core located within each sector.

RESULTS

590 biopsy cores were analyzed. Only 47% (92/197) of TRUS-cores targeting the base sampled any of the MP-MRI defined base, which was significantly less than TRUS-cores targeting the mid-gland (97%, 192/199) and apical (94%, 182/194) regions (p<0.001). Sampling percentages were not significantly different between right and left-sided TRUS-biopsies of base (p=0.07), mid-

gland (p=0.7) and apical regions (p=0.6). Of the 47% of TRUS-cores targeting the base that did touch the MP-MRI defined base, only 26%±18% of the total core length was within the base region-significantly less than mean total core lengths of mid-gland (59%±24%) and apical (57%±28%) TRUS-targeted cores within their corresponding MP-MRI regions (p<0.001). A subgroup analysis of TRUS-cores targeting the base of prostate revealed fewer TRUS-cores sampling the MP-MRI defined base for prostates with volume greater than 45cm³ (n=24) compared to smaller prostates (n=26): 23%±24% versus 67%±25%, respectively (p<0.001).

CONCLUSION

The PI-RADS MP-MRI definitions of apex, mid-gland and especially base do not match standard TRUS-biopsy, particularly in the base of larger prostates. Results from this study could be used to define more TRUS relevant PI-RADS definitions of prostate sectors on MP-MRI.

CLINICAL RELEVANCE/APPLICATION

These results have implications for TRUS-guided biopsy of MP-MRI prostate lesions without software fusion assistance ("cognitive fusion"), as it may lead to inaccurate targeting.

SSK10-06 Does Compliance with PIRADSv2 Technical Requirements Guarantee Image Quality or Adequacy in Prostate mpMRI Reads? A Multi-Institution Multi-Reader Study

Wednesday, Dec. 4 11:20AM - 11:30AM Room: N227B

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PURPOSE

To determine whether compliance with PIRADSv2 technical requirements is related to perceived image quality during prostate mpMRI read outs.

METHOD AND MATERIALS

62 prostate MRI examinations including T2W and DWI from 62 different institutions acquired within the last 12 months that were consecutively referred to our center were included. 6 readers assessed images as adequate or inadequate for use in PCa detection and assessment in addition to ranking image quality on a 1-5 scale. PIRADSv2 technical requirements were synthesized into sets of 7 and 10 rules for T2W and DWI, respectively. Image compliance was assessed using DICOM metadata. Statistical analysis of survey results and image compliance was performed based on reader quality scoring (Kendall Rank Tau-b) and reader adequate scoring (Wilcoxon test for association) for T2 and DWI quality assessment.

RESULTS

52/62 (83%) T2 and 38/62 (61%) DW images were rated to be adequate by a majority of readers. Reader adequacy scores showed no significant association to any rules or combination of rules. For T2 quality, 10/62 (16%) scored as high quality (score >3) by a majority of readers and 18 studies met all 7 T2 rules. There was a weak correlation (tau-b=0.22) between compliance with PIRADSv2 technical standards and image quality for T2 which was significant(p-value=0.01). Studies following all PI-RADSv2 T2 rules achieved a higher average quality score (median avg score = 3.58 for 7/7 vs. median avg score = 3 for <7/7, p=0.012). There was no significant association for individual T2 rules. For DWI quality, 6/62 (9%) scored as high quality by a majority of readers and 4 studies met all 10 DWI rules. Analysis of DWI quality scores found no relationship with PIRADSv2 compliance.

CONCLUSION

Many prostate mpMRI images are of inadequate quality for clinical use and very few images are of high quality. This is especially true for DWI. Adherence to PIRADSv2 technical requirements doesn't necessarily increase the likelihood of having a qualitatively adequate T2W or DWI for clinical use.

CLINICAL RELEVANCE/APPLICATION

High quality MRIs are needed for PCa screening and accurate targeting in MRI guided biopsies. The PIRADSv2 Minimum Technical Standards are not a sufficient threshold to ensure quality.

SSK10-07 Head-to-Head Comparison of PI-RADS 2 versus PI-RADS 2.1: Moderate Agreement and Slight Changes in Scoring and Cancer Localization

Wednesday, Dec. 4 11:30AM - 11:40AM Room: N227B

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PURPOSE

Our goal was to evaluate the novel scoring system in an intra-lesion comparison to the previous version 2 with respect to scoring variability, cancer detection and usage of the new prostate segments.

METHOD AND MATERIALS

3.0 T-MRI Datasets of 200 patients with MRI/TRUS biopsy (10-core systematic and targeted biopsies) were evaluated in a blinded / randomized setting. Lesions were marked and PI-RADS 2 and PI-RADS 2.1 assessment categories were assigned by one of three experienced radiologists (>5 years of reporting prostate MRI), with at least 6 months between the reading sessions. Tumor location and histopathology results were correlated and detection rates of clinically significant PCa (csPCa; >=Gleason 3+4) were tabulated against the scores for both versions.

RESULTS

214 lesions were identified and compared, 135 (63.1%) in the peripheral zone (PZ), 79 (36.9%) in the transition zone (TZ). There was no significant difference in the median PI-RADS 2 vs. 2.1 score (Wilcoxon signed rank PZ: p=0.8 and TZ: p=0.681). Distribution of PI-RADS-scores and csPCa detection rates for PI-RADS 2 vs 2.1 were: 1: 6 vs. 18 (16.7%/11.1%), 2: 51 vs. 31 (7.8%/12.9%), 3: 28 vs. 35 (17.9%/14.7%), 4: 60 vs. 59 (47.5%/44.1%), 5: 69 vs. 71 (62.3%/62.0%). Cohen's kappa for PI-RADS 2 vs. 2.1 was 0.568 and Cohen's weighted kappa was 0.78. Separated by zones detection rates were (PZ, PI-RADS 2/2.1) 1: 33.3%/22.2%, 2: 10.0%/16.7%, 3: 16.7%/14.3%, 4: 47.2%/47.1% and 5: 65.0%/63.4% and (TZ, PI-RADS 2/2.1) 1: 0.0%/0.0%, 2: 6.5%/10.5%, 3: 20.0%/15.4%, 4: 50.0%/25.0% and 5: 58.6%/60.0%. ROC analysis of the significant cancer detection accuracy revealed an AUC of 0.718 (CI 95% 0.631-0.0.805, PI-RADS 2) and 0.702 (0.613-0.791, PI-RADS 2.1) for peripheral zone lesions and 0.806 (0.706-0.907, PI-RADS 2) and 0.803 (0.702-0.904, PI-RADS 2.1) for transition zone cancers (p>0.05 for both comparisons). The new segments (Left/Right Base PZm) were marked in 5/135 (3.7%) of the PZ lesions.

CONCLUSION

Comparing PI-RADS 2 vs. 2.1 showed slight changes in the overall scoring with more pronounced changes in the lower scores and moderate to good intra-reader agreement between the two versions. ROC-performance remained stable at a high level for both PZ and TZ and the newly added segments are used in few instances.

CLINICAL RELEVANCE/APPLICATION

PI-RADS 2.1 introduces slight changes which should not prevent an immediate application of the new version.

SSK10-08 Diagnosis of Transition Zone Prostate Cancer: Comparison of the Prostate Imaging Reporting and Data System (PI-RADS) Version 2 and Version 2.1

Wednesday, Dec. 4 11:40AM - 11:50AM Room: N227B

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PURPOSE

To address limitations in the Prostate Imaging Reporting and Data System version 2 (PI-RADS v2), including interreader reproducibility and ambiguous assessment criteria for T2-weighted imaging of the transition zone (TZ), the PI-RADS Steering Committee developed an updated version (PI.RADS v2.1) in 2019. This study aimed to compare the diagnostic performance of PI-

RADS v2 and v2.1 for detecting TZ prostate cancer (TZPC) on multiparametric prostate MRI (mpMRI).

METHOD AND MATERIALS

This retrospective study received institutional review board approval. The participants comprised 58 patients with suspected TZPC who were undergoing MRI-ultrasound fusion-guided prostate-targeted biopsy (MRGB: at least two cores per MRI-targeted lesion) for a suspected TZ lesion after 3-T mpMRI, including T2-weighted imaging and diffusion-weighted imaging. The standard of reference was MRGB-derived histopathology. A lesion with Gleason score (GS) >= 7 or with GS = 3 + 3 and tumor size >= 0.5 mL (maximum tumor diameter >= 8 mm) was considered as clinically significant PC (csPC). Two readers independently assigned each TZ lesion with a score of 1-5 for T2WI, a score of 1-5 for DWI, and the overall PI-RADS assessment category according to PI-RADS v2 and v2.1. Diagnostic performance including diagnostic sensitivity, diagnostic specificity, and area under the ROC curve (AUC) were compared between the two methods using the McNemar and Delong tests.

RESULTS

Of the 58 patients, 26 were diagnosed with csPC (GS=3+3, 9; GS=3+4, 9; GS=3+5, 1; GS=4+3, 4; GS=4+4, 3) and 32 with benign lesions. Sensitivity between both methods did not differ (100% vs. 92%, p=0.50). Specificity and accuracy were significantly higher for v2.1 than for v2 (56% vs. 25%, p=0.002 and 72% vs. 59%, p=0.039, respectively). AUC tended to be higher in v2.1 than in v2, but the difference was not significant (0.859 vs. 0.799, p=0.062). In particular, PI-RADS v2.1 led to 10 false-positive results of category 3 in PI-RADS v2 being identified as true-negative results of category 2 in PI-RADS v2.1.

CONCLUSION

These observations suggest that PI-RADS v2.1 appears preferable for evaluating TZ lesions in comparison with PI-RADS v2.

CLINICAL RELEVANCE/APPLICATION

PI-RADS v2.1 is suggested to be a more suitable method for detecting csPC in TZ before prostate biopsy. The revisions of PI-RADS have steadily achieved standardization of qualitative assessment using mpMRI for csPC in the TZ.

SSK10-09 Zoomed EPI versus Conventional EPI DWI in Prostate Imaging: Impact on PIRADS Scoring and Cancer Detection

Wednesday, Dec. 4 11:50AM - 12:00PM Room: N227B

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PURPOSE

Conventional echoplanar (EPI) diffusion-weighted imaging (DWI) is prone to susceptibility artifacts. One possible alternative is zoomed EPI DWI, which has already been shown to reduce distortion artifacts compared to conventional DWI. The aim of this study was to evaluate the impact of zoomed EPI DWI on prostate cancer detection and lesion classification in multiparametric prostate MRI.

METHOD AND MATERIALS

Seventy-two patients (mean age 65 y, age range 46 - 84 y) with suspected prostate cancer who underwent prostate MRI at 3T were included in this retrospective study. Besides T2-weighted and dynamic contrast-enhanced (DCE) sequences, each exam included both conventional EPI DWI and zoomed EPI DWI. All patients had micro-enema before prostate MRI. Lesions were classified according to PIRADS v2. All 72 patients had prostate biopsy (combined systematic prostate biopsy and TRUS-guided prostate biopsy) and 14/72 patients also underwent prostatectomy. The sensitivity and specificity of mpMRI with conventional EPI (mpMRIc) or zoomed EPI DWI mpMRIz) were evaluated and compared using receiver operating characteristic (ROC) analysis, with the histopathological workup as the standard of reference.

RESULTS

75 lesions (in 52 patients) were identified on mpMRI (PIRADS 3 or higher). 32/75 lesions (42.7%) were located in the peripheral zone. Based on mpMRIc, 43/75 lesions (57.3%) were classified as PIRADS 3, 21/75 (28.0%) as PIRADS 4 and 11/75 (14,7%) as PIRADS 5. Based on mpMRIz, 52/75 lesions (69.3%) were rated as PIRADS 3, 14/75 (18.7%) as PIRADS 4 and 9/75 (12.0%) as PIRADS 5. No lesions were detected in 20 patients; in this case, the PIRADS score was set to 2. mpMRIc had a lesion-based sensitivity of 77.8% and a specificity of 93.7%, while mpMRIz DWI had a sensitivity of 55.6% and specificity of 95.2%. The accuracy of mpMRIz was significantly lower when compared to mpMRIc (p = 0.0064).

CONCLUSION

The accuracy of mpMRI with conventional EPI DWI for prostate cancer detection is superior to the accuracy of mpMRI with zoomed EPI DWI. Zoomed EPI DWI cannot be currently recommended for routine clinical prostate examinations.

CLINICAL RELEVANCE/APPLICATION

Our study shows that diffusion restriction in prostate cancer is less pronounced on zoomed EPI DWI when compared to conventional EPI DWI with identical b-values, leading to lower PIRADS scores and lower diagnostic accuracy.

SSK11

Genitourinary (Functional Renal Imaging and Contrast Issues)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: N226

GU

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSK11-01 The Effect of Iodinated Contrast Medium Volume on Post-Contrast Acute Kidney Injury after Contrast-Enhanced CT in 3,450 Patients

Wednesday, Dec. 4 10:30AM - 10:40AM Room: N226

Participants
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PURPOSE

Iodinated contrast medium (CM) is still considered a risk factor for post-contrast acute kidney injury (PC-AKI), particularly in patients with chronic kidney disease and diabetes. However, the impact of the volume of intravenously administered CM has not been evaluated in a large population. The purpose of this work was to determine the association between CM-volume and the incidence of PC-AKI in patients who underwent contrast-enhanced computed tomography (CECT).

METHOD AND MATERIALS

This retrospective study included all patients who underwent CECT between May 2017 and November 2018 in a large academic medical center. All patients with at least one serum creatinine (SCr) value within 7 days before, and at least one SCr value within 24-96 hours after CECT were included. The primary outcome was PC-AKI, defined as >50% or >0.3mg/dL increase in SCr 24-96 hours after CECT. Patient demographics, the 35 most relevant diagnoses (coded according to The International Classification of Diseases 10), SCr, eGFR, and administered CM volume were extracted systematically searching the hospital electronic medical record system using a structured query language (SQL). Univariable and multivariable logistic regression analyses were performed.

RESULTS

In total, 3,450 patients were included. PC-AKI occurred in 207 patients (6.0%). Administered median CM volume was 98 mL (84-124, interquartile) in non PC-AKI, and 100 mL (85-130, interquartile) in PC-AKI. Univariable analyses showed that CM-volume normalized for weight (calculated as iodine dose/body weight) was not associated with PC-AKI (p=0.172). CM volume normalized for eGFR (calculated as iodine dose/eGFR) was associated with PC-AKI (OR 1.12 {1.03-1.21}, P=0.005). Similarly, diabetes mellitus (DM), atrial fibrillation (AF), and history of cerebral infarction were associated with PC-AKI in univariable analyses (all P<0.05). In multivariable models adjusted for age, gender and race, independent associations were found for DM, AF, and history of cerebral infarction (all P<0.05), while CM-volume normalized for eGFR was not independently associated with AKI (P>0.05).

CONCLUSION

In our retrospective cohort of 3,450 patients referred for CECT, the administered CM volume was not independently associated with PC-AKI.

CLINICAL RELEVANCE/APPLICATION

Our study suggests that typical volume of intravenously administered iodinated CM does not have an independent effect on the development of PC-AKI in patients referred for CECT.

SSK11-02 Development of Imaging Biomarkers of Contrast-Induced Nephropathy Using Contrast-Enhanced Ultrasound: An Animal Study

Wednesday, Dec. 4 10:40AM - 10:50AM Room: N226

Participants
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PURPOSE

To investigate imaging biomarkers of contrast induced nephropathy (CIN) using contrast enhanced ultrasound (CEUS)

METHOD AND MATERIALS

CIN model was made by administering indomethacin (10mg/kg), L-NAME (15mg/kg), and iopamidol (1ml/kg) in Spargue-Dawley male rats. After 24 hours, CEUS was performed in CIN rats (n=6) and control rats (n=6) with 12-5 MHz linear probe. Rats were injected with 0.6 ml of Sonovue (Bracco, Milano, Italy) via tail vein using infusion pump at a rate of 300 ml/hr and CEUS was recorded for 5 minutes from contrast agent injection. Image analysis was performed using dedicated software (QLAB, Philips Medical Systems) and peak enhancement (PE), time to peak enhancement (TTP), and acceleration time (AT) was measured and compared between two groups. After CEUS, the rats were sacrificed and blood and kidney tissue were harvested. Blood urea nitrogen (BUN) and creatinine (Cr) were measured to confirm the development of CIN. Cell apoptosis markers was assessed in kidney tissue. Morphological changes of tubular cells were evaluated by transmission electron microscopy (TEM). Statistical analysis was performed using Mann-whitney test and $P<0.05$ was considered as statistically significant.

RESULTS

BUN and Cr was significantly elevated in CIN model (BUN/Cr, 157±41/1.6±0.5 mg/dL) compared to control (15.5±3.3/0.3±0.0 mg/dL, $P<0.001$). Apoptotic maker (Bax/Bcl-2 level) was significantly higher in CIN model compared to control group ($P<0.01$). More cells were stained with cleaved caspase-3 immunohistochemical staining, suggesting more apoptotic cells in CIN model kidney tissue. On TEM, vacuole formation and mitochondrial expansion phenomenon was detected in CIN group. In terms of CEUS parameters, PE was significantly higher in control group (median, 15.9 dB; interquartile range[IQR], 3.6) than CIN group (13.1 dB; IQR, 5.1, $P=0.043$). TTP was significantly shorter in control group (6.9 sec; IQR, 4.0) compared to CIN group (11.8 sec; IQR, 3.9, $P=0.008$). AT was also significantly shorter in control group (2.3 sec; IQR, 1.2) than CIN group (4.2 sec; IQR, 1.9, $P=0.003$).

CONCLUSION

CEUS parameters including PE, TTP and AT can be used as an imaging biomarker of CIN. In the case of CIN, PE was decreased and both TTP and AT was prolonged.

CLINICAL RELEVANCE/APPLICATION

CEUS parameters can be used as a biomarker for the understanding pathophysiology of CIN and the development of prevention strategies of CIN.

SSK11-03 Chemical Exchange Saturation Transfer (CEST) and Magnetization Transfer (MT) Magnetic Resonance Imaging Helps Detect Metabolic and Structural Characteristics in an Animal Model of Renal Fibrosis

Wednesday, Dec. 4 10:50AM - 11:00AM Room: N226

Participants
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PURPOSE

To investigate the value of combined chemical exchange saturation transfer (CEST) and conventional magnetization transfer imaging (MT) in detecting the metabolic and structural characteristics of renal fibrosis in rats with unilateral ureteral obstruction (UUO).

METHOD AND MATERIALS

This prospective study was approved by the Institutional Laboratory Animal Ethics Committee. Thirty-five Sprague-Dawley rats underwent UUO surgery (n = 25) or sham surgery (n = 10). The obstructed and contralateral kidneys were evaluated on days 1, 3, 5 and 7 after surgery as cross-sectional or longitudinal study. After routine MRI, CEST and MT examinations, 18F-fluorodeoxyglucose (FDG) positron emission tomography (PET) was acquired to detect glucose metabolism. Fibrosis was subsequently measured by histologic and Western blot analysis. Pearson correlation analysis was used to compare correlations between asymmetrical magnetization transfer ratio at 1.2 ppm (MTRasym(1.2ppm)) and maximum standard uptake values (SUVmax), and between magnetization transfer ratio (MTR) and a-smooth muscle actin (a-SMA).

RESULTS

MTRasym(1.2ppm) and MTR of the UUO renal cortex and medulla on day 3 and day 7 were significantly different from those of the contralateral kidneys (all $P < .05$). MTRasym(1.2ppm) and MTR of the UUO renal cortex and medulla on day 7 were significantly different from those of the sham-operated kidneys (all $P < .05$). MTRasym(1.2ppm) of UUO kidneys medulla was fairly negative correlated with SUVmax ($r = -0.350$, $P = .021$), and MTR of UUO kidneys medulla was strongly negative correlated with a-SMA ($r = -0.744$, $P < .001$).

CONCLUSION

CEST and MT could provide molecular level metabolic and structural information for comprehensive assessment of renal fibrosis in UUO rats.

CLINICAL RELEVANCE/APPLICATION

In rat models of renal fibrosis, MTRasym(1.2ppm) correlated with SUVmax, and MTR correlated with a-SMA. Extrapolation of these finding from animal models to human subjects suggested that combined chemical exchange saturation transfer (CEST) and conventional magnetization transfer (MT) might potentially provide methods for diagnosis and characterization of renal fibrosis in patients with chronic kidney disease.

SSK11-04 Diagnostic Efficiency of Magnetization Transfer (MT) Technique in Staging of Diabetic Nephropathy

Wednesday, Dec. 4 11:00AM - 11:10AM Room: N226

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

To analyze the diagnostic efficiency of magnetization transfer (MT) technique in staging of diabetic nephropathy (DN).

METHOD AND MATERIALS

48 patients with DN were enrolled as the observation group in this study, and 35 healthy volunteers as the control group. Patients with DN were staged to I-IV according to eGFRs as well as renal function parameters (UAER,Scr,BUN) as a reference standard. All subjects underwent examination on a 3.0T MRI scanner (MAGNETOM Skyra, Siemens Healthcare, Erlangen, Germany) with an 18-channel body phased-array surface coil. A 3D fast low angle shot (FLASH) sequence was scanned for two times to acquire MT data, first time with a MT saturation pulse (MTon) and second time without (MToff). For MT quantification, the magnetization transfer rate (MTR) was calculated using following equation: MTR =(MToff-MTon)×100/MToff. MTR value was measured on the MT map of each subject using the region of interest method. Multiple regions of interest are drawn and averaged in the medullitary region of the upper kidney, renal hilum, and lower pole. The difference of MTR and laboratory examination in each stage were compared using one-way AVNON. The sensitivity and specificity of MTR value in the diagnosis of diabetic nephropathy at different stages were analyzed by ROC curve.

RESULTS

The MTR value of the cortex and medulla were gradually increasing with increase of DN stage ($p<0.05$). After ROC analysis, the MTR values of the renal cortex and medulla had a great preformance for distinguishing healthy control group from observation group, as well as in distinguishing DN VI stage group from other three groups with the area under the curve (AUC) of 0.988 and the sensitivity and specificity of 100.0% and 97.0%. The diagnostic efficiency of MTR values in renal cortex had no difference with AUC of 0.975 with the sensitivity and specificity of 94.1% and 95.4% (Delong's test, Z = 1.696, P = 0.090).

CONCLUSION

The MTR values of the renal cortex medulla have higher diagnostic efficiency in distinguishing the staging of DN, especially in identifying patients with severe diabetic nephropathy.

CLINICAL RELEVANCE/APPLICATION

MT can provide supplementary information for clinical staging about DN.

SSK11-05 Functional MR Imaging Evaluation of Renal Allograft: Role of Blood Oxygen Level Dependent (BOLD) MRI and Diffusion-Weighted (DW) MRI

Wednesday, Dec. 4 11:10AM - 11:20AM Room: N226

Participants
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PURPOSE

To study the role of Blood Oxygen Level Dependent [BOLD] MRI and Diffusion weighted [DW] MRI in evaluation of Renal Allografts and their ability to differentiate normal allografts, acute allograft dysfunction [AAD] and chronic allograft dysfunction[CAD] and also to understand the correlation between R2* & ADC values and clinical / biopsy parameters.

METHOD AND MATERIALS

This prospective case-control study included 50 post renal transplant patients. Patients were segregated into three different categories - Normal allograft, AAD and CAD, based on pre-determined clinical criteria. BOLD MRI and DW MRI studies were

performed. Mean R2* and ADC values were analysed by Pearson correlation and were compared across groups using Kruskal Wallis test. All tests were performed with a two-tailed type-I error rate of P <0.05. A P< 0.05 was considered statistically significant. ROC curves were drawn to evaluate the feasibility of differentiation.

RESULTS

Out of 50 patients, 23 had normal allografts, 16 had acute graft dysfunction and 11 had chronic graft dysfunction. Mean R2* values in cortex and medulla were 24 ± 2 and 26 ±2 in the normal allograft group,18 ± 2 and 15 ± 2 in the AAD group and 41± 4 and 40 ± 5 in the CAD group. Mean ADC values in patients in the cortex and medulla were 2.38 ±0.08 and 2.37 ±0.10 in the normal allograft group, 1.99± 0.11 and 1.92 ±0.16 in the AAD group and 1.69±0.13 and 1.67 ±0.11 in the CAD group. The higher the percentage of interstitial edema and tubular atrophy(as in acute dysfunction), lower are the R2* and ADC values. The higher the percentage of interstitial fibrosis and tubular atrophy(as in chronic graft dysfunction), lower the ADC value and higher the R2* value. R2* values were significantly reduced in cortex and medulla (p value < 0.001) in AAD group.

CONCLUSION

BOLD MRI-based R2* and DW MRI-based ADC values in renal cortex and medulla significantly correlate with renal functions and biopsy findings and are likely to be useful in detection of allograft dysfunction and in differentiation of normal allograft from AAD. The role in differentiation of AAD and CAD was not found to be significant.

CLINICAL RELEVANCE/APPLICATION

BOLD MRI and DW MRI techniques are fast, non-invasive and does not require contrast injection. These functional MRI parameters [R2*and ADC] are therefore likely to emerge as useful additional imaging options for prompt diagnosis of allograft dysfunction in post renal transplant patients.

SSK11-06 Evaluation of Fourier Decomposition MRI for the Assessment of Perfusion Properties of the Human Kidney: Initial Results

Wednesday, Dec. 4 11:20AM - 11:30AM Room: N226

Participants
Alexandra Ljimani, MD, Dusseldorf, Germany (*Presenter*) Nothing to Disclose
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Julia Stabinska, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate Fourier decomposition MRI (FD) in comparison to arterial spin labeling (ASL) for the assessment of renal perfusion properties in healthy subjects and patients with unilateral renal artery stenosis (RAS) (80-90%).

METHOD AND MATERIALS

Fifteen healthy volunteers (mean age 33.0±10.1 years) and five patients with unilateral RAS (mean age 58.4±16.2 years) were examined on a 1.5 T whole-body MR-scanner (Magnetom Avanto, Siemens Healthineers AG) with a non-contrast enhanced dynamic 2D-TrueFISP sequence (TR/TE 2.06/0.89 ms, acquisition time 180 ms/image, 250 images) and FAIR-TrueFisp ASL sequnece (TR/TE 4.0/2.0 ms, TI 1200 ms, 30 averages) in coronal direction. The acquisition time for FD was 1.30 min and ASL 4.16 min, respectively. No ECG or respiratory triggering was used. Image registration algorithm (fMRLung 3.0, Siemens Corporate Research) was performed to compensate the spatial variation of the renal structure. Perfusion parameter maps were calculated for FD and ASL. Perfusion values were determined over the whole organs. Renal perfusion determined by FD and ASL was calculated for healthy subjects and separated for each kidney of the RAS patients. All results were compared using the student t-test.

RESULTS

The average renal perfusion of healthy volunteers was for the right kidney FD 275,4±137,2 ml/100ml/min, ASL 277,2±159,9 ml/100ml/min and for the left kidney FD 278,1±158,1 ml/100ml/min, ASL 319,4±157,2 ml/100ml/min, respectively. There was no significant difference in renal perfusion measured by FD or ASL in healthy volunteers (p>0.05). However, significant difference in side separate renal perfusion could be measured as well by FD as by ASL of patients with unilateral RAS (p<0.05).

CONCLUSION

FD seems to be an appropriate method for rapid measurement of the renal perfusion. Due to the fast acquisition time, the perfusion measurement by FD can easily be attached to any clinical protocol. Renal perfusion measured by FD shows comparable results to the already established ASL method. Alterations of renal perfusion, as unilateral RAS, further can be detected by the new FD method. Further studies are required to determine the clinical value of FD for functional renal imaging.

CLINICAL RELEVANCE/APPLICATION

FD is novel promising approach for rapid assessment of renal perfusion and might improve functional renal MR imaging in future.

SSK11-07 Assessment of Obstructive Renal Injury with Magnetic Resonance Arterial Spin Labeling: An Experimental Study in a Rat of Unilateral Ureteral Obstruction

Wednesday, Dec. 4 11:30AM - 11:40AM Room: N226

Participants
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PURPOSE

To investigate the potential of magnetic resonance arterial spin labeling (ASL) in assessment of obstructive renal injury in a rat model of Unilateral Ureteral Obstruction (UUO).

METHOD AND MATERIALS

This study was approved by the institutional animal care and use committee. UUO was created in each left kidney of 40 rats. Eight rats from the model group (n=40) were scanned at each of the five time points (on days 1, 2, 3, 4, 5 after UUO) and then sacrificed for histological examination. Contralateral kidneys were examined as controls. Another eight rats were examined before the onset of UUO to get the baseline data. Hematoxylin-eosin, Masson and a-smooth muscle actin (a -SMA) staining assays were performed. For quantification of renal blood flow (RBF) from a 3.0T scanner, a combination of flow-alternating inversion-recovery (FAIR) labeling scheme and EPI readout was carried out with following parameters for both global (control) and slice-selective (label) inversion: TR/TE: 3000/35ms; TI: 1200ms; FOV: 60×60mm2; matrix: 76×58; slice thickness: 4mm; NSA: 10. RBF were analyzed and correlated with the histopathological results.

RESULTS

Histopathologic examination revealed renal fibrosis of obstructive renal injury on the side with UUO. RBF with ASL of the obstructive lateral kidney decreased gradually with the prolongation of obstruction. Mean RBF with ASL of the left kidney with days 1, 2, 3, 4, 5 after the UUO were 187.33±31.03, 174.83±24.01, 111.54±30.03, 91.44±29.93, 86.19±22.93 ml/100g/min, respectively, while the baseline data was 292.36±16.54 ml/100g/min. The RBF with day 1 after UUO significantly decreased in comparison to the control ($p < 0.01$). The expression of a-SMA in renal interstitial tissue increased gradually after UUO. RBF with ASL of the obstructive lateral kidney was negatively correlated with the positive expression of a -SMA ($r = -0.72$, $p<0.01$).

CONCLUSION

In this model, obstructive renal injury in the early phase was detected with magnetic resonance ASL; the degree of renal fibrosis was correlated with the degree of decrease in RBF.

CLINICAL RELEVANCE/APPLICATION

ASL may be a new kind of noninvasive technique to show the change of RBF in the process of obstructive renal injury and even other diseases, reflecting pathophysiological changes in early stage.

SSK11-08 Non-invasive Measurements of Circadian Variations in Renal Blood Flow Linked to Urinary Output Parameters

Wednesday, Dec. 4 11:40AM - 11:50AM Room: N226

Participants
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PURPOSE

In humans, numerous processes are influenced by a circadian rhythm. This also applies to the kidneys and recent years has seen a growing interest in this field. The novel MRI tehchniques Phase contrast (PC), Arterial Spin Labelling (ASL) and Blood Oxygen Level Dependent (BOLD) have made it possible to study renal perfusion and oxygenation non-invasively giving a number of advantages such as no risk for contrast induced conditions and short-time repeatability. In this study we studied total and regional renal perfusion and regional renal oxygenation over 24 hours linked to urinary output parameters in healthy volunteers.

METHOD AND MATERIALS

Sixteen healthy volunteers (8 female), mean age 23 years were repeatedly scanned at 3T using a scan protocol including PC, ASL and BOLD sequences every fourth hour for 24 hours. Subjects received a urinary catheter to measure urine output parameters (urine production, excretion of Na+, K+, protein, creatinine and urea) during the study. In each subject, both kidneys were analyzed regarding total renal blood flow, regional (cortex, outer and inner medulla) perfusion and regional oxygenation.

RESULTS

Significant circadian variations were found for total renal blood flow measured by PC MRI with increased flow from noon to midnight and thereafter decreasing flow to the morning hours. For regional renal perfusion measured by ASL no significant circadian variations could be seen although a similar pattern as for total renal blood flow was seen for cortical perfusion. For oxygenation by BOLD, no significant circadian variations could be seen. For urinary parameters significant circadian variations could be seen for urine production, excretion of Na+, K+, Creatinine and Urea, all of them showing decreasing values during the night hours. Urinary protein excretion also showed decreasing values during the night but this was not found to be statistically significant.

CONCLUSION

In this study we were able to detect circadian variations in total renal blood flow using non-invasive PC MRI. The circadian renal blood flow pattern correlated well to the circadian pattern of a number of urinary parameters also measured. For regional renal perfusion and oxygenation, no significant circadian variations could be detected.

CLINICAL RELEVANCE/APPLICATION

Knowledge of circadian variations of renal blood flow could be important for future studies/clinical applications dealing with renal blood flow alterations.

SSK11-09 Optimizing Renal CT Angiography Using 80kV and Iterative Reconstruction: Reducing Radiation Dose and Reducing Contrast Agent with Improving Image Quality

Wednesday, Dec. 4 11:50AM - 12:00PM Room: N226

Participants
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PURPOSE

To explore the application of using 80 kV and iterative reconstruction in reducing radiation dose and reducing contrast agent with improving image quality to optimize renal CT angiography.

METHOD AND MATERIALS

Seventy patients for renal CT angiography were prospectively collected and randomly divided into group A and group B. Group A used 120kV tube voltage and 600mgI/kg contrast agent, and was reconstructed with 40%ASIR. Group B used 80kV tube voltage and 350mgI/kg contrast agent, and was reconstructed with ASIR-V from 40% to 100% with 10% interval. The CT values and standard deviation (SD) of right renal artery, left renal artery were measured to calculate the signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) for renal arteries. The image quality was subjectively scored by two experienced radiologists blindly using a 5-point system. The effective dose (ED) and total contrast agent was calculated.

RESULTS

There was no significant difference in population characteristics between the two groups ($p>0.05$). Group B had significantly lower contrast agent (21.74±3.08g) (reduced by 43.0%) and effective radiation dose(2.10±0.20mSv) (reduced by 67.1%) than those in group A (38.11±3.74g and 6.39±1.76mSv) ($p<0.001$). The CT values of renal arteries in group B with any reconstructions were slightly higher than those in group A, but the difference was not statistically significant ($P>0.05$). Compared with 40%ASIR reconstruction in group A, the SD values of renal arteries with 60%ASIR-V to 100%ASIR-V in group B were significantly lower ($p<0.001$), and the SNR values with 60%ASIR-V to 100%ASIR-V and the CNR values with 70%ASIR-V to 100%ASIR-V in group B were significantly higher($P < 0.001$). The subjective scores on image quality by two radiologists had excellent agreement (Kappa>0.75,$P<0.05$), and subjective scores with 50%ASIR-V to 100%ASIR-V in group B were significantly higher than 40%ASIR in group A, and 70%ASIR-V provided the highest subjective score.

CONCLUSION

In renal CT angiography, using 80 kV and iterative reconstruction can improve image quality and significantly reduce radiation dose and contrast agent at the same time.

CLINICAL RELEVANCE/APPLICATION

Using 80kV and iterative reconstruction can provide better image quality and lower radiation dose and contrast agent for renal CT angiography, which help to optimize the scanning protocol of renal CT angiography.

SSK12

Health Service, Policy and Research (Value, Outcomes, and Risk)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S104A

HP RS SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Hanna M. Zafar, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose
K. Pallav Kolli, MD, San Francisco, CA (*Moderator*) Investor, Adient Medical Inc

Sub-Events

SSK12-01 Patient-Reported Financial Toxicity in Multiple Sclerosis: Predictors and Association with Neuroimaging and Medication Non-Adherence

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S104A

Participants
Gelareh Sadigh, MD, Atlanta, GA (*Presenter*) Nothing to Disclose
Neil Lava, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Abstract Co-Author*) Editor, Journal of the American College of Radiology; Support, Harvey L. Neiman Health Policy Institute; In-kind support, Reed Elsevier;

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PURPOSE

To assess health-related financial toxicity in multiple sclerosis (MS) patients and its impact on financial coping strategies and care non-adherence.

METHOD AND MATERIALS

Adult patients with new or established diagnoses of MS visiting an outpatient neurology clinic were prospectively recruited. Financial toxicity at study entry was measured using the Comprehensive Score for Financial Toxicity Patient-Reported Outcome Measure (COST) score (range 0-44, the lower the COST score, the worse the financial toxicity). Linear regression identified independent sociodemographic, clinical, and insurance correlates of financial toxicity. Financial coping strategies and care non-adherence within 3 months prior to study entry were assessed in those with established diagnoses.

RESULTS

A total of 242 patients were recruited (44yo [95%CI,42-45]; 77% female; 47% White), median months from diagnosis, 62 (IQR,28-120). 94% have established diagnoses; 87% with relapsing remitting MS. The mean Expanded Disability Status Scale score among participants was 1.8 (95%CI,1.5-2.1) corresponding to the ability to walk without any aid. Mean enrollee COST score was 17 (95%CI,16-18.5), with 21% having at least one emergency department visit or inpatient hospitalization in the 3 months prior to entry. In response to financial burden, 62% used at least one financial coping strategy (see fig. 1). Medication and imaging non-adherence were reported by 30% and 13% of patients. In multivariable analyses, the key correlate of lower financial toxicity (i.e. higher COST score) was higher financial self-efficacy (e.g., having more confidence in being able to manage money to last for a lifetime) (coefficient 1.27 [95%CI, 1.02-1.52]; $p<0.001$). COST scores correlated with health-related quality of life, financial coping strategy use and care non-adherence ($p<0.001$).

CONCLUSION

Patients with MS are at high risk for financial toxicity, which impacts quality of life, and results in adopting financial coping strategies and care non-adherence.

CLINICAL RELEVANCE/APPLICATION

Identifying MS patients at risk for financial toxicity will help target interventions to cope with financial burden, and may improve both quality of life and treatment adherence.

SSK12-02 Financial Burden of Advanced Imaging in Radiology (FAIR Study)

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S104A

Participants
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Diana M. Gomez-Hassan, MD, PhD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Imaging encounters suffer from lack of price transparency and surprise billing for patient cost share, exposing vulnerable individuals to financial harm. Financial burden contributes to medical debt and care nonadherence. Despite the need, financial fragility screening is heterogeneously implemented. We assess acceptability of financial screening and estimate financial burden among those receiving advanced imaging (CT/MRI) in outpatient imaging settings at a single institution.

METHOD AND MATERIALS

We conducted a cross sectional anonymous survey of those >=22 years receiving advanced imaging at outpatient imaging clinics (n=5). To assess financial burden, we queried imaging out of pocket cost (OOP) worry, use of financial coping strategies and care nonadherence due to medical cost. Logistic regression assessed effects of demographics, chronic disease, pretest OOP notification recall and imaging OOP worry on financial coping and care nonadherence. We included an interaction term for recall and worry.

RESULTS

97% of surveys from consecutive patients had at least one question answered (Fig. 1). 66% of respondents were comfortable answering items about financial well-being in imaging clinic. 18% recalled being notified of the OOP prior to exam. 35% used at least one financial coping strategy; key correlates: test OOP worry (OR=5.2, 95%CI=2.5-11.0), worry x recall, (OR=4.7, 95%CI=1.1-19.8) income >$50K (OR=0.3, 95%CI=0.1-0.7), any chronic disease (OR=3.7, 95%CI=1.8-7.5). 10% reported at least one nonadherence event; correlates: test OOP worry (OR=9.6, 95%CI=3.3-28) and ACA insurance (OR=19.1, 95%CI=1.2-297).

CONCLUSION

Financial coping strategies among those who responded to financial screening is common; care non-adherence, less so. Psychological worry about OOP highly correlated with both outcomes, suggesting that screening for financial worry may identify patients at high risk for using savings or assuming debt for care. Further, OOP recall magnifies the effect of worry on financial coping. A large minority declined to answer financial questions, suggesting that screening in the imaging outpatient setting will incompletely capture financial burden in this population.

CLINICAL RELEVANCE/APPLICATION

Outpatient imaging represents an appropriate venue for implementing financial screening and referral of financially vulnerable individuals. Price transparency interventions may intensify OOP worry.

SSK12-03 Comparative Effectiveness of Active Surveillance for Localized Prostate Tumors With versus Without MRI: A Decision Analysis

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S104A

Participants
Stella Kang, MD,MSc, New York, NY (*Abstract Co-Author*) Royalties, Wolters Kluwer nv
Rahul D. Mali, MBBS,MPH, New York, NY (*Presenter*) Nothing to Disclose
Stacy Loeb, MD,MSc, New York, NY (*Abstract Co-Author*) Consultant, Eli Lilly and Company; Consultant, General Electric Company; Consultant, Bayer AG; Consultant, Lumenis Ltd; Equity, Gilead Sciences, Inc; Travel support, sanofi-aventis Group

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PURPOSE

To evaluate different active surveillance (AS) strategies for prostate tumors with versus without MRI by comparing quality-adjusted life expectancy (QALE) and life expectancy (LE), given non-uniform practice of surveillance.

METHOD AND MATERIALS

We constructed a state-transition cohort model to compare QALE and LE of surveillance strategies in hypothetical men aged 60 years with low-grade prostate cancer. Strategies included: 1) watchful waiting (no testing; treat symptomatic disease only); 2) PSA every 6 months and annual biopsy; 3) requisite annual MRI, annual biopsy regardless of MRI result; 4) requisite annual MRI and annual biopsy only if PI-RADS score >=3; 5) requisite annual MRI and biopsy only if PI-RADS score >=4; 6) annual MRI only for rising PSA, and annual biopsy only if PI-RADS score >=3; and 7) PSA every 6 months, MRI according to the PRIAS protocol (at years 1, 3, 7, 10, and then every 5 years), and biopsy only if PI-RADS score >=4. We incorporated age, comorbidity, misclassification of cancer grade, cancer progression risks, and ending surveillance at age 75. Sensitivity analysis assessed the impact of varying parameter values on results.

RESULTS

In 60-year-old men, QALE and LE were the highest and essentially equivalent in two surveillance strategies: annual MRI with biopsy of lesions with PI-RADS >=4, and annual MRI with annual biopsy regardless of MRI results (both with 22.10 quality-adjusted life years; 23.05 life years). These strategies using annual MRI yielded a benefit compared with no MRI (i.e. PSA every 6 months and annual biopsy) in terms of both QALE (+12 days) and LE (+7 days). AS extended LE compared with watchful waiting at all ages. However, AS yielded higher QALE than watchful waiting only until age 62. This age threshold was driven by increasing rates and severity of treatment complications with age, and less frequent MRI using the PRIAS schedule as well as a higher PI-RADS biopsy threshold did not extend QALE over watchful waiting.

CONCLUSION

AS with annual MRI and biopsy of only lesions with PI-RADS score >=4 yields essentially equivalent QALE and LE compared with annual MRI and biopsy in men with low-grade prostate tumors, allowing for preference-based decisions.

CLINICAL RELEVANCE/APPLICATION

In active surveillance of prostate tumors, annual MRI with a biopsy threshold of PI-RADS 4 provides similar effectiveness than more frequent biopsy, and greater effectiveness than surveillance without MRI.

SSK12-04 PET/CT Utilization of Non-Small Cell Lung Cancer at Diagnosis: Does it Impact Survival?

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S104A

Participants
Rustain L. Morgan, MD, MS, Aurora, CO (*Presenter*) Nothing to Disclose
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Cathy Bradley, PhD, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The type of imaging utilized to stage a patient with newly diagnosed non-small cell lung cancer impacts their cancer specific survival.

METHOD AND MATERIALS

The linked Surveillance, Epidemiology, and End Results (SEER)-Medicare database between 2007 and 2015 was used to compare patient characteristics and hospital region by initial imaging modality used for patients with non-small cell lung cancer. The primary outcome was 3-year cancer specific survival (CSS). Cox proportional hazard models adjusted for imaging, age, sex, region, education, race, cancer stage, and treatment, which were examined by backward elimination. We also explored how initial imaging use varied by patient characteristics and hospital region.

RESULTS

Thirty-six thousand, four hundred seventy one patients with newly diagnosed non-small cell lung cancer underwent initial diagnostic imaging. Of those, 24.4% (n=8,884) received CT alone as their initial imaging modality, 2.4% (n=887) underwent only PET imaging, and 71.9% (n=26,700) of the patients' initial imaging included both a PET and CT exam. In the adjusted survival models compared by intial imaging modality, patients who underwent a PET exam with or without CT had better cancer specific survival than CT alone, (hazard ratio [HR] 0.66; 95% CI 0.638-0.682; P =<0.001) (HR 0.611 95% CI 0.55-0.678; P = <0.001) respectively. The overall survival was also significantly improved with PET and diagnostic CT or PET alone (hazard ratio [HR] 0.671; 95% CI 0.651-0.692; P =<0.001) and (hazard ratio [HR] 0.604; 95% CI 0.551-0.662; P =<0.001) respectively, when compared to patients who only received CT imaging.

CONCLUSION

Among patients with non-small cell lung cancer, initial staging that included PET imaging was associated with improved three-year cancer specific and overall survival compared to initial staging with CT alone.

CLINICAL RELEVANCE/APPLICATION

Utilization of PET/CT imaging at diagnosis of non-small cell lung cancer improves survival, however approximately a quarter of patients are not receiving this imaging.

SSK12-05 Are We in Agreement? Outcomes of Pathology Results Discordant with Imaging Findings After CT-Guided Biopsy

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S104A

Participants
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Sujithraj Dommaraju, MBBS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Bettina Siewert, MD, Boston, MA (*Abstract Co-Author*) Editor, Wolters Kluwer nv; Reviewer, Wolters Kluwer nv;
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Olga R. Brook, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess the value of radiology review meetings (RRMs) evaluating concordance between pathology results and imaging findings of CT-guided biopsy.

METHOD AND MATERIALS

In this HIPAA-compliant, IRB retrospective review, 926 consecutive unique body CT-guided biopsies performed between 01/15-12/17 were included. Weekly RRM was implemented in July 2016. 453 patients were reviewed in the RRM (prospective group), and results were classified as concordant or discordant with appropriate recommendations generated by radiology team. 473 patients not reviewed at RRMs were retrospectively classified by an abdominal imaging clinical fellow (retrospective group). Times to re-intervention (TRI) and times to definitive diagnosis (TDD) were obtained for discordant cases: 49/453 (11%) in prospective (n=2, lost to follow-up) and 55/473 (12%) in retrospective group (n=5, lost to follow-up).

RESULTS

CT-guided biopsy yielded a concordant result in 89% (822/926) of the cases. Re-intervention with biopsy and surgery yielded a shorter time to the definitive diagnosis compared to clinical and imaging follow up ($p<0.001$). When radiologists evaluated concordance between pathology and imaging findings and recommended re-biopsy for discordant cases, the number of biopsies performed as re-intervention is increased (50%, 11/22 vs. 13%, 4/31; $p=0.005$). Referring physicians tend to follow recommendations for re-biopsy provided by radiologists, while when no recommendations are provided by radiologists they tend to choose imaging follow-up or surgery instead (64%, 30/47 vs. 38%, 19/50; $p=0.011$). Unfortunately, 49% (23/47) of the cases were discussed by the referring physician with the patient before review at weekly RRM by radiologist. This may explain why even in the prospective group clinicians did not always pursue re-biopsy even if recommended by radiologist.

CONCLUSION

Radiologists frequently recommend re-biopsy for cases with discordant findings on imaging versus pathology. In cases without radiology input, clinicians tend toward clinical and imaging follow-up instead of re-biopsy. Re-intervention with biopsy or surgery results in shorter time to diagnosis. This provides yet another reason for radiologists to be more involved in patient care.

CLINICAL RELEVANCE/APPLICATION

Radiologist's participation in pathology results review after CT-guided biopsy results in higher rate of re-biopsy for discordant cases and thus shortens average time to diagnosis.

SSK12-06 Assessing Cancer Yield and Compliance with 6-, 12-, (18-) and 24-month Follow-Up for BI-RADS 3 Lesions at Recall from Screening for Women in the National Mammography Database (NMD)

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S104A

Participants
Wendie A. Berg, MD, PhD, Gibsonia, PA (*Presenter*) Nothing to Disclose
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PURPOSE

Probably benign, BI-RADS 3 (BR3) assessments are reserved for specific imaging findings known to have <= 2% likelihood of malignancy. We assessed compliance, outcome and cancer yield after BR3 assessments at 6-, 12-, (18-) and 24-month follow-up.

METHOD AND MATERIALS

This retrospective cohort HIPAA-compliant study included all women recalled from screening mammography followed by BR3 assessment at additional evaluation from 2009 to 2018, from 471 NMD facilities. Only the first BI-RADS 3 occurrences were analyzed for women >= age 25 with no reported personal history of breast cancer with biopsy or >= 2-yr imaging follow-up, or downgraded to BI-RADS 1 or 2 with >= 1-yr follow-up. Outcomes were analyzed: "6-mo" visit is defined as 91-270 days after BR3 assessment; 12-mo, 271-460 days; 18-mo, 461-640 days; 24-mo, 641-820 days. Cancer yield (CY) is calculated as number of breast cancers per number of women. PPV3 is probability of breast cancer per number of biopsies performed.

RESULTS

In 65,908 women (median age 55 years; range 25-90), results from 204,439 mammograms were included. Overall biopsy rate of BR3 lesions was 10.06% (6633/65,908) with CY of 1.34% (885/65,908, 95%CI 1.25 to 1.43%), PPV3 13.3%. 612 (0.9%) women had biopsy at the initial recall/BR3 visit yielding 37 cancers. 2622 women (4.0%) had follow-up at <= 90 days: 503 (19.2%) biopsied, CY 1.41% (37/2622). 44,326 (67.3%) women had follow-up at 6-mon: 4301 (9.7%) biopsied, 653 (15.2%) cancers, CY 1.47%. 29,688 (45.0%) women had follow-up at 12-mo: 1620 (5.5%) biopsied, 301 (18.6%) cancers, CY 1.01%. 7584 (11.5%) women had follow-up at 18-mo: 417 (5.5%) biopsied, 85 (20.4%) cancers, CY 1.12%. 6948 (10.5%) women had follow-up at 24-mo: 273 (3.9%) biopsied, 46 (16.8%) cancers, CY 0.66%. CY for 21,729 cases downgraded by 6-mo and seen again by 12-mo = 0.24%. CY for 22,629 cases downgraded by 1 yr and seen again by 24-mo = 0.26% ($p < 0.0001$ for all BR3 CY comparisons).

CONCLUSION

Compliance with 6-month follow-up was high at 67.2%. Overall CY for probably benign findings was 1.34%, with CY at each follow-up below accepted limit of 2%.

CLINICAL RELEVANCE/APPLICATION

In the NMD, use of BR3 assessments is appropriate, with < 2% overall cancer yield. 653/885 (73.8%) cancers were diagnosed at or before 6-mo visit. Continued imaging surveillance of BR3 is supported by malignancy rates > those of BR1 or -2 at each follow-up.

SSK12-07 Cost-Effectiveness of MRI-Guided Thrombolysis for Stroke with Unknown Time of Onset

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S104A

Awards
Trainee Research Prize - Resident

Participants
Wolfgang G. Kunz, MD, Munich, Germany (*Presenter*) Grant, Medtronic plc
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Matthias P. Fabritius, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

In acute ischemic stroke, about 25% of patients present with unknown time of onset, which is a contraindication for intravenous thrombolysis (IVT) treatment. Among this patient group, MRI has been shown to identify patients with salvageable brain tissue. The recent WAKE-UP trial demonstrated a clinical benefit of such MRI-guided IVT administration over best supportive care (BSC). We aimed to determine the cost-effectiveness of this management strategy.

METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with MRI-guided IVT or BSC (Figure 1). The analysis was performed in a United States setting from a societal perspective. Input parameters for the model were based on most recent and best available evidence (Table 1), including outcome data from the WAKE-UP trial (Figure 2). Starting age was set to 65 years according to the median age in the trial. Probabilistic sensitivity analyses (PSA) were performed using 10,000 Monte Carlo simulations to estimate uncertainty. Incremental costs (IC), incremental effectiveness (IE), and incremental cost-effectiveness ratios (ICER) were derived. Cost-effectiveness acceptability rates were determined for varying willingness-to-pay (WTP) thresholds.

RESULTS

Based on outcome data of 503 randomized patients, the base-case analysis identified MRI-guided IVT as the strategy that resulted in incremental QALYs and cost-savings over the projected lifetime compared to BSC (IC: -$21,481; IE: +0.62 QALYs; ICER: IVT dominant). Adjusting for all input parameter uncertainty in PSA, MRI-guided IVT was the preferred strategy with acceptability rates of >99% at all WTP thresholds ranging from $0 to $150,000 per QALY (Figure 3). Simulations led to 99.47% dominant/cost-saving iterations (Figure 4).

CONCLUSION

MRI-guided IVT is projected to provide long-term clinical benefit whilst also leading to long-term cost-savings in the management of stroke patients with unknown time of onset.

CLINICAL RELEVANCE/APPLICATION

Providing MRI-guided IVT in stroke with unknown onset requires dedicated infrastructure. Based on the projected health and cost benefits, investments to support such an infrastructure are justified.

SSK12-08 Cost-Effectiveness Analysis of Local Ablation and Surgery for Liver Metastases of Oligometastatic Colorectal Cancer

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S104A

Participants
Matthias F. Froelich, MD, Mannheim, Germany (*Presenter*) Consultant, Smart Reporting GmbH
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Wolfgang G. Kunz, MD, Munich, Germany (*Abstract Co-Author*) Grant, Medtronic plc

PURPOSE

To evaluate the cost-effectiveness of local ablative and surgical approaches in the treatment of liver metastases of oligometastatic colorectal cancer (omCRC).

METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with the treatment strategies radiofrequency ablation (RFA), microwave ablation (MWA), and surgical resection. A United States healthcare perspective was applied. Model input parameters were based on best available and most recent evidence (Table 1). The starting age was set to 73 years. Probabilistic sensitivity analyses (PSA) were performed using 10,000 Monte Carlo simulations to estimate model uncertainty. The percentage of cost-effective iterations was determined for different willingness-to-pay (WTP) thresholds.

RESULTS

The base-case analysis showed that surgery lead to higher costs ($49,447.86 vs. $42,467.97 vs. $42,245.78) while providing best outcomes compared to RFA and MWA (8.12 vs. 6.97 vs. 8.03 QALYs). In PSA, MWA was the most cost-effective strategy for all WTP thresholds below $80,000 per QALY. For increasing WTP thresholds, surgery showed comparable yet increasingly higher percentages of cost-effective iterations compared to MWA. Local ablation with RFA was dominated by either MWA or surgery at all

WTP thresholds.

CONCLUSION

In omCRC patients with liver metastases, treatment with MWA and surgery are estimated to provide comparable efficacy. MWA was identified as the most cost-effective strategy in intermediate resource settings and should be considered as an alternative to surgery in high resource settings.

CLINICAL RELEVANCE/APPLICATION

In case patients are eligible for local treatment as well as surgery, MWA and surgery can be offered as comparable treatment options to omCRC patients with liver metastases.

SSK12-09 Early Admission and Mortality Rates for Common Outpatient Interventional Radiology Procedures

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S104A

Participants
Ammar Sarwar, MD, Boston, MA (*Presenter*) Stockholder, Agile Devices, Inc; Scientific Advisory Board, Agile Devices, Inc; Grant Support, Sirtex Medical Inc
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Max P. Rosen, MD,MPH, Weston, MA (*Abstract Co-Author*) Stockholder, Everest Scientific Inc Consultant, PAREXEL International Corporation Stockholder, Cynvenio Biosystems, Inc Medical Advisory Board, Cynvenio Biosystems, Inc
Sharina Person, PhD, Worcester, MA (*Abstract Co-Author*) Nothing to Disclose
Arlene Ash, PhD, Worcester, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Patient outcomes for outpatient interventional radiology (IR) procedures have been reported for single institutions, but not more broadly. In this study, we use national Medicare data to evaluate early admission and mortality rates after common outpatient IR procedures.

METHOD AND MATERIALS

Working with the Center for Medicare and Medicaid (CMS) Chronic Conditions Data Warehouse (CCW) and Research Data Assistance Center, we identified and obtained all outpatient claims for interventional radiology (IR) procedures and determined 7- and 30-day readmission and crude mortality rates, for the most common IR procedures performed in 2012. One hundred percent of the national outpatient Medicare claims files were obtained from CMS. The frequency of procedures, 7 and 30-day admission rates; and 7 and 30-day crude mortality rates were determined.

RESULTS

In 2012, dialysis fistulagram and port placement (N=114,208 and 92,313) were the most commonly performed outpatient interventional radiology procedures amongst the Medicare population; they were performed nearly three times as frequently as the third most common procedure, liver biopsy (N=38,332). TIPS had the highest 7- and 30-day admission rates (14% and 42%), followed by percutaneous biliary drainage (13% and 40%). Percutaneous gastrostomy and transhepatic cholangiogram had the highest 7-day mortality rate (2% each). Three procedures had at least 10% 30-day mortality (TIPS 10%, percutaneous cholangiogram 11%, percutaneous biliary drainage 12%).

CONCLUSION

Early mortality and admission are moderately common following outpatient IR procedures. Predictive models that account for patient risk could be useful both 1) to account for differences among labs in the difficulty of their patients, and 2) to flag higher risk patients undergoing higher risk IR procedures as potential candidates for in-hospital care.

CLINICAL RELEVANCE/APPLICATION

With increasing interest in Office-Based Labs in IR practice, early admission and mortality rates should be explored as potential quality indicators for outpatient IR procedures.

SSK13

Molecular Imaging (General Subspecialties)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S505AB

MI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Kathryn A. Morton, MD, Salt Lake City, UT (*Moderator*) Nothing to Disclose

Sub-Events

SSK13-01 To Examine the Potential Role of 2-fluorodeoxyglucose Positron Emission Tomography Integrated with CT (FDG-PET/CT) in Monitoring IFIs and Therapy Decision-Making

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S505AB

Participants
Sikandar M. Shaikh, DMRD, Hyderabad, India (*Presenter*) Nothing to Disclose

PURPOSE

Invasive fungal infections (IFIs) are most common in immunosuppressed patients and can be life-threatening. Inadequate or no treatment is associated with high morbidity and mortality. We examined the potential role of 2-fluorodeoxyglucose positron emission tomography integrated with CT (FDG-PET/CT) in monitoring IFIs and therapy decision-making.We also evaluated the role of baseline metabolic parameters in predicting the metabolic response.

METHOD AND MATERIALS

All patients between April 2016 and March 2019 who were diagnosed with IFIs, and underwent treatment with antifungal drugs, and who also underwent FDG-PET/CT at baseline and at one or more timepoints during treatment were retrospectively included. The patient data was reviwed for pathology, microbiology, and laboratory findings. All FDG-PET/CT scans were performed according to standardized protocols. For each scan, the global total lesion glycolysis (TLG) and metabolic volume (MV), highest maximum standardized uptake value (SUVmax), and peak standardized uptake value (SUVpeak) were determined. The role of FDG-PET/CT on monitoring antifungal therapy was assessed by looking at the clinical decision made as result of the scan. Furthermore, the added value of the baseline metabolic parameters in predicting metabolic response to the antifungal treatment was evaluated.

RESULTS

Twenty-eight patients who underwent total 98 FDG-PET/CT scans were included with a mean age of 43?±?22 years. FDG-PET/CT results altered management in 14 out of the 28 patients (50%). At the final FDG-PET/CT scan, 19 (68%) had a complete metabolic response (CMR), seven a partial response and two patients were defined as having progressive disease. Using receiver operative analysis, the cut-off value, sensitivity, specificity, and significance for the baseline TLG and MV to discriminate patients with CMR were 160, 94%, 100%, p? **CONCLUSION**

FDG-PET/CT is useful in the monitoring of IFIs resulting in management therapy change in half of the patients. Baseline TLG and MV were found to be able to predict the metabolic response to antifungal treatment.

CLINICAL RELEVANCE/APPLICATION

FDG PET-CT has potential role in the evalaution of Fungal Infections and impact on treatment.

SSK13-02 Glycosaminoglycan Chemical Exchange Saturation Transfer Imaging of the Talocrural Joint in Patients with Osteochondral Lesions and Healthy Volunteers

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S505AB

Participants
Daniel B. Abrar, MD, Dusseldorf, Germany (*Presenter*) Nothing to Disclose
Miriam Frenken, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Anja Lutz, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
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Christoph Schleich, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To optimize a glycosaminoglycan chemical exchange saturation transfer (gagCEST) protocol for imaging of glycosaminoglycans (GAG) at 3T and to compare gagCEST values between patients with osteochondral lesions and healthy volunteers (HV).

METHOD AND MATERIALS

We used Bloch-McConnel simulations for optimization of the gagCEST protocol. Therefore, the following T1 and T2 relaxation times

We used Bloch-McConnel simulations for optimization of the gagCEST protocol. Therefore, the following T1 and T2 relaxation times of cartilage at 3T were used: T1 = 1.2 s, T2 = 0.039 s.11 HV (age 24 ± 5 years) and 4 patients (age 32 ± 9 years) with ostheochondral lesions were examined with the optimized gagCEST protocol. In addition, T1 and T2 values were determined to evaluate, if the relaxation times used in the simulation were accurate. Sequence parameters of the gagCEST sequence were: FOV = 160 x 160 mm², slice thickness = 5 mm, TE/TR = 3.5ms/7.2ms. 25 CEST images with a frequency offset between -3 ppm and 3 ppm and one S0 image were recorded. An acquisition of an additional water saturation shift referencing sequence was applied in order to correct remaining magnetic field inhomogeneities.

RESULTS

The optimization with the Bloch-McConnel simulations showed an ideal B1 amplitude of 0.8 µT and a pulse and interpulse duration of 300 ms. We found a mean T1 time of (0.88 ± 0.13) s and a mean T2 time of (0.033 ± 0.005) s. These values significantly differed from values used in simulation. Nevertheless, further simulations revealed the same optimal pulse sequence parameters for the CEST sequence. HVs showed a significant higher gagCEST effect compared to patients (HV: MTRasym = (1.40 ± 0.71) %; patients: MTRasym = (0.05 ± 0.28) %; p-value < 0.01).

CONCLUSION

The proposed gagCEST protocol showed good performance and could distinguish between HV and patients with ostheochondral lesions.

CLINICAL RELEVANCE/APPLICATION

Our proposed gagCEST protocol allows for further molecular investigation of cartilage at the talocrural joint in different clinical settings and larger studies.

SSK13-03 Insect Larvae in Medical Imaging: New Screening System for Gut Inflammatory Compounds Using CT, MR, and PET

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S505AB

Participants
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PURPOSE

This study aims to propose and validate CT, MR and PET imaging features of gut inflammation in the insect Manduca sexta. The Epithelial structure and intestinal innate immune response in M.sexta are functionally and mechanistically comparable to humans, making M.sexta a valuable model to study the innate part of gut inflammation. This, together with the cost-effective raring and the large, cylindrical gut of M.sexta larvae will provide a quick and easy system to screen for new effectors and inhibitors of gut inflammation for pharmaceutical purposes.

METHOD AND MATERIALS

We established contrast-enhanced CT and MR as well as FDG-PET imaging, methods firstly applied to insects, to detect gut inflammation. Bacillus thuringiensis infected animals(n=19) were used as a positive control and compared to healthy animals(n=20). The gut wall of Bt and control animals were analyzed for histopathologic evidence of inflammation via cryosections. Then, ROC curves of contrast-enhanced MR and CT gut wall thickness, proportional T1 signal and signal attenuation of the gut wall, as well as the anterior SUV Max were determined. Next, we used CT, MR, and PET to investigate if animals fed with 5% dextran sulfate sodium(n=14) showed signs of gut inflammation.

RESULTS

Control and Bt-infected animals differed significantly in each diagnostic finding. All diagnostic features were excellent or good with ROC-areas of 0.96-0.8 and correlated to each other. We propose contrast-enhanced CT gut wall thickness(sen. 92% and spec. of 100%) and MRI gut wall thickness(sen. and spec. of 90%) as key diagnostic findings of gut inflammation in M.sexta. Cryosections of animals fed with Bt showed a swollen and fragmented gut wall. Animals fed with DSS showed only significant differences in 3 of 5 features suggesting only a moderate gut inflammation. In accordance with this, Bt-fed animals showed a significantly lower survival compared to DSS fed animals(p=0.0002). Both groups showed a significantly lower survival(p=0.0001) compared to the control group. Finally, we validated the empirical CT and MRI resolution using gut phantoms and µCT.

CONCLUSION

The M.sexta screening system allows fast screening for new effectors and inhibitors of gut inflammation and could drastically reduce vertebrate animal usage in preclinical studies.

CLINICAL RELEVANCE/APPLICATION

The investigation of inhibitors of gut inflammation helps to find new therapies for inflammatory bowel diseases.

SSK13-04 Pharmacological Activation of Human Brown Adipose Tissue is Less Effective than Cold Exposure

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S505AB

Participants
Ajay Kumar, MD, PhD, Troy, MI (*Presenter*) Research Grant, Mallinckrodt plc
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PURPOSE

Recent studies have shown that most adult humans have brown fat cells that could be activated via the adrenergic system. Once activated, thermogenesis in these cells could affect the body's energy balance and might be instrumental in weight management. Our objective was to test whether pharmacological stimulation of the adrenergic system using an FDA-approved beta3 agonist (Mirabegron, MRB) is as effective in increasing oxidative metabolism in brown adipose tissue (BAT) as the exposure to mild cold (i.e. non-shivering) temperature.

METHOD AND MATERIALS

Six adult lean normal subjects (3F/3M, 24.1 + 4.2 years, BMI = 23.7 + 2.5) underwent 15O-water and 18F-fluorodeoxyglucose (FDG) PET/CT scans either following 1h of cold stress exposure or 3h after MRB intake. Blood flow (ml/100g/min) and glucose uptake (SUV) were calculated from PET scans at the location of supraclavicular BAT. Changes in whole body daily energy expenditure (DEE) pre and post cold/MRB was measured using indirect calorimetry. BAT oxygen consumption (MRO2, ml/100g/min) was determined and used to calculate the contribution of cold- or MRB-activated BAT to whole body DEE.

RESULTS

BAT blood flow was found to be significantly higher during cold as compared to MRB intake (16.7 + 7.7 vs. 11.7 + 6.5; p = 0.041), resulting in significantly higher BAT mass during cold (73 + 67g, vs. 53 + 50g, p = 0.048). The ratio between the amount of pharmacologically activated and cold-activated BAT mass was 0.67 + 0.24. Moreover, MRO2 in BAT was significantly higher during cold as compared to MRB intake (1.37 + 0.67 vs. 1.0 + 0.49 ml/100g/min, p = 0.044). Overall, the DEE associated with activated BAT was found to be significantly higher than the DEE linked to MRB activation (7.4 + 5.8 vs. 4.5 + 3.9 kcal/d, p = 0.047).

CONCLUSION

Our findings indicates that activation of BAT using MRB is possible, however to a lesser extent (~2/3) than activations using mild cold exposure. As cold exposure is a more natural way to activate BAT, pharmacological activation of BAT using a beta receptor agonist with possible side effects appears to be a suboptimal method to increase DEE.

CLINICAL RELEVANCE/APPLICATION

The contribution of MRB-activated BAT to whole body energy expenditure is negligible (5 - 15 kcal/d) and as such is unlikely to contribute to weight loss in subjects that are on a chronic MRB regimen.

SSK13-05 Irisin Induces White Adipose Tissue Browning in Mice by MR Imaging In Vivo

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

Our study was to evaluate the browning process of Irisin on white adipose tissue (WAT) using MR imaging in vivo.

METHOD AND MATERIALS

After cultured white adipocytes were treated by different concentrations (0, 20 and 40nM, 24 hours), immunohistochemistry and western blotting (UCP 1 and DIO 2, the specific protein of brown adipocyte) were used to evaluate the browning of white adipocyte. After intraperitoneal injection of Irisin (200ng/d each) and saline (200ul each) into female C57BLKS/J mice (n=7, 10-12w), T1 weighted imaging and chemical shift selective imaging (CSSI) were performed at pre-injection and 14 days post-injection to measure the volume of WAT and the signal-noise ratio (SNR) of WAT in selective fat imaging of CSSI. Browning of WAT in MRI were compared to reference standard by histological white adipocyte area in H&E, immunohistochemistry and western blotting.

RESULTS

Primary white adipocytes were successfully cultured and induced to mature. After the intervention of Irisin, the expression levels of UCP 1 and DIO 2 proteins in white adipocytes increased significantly with the increase of the Irisin concentration. The volume of subcutaneous, visceral and total WAT after Irisin intervention by MRI was significantly lower than that of the controls. The SNR of WAT was lower than that of control, which to indicate the lipid fraction decrease and browning of WAT after Irisin injection (Figure). The area of white adipocytes in Irisin group were significantly lower than that of the controls, and the expression levels of UCP1 and Dio2 proteins were also significantly increased.

CONCLUSION

Our study was demonstrated that MR imaging could non-invasively assess browning of WAT after Irisin intervention in mice. Irisin not only reduced the volume of WAT, but also further decreased lipid fraction of WAT.

CLINICAL RELEVANCE/APPLICATION

Irisin can play a potential role in activation of browning of WAT and can be a new therapeutic target in metabolic diseases. MR imaging will play an important monitor role in this process.

SSK13-06 Glycosaminoglycan Remodeling of Lumbar Intervertebral Discs in Elite Rowers throughout Their Annual Training Cycle

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S505AB

Participants
Miriam Frenken, Dusseldorf, Germany (*Presenter*) Nothing to Disclose
Daniel B. Abrar, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Laszlo Kasprowski, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Bernd Bittersohl, MD, Bern, Switzerland (*Abstract Co-Author*) Nothing to Disclose
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Christoph Schleich, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the glycosaminoglycan (GAG) content of lumbar intervertebral discs (IVD) in elite rowers (ER) at different stages of their annual training cycle and compared to healthy volunteers (HV) using GAG chemical exchange saturation transfer (gagCEST).

METHOD AND MATERIALS

205 lumbar IVD of 21 ER (23 ±3 years, 9 female, 11 male) and 25 HV (27 ±2 years, 13 female, 12 male) were prospectively examined with 3T magnetic resonance imaging (MRI). Standard T2 weighted (T2w) sequences were used for morphological grading according to the Pfirrmann classification. GAG content of the nucleus pulposus (NP) and annulus fibrosus was determined with gagCEST in non-degenerated discs according to Pfirrmann. ER were examined during the peak of their competition preparation (T0) and 6 months later during the peak of their post-competition recovery period (T1).

RESULTS

At T0 we found significantly higher gagCEST values in ER compared to HV (NP: 4.26 ±2.37% vs. 3.38 ±1.72%, $p<0.05$; confidence interval (CI) 0.32%/1.44%; AF: 2.75 ±1.7% vs.1.961 ±1.23%, $p<0.01$; CI 0.4%/1.2%). At T1 gagCEST values decreased and illustrated no significant difference compared to HV (NP: 3.55 ± 2.31%, $p = 0.531$, CI 0.038%/0.73%; AF: 2.31 ±1.57%, $p = 0.073$, CI 0.03%/0.74%).

CONCLUSION

Compared to HV lumbar IVD of ER show significantly higher gagCEST values during the peak of their competition preparation and similar values during the recovery period, indicating a GAG remodelling effect by training.

CLINICAL RELEVANCE/APPLICATION

Physical exercise (rowing) potentially prevents molecular GAG depletion in lumbar IVD.

SSK13-07 Visceral Fat Browning in a Murine Model Detected by Z-Spectrum Imaging

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S505AB

Participants
Alessandro Scotti, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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Weiguo Li, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Chong Wee Liew, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Kejia Cai, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

PURPOSE

Conversion of visceral fat into brown fat (browning) is highly beneficial in reducing the risk of metabolic disease, but its study is limited by resistance to conventional browning stimuli and inadequate noninvasive imaging [1,2,3]. Here we report the successful detection of white adipose tissue browning in a transgenic mouse model by measurement of depots size and fat-water fraction (FWF) from longitudinal Z-Spectrum MRI.

METHOD AND MATERIALS

The transgenic murine model was developed by ablation of the transcriptional regulator TRIP-Br2 (TRIP-Br2 KO mice) [4] and treated IP with 1mg/Kg of ß3-AR agonist CL316,243 every day for two weeks. Age-matched wild types were treated with saline. Animals underwent MRI at a 9.4T scanner before and 4, 10 and 15 days after treatment start. The size of the perirenal depots was measured on multislice T2-weighted sequences. Z-Spectrum Imaging was performed with a CEST sequence with a single slice FSE readout. Z-spectral data were fitted to a multi-Lorentzian model including the direct saturation of both water and fat and the FWF was quantified from the fitted amplitudes in every pixel [3].

RESULTS

ROI analysis showed that the perirenal fat depots decreased in size over time in the KO mice, with volumes shrinking from 11.7±1.9mm3 before treatment to 6.9±2.4mm3 after two weeks, compared to the wild types. FWF also was found decreased in the drug treated mice compared to the control group, with differences between the groups in perirenal fat up to 15% already detectable after 4 days, and increased to 20% at ten days, but decreased at 2 weeks. The changes are consistent with increased perfusion and reduced lipid content, markers of brown-like cells activation. Also subcutaneous fat showed a sustained decrease in FWF, reaching an average of 25% at the end of the study, but with a higher variability. The different timeline of changes in the fat depots might indicate a hierarchy to the activation mechanism [5].

CONCLUSION

ZSI has proven to be able to detect browning of white adipose tissue in a murine model chronically treated with adrenergic drug.

CLINICAL RELEVANCE/APPLICATION

Visceral fat is associated with high risk of metabolic disease and is resistant to conventional browning stimuli. Monitoring its browning will be instrumental in combating epidemic metabolic diseases.

SSK13-08 Granzyme B PET Imaging to Assess Innate Immune Responses

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S505AB

Participants
Kathleen M. Capaccione, MD,PhD, New York, NY (*Presenter*) Nothing to Disclose
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Akiva Mintz, MD, PhD, Paramus, NJ (*Abstract Co-Author*) Consultant, Regeneron Pharmaceuticals, Inc

PURPOSE

Granzyme B is a serine protease released by active CD8+ T cells, macrophages and natural killer cells that facilitates granule-mediated apoptosis. Prior studies have demonstrated the utility of granzyme B PET imaging of CD8+ T cells to assess adaptive immunity in response to immunotherapy. Our goal is to examine the potential of granzyme B PET imaging as a biomarker of the innate immune system, which can expand its use for imaging T-cell independent diseases as well as the initial innate immune trigger of an adaptive immune response.

METHOD AND MATERIALS

Athymic nude mice were injected in the left shoulder with lipopolysaccharide (LPS) in Matrigel to induce a T-cell independent immune response. Seventy-two hours later we injected 68Ga-NOTA-GZP as previously reported and performed PET/CT imaging one hour after injection.

RESULTS

PET-CT demonstrated specific binding of the 68Ga-NOTA-GZP at the site of LPS injection within the left shoulder when compared to control animals injected with PBS. Nonspecific uptake was also seen in the liver and the bladder, suggesting routes of elimination.

CONCLUSION

Specific 68Ga-NOTA-GZP accumulation at the site of LPS injection in T cell deficient animals supports the use of granzyme B PET imaging for innate immune responses. Future studies will examine the role of granzyme B imaging in specific disease states mediated by innate immunity.

CLINICAL RELEVANCE/APPLICATION

Granzyme B PET imaging may aide the early diagnosis and evaluation of disease progression of infection and inflammation mediated by the innate immune system.

SSK13-09 Loss of Glycosaminoglycans of Lumbar Intervertebral Discs in Patients With Ankylosing Spondylitis

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S505AB

Participants
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PURPOSE

To evaluate the glycosaminoglycan (GAG) content of lumbar intervertebral discs (IVD) in patients with ankylosing spondylitis (AS) using GAG chemical exchange saturation transfer (gagCEST).

METHOD AND MATERIALS

195 lumbar IVD of 15 patients with AS (mean age 50 ±10 years) and 25 healthy control patients (HC) were prospectively examined with 3 T magnetic resonance imaging (MRI). MRI protocol contained morphological T2 weighted (T2w) images to grade IVD according to the Pfirrmann classification and biochemical imaging with gagCEST to calculate a region of interest (ROI) of the nucleus pulposus (NP) and annulus fibrosus (AF). Prior to statistical testing of gagCEST effects in patients and HC, IVD were classified according to Pfirrmann.

RESULTS

Significantly lower gagCEST values of NP and AF were found in non-degenerative IVD (Pfirrmann 1 and 2) of AS patients compared to HC (NP: 1.88 % ±1.21% vs. 3.38 % ±1.71%; $p<0.01$; confidence interval (CI): 0.89%/2.11%. AF: 1.11 % ± 1.07 % vs. 1.96 %± 1.23 %; $p<0.01$; CI 0.39%/1.3%).

CONCLUSION

GagCEST analysis of morphologically non-degenerative IVDs in T2w images showed significantly lower GAG values in patients with AS in the NP and AF compared to HC.

CLINICAL RELEVANCE/APPLICATION

Our results potentially allow for the detection of GAG loss prior to morphological degeneration.

SSK14

Musculoskeletal (Interventional)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E353A

IR MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Kenneth S. Lee, MD, Madison, WI (*Moderator*) Grant, General Electric Company; Grant, National Basketball Association; Grant, Johnson & Johnson; Research support, SuperSonic Imagine; Royalties, Reed Elsevier
Adam C. Zoga, MD,MBA, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSK14-01 Augmented Reality and Artificial Intelligence-Based Navigation during Percutaneous Vertebroplasty

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E353A

Participants
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PURPOSE

To assess technical feasibility, accuracy, safety and patient radiation exposure of a novel navigational tool integrating augmented reality (AR) and artificial intelligence (AI), during percutaneous vertebroplasty of patients with vertebral compression fractures (VCFs).

METHOD AND MATERIALS

This retrospective study compared the trans-pedicular access phase of percutaneous vertebroplasty between two groups of 50 patients with symptomatic single-level VCFs. Trocar insertion was performed using AR/AI-guidance with motion-compensation in Group A, and standard fluoroscopy in Group B. Technical feasibility was recorded for Group A. Accuracy of trocar placement (distance between planned/actual trajectory on sagittal/coronal fluoroscopic-images); complications; time for trocar deployment; and radiation dose/fluoroscopy-time were recorded and compared between group A and B.

RESULTS

Technical feasibility in Group A was 100%. Time for trocar deployment was significantly longer in Group A (642 ± 210s) than Group B (336 ± 60s; p= 0.001). Dose-Area Product and fluoroscopy-time were significantly lower in Group A (160.9 ± 220 mGy.cm2 and 5.2 ± 3.4) than Group B (298.2 ± 190.2 mGy.cm2 and 9.97 ± 4.8s; p=0.019 and 0.001), respectively. Time for trocar deployment was significantly longer in Group A (538 ± 182s) than Group B (374 ± 182s; p= 0.001). Accuracy measures for each group are ongoing. No complications were observed in the entire population.

CONCLUSION

AR/AI-guided percutaneous vertebroplasty appears feasible, accurate and safe, and facilitates lower patient radiation exposure compared to standard fluoroscopic-guidance.

CLINICAL RELEVANCE/APPLICATION

AR/AI-guided percutaneous vertebroplasty allows lower patient/operator radiation exposure compared to standard fluoroscopic-guidance.

SSK14-02 Short and Long Term Outcomes of Image-Guided Retrocalcaneal Bursal Injections

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E353A

Participants
Sean Boone, MD, Bronx, NY (*Presenter*) Nothing to Disclose
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PURPOSE

The efficacy of ultrasound (US) guided and fluoroscopically (FL) guided RC bursal steroid injections for heel pain is not well understood, and no large series or extended follow-up has been previously reported. The purpose of this retrospective review is to evaluate the short and long term outcomes of this procedure.

METHOD AND MATERIALS

After IRB approval, consecutive FL and US guided RC bursa injections were retrospectively reviewed (2013-2019). Pre-procedure US images were scored by 2 blinded MSK Radiologists in consensus for degree (scale 0-3) of Achilles tendinopathy (AT) and RC bursitis. VAS pain scores (scale 0-10) were obtained pre-procedure and 1-4 weeks post-procedure; short term response was considered excellent (7-10 point decline), good (4-6 point decline), fair (1-3 point decline), or none. Review of medical records was performed for long-term outcome evaluation. VAS response categories were analyzed using student's t-test.

RESULTS

263 injections were performed. 240 injections (167 US, 73 FL) in 194 heels had at least 6 months of follow-up (range 190-1919 days): 160 female; mean age 54.5 (range 30-86); 90 right heel. Insertional AT and RC bursitis was present in 100% (263/263) and 85% (223/263), respectively. Short term VAS pain scores were available for 75 injections. Median pre- and post-procedure pain scores were 9 (IQR 7.25 to 10) and 3 (IQR 0 to 6). A statistically significant decrease in pain scores was noted post-injection, with good/excellent response in 65% and mean change of -5.17 (95% CI -4.43, -5.90; $p<0.00001$). On chart review, 24 (13%) patients received repeat injection, 16 (8%) had surgery, 10 (5%) had both, and 144 (74%) had no further procedure. Four cases of Achilles rupture or high-grade tear occurred 15-79 days post- procedure.

CONCLUSION

Image-guided RC bursa injections yielded significant short term pain score reduction ($p<0.00001$). Subsequent Achilles high grade tear or rupture was infrequent (1.5%).

CLINICAL RELEVANCE/APPLICATION

This is the first report on both short and long-term outcomes of image-guided retrocalcaneal bursa steroid injection, and is the largest (n=240) patient cohort studied for this procedure.

SSK14-03 Safety and Efficacy of Bone Marrow Aspirate and Biopsy in Severely Thrombocytopenic Patients

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E353A

Participants
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Jeremiah R. Long, MD, Ft Belvoir, VA (*Abstract Co-Author*) Nothing to Disclose
Travis J. Hillen, MD, Saint Louis, MO (*Abstract Co-Author*) Consultant, Biomedical Systems Consultant, Medtronic plc
Jack W. Jennings, MD, Saint Louis, MO (*Abstract Co-Author*) Speakers Bureau, Merit Medical Systems, Inc; Consultant, Merit Medical Systems, Inc; Consultant, Medtronic plc; Consultant, Galil Medical Ltd; Consultant, BTG International Ltd; Consultant, C. R. Bard, Inc

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PURPOSE

To assess the safety and efficacy of fluoroscopically guided drill assisted bone marrow aspirate and biopsy in severely thrombocytopenic patients.

METHOD AND MATERIALS

This retrospective study received IRB approval with a waiver of patient informed consent. From January 2013 through December 2016 a total of 739 bone marrow aspirate and biopsy (BMAB) procedures were performed at a single institution under the direct supervision of a fellowship trained musculoskeletal radiologist using fluoroscopic guidance and a drill-assisted needle. Of these patients 111 BMAB were performed in 94 patients who received a CT scan of the pelvis and biopsy site within 7 days following the BMAB. These 94 patients were subdivided based on their platelet count: severe thrombocytopenia (<20 platelets/mm3) 16 BMAB in 15 patients, average 11.8 platelets/mm3; thrombocytopenia (20-50 platelets/mm3) 16 BMAB in 15 patients, average 30.1 platelets/mm3; and control (>50 platelets/mm3) 79 BMAB in 64 patients, average 213.1 platelets/mm3. The procedure report was reviewed for sedation time, aspirate volume, and aggregate size of core biopsy specimens. The electronic medical record was reviewed for specimen adequacy; pathologic diagnosis; body mass index; pre and post procedure labs including platelet count, HGB, HCT, PT, and INR levels; post-procedural transfusion; and complications including mortality at 30 and 90 days. CT scans were independently reviewed by 2 fellowship trained radiologists for the presence or absence of subcutaneous fat stranding superficial to the biopsy site or post-procedural hematoma, graded 1 to 4. Discrepancies were resolved by consensus review.

RESULTS

There was no significant difference in diagnostic yield, CT identified post-procedural hematoma, or the hemoglobin and hematocrit levels pre and post procedure between the three groups. 6 patients (1 severely thrombocytopenic, 2 thrombocytopenic, and 2 control) were lost to follow-up. There was no significant difference in complication rate or all-cause mortality at 30 and 90 days post procedure. There was a significant difference in transfusion at 30 days with thrombocytopenic and severely thrombocytopenic patients more likely to receive transfusion.

CONCLUSION

The risks of postoperative hemorrhage or complication following image-guided BMAB are not significantly different in patients with

severe thrombocytopenia and control.

CLINICAL RELEVANCE/APPLICATION

Image guided BMAB is a procedure that can be safely performed in patients with severe thrombocytopenia.

SSK14-04 Utility of CT-Guided Percutaneous Rib Biopsy and Factors Affecting Diagnostic Yield

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E353A

Participants
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Carol L. Andrews, MD, Baden, PA (*Abstract Co-Author*) Author, Reed Elsevier
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PURPOSE

To determine the utility of CT-guided percutaneous rib biopsy and factors that affect diagnostic yield

METHOD AND MATERIALS

We retrospectively reviewed percutaneous CT-guided rib biopsies performed in a large academic medical center from 2008-2017 (n=88). Patient demographics, nuclear imaging studies, CT imaging features, biopsy technique (FNA and/or core), performing radiologist, periprocedural complications and pathology results were recorded. CT imaging feature categorization included lesion matrix (sclerotic, lytic or mixed), lesion size (>/≤ 2cm), presence of bony destruction, and presence of an associated soft tissue mass. Overall diagnostic yield was calculated from the number of diagnostic biopsies over total number of biopsies. Diagnostic yield was also calculated for subgroups stratified by patient demographics, technique, presence of prior nuclear imaging, CT imaging features and pathology results. All variables were compared between diagnostic and non-diagnostic samples using chi-square test. Multivariate logistic regression was performed to determine factors which predicted biopsy outcome.

RESULTS

The overall diagnostic yield was 92.0%. No complications were noted. The diagnostic yield was significantly different depending on lesion matrix (95.5% for lytic, 91.7% for mixed, and 66.7% for sclerotic, p=0.011), the presence of an associated soft tissue mass (96.7% versus 81.5%, p=0.044), and size of the lesion (97.1% versus 73.7% for larger versus smaller lesions, p=0.004). The diagnostic yield for various subgroups is listed in table 1 (See attached). Multivariate logistic regression demonstrated a statistically significant result for lesion size when adjusting for other covariates (lesion matrix, soft tissue component and prior nuclear medicine study). Biopsies of large lesions predicted a diagnostic result (Odds ratio 8.91, p=0.04).

CONCLUSION

Percutaneous rib biopsy utilizing CT-guidance is a safe and effective procedure with a high diagnostic yield. The diagnostic yield is higher for lytic than sclerotic lesions, lesions with an associated soft tissue mass, and large lesions. Multivariate analysis shows that the lesion size affects diagnostic yield. Larger lesions resulted in a higher diagnostic yield than smaller lesions.

CLINICAL RELEVANCE/APPLICATION

CT-guided percutaneous rib biopsy results in a high diagnostic yield particularly for large lytic osseous lesions with an associated soft tissue mass.

SSK14-05 Efficacy and Outcome of Repeat Epidural Steroid Injection for Partially Responded Lumbar HIVD Patients under "Wait-And-See" Policy as a Pain Management Option

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E353A

Participants
Bo Ram Kim, MD, Seongnam-si, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate efficacy of epidural steroid injection (ESI) under 'wait-and-see (WaS)' policy, based on 1-year clinical outcome of responded lumbar herniated intervertebral disc (HIVD) patients to initial ESI

METHOD AND MATERIALS

592 lumbar HIVD patients received steroid injection from Jan 2017 to Dec 2017 in our institution. The cohort was managed pain and follow up for 1-year under 'WaS' policy to performed repeated ESI under close observation of initial injection response without prescheduled ESI session within 3 weeks, that is performed in our routine clinical practice. 3-week and 1-year telephone interview and medical record review was conducted for residual symptom, total injection number, operating status. After excluding patients with complete response without residual pain or no response with over 70% residual symptom in 3-week pain assessment, 141 responded patients comprised our study population. We divided patients into 2 groups: WaS group (n=124) and early repeat ESI, which repeat ESI within 3weeks (early ESI, n=17) group. Evaluations of characteristics and outcome results were performed chi-squared or independent Student t-test.

RESULTS

Six patients (4.8%) of WaS group and one patient (5.9%) of early ESI group underwent operation within 1 year (P = 0.853). All operations were undergone for patients with poor response that is >=50% residual symptom. Mean 1.52±0.82 session of ESIs were performed for WaS group and 2.29±0.47 session of ESIs were performed for early ESI group during follow-up period (P=0.000). 78 patients (62.9%) of WaS group could control pain with a single ESI during 1 year, though one underwent surgery at outside hospital. Time interval between first and second ESI (97.15 vs. 15.47 days, P = 0.000) and between second and third ESI (80.43 vs. 50.40 days, P = 0.395) is longer in WaS than early ESI group.

CONCLUSION

"Wait-and-see" policy could be an effective pain management option for lumbar HIVD patients with response to initial ESI. Moreover, effective option for avoiding unnecessary repeat ESI and delaying repeat injection point.

CLINICAL RELEVANCE/APPLICATION

Intermittent ESI for responded lumbar HIVD patients under 'wait-and-see' policy could reduce medical cost and side effect related steroid injection by avoiding unnecessary repeat ESI and delaying repeat ESI point.

SSK14-06 Cryoablation for Advanced and Refractory Desmoid Tumors: A Promising Treatment?

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E353A

Participants
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PURPOSE

To assess efficacy and safety of percutaneous cryoablation (CA) for advanced and refractory extraabdominal desmoid tumors

METHOD AND MATERIALS

This retrospective study reviewed 31 consecutive patients with painful desmoid tumors (EVA>5) evolving despite well-managed medical treatment treated by CA between 2007 and 2019. Pain reduction, progression free survival (PFS) (clinical or radiographics), tumor shrinkage rate (TSR) (volume of the tumor at 1 and 3 years compared to the volume before treatment) and complications were collected. Clinical efficacy of treatment was defined by VAS<3 after CA. Kaplan Meier method was used to outline PFS. Paired sample t-test was used to compare volume of tumors before treatment and at 1 year and 3 year.

RESULTS

With a median follow-up of 30 months (range 1- 98 months, IQR: 8-54), the PFS was 82.6% (CI95%: 69.2, 95.9) at 1 year and 75.7% (CI95%: 60.6, 90.8) at 3 years. Clinical efficacy of treatment was obtained for 89.6% (CI 95%: 78.6,100) of patients. Median volume of desmoid tumor before treatment was 92.4mL (range 2.1-1727.9 mL, IQR: 49.7- 298.5). TSR was 48.2% (CI95%: 37.2, 72.3; p=0.002) at 1 year and 74,4% (CI95%: 59.1, 89.8; p=0.002) at 3 year. Thermo protective measures for critical structures closed to the tumor were used in 74,2% of cases. Five patients (16.2%) required 2 sessions of CA for total control. Adverse events rate was 31.2%, the most common was oedema and temporary increase of pain in the days following CA.

CONCLUSION

CA is an effective treatment for advanced and refractory extraabdominal desmoid tumor, that induces durable responses. Safety profile is acceptable but requires a good mastery of protective measures for surrounding organs.

CLINICAL RELEVANCE/APPLICATION

Among patients with progressive, refractory and symptomatic desmoid tumors, CA is an effective treatment that induces durable responses.

SSK14-07 CT-Guided Bone Marrow Aspirations and Biopsies: Retrospective Review and Comparison with Blind Procedures

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E353A

Participants
Connie Y. Chang, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

To assess the added value, if any of performing bone marrow aspirations and biopsies with CT-guidance

METHOD AND MATERIALS

76 consecutive CT-guided and 70 blind bone marrow aspirations and biopsies performed January to October 2017 were reviewed. All CT-guided biopsies were performed with the same 11 gauge battery-power drill-assisted device. Blind biopsies were performed with either the 11 gauge battery-powered drill-assisted device or a 13 gauge manual device. Pathology reports were reviewed for adequacy of smears and biopsies (categorized as adequate, suboptimal, and not adequate), and core and core volume. Patient age, gender, and body mass index (BMI), core length, core volume, procedure diagnosis, and diagnosis were compared by T-tests with $P < 0.05$ considered statistically significant.

RESULTS

There was no significant difference between the age (CT: 67 ± 14, range 26-93 years; blind: 63 ± 13, range 23-85 years; P = 0.1), BMI (CT: 29 ± 6, range 18-46; blind: 27 ± 5, range 19-42; P =0.1), and biopsy site (CT 42 left ilium, 34 right ilium; blind: 27 left ilium, 41 right ilium, 2 not specified; P = 0.8) between the CT-guided and blind biopsies. The blind biopsy group (48 M, 22 F) had a higher proportion of male patients than the CT-guided biopsy group (38 M, 38 F) (P = 0.02). More CT-guided aspirate smears than blind aspirate smears were categorized as adequate (CT: 72 (97%) adequate, 2 (3%) suboptimal, 0 inadequate, 1 not obtained; blind: 58 (85%) adequate, 5 (7%) suboptimal, 5 (7%) inadequate, 2 not obtained) (P = 0.02). More CT-guided biopsy samples than blind biopsy samples were categorized as adequate (CT: 72 (95%) adequate, 4 (5%) suboptimal, 0 inadequate; blind: 54 (77%) adequate, 9 (13%) suboptimal; 7 (10%) inadequate) (P = 0.002). The CT-guided biopsies had a longer core length (CT: 1.3 ± 0.6, range 0-3.5 mm; blind: 1.0 ± 0.5, range 0-2.6 mm; P = 0.001) and a higher core volume (CT: 0.05 ± 0.03, median 0.03, range 0-0.2 mm3; blind: 0.05 ± 0.05, median 0.04, range 0-0.3 mm3; P = 0.04).

CONCLUSION

CT-guided bone marrow procedures were more likely to result in an adequate smear aspirate and biopsy sample and yielded longer cores with higher core volumes.

CLINICAL RELEVANCE/APPLICATION

CT guidance is helpful in bone marrow procedures. Further studies should be performed to study the cost effectiveness of routine CT guidance, and also to define the situations in which CT guidance should be used for marrow biopsies.

SSK14-08 Safety and Efficacy of Image Guided Radiofrequency Ablation of Genicular Nerve for Pain Management in Patients with Moderate to Severe Osteoarthritis of the Knee: Initial Single Institution Experience

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E353A

Participants
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Philip K. Wong, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To analyze the safety and efficacy of image-guided genicular nerve radiofrequency ablation (RFA) for the treatment of pain in non-surgical candidates with moderate to severe knee osteoarthritis (OA)

METHOD AND MATERIALS

In an IRB approved prospective study, 44 consecutive patients with pain from moderate to severe knee OA refractory to anti-inflammatory analgesia and failed multiple intraarticular lidocaine-steroid injections who underwent RFA of genicular nerves were included. All patients initially underwent anesthetic blocks of the superior medial/lateral and inferior medial genicular nerve branches and experienced great short-term pain relief of >6 points out a 10 scale. Radiofrequency ablation of the same nerve branches were performed 1-2 weeks after nerve block. Efficacy of the treatment was evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Knee Injury and Osteoarthritis Outcome Score (KOOS) to assess overall symptoms, stiffness, pain, and functional daily living pre block/ablation.

RESULTS

A total of 53 knees were treated in 44 patients. The average age of the patients was 66 +/- 15.8 years. Mean follow-up time was 2 weeks, 1 and 3 months. No procedure related complication was identified. The mean total KOOS score (out of 100) improved significantly from baseline at 26.9 to 62.7 3months post treatment ($p<0.001$). Sub-analysis of the pain component of the KOOS questionnaire demonstrated significant improvement in mean overall symptoms score from 14.7 to 39.6 ($p<0.001$). Mean stiffness score improved from 39.5 to 61 ($p<0.001$) and mean pain score from 26.5 to 55.3 ($p<0.001$). There was also significant improvement in the functional daily living limitations with mean baseline score of 27.6 and 3 month post therapy score of 53 ($p<0.001$). There was a greater number of patients with Grade III (n=34) and grade IV (n=10) arthritis according to the Kellgren-Lawrence classification.

CONCLUSION

Imaged-guided radiofrequency ablation of genicular nerves is a safe treatment option with good short-term outcome in patients

Imaged-guided radiofrequency ablation of geniculate nerves is a safe treatment option with good short-term outcome in patients that do not qualify for TKA because of comorbidities with moderate to sever OA of the knee refractory to conservation treatments.

CLINICAL RELEVANCE/APPLICATION

Cooled RFA of the ginicular proves a safe way to treat knee arthritis pain.

SSK14-09 Minding the Gap: Vertebral Body Fracture Clefts and What They Mean for Post-Vertebroplasty Outcomes

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E353A

Participants
Caroline M. Tomas, MD, Aurora, CO (*Presenter*) Nothing to Disclose
Mary Kristen Jesse, MD, Aurora, CO (*Abstract Co-Author*) Faculty, Medtronic plc

PURPOSE

Percutaneous vertebroplasty/kyphoplasty has been documented as a safe and effective treatment for vertebral body fractures. Because cement nonunion is a documented cause of failed vertebral cement fixation, we focus on how pre;procedural fracture cleft morphology and procedural cement filling may be associated with the development of nonunion and furthermore how this may affect patient outcomes.

METHOD AND MATERIALS

Retrospective review of 296 patients (172 women, 124 men) who underwent vertebroplasty/kyphoplasty for compression fractures. Variables included pre-procedure CT/MRI cleft presence and morphology, pain improvement, underlying pathology, fracture level, morphology of cement fill, and postprocedure non-union. Statistical analysis was performed utilizing ordinal logistic regression, logistic regression, Fisher's exact, and conditional t-tests of proportions, with significance level set to 0.05.

RESULTS

Majority of patients with non-union cement fill (75%) demonstrated large cleft morphology. The presence of a fracture cleft resulted in an 4.981 odds ratio of non-union and odds of cleft presence is 5.195 times higher for non-union (95% CI: 1.636, 20.157). There was a significant association between non-union cement fill and cleft-only fill ($p<0.0001$). Patients with secondary osteoporosis had 2.831 higher odds of cleft (95% CI: 1.119, 7.299). Odds of cleft presence was 1.029 times higher for each one year increase in age (95% CI: 1.119, 7.299). The presence of a vertebral cleft did not significantly alter pain relief outcomes.

CONCLUSION

Because risk of cement non-union increases with increasing age, secondary osteoporosis, size of the fracture clefts, and cleft-only cement fill, we should pay special attention when these variables are present to adjust our procedure protocol and expectation. The presence of a cleft should not deter the decision to proceed with vertebroplasty/kyphoplasty, as pain relief was not significantly altered; however added attention to increasing trabecular fill during the procedure is warranted to decrease the risk of non-union.

CLINICAL RELEVANCE/APPLICATION

Advanced age, secondary osteoporosis, cleft size, and cleft-only cement fill should be considered when setting vertebroplasty protocol and expectation. Increasing trabecular fill is optimal.

SSK15

Nuclear Medicine (Gastrointestinal Oncology Nuclear Medicine and PET)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E451A

GI NM

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Steve Cho, MD, Madison, WI (*Moderator*) Research Grant, General Electric Company; Consultant, Advanced Accelerator Applications SA;

Sub-Events

SSK15-01 Integrated Time-Of-Flight 18F-FDG PET/MRI For Assessment of Pathologic Response to Neo-Adjuvant Chemo-Radiotherapy in Borderline Resectable Pancreatic Ductal Adenocarcinoma

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E451A

Awards
Trainee Research Prize - Fellow

Participants
Ishan Garg, MBBS, Rochester, MN (*Presenter*) Nothing to Disclose
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PURPOSE

To determine if parameters derived from integrated time-of-flight 18F-FDG PET/MRI correlate with pathologic response after neoadjuvant chemo-radiotherapy (CRT) in patients with borderline resectable pancreatic ductal adenocarcinoma (PDAC).

METHOD AND MATERIALS

Patients with FDG-avid (SUVmax>=4) borderline resectable PDAC on baseline PET/MRI who also underwent a post-CRT PET/MRI prior to surgical resection were included. Primary tumor SUVmax, glucose-corrected SUVmax (SUVgluc), SUVmean and volumetric PET parameters (total lesion glycolysis and metabolic tumor volume) were measured using anatomic guidance from simultaneously acquired contrast-enhanced MRI. Metabolic response on PET/MRI was correlated to histologic treatment response using College of American Pathologists grading system (path grade). Complete metabolic response (CMR) defined as FDG uptake indistinguishable from surrounding background and normalization of post-CRT CA 19-9 were evaluated as surrogates of path grade 1/0 (marked or complete response).

RESULTS

34 patients (52.9% males; mean age: 62-years, range 23-80) were included. Follow-up duration was 17.6±5.7 months (mean ± SD). Pathologic response grades were either 1/0 (n=13) or 2/3 (n=21). Complete metabolic response on post-CRT PET/MRI was observed in 20 patients - 12 with path grades 1/0, and 8 with path grade 2. CMR was superior to normalization of post-CRT CA 19-9 as a surrogate for path grade 1/0 (sensitivity 92.3 v/s 66.7%; specificity 61.9 v/s 18.2%; PPV 60 v/s 40%; NPV 92.9 v/s 40%; AUC 0.77 v/s 0.42; P <0.05). Using ROC analysis, a relative change of >=50% in SUVgluc had 100% sensitivity, 61.9% specificity, 61.9% PPV and 100% NPV for path grade 1/0.

CONCLUSION

Qualitative and quantitative parameters derived from FDG PET/MRI correlate with pathologic response after neoadjuvant CRT and had better performance than normalization of post-CRT CA 19-9 as a surrogate for path grade 1/0.

CLINICAL RELEVANCE/APPLICATION

Qualitative and quantitative parameters derived from 18F-FDG PET/MRI show promise for assessment of pathologic response to CRT in patients with borderline resectable PDAC and merit evaluation in larger studies.

SSK15-02 18F-FDG PET-MR Enterography in Predicting Histological Active Disease in Ulcerative Colitis: A Randomized Controlled Trial Using Nancy Index

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E451A

Participants

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PURPOSE

To evaluate the diagnostic performance of PET-MR enterography in detecting histological active inflammation in patients with ulcerative colitis and the impact of bowel purgation on diagnostic accuracies of PET-MR parameters.

METHOD AND MATERIALS

Fifty patients were enrolled in this randomized controlled trial (clinicaltrials.gov [NCT03781284]). 40 patients were randomized in two study arms, in which bowel purgation was performed either before or after PET-MR enterography. All patients underwent ileocolonoscopy with mucosal biopsies after PET-MR within 24h. Diagnostic performance of MR morphological parameters (MRmorph), diffusion-weighted imaging (DWI) and PET in detecting histological inflammation determined by Nancy index was compared with each other and between study arms. Correlation between PET and histological inflammatory severity was calculated.

RESULTS

In study arm without previous bowel purgation, SUVmax ratio of bowel segment (relative to SUVmax of the liver) facilitated the highest specificity and diagnostic accuracy compared to MRmorph and DWI. Bowel cleansing led to markedly increased metabolic activity of bowel segments, resulting in significantly reduced specificity of PET compared to study arm without purgation (0.808 vs. 0.966, $p = 0.007$, respectively). Inter-observer concordance for assessing MRmorph was clearly increased after bowel cleansing (Cohen's κ: 0.847 vs. 0.665, $p = 0.013$, respectively), though diagnostic performance of MRmorph was not significantly improved. Our findings suggested that the change of metabolic status was mainly associated with the grade of neutrophil infiltrate and less dependent on chronic infiltrate.

CONCLUSION

PET-MR enterography was an excellent non-invasive diagnostic method in the assessment of ulcerative colitis without the need of previous bowel purgation.

CLINICAL RELEVANCE/APPLICATION

SUVmaxRatio was a reliable parameter facilitating best diagnostic operating characteristics in predicting histological active disease in patients with ulcerative colitis and no previous bowel purgation was needed for PET-MR.

SSK15-03 CT-Attenuation and FDG Uptake of Visceral Adipose Tissue Can Predict the Risk of Peritoneal Recurrence in Gastric Cancer Patients after Curative Surgical Resection

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E451A

Participants
Jeong Won Lee, MD,PhD, Incheon, Korea, Republic Of (*Presenter*) Nothing to Disclose
Sang Mi Lee, Cheonan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

CT-attenuation and FDG uptake of adipose tissue have been used as imaging parameters that reflect qualitative characteristics of adipose tissue. Given that gastric cancer grows in an adipose tissue-dominated environment, gastric cancer might have interaction with visceral adipose tissue (VAT). The purpose of this study was to investigate the prognostic significance of CT-attenuation and FDG uptake of VAT to predict recurrence-free survival (RFS), peritoneal RFS and overall survival (OS) in patients with advanced gastric cancer (AGC).

METHOD AND MATERIALS

We retrospectively enrolled 117 patients with AGC who underwent staging FDG PET/CT and subsequent curative surgical resection. CT-attenuation and FDG uptake (SUV) of VAT and maximum FDG uptake of primary tumor (SUVmaxT) were measured from PET/CT images. The relationship of VAT attenuation and SUV with clinico-histopathologic factors and survival was assessed.

RESULTS

There was a significant positive correlation between VAT attenuation and SUV ($p<0.001$, $r=0.799$). In correlation analyses, both VAT attenuation and SUV showed significant positive correlations with T stage, tumor size, and platelet-to-lymphocyte ratio ($p<0.05$), and patients who died during follow-up had significantly higher VAT attenuation and SUV than those who survived ($p<0.05$). Patients with high VAT attenuation and SUV showed significantly worse RFS, peritoneal RFS, and OS than those with low values ($p<0.05$). On multivariate survival analysis, VAT attenuation and SUV were remained as significant predictors for peritoneal RFS and OS after adjusting age, sex, tumor stage, and SUVmaxT ($p<0.05$).

CONCLUSION

CT-attenuation and FDG uptake of VAT on staging FDG PET/CT were correlated with tumor characteristics and were significant independent predictive factors for peritoneal RFS and OS in patients with AGC.

CLINICAL RELEVANCE/APPLICATION

The qualitative characteristics of visceral adipose tissue measured on FDG PET/CT could be used to predict the risk of periteoneal recurrence in patients with advanced gastric cancer after surgical resection.

SSK15-04 Standardized Uptake Values on 68Ga-DOTATATE PET/CT Predict Response to Somatostatin Analog Therapy in Gastroenteropancreatic Neuroendocrine Tumors

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E451A

Participants
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Daniel Pryma, MD, Philadelphia, PA (*Abstract Co-Author*) Research Grant, Siemens AG; Research Grant, 511 Pharma; Research Grant, Progenics Pharmaceuticals, Inc; Research Consultant, Progenics Pharmaceuticals, Inc; Research Consultant, 511 Pharma; Research Consultant, Actinium Pharmaceuticals, Inc; Research Consultant, Nordic Nanovector ASA

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PURPOSE

68Ga-DOTATATE PET/CT provides a quantitative measure of tumor somatostatin receptor status in gastroenteropancreatic neuroendocrine tumors (GEP-NETs). We examined the ability of standardized uptake values (SUVs) on 68Ga-DOTATATE PET/CT to predict response to somatostatin analog (SSA) therapy.

METHOD AND MATERIALS

The medical records of 108 consecutive patients with grade 1-2 GEP-NETs on SSA monotherapy who received 68Ga-DOTATATE PET/CT scans at a single institution were reviewed to obtain baseline characteristics, 68Ga-DOTATATE SUVmax, and progression-free survival (PFS) data. A receiver operating characteristic curve was constructed to determine the optimal SUVmax cutoff for stratification. PFS in the high vs. low SUVmax groups was compared with Kaplan-Meier survival analysis. The effects of baseline characteristics and SUVmax on PFS were examined with univariate and multivariate Cox regression.

RESULTS

SUVmax was significantly higher ($p<0.001$) in pancreatic compared to gastrointestinal NETs, but did not vary with other baseline clinical, pathologic, and laboratory characteristics. Median clinical follow-up was 16 months, and PFS at 6, 12, and 18 months was 91 ± 3%, 80 ± 4%, and 61 ± 6%, respectively. The best SUVmax cutoff of 18.35 from ROC analysis yielded sensitivity and specificity of 39% and 98%, respectively, for disease progression by 12 months (area under the curve=0.66). The low SUVmax group showed significantly shorter PFS compared to the high SUVmax group ($p<0.0001$) with median of 6.6 months vs. >24 months, which was reproduced in a subgroup analysis of 30 SSA naïve patients ($p<0.05$). On univariate analysis, high tumor grade, Ki-67, and mitotic index, as well as low SUVmax and no prior SSA therapy, were identified as predictors of early treatment failure. Only low SUVmax remained statistically significant on multivariate analysis with hazard ratio of 6.85. (95% CI: 2.10-22.34). In a subgroup analysis of 46 grade 2 patients, short PFS on SSA was again predicted by SUVmax<18.35 ($p<0.01$), but not with the Ki-67 cutoff value of 10% ($p=0.38$).

CONCLUSION

Low SUVmax on 68Ga-DOTATATE PET/CT independently predicts early failure on SSA monotherapy in grade 1-2 GEP-NET patients with high specificity.

CLINICAL RELEVANCE/APPLICATION

Based on 68Ga-DOTATATE PET/CT, clinicians can better inform patients on the expected benefit of SSA therapy, especially when access to SSA is difficult, and offer proactive discussion on alternatives.

SSK15-05 68Ga-DOTATATE PET/CT Parameters for the Early Prediction of Response to Peptide Receptor-Mediated Radionuclide Therapy (PRRT) for Metastatic Neuroendocrine Tumors (NET)

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E451A

Participants
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PURPOSE

To determine whether change in 68Ga-DOTATATE (DT) uptake at tumor sites is predictive of early response to PRRT. A secondary aim was to determine whether DT uptake in reference tissues changes after first cycle of PRRT (C1).

METHOD AND MATERIALS

There were 36 patients (20 men, 16 women; mean age, 60 yrs) with metastatic well-differentiated NETs (Ki67<30%, median Ki67, 6.6) being considered for PRRT who underwent baseline & follow-up DT PET after C1. SUVmax in reference tissues (mediastinal blood pool, liver & spleen) were recorded at baseline and after C1. Response to therapy at 4 months post 4th cycle of PRRT, assessed by RECIST 1.1, was available for 28 patients (mean time to response assessment, 10.9 mo; range 6-16). SUVmax & SULpeak were recorded in <=5 marker lesions per patient (<= 2 per organ). Response to therapy was compared to SUVmax & SULpeak at baseline, change in SUVmax and SULpeak after C1, and change in ratio of average SUVmax/ SULpeak of tumor to liver and spleen.

RESULTS

At baseline and after C1, mean SUVmax in blood pool, liver and spleen were 1.45 and 1.42 (-0.7%); 5.2 and 5.8 (+13%); and 16 and 19.4 (+28.4%), respectively. There were 15/28 (53.6%) patients with stable disease (SD), 10/28 (35.7%) with partial response (PR) and 3/28 (10.7%) with progressive disease (PD). The most predictive parameters for response were baseline SUVmax & change in SUVmax/SULpeak ratio of tumor/spleen. Baseline SUVmax for SD, PR and PD was 43.8 (range: 13.5-111.2), 43.3 (range: 11-137.7) & 26.2 (range: 16.5 - 40.2), respectively. Change in SUVmax ratio of tumor/spleen for SD, PR and PD was -24.2% (range: 11.2 [-77.1]), -33.5% (range: 7.8-[-70.8]) & -13.3% (range: 0.8-[-39.6]), respectively. Change in SULpeak ratio of tumor/spleen for SD, PR and PD was -24.4% (range: 19.9-[-76.9]), -36% (range: 0.7-[-84.8]) & -7.8% (range: 19.2-[39.3]), respectively.

CONCLUSION

There is generally an SUV increase in liver & spleen after C1, with little change in blood pool activity. Although there is significant overlap in measured parameters, likely limiting utility of early prediction of response on an individual basis, lower SUVmax at baseline and smaller decrease in SUVmax/ SULpeak tumor to spleen ratio were the most predictive parameters for early disease progression.

CLINICAL RELEVANCE/APPLICATION

There is significant overlap in measured DT-PET parameters, likely limiting utility of early prediction of response on an individual basis.

SSK15-06 Diffusion-weighted MRI (DWI) and 68Ga-DOTATATE PET/CT: Comparison of Both Modalities in Assessment of Tumor Response of Hepatic Metastases of Primary Neuroendocrine Tumor (NET) Undergoing Selective Internal Radiotherapy with 90Yttrium-microspheres

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E451A

Participants
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PURPOSE

To compare ADC values of DWI and SUV of 68Ga-DOTATATE PET/CT in assessing treatment response in patients with liver metastases of primary NET following SIRT.

METHOD AND MATERIALS

30 patients with 80 target liver metastases of primary NET who underwent abdominal MRI with DWI and 68Ga-DOTATATE PET/CT before and after SIRT were included. Tumor size, mean ADC values of the lesions and normal liver, intralesional SUVmax and SUV mean, tumor to spleen ratio (T/S ratio), and tumor to liver ratio (T/L ratio) were measured. Tumor response to radioembolization was categorized with respect to Response Evaluation Criteria in Solid Tumors v1.1 (RECIST) on follow-up examination.

RESULTS

67/80 metastases were categorized as stable disease (SD) and 13/80 metastases as partial remission (PR). Intralesional ADCmin and ADC mean increased significantly ($p < 0.006$) in the group of PR and SD with a significant higher increase of ADCmin values in the PR group (54,1 ± 14,6 % vs. 24 ± 4,9 %, $p = 0,02$) before and after SIRT. Currently used SUV measurements showed significant decrease in the PR group (SUV max, SUVmean, T/S ratio and T/L ratio), whereas only SUV max, SUVmean, T/S ratio (max/max) decrease significantly in the SD group. Using ROC curves, SUVmean was found the best metric (AUC 0.75), however similar results were found for ADCmin (AUC 0.7).

CONCLUSION

SUV measurements of 68Ga-DOTATATE PET/CT but also ADC values on DW-MRI seem to represent a valuable, functional maker for evaluation of response to SIRT treatment of hepatic metastases in patients with primary NET and may help in assessing further therapeutic strategies.

CLINICAL RELEVANCE/APPLICATION

DW-MRI appears similar to 68Ga-DOTATATE PET/CT for quantitative response assessment in patients with hepatic metastases of NET and may be used to guide further management of patients who undergo SIRT.

SSK15-07 Tumor Volume Remains the Most Important Variable When Considering Radiomic Feature Analysis in Anal Cancer

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E451A

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PURPOSE

Anal squamous cell carcinoma is a rare disease and most cases can be effectively with chemoradiotherapy. However if locoregional relapse occurs, outcomes following surgical salvage are often poor. Novel biomarkers have the potential to help predict response to treatment and select patients for appropriate follow up pathways based on risk of relapse. We aimed to explore the potential of pre-treatment PET-CT radiomic features in predicting locoregional failure and survival in these patients.

METHOD AND MATERIALS

257 consecutive patients between Jan 2012 and Jan 2018 underwent staging PET-CT. Clinical outcomes were overall survival (OS) and locoregional relapse. Radiomic features (RFs) comprising conventional PET and CTparameters, texture and shape features were extracted using LifeX software. Unsupervised learning, usingPrinicipal Components Analysis, on those parameters was then performed to generate clusters of patients. Clinical variables and endpoints were then assessed across the clusters generated. In addition, supervised learning, using elastic net regularisation, was also performed. Multivariable clinical risk prediction models, built using standard clinical parameters, with/without RFs were assessed using concordance probability estimate (CPE), adjusted R-squared (R2) and likelihood ratio-test statistic (LRT).

RESULTS

Unsupervised learning highlighted that: (1)many of the RFs correlated to tumour size; (2) patient clusters using RFs correlated with T-Stage and MRI size thus tumour volume. The final multivariable risk prediction model with RFs contained one textural and one volume-based PET parameter (CPE = 0.76, R2= 0.17, LRT = 36.7), which performed marginally better than a clinical model using tumour volume (CPE = 0.75, R2=0.14, LRT = 30.0).

CONCLUSION

Survival prediction models were enhanced by a textural feature and a volume-specific parameter identified using supervised learning. Primary tumour size remains the most important factor in predicting outcome. Challenges in accurate assessment of lesion size are well known on MRI, tumour volume can be easily assessed with appropriate PET-CT reporting software and this information should be considered in routine reporting and prediction modelling.

CLINICAL RELEVANCE/APPLICATION

Improvements in risk stratification may avoid excessively intense follow up protocols while ensuring early diagnosis of locoregional failure and the best chance of successful salvage.

SSK15-08 Intratumoral Metabolic Heterogeneity and Other Quantitative 18F-FDG PET/CT Parameters for Prognosis Prediction in Esophageal Cancer

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E451A

Participants
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PURPOSE

To evaluate the impact of intratumoral metabolic heterogeneity and other quantitative FDG PET/CT parameters for predicting patient outcomes in esophageal cancer.

METHOD AND MATERIALS

This IRB and HIPPA complaint retrospective study included a total of 71 patients with biopsy proven adenocarcinoma or squamous cell carcinoma of the esophagus who had a FDG PET/CT for initial staging. Automated gradient-based segmentation method was used to assess the primary tumor standardized uptake value maximum and peak (SUV max and SUV peak), metabolic tumor volume (MTV) and metabolic intratumoral heterogeneity index, calculated as the area under cumulative SUV-volume histograms (AUC-CSH), with lower AUC-CSH indexes corresponding to higher degrees of tumor heterogeneity. Patient's demographics and tumor staging were also collected. Median follow up time was 28.2±30.3 months. Overall survival (OS) and progression free survival (PFS) were calculated using univariate cox regression with the adjustment of age, gender, staging, treatment and histological grade. All pet measurements were normalized and the hazard ratios change was equivalent to one standard deviation.

RESULTS

The patients' mean age was 64±10.3 years and there were 6 patients with stage I, 11 with stage II, 31 with stage III, 21 with stage IV disease, and 2 with unknown staging. Median survival was 16.1 months. Forty-six patients died and 15 were alive as of the end of the study (for 10 patients no recent information on survival was available). Eighteen patients had recurrence as of the end of the study. Higher MTV was significantly associated with reduced PFS for every standard deviation increase (HR=0.193, 95% CI=0.052-0.711, p=0.0134). Higher AUC-CSH (lower tumor heterogeneity, homogeneous tumor) was significantly associated with increased PFS for every standard deviation increase in the area under the curve (HR=10.779, 95% CI=1.306-88.957, p=0.0272).

CONCLUSION

There was a significant association of MTV and tumor heterogeneity with progression free survival for patients with esophageal cancer.

CLINICAL RELEVANCE/APPLICATION

FDG PET/CT quantitative parameters, particularly intramural metabolic heterogeneity, can provide prognostic information on initial staging scan, potentially leading to a more personalized approach for patient's treatment.

SSK15-09 Early Utilization of SPECT/CT to Improve Localization and Reduce Time to Diagnosis and Intervention in Acute Gastrointestinal Bleeding

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E451A

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PURPOSE

Approximately 2% of the admissions to the emergency department are for acute GIB, with 1 in 4 requiring immediate attention. Planar scintigraphy using Tc-99m tagged red blood cells (Tc-99m RBCs) is used as an ideal first line diagnostic option in suspected GIB due to being non-invasive and having a very high sensitivity. However, due to this high sensitivity, it is often the case that patients with positive or equivocal Tc-99m RBC scans have negative findings on CT angiography and/or catheter based angiography. These patients that continue to bleed ultimately require provocative angiograms or invasive procedures like surgery, which are risky and often also negative. This is due to a combination of low confidence of interpretation and poor localization of planar scintigraphy. We hypothesized that by utilizing hybrid SPECT/CT in cases of suspected GIB, we would be able to improve confidence of interpretation and localization of the bleed, and this was tested and proven in our institution. Yet, while we found a high negative predictive value of adding SPECT/CT, positive predictive value was still low. As it is well known that the sooner a bleed is identified, the higher chances are of successful treatment, we proposed a new protocol in which SPECT/CT is utilized earlier. Thus, the purpose of this report is to evaluate if a change in imaging protocol with early utilization of SPECT/CT can improve localization of acute GIB and decrease time to intervention, and/or eliminate unnecessary procedures.

RESULTS

In our retrospective analysis, 49 patients who underwent planar scintigraphy and hybrid SPECT/CT for suspected acute non-variceal GIB were included. 28 of them had positive studies on nuclear imaging (planar and SPECT/CT), while 21 were negative. For confidence of interpretation, of the 20 patients that were deemed "equivocal" on planar imaging, 13 were found to be negative and 7 positive on hybrid SPECT/CT. For localization, only 6 of the 28 positive patients had a bleed that was accurately localized on planar imaging, while all 28 were accurately localized on SPECT/CT. Finally in terms of outcomes, of the 28 patients with positive studies on nuclear medicine imaging, only 6 were found to be positive on angiography or endoscopy (PPV: 21.4%). However, all 21 patients who were negative on SPECT/CT were also negative on angiography or endoscopy (NPV: 100%). In our limited experience with the new protocol in 4 cases, time to diagnosis and/or intervention has been reduced by 50%.

CONCLUSION

Our retrospective analysis previously showed that SPECT/CT improves confidence of interpretation, localization, and ultimately outcomes in the diagnosis of GIB. While the PPV of 21.4% is low, it is still higher than planar scintigraphy alone, and likely is mostly due to slow or intermittent GI bleeding that is detected by SPECT/CT but not brisk enough to be seen on subsequent testing. On the other hand, our analysis demonstrated a 100% NPV, which can be utilized to avoid further unnecessary and possibly invasive or risky tests. Furthermore, SPECT/CT eliminated "equivocal" findings which are often reported on planar scintigraphy alone, and allowed for more accurate localization in all positive cases. Due to these findings and the fact that the initial flow phase of planar scintigraphy (first minute) is comparable to the first order angiographic arterial phase, we proposed that any tests that were positive or equivocal in that first minute should have their planar imaging stopped and go directly to SPECT/CT. Thus, as opposed to 60 minutes of planar testing, these higher risk cases would have SPECT/CT imaging completed within 30 minutes of tagged RBC injection. Any that were negative on SPECT/CT would not need further provocative or invasive testing, while those that were positive would proceed directly to angiography. In our limited experience of our first 4 patients in which we have implemented this protocol, definite diagnosis (in negative cases) or intervention (in positive cases) was achieved at least 50% faster (30 minutes vs. 60+ minutes for planar plus additional SPECT/CT). Based on our findings, we propose a similar protocol be implemented in centers where GIB are evaluated and treated to improve time to diagnosis or intervention, and eliminate any unnecessary testing.

METHODS

Retrospective analysis from 2001-2014 of patients with suspected non-variceal GIB who underwent planar tagged RBC scintigraphy and hybrid SPECT/CT prior to angiogram or endoscopy/colonoscopy. Data on confidence of interpretation, localization, and outcomes were collected and analyzed. Based on the results, a new protocol was implemented at our institution as follows: all patients in whom GIB is suspected, the planar scintigraphic images are watched in the flow phase (first minute), and if there is a definite positive, probable positive, or equivocal finding, the study is stopped and a SPECT/CT is performed.

SSK16

Neuroradiology (Movement Disorders)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S401CD

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Michael M. Zeineh, PhD, MD, Stanford, CA (*Moderator*) Research funded, General Electric Company;

Sub-Events

SSK16-01 Bi-Modality MRI Radiomics Features in Identifying Parkinson's Disease and Its Clinical Subtypes

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S401CD

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PURPOSE

Due to lacking of objective biomarkers, it remains a big challenge to reach a good diagnosis for Parkinson's disease (PD). Thus, we hypothesized that, in combination with radiomics and machine-learning methods, MRI-based iron quantification and structure measurement might contribute to constructing imaging biomarker.

METHOD AND MATERIALS

245 PD patients and 170 normal controls were finally included in data analysis. All of them underwent ESWAN and high-resolution 3D T1-weighted imaging scanning. Quantitative susceptibility mapping (QSM) and R2* were processed from ESWAN data. Based on newly created age-specific QSM template, symmetrical registration technology (ANTs) was used to obtain subcortex segmentations in the individual QSM and R2* space. FSL-FIRST and ANTs-CorticalThickness methods were used to segment subcortical and cortical regions respectively. Radiomics features including histogram and GLCM features in QSM, R2* and T1 images were obtained from the segmented subcortical regions. Normalized cortical features including thickness, volume, mass and surface area were calculated. In summary, 1408 radiomics features were obtained. Random Forest (RF) algorithm was used to perform feature selection with 1000 permutation and top-20 features were selected.By inputting these top-20 features, RF classifier was constructed to classify different PD subtypes and normal controls with 1000 iterations for each test.

RESULTS

We observed that the obtained 20 features, where the mean QSM signal of bilateral substantia nigra (SN) occupied the top 2 features (the impotence were 100% for left SN and 84% for right SN), had good generalization. In the classification between PD patients and normal controls, the accuracy was 81.3%, while it was 77.4% for early PD and 81.2% for late PD. The performance to identify different motor subtypes were both 79.9%. Besides, we identically subdivided PD patients into 4 classes according to an ascending rank of UPDRS scores, and the diagnostic accuracies were 79.3%, 80.2%, 80.1% and 85% from early to late stages.

CONCLUSION

Radiomics features calculated from iron and structure images could reach a good performance of PD diagnosis. By feature selection, we confirmed that nigral iron content (mean signal) is the most important feature for PD.

CLINICAL RELEVANCE/APPLICATION

Radiomics features calculated on brain iron and structural images have good generalization ability to diagnose PD with acceptable accuracy.

SSK16-02 Diagnostic Accuracy of the Magnetic Resonance Parkinsonism Index and Midbrain-to-Pons Ratio in Differentiating Progressive Supranuclear Palsy from Parkinson's Disease and Controls

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S401CD

Participants
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PURPOSE

To compare the efficacy of MRPI and M/P ratio in the diagnosis and differentiation of Progressive Supranuclear Palsy from Parkinson's disease and Controls.

METHOD AND MATERIALS

40 consecutive patients were enrolled in this study, satisfying the diagnostic criteria by the National Institute for Neurological Disorders and Stroke, and the Society for PSP (NINDS SPSP), along with 40 PD and 40 control patients. All patients were assessed using standard MR imaging protocol.Standard MPrage sequence was included .The area of midbrain ,pons was calculated on midsagittal images while diameter of MCP and SCP on parasagittal and coronal images respectively .MRPI was calculated by multiplying the pons area/midbrain area ratio by MCP width/SCP width ratio. The midbrain/pons (M/P) ratio was measured as the ratio of midbrain area to pons area.

RESULTS

Mean MRPI in PSP patients (19.1 ± 4.87) was significantly higher than that in PD patients (9.11 ± 1.6) and controls (9.21 ± 2.11). In this study, MRPI was 100% sensitive, specific, and accurate in differentiating PSP from PD and was 100% sensitive, 100% specific, and 100% accurate in differentiating PSP from controls. Positive correlation was found between the duration of disease, and MRPI in the present study. MRPI was superior to the M/P ratio in differentiating between PSP and PD patients on an individual basis. No overlapping values were observed in the PSP and PD patients.There was moderate association between outcome of NINDS SPSP Criteria for PSP cases and MRPI (Eta squared=0.03). Also, moderate association between outcome of NINDS SPSP Criteria for PSP cases and M/P ratio (Eta squared=0.08) was seen. There was also a significant difference seen between the MRPI values of possible and probable cases of PSP (t=6.46, p>0.001).

CONCLUSION

Magnetic Resonance Parkinsonism Index is more sensitive, specific, and accurate than M/P ratio in differentiating PSP from PD in the early stages on an individual basis

CLINICAL RELEVANCE/APPLICATION

MR Parkisnons Index is a simple MRI based calculation that should routinely be included in patients with atypical Parkinsons disease and can significantly impact management and prognosis

SSK16-03 Twelve-Year Diffusion Changes in the Deep Gray Nuclei on Serial MRI in Parkinson's Disease

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S401CD

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PURPOSE

Basal ganglia pathology has been linked to motor deterioration in Parkinson's disease (PD). Diffusion tensor imaging (DTI) interrogates deep gray nuclei (DGN) microstructure in vivo, but results from cross-sectional studies in PD have been inconsistent. We investigated temporal DTI profiles in the DGN (caudate, putamen and thalamus) over a 12-year study in relation to their clinical progression.

METHOD AND MATERIALS

PD patients and HC underwent 3 scans 6 years apart (157 subjects in total at baseline), on the same 1.5T scanner. Patients were clinically evaluated using the UPDRS and H&Y staging. The standardized protocol included DTI and structural MPRAGE sequences. The DGN were segmented through FSL FIRST. Structures were individually screened and corrected during quality assessment. The segmentation masks were resampled to the DTI space and used to sample DTI indices (FA, MD, AD, RD) from each nucleus. Statistical analysis was carried out using a generalized estimating equation (GEE) to investigate differences between HC and PD at baseline, along with their longitudinal progression, adjusting for age and sex. Additionally, the GEE was used to predict H&Y and UPDRS motor scores. Statistical significance was accepted at $p < 0.05$.

RESULTS

Longitudinal analysis revealed a more severe increase in caudal diffusivity as compared to other DGN. DGN DTI indices were significantly different between HC and PD at the 3rd timepoint. Increasing diffusivity in the caudate correlated with worsening UPDRS and H&Y scores. Putaminal diffusivity correlated with worsening H&Y scores only.

CONCLUSION

Neuronal degeneration is accompanied by decrease in FA and increase in diffusivity. However, significant nucleic DTI differences only manifest in the later stages of PD. This may be secondary to known effects of iron on DTI indices, which artifactually reverse and thence blunt expected DTI changes. The correlation between increased diffusivity and worsening motor performance suggests neuronal degeneration related to PD. This degeneration likely linked to a loss of dopaminergal neurons characteristic to PD in the caudate and putamen throughout the progression of the disease.

CLINICAL RELEVANCE/APPLICATION

Temporal changes to diffusivity suggest artefactual effects from iron deposition during early stages in PD patients. Caudate diffusivity was shown to be an effective biomarker for motor performance.

SSK16-04 Response to Deep Brain Stimulation Correlates with L-DOPA Responsiveness

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S401CD

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PURPOSE

Deep brain stimulation (DBS) of the subthalamic nucleus (STN) or globus pallidus pars interna (GPi) is indicated in patients with refractory Parkinson's disease (PD) with significant motor fluctuations. While clinical characteristics facilitate patient selection, currently no objective tool to predict response to DBS exists. We examined resting state functional magnetic resonance imaging (rsfMRI) to determine the feasibility of this modality to identify early responders to DBS with minimal programming.

METHOD AND MATERIALS

Ten patients with advanced PD underwent preoperative rsfMRI under anesthesia in preparation for DBS surgery. Motor scores (UPDRS-III) were collected before and after DBS. Scans were performed on a 3T MR scanner, and images were preprocessed to correct for spatial and temporal artifacts. Regions of interest (ROIs) were defined using the Harvard-Oxford and ATAG-MNI04 basal ganglia (BG) atlases. Functional connectivity (FC) was calculated using the MATLAB®-based CONN toolbox via two-tailed bivariate correlations. Significant FC differences between patients who were good responders (> 30% improvement) following DBS versus those who were poor responders (< 30% improvement) were evaluated with an ROI-to-voxel analysis (FDR-corrected $p < 0.05$).

RESULTS

Patients who responded more favorably to DBS had desynchronization between the putamen and supplementary motor area (SMA) and synchronization between the lentiform nucleus with the superior frontal gyrus (SFG) (Figure 1), similar to characteristic changes seen following L-DOPA administration ($p=0.0001$).

CONCLUSION

Our findings show promise in the ability of rsfMRI to potentially improve patient selection and provide better pre-surgical consultation for patients regarding early prognosis from DBS.

CLINICAL RELEVANCE/APPLICATION

Resting state functional MRI (rsfMRI) can be used as an objective biomarker to identify those patients who are most likely to benefit from deep brain stimulation surgery.

SSK16-05 Functional Connectivity Patterns Predictive of Treatment Response in Deep Brain Stimulation for Dystonia

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S401CD

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PURPOSE

Globus pallidus interna (GPi) deep brain stimulation (DBS) is an effective method of treatment for medication-refractory primary generalized and cervical dystonia. However, up to 25% of patients do not respond to DBS, mainly attributed to factors such as: variation in stimulation parameters, target selection, and lack of objective biomarker. Moreover, DBS treatment in dystonia is further complicated due to delayed improvement of dystonic symptoms after stimulation, making optimal device programming challenging. An understanding of the brain connectivity patterns that underpin positive treatment response may prove to be a valuable biomarker to improve outcomes and reduce side effects by improved DBS targeting and programming.

METHOD AND MATERIALS

Group-level analysis of 39 patients with optimized DBS of GPi for primary dystonia was performed. UDRS score percentage change from pre-surgery and six months post-surgery was the primary end point. After co-registration and normalization of post-operative CT/MRI images into standard MNI atlas space, electrode contacts were reconstructed along the lead trajectories using the PaCER algorithm with manual refinement. Volume of tissue activated (VTA) was estimated based on the final DBS programming settings. The VTA was used for seed-based connectivity analysis in each subject using a group-averaged resting-state fMRI dataset of 1000 patients from the Human Connectome Project. Group-level analysis was performed using subjects' first level rs-fMRI t-score maps correlated with percentage change in UDRS score. Controlling for family-wise error rate, statistical significance was considered as $p<.001$.

RESULTS

Stimulation volumes with greater connectivity to the motor network correlated with improvement in UDRS score. In particular, the primary motor cortex, supplementary motor cortex, and ventral thalamus correlated strongly with UDRS improvement. Expected regions in the motor cerebellum (including lobules IV, V, VI, and VIII) also strongly correlated with UDRS improvement.

CONCLUSION

Functional imaging is a promising tool for medication-refractory primary dystonia patients' DBS treatment planning and outcome prediction.

CLINICAL RELEVANCE/APPLICATION

Functional MRI connectivity patterns may serve as a valuable biomarker for DBS targeting and programming in patients with primary dystonia.

SSK16-06 A Deeper Impact - Using MR Guided Focused Ultrasound for the Treatment of Essential Tremor Targeting Both Thalamic Ventralis Intermidius Nucleus and the Subthalamic Zona Incerta

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S401CD

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PURPOSE

Essential Tremor (ET) is estimated to affect 10 million people in the United States. Magnetic Resonance guided focused ultrasound (MRgFUS) is a non-invasive treatment for ET that allows targeted thermal ablation of brain tissue under real time image guidance. Previous studies have demonstrated successful targeting of the thalamic Ventral Intermedius Nucleus (Vim) to be an effective treatment in ET; this paper describes the world's first trial using MRgFUS to target both the thalamic Vim and the subthalamic Zona Incerta (ZI).

METHOD AND MATERIALS

This prospective study enrolled 13 patients with medication refractory ET for unilateral MRgFUS procedure. Tremor severity and functional impairment were assessed at baseline and regular intervals post-treatment for 24 months, using the Clinical Rating Scale for Tremor (CRST), Quality of Life in Essential Tremor (QUEST) and Bain-Findley Spirals (BFS) scores. BFS Spirals were also collated intraoperatively: immediately pre-procedure, after targeting the Vim and after targeting the ZI. All spirals were scored by 3 blinded movement disorder Neurologists. The percentage improvement in the spiral scores after Vim ablation and after ZI ablation were compared and analysed.

RESULTS

In all patients there was successful thermal ablation of the target tissue at both Vim and ZI, with improvement in all parameters over the 24months: CRST tremor score of the treated arm 73.5% and the non-treated arm 38.4%, QUEST 38%, BFS 46.9%. The intraoperative BFS scores demonstrated the additional benefit of targeting the ZI was 21.8% - improvement after Vim lesioning 27.9% but after both Vim and ZI lesioning was 49.7%. One patient (7.69%) experienced a significant adverse event; post-treatment unilateral hemi-chorea persistent at 2 years.

CONCLUSION

Our study provides further evidence that MRgFUS is an effective curative treatment for ET and demonstrates the additional benefit of targeting the subthalamic ZI with the thalamic Vim. Furthermore improvement in the tremor scores of non-treated arm shows the positive bilateral effects of targeting the ZI.

CLINICAL RELEVANCE/APPLICATION

MRgFUS has the potential to revolutionise the treatment of movement disorders such as ET It provides an non-invasive alternative

to current surgical therapies such as DBS.

SSK16-07 Cerebellar Atrophy and Cognitive Impairment in Friedreich Ataxia

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S401CD

Participants
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PURPOSE

Recent studies have suggested the presence of a significant atrophy affecting the cerebellar cortex in Friedreich ataxia (FRDA) patients, an area of the brain long considered to be relatively spared by the neurodegenerative phenomena occurring in this condition. Cognitive deficits, which occurs in FRDA patients, have been associated to cerebellar volume loss in other conditions. Aim of this study was to investigate the correlation between cerebellar volume and cognition in FRDA.

METHOD AND MATERIALS

19 patients with genetically confirmed FRDA (M/F:13/6; 28.4±14.1y), along with a group of 20 healthy controls (HC) of comparable age and sex (M/F:11/9; 29.4±9.7y) were included in this study. All subjects underwent an MRI scan including a 3D-T1-weighted sequence and a neuropsychological examination mainly oriented at cognitive domain that are related to cerebellar function (i.e. visuo-perception and visuo-spatial functions, visuospatial memory and working memory). Cerebellar global and lobular volumes were computed using the Spatially Unbiased Infratentorial Toolbox (SUIT v3.2), implemented in SPM12. Furthermore, a cerebellar Voxel Based Morphometry (VBM) analysis was also carried out. Correlations between MRI metrics and clinical data were tested via partial correlation analysis, correcting for age and sex.

RESULTS

FRDA patients showed a significant reduction of the total cerebellar volume (p=0.004), significantly affecting the Lobule IX (p=0.001). At the VBM analysis, a cluster of significant reduced GM density encompassing the entire lobule IX was found (p=0.003). When correlations were probed, a direct correlation between Lobule IX volume and impaired visuo-spatial functions was found (r=0.580, p=0.02), with a similar correlation between the same altered function and results obtained at the VBM (r=0.520; p=0.03).

CONCLUSION

With two different and complementary image analysis techniques, we confirmed the presence of cerebellar volume loss in FRDA, mainly affecting the posterior lobe. In particular, Lobule IX atrophy correlate with worst performances at visuo-spatial functions, further expanding our knowledge about the physiopathology of cognitive damage in FRDA.

CLINICAL RELEVANCE/APPLICATION

In FRDA patients, a significant cerebellar atrophy is present, mainly affecting the posterior lobe and Lobule IX in particular, which also correlate with cognitive performance in the domain of visuo-spatial abilities

SSK16-08 Functional and Structural Integrity Following Focused Ultrasound Thalamotomy and Its Correlation With Tremor Relief

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S401CD

Participants
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PURPOSE

We aim to explore the impact of MRgFUS treatment functional connectivity nd white matter integrity in tremor-related circuits and test whether tremor improvement is correlated to specific pre- or post-treatment functional responsese.

METHOD AND MATERIALS

60 patients with either essential tremor or Parkinson's disease underwent tremor and quality-of-life assessments prior to and at one and six months following focused ultrasound ablation. 21 patients underwent MRI including T1, T2-Flair and resting-state fMRI before treatment and at one day, 7-10 days, 1-3 months, and 4-12 months following it. 39 patients underwent MRI including T1, T2-Flair and diffusion tensor weighted imaging before treatment and at similiar time points to the fMRI group. Diffusivity parameters were calculated and fiber tractography measures were extracted. Changes in functional connectivity and in diffusivity parameters were assessed in different brain areas that are related to tremor.

RESULTS

Decreased functional connectivity was found between the dentate nucleus and the motor thalamus following ablation. Long term damage, was found in the ablated core and in the tract connecting the thalamus and red-nucleus. Inverse correlation was found between fractional anisotropy in the motor thalamus one day following ablation and tremor improvement in both patient groups, with lower values before treatment associated with better outcome (tremor relief) in essential tremor patients.

CONCLUSION

long-term changes in functional connectivity and white matter integrity are present following focused ultrasound thalamotomy. Regions demonstrating long-term white matter changes may be responsible for the tremor relief seen in patients, implicating these regions in the disorder's pathogenesis.

CLINICAL RELEVANCE/APPLICATION

The expected findings of this project would ultimately aid in more accurate patient selection for thalamotomy, as well as assist in further development of ET tremor treatments.

SSK16-09 Correlation between Fractional Anisotropy (FA) and Apparent Diffusion Coefficient (ADC) Changes in the Targeted Ventral Intermediate Nucleus (VIM) after MRgFUS Thalamotomy and Clinical Outcome: Preliminary Results in a Single Center

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S401CD

Participants
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PURPOSE

The aim of the study was to evaluate changes of Fractional Anisotropy (FA) and Apparent Diffusion Coefficient (ADC) in the Ventral Intermediate Nucleus (VIM) of the thalamus after MR-guided focused ultrasound (MRgFUS) thalamotomy and the correlation with clinical outcome.

METHOD AND MATERIALS

In the period February 2018-March 2019 we enrolled 39 patients with disabling and refractory tremor (18 Essential Tremor (ET), 21 Parkinson Disease (PD) tremor, mean age 64,6 years) who underwent to unilateral VIM ablation using MRgFUS. The MRgFUS sonications were performed using a 3-Tesla MRI (GE) and a focused ultrasound system (ExAblate Neuro, Insightec). Measurements of the FA and ADC values were performed before thalamotomy, and 1 day, 1 month and 6 months thereafter using Avantage Workstation AW4.7 (GE Healthcare). Clinical evaluation was performed using the Fahn-Tolosa-Marin Scale (FTM) for tremor before treatment, 1 day, 1 month and 6 months thereafter.

RESULTS

Treatment was effective (considerable and immediate reduction of tremor) in 38 out of 39 patients (97,4%). Changes in FA and ADC values after treatment were statistically significant. There was a statistically significant ($p<0,005$) positive correlation between FA values in the targeted VIM at 1 day after thalamotomy and FTM score at 6 months after treatment. There were not a statistically significant association between ADC values and clinical outcomes.

CONCLUSION

Our data have demonstrated that MRgFUS thalamotomy for treatment of ET and PD tremor results in a significant change of FA and ADC values in the target VIM. Particularly, FA values at 1 day after thalamotomy showed significant associations with clinical outcome. The limitations of this report are the small number of patients and the short follow-up period. Large randomized studies are needed to assess if FA value may be considered a possible imaging marker for early prediction of clinical outcome after MRgFUS thalamotomy for ET and PD tremor.

CLINICAL RELEVANCE/APPLICATION

MRgFUS thalamotomy for treatment of ET and PD tremor results in a significant change of FA and ADC values in the target VIM: these changes may be considered a possible imaging marker for clinical outcome and provided an important prognostic value.

SSK17

Neuroradiology (Brain Tumors 2)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S402AB

NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSK17-01 Clinical Trial Specific MRI Exam Cards: An IROC NCI NCTN Initiative to Harmonize Neuro-Oncology Acquisition Approaches in Multi-Institutional Clinical Trials for Improved AI Driven Quality Assurance and Analysis

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S402AB

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PURPOSE

As the Imaging and Radiation Oncology Core (IROC) is tasked within the NCI NCTN to assure the quality of imaging performed within clinical trials, we have monitored the consistency of MR sequence parameters. While standard of care imaging should adhere to best practices such as the Brain Tumor Imaging Protocol (BTIP), tremendous variability still exists. In order to facilitate harmonization and consistent practice, we initiated this project to develop clinical trial specific MR exam cards for neuro-oncologic imaging.

METHOD AND MATERIALS

MR acquisition parameters from 4011 exam timepoints and >21K sequences obtained within 5 clinical NCTN trials of 970 different patients were reviewed. Acceptable ranges were defined for key MR sequence parameters and prototype brain clinical trial MRI exam cards developed for three MR vendor systems (GE, Philips, Siemens). An initial local feasibility assessment followed by a pilot multi-center demonstration protocol was developed. Several DLM based AI tools were explored for automated QC testing and analytics.

RESULTS

The variability and lack of adherence to all protocol expectations was extensive, which did not necessarily impact the visual read interpretation, however did impact analytical tools. Even labeling for MR sequences presented an unanticipated variability making AI tool based processing extremely burdensome. Those findings confirmed the need for radically improved MR exam card management that has been initially piloted in our local environment and is ongoing in a multi-centered pilot.

CONCLUSION

Innovative MR Exam card management is essential to improve consistency for Neuro-Oncologic imaging especially when deep learning model based AI driven analytics are to be employed. In order to utilize QA tools at the time of image generation, the benefits of proactive exam card management are readily recognizable for both standard of care and clinical trial imaging.While distributed exam card management can not yet be done in a vendor neutral way, efforts like this will idenify the benefits and needs of such capabilities.

CLINICAL RELEVANCE/APPLICATION

Proactive exam card management is necessary for both standard of care and clinical trial imaging to enable more consistent MRI

and integration of AI driven quality assurance processes.

SSK17-02 CT, Conventional and Advanced MR Imaging Descriptors for Differentiating Tumefactive Demyelinating Lesions from Gliomas and Lymphomas: Determining ADC Cut-Off Value, Degree of Correlation and Diagnostic Performance of Descriptors

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S402AB

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PURPOSE

To determine ADC cut off values for differentiating TDLs from gliomas and lymphomas To determine degree of correlation of CT and MR descriptors with tumefactive demyelinating lesions (TDLs) in comparison to gliomas and lymphomas To determine diagnostic performance of these descriptors in differentiating TDLs from gliomas and lymphomas

METHOD AND MATERIALS

Histopathology proven consecutive cases of TDL, glioma, and primary CNS lymphoma (PCNSL) from January 2012 to August 2018 were included in study, which are 28-TDLs, 107 Gliomas (HGG-66, IGG-19, LGG-22) and PCNSL 22 cases. Plain CT brain done with 128 slice scanner. MRI protocol included T1, T2, FLAIR, DWI/ADC, SWI, DSC - Perfusion, post contrast and MR spectroscopy. All cases were evaluated by 2 neuroradiologists with 5 years experience. Evaluation of CT density in lesions were done in areas which showed enhancement in MR contrast study, they were visually graded and quantified. In MRI, lesions were evaluated for marginal T2 SI, ADC quantification, oedema, mass effect, vessels within lesion, MRS and perfusion characteristics. ADC values were evaluated for significant variation between lesions and then plotted in ROC curve for cut off value. Pearson correlation coefficient was used to analyze the degree of correlation. Logistic regression with trained model was used to obtain diagnostic performance parameters.

RESULTS

ADC cut off value obtained was 775x10-6mm2/s, below which diagnosis of PCNSL or HGG to be considered. With Pearson correlation coefficient, descriptors could be orderly arranged with respect to degree of correlation irrespective of directionality. The diagnostic performance parameters obtained for differentiating TDLs from differentials are sens-85%, sp-100%, PPV-100%, NPV-96%, Accuracy 97%. These parameters and correlation coefficients are also separately tabulated for TDL vs PCNSL, TDL vs HGG.

CONCLUSION

Use of ADC cut off value, CT and MR descriptors of high degree correlation can provide specific diagnosis of TDL with high diagnostic accuracy and can be confidently differentiated from gliomas and PCNSL.

CLINICAL RELEVANCE/APPLICATION

This study describes ADC cut off values, CT and MR descriptors which aid in specific diagnosis of TDL with high diagnostic accuracy. This is of importance, as TDLs need to be differentiated from gliomas and lymphomas due to conservative steroid management of TDLs and thus avoiding un-necessary invasive surgical procedure.

SSK17-03 Predicting Glioblastoma Recurrence from Preoperative MR Scans Using Fractional Anisotropy Maps with Free Water Suppression

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S402AB

Awards
Trainee Research Prize - Medical Student

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PURPOSE

Diffusion tensor imaging (DTI), and in particular fractional anisotropy (FA) maps have shown promise in predicting areas of tumor recurrence in glioblastoma. However, analysis of peritumoral edema, where most recurrences occur, is impeded by free water contamination of the DTI signal. In this study we evaluated the benefit of a novel, deep learning based approach for free-water correction of DTI data for prediction of later recurrence already from the first MR scans.

METHOD AND MATERIALS

We investigated 35 glioblastoma cases from our prospective glioma cohort. The preoperative MR image as well as the first MR scan showing tumor recurrence were semi-automatically segmented into contrast-enhancing and FLAIR-hyperintense areas and non-linearly co-registered. Free-water correction of DTI data was performed using a model based on an artificial neural network, trained with synthetically generated data, and RESTORE was employed for tensor estimation. 10th, 50th and 90th percentile of FA values (both for original and free-water corrected DTI data) were collected for areas with and without recurrence in the peritumoral edema.

RESULTS

We found significant differences in free-water corrected FA maps between areas of recurrence-free edema and areas with later tumor recurrence in all of the three percentiles with p10= 0.001111, p50= 0.0031 and p90< 0.00001 (Wilcoxon rank-sum test). In contrast, the original FA maps only showed differences in the 90th percentile, while the 10th and 50th percentile did not differ (p90= 0,0003 vs. p10= 0,07515 and p50= 0,079).

CONCLUSION

Free-water corrected FA maps emerge as a promising tool to better assess the peritumoral edema for tumor infiltration. After free-water correction, the FA values of regions with later tumor recurrence were significantly lower than those of pure edema. This may reflect tumor infiltration not visible in conventional imaging and may therefore reveal important information for personalized treatment decisions.

CLINICAL RELEVANCE/APPLICATION

This new approach may help to predict local tumor recurrence on baseline MR scans of glioblastoma patients which may improve surgery and radiation planning tremendously.

SSK17-04 Deep Learning-Based Discrimination between Glioblastoma versus Single Metastasis on Conventional Magnetic Resonance Images

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S402AB

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PURPOSE

To evaluate the performance of deep learning-based model in discriminating glioblastoma and single brain metastasis using conventional magnetic resonance images

METHOD AND MATERIALS

This retrospective study consecutively included 598 patients with magnetic resonance detected single brain mass, whom were pathologically confirmed as either glioblastoma (n=318) or metastasis (n=217). Among the total study group, 450 patients were randomly selected for model training (glioblastoma = 300, metastasis = 150) and 48 patients (glioblastoma = 32, metastasis=16) for model validation. Another 100 patients (glioblastoma =50, metastasis =50) were leaved out on patient-level as test dataset. Roughly placed rectangular regions of interest (ROIs) were drawn on every slice of which mass was visualized on preoperative axial T2 weighted images including the peritumoral T2 hyperintense area. Contrast-enhanced T1 weighted images were registered on the T2 weighted images and corresponding slides were also used for model training. A pretrained convolutional neural network (named ResNet50 model) was fine-tined to classify the lesions. Multi-channel representations of T1 and T2 weighted images were used for model training. Ensemble learning method was used with 5-fold cross validation.The diagnostic performance of deep learning-based model and two radiologists (with 14 and 4 years of experience) were evaluted using test dataset. Accuracy, precision, recall and F1-score were calculated for performance evaluation.

RESULTS

Te diagnostic performance of the ResNet50-based model was 89% in terms of average classification accuracy. The classifier's precision, recall and F1-score were 0.940, 0.855 and 0.893, respectively. The diagnostic accuracy, precision, recall and F1-Score of the two radiologists were 88%, 0.865, 0.9, 0.882 and 77%, 0.760, 0.745, 0.752, respectively.

CONCLUSION

Deep learning-based model can accurately discriminate glioblastoma and single brain metastasis using conventional magnetic resonance images

CLINICAL RELEVANCE/APPLICATION

Deep learning-based model may be used as a tool in preoperative decision making in cases with clinical suspicion of either glioblastoma and single brain metastasis.

SSK17-05 The Perfusion Characteristics of Dynamic Susceptibility Contrast Perfusion-Weighted Imaging in Patients' Malignant Brain Tumors Treated with Immunotherapy

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S402AB

Participants

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PURPOSE

The immune checkpoint blockade therapy is a novel treatment in the malignant brain tumors. However, it is reported that dramatic imaging change on conventional MRI is common in such patients after immunotherapy, which is a dilemma for accurate evaluation of treatment response. The purpose of this study is to assess changes of relative cerebral blood volume (rCBV) derived from DSC-PWI in patients with malignant brain tumors treated with immunotherapy.

METHOD AND MATERIALS

MRI images of 45 patients with malignant brain tumors treated with immunotherapy were reviewed. , 25 patients with radiation necrosis or pseudoprogression without immunotherapy were enrolled in this study for comparison. Pathology result or serial follow-up MRI examinations were acquired to conform the final diagnosis. The rCBV maps with contrast leakage correction were generated using FDA-approved NordicICE program. Two neruoradiologists measured the maximal rCBV ratio of rCBV without and with contrast leakage correction, and compared the maximal rCBV ratio between the true tumor progression lesions and pseudoprogression after immunotherapy, and lesions of radiation necrosis/pseudo-progression changes without immunotherapy using Mann-Whitney U test.

RESULTS

There were 27 true tumor progression lesions and 9 pseudo-progression lesions after immunotherapy were evaluated. The mean maximal rCBV ratio of rCBV with contrast leakage correction of true tumor progression lesions (2.88±1.357) was higher than rCBV without contrast leakage correction (1.27 ± 0. 69, $p<0.001$). The mean maximal rCBV ratio of rCBV without contrast leakage correction after immunotherapy was also higher than rCBV without contrast leakage correction of the patients with radiation necrosis or pseudoprogression without immunotherapy (0.83±0.55, $p=0.013$)

CONCLUSION

The MR imaging changes after immunotherapy in patients with malignant brain tumors are complex. The pseudoprogression lesion after immunotherapy may be mixed with necrosis/pseudo-progression and active inflammatory changes. The combination of rCBV without and with contrast leakage correction derived from MR DSC-PWI is useful in differentiating true tumor progression lesions with necrosis/pseudo-progression in such patients treated with immunotherapy.

CLINICAL RELEVANCE/APPLICATION

The rCBV changes are useful in differentiating true tumor progression lesions with necrosis/pseudo-progression in such patients treated with immunotherapy.

SSK17-07 Machine Learning Using Texture Analysis for Prediction of Glioma Grade Using Unenhanced Brain Computed Tomography

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S402AB

Participants
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PURPOSE

The purpose of this study was to determine whether machine learning methods based on unenhanced brain computed tomography (CT) features have adequate diagnostic ability to differentiate GBM from grade III glioma.

METHOD AND MATERIALS

We included 91 patients with pathologically confirmed high-grade glioma who underwent unenhanced brain CT for preoperative study. Of the 91 patients, 32 had grade III glioma and 59 had GB. Age, sex, tumor size, and 12 histogram and texture parameters (minimum; mean; standard deviation; and maximum normalized signal, skewness, kurtosis, homogeneity, energy, contrast, correlation, entropy, and dissimilarity) were assessed using unenhanced CT. We developed six prediction models with machine learning and calculated the area under the receiver operating characteristic curve (AUC) of the models using 5-fold cross validation; two board-certified radiologists, including one neuroradiologist and one general radiologist, compared the performances of these models.

RESULTS

The extreme gradient boosting produced the highest AUC (0.85), followed by random forest (0.79), multi-layer perceptron (0.76), support vector machine (0.75), k-nearest neighbor (0.74), and logistic regression (0.71). Age and kurtosis were the most important factors for differentiation, followed by minimum value (Gini index = 0.115, 0.115, and 0.105). AUC obtained from the extreme gradient boosting and that evaluated by the neuroradiologist were significantly higher than that evaluated by the general radiologist (0.85 vs. 0.85, 0.67, $p = 0.01$ and $p < 0.01$, respectively).

CONCLUSION

The performance of machine learning in the differentiation of GBM from grade III glioma was superior to that of an experienced general radiologist; this performance is highly dependent on the selection of the type of machine learning.

CLINICAL RELEVANCE/APPLICATION

Machine learning methods based on the assessment of unenhanced brain CT features may be a cost-effective imaging technique for differentiating GBM from grade III glioma.

SSK17-08 Prediction for Grading of Stereotactic Biopsy Glioma Targets Based on Preoperative MRI Textural Analysis

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S402AB

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PURPOSE

To explore the value of textural analysis based on T1 BRAVO+C images for grading of glioma targets by stereotactic biopsy (WHO grade II and III).

METHOD AND MATERIALS

A total of 36 diffuse glioma cases and 64 puncture targets were included in this study. All underwent preoperative MR scanning and intraoperative MR-guided stereotactic puncture biopsy. Histopathological diagnosis was WHO grade II or III diffuse glioma. By Omni Kinetics software, regions of interest (ROIs) which were consistent with the puncture target were delineated on 3D T1 BRAVO+C images, size of which was about 10×10 mm. Texture features of each ROI were automatically calculated by the software. Mann-Whitney rank sum test was used to analyze the texture differences between WHO grade II and III ROIs. Receiver operating characteristic curve (ROC) was used to evaluate the diagnostic value of textural analysis for grading glioma targets. Cutoff value was set according to Youden index, and sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were all calculated.

RESULTS

Texture features Maxintensity (P=0.001), Quantile 95 (0.002), Range (< 0.001), Variance (< 0.001), Standard deviation (< 0.001), Sum variance (0.022) and Cluster prominence (< 0.001) were higher in WHO grade III gliomas than those of WHO grade II. While WHO grade II gliomas had higher Uniformity (P=0.001) and ShortRunLowGrayLevelEmphasis values (0.018) than WHO grade III ones. First-order features Maxintensity (area under the curve (AUC) = 0.751, sensitivity = 96.6%, NPV = 94.2%), Quantile 95 (0.737, 86.2%, 80.0%) and Range (0.801, 89.7%, 87.0%); AUC value was the highest in Variance and Standard deviation (0.826); Uniformity (AUC = 0.746, specificity = 82.8%, PPV = 76.2%). Second-order gray-level co-occurrence matrix features Cluster prominence (AUC = 0.784, specificity = 89.7%, PPV = 85.8%), and Sum variance (0.675, 96.6%, 91.0%). Diagnostic efficiency of high-order gray-level run-length matrix features was slightly lower than first-order and second-order features. AUC was 0.887 (95% confidence interval: 0.805-0.969, P<0.001) by combined ROC analysis with multiple texture features.

CONCLUSION

Textural analysis on T1 BRAVO+C images may be helpful in grading glioma targets by stereotactic biopsy (WHO II and III).

CLINICAL RELEVANCE/APPLICATION

This research is helpful for grading gliomas, and guiding precise selection of puncture targets preoperatively.

SSK17-09 Reduction of Intratumoral Perfusion in Brain Cancers Patients by Noninvasive Electrical Stimulation

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S402AB

Participants
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PURPOSE

Invasive electrical stimulation of bodily tumors has been shown to reduce tumor perfusion and even potentially induce necrosis.

Transcranial electrical stimulation (tES) is currently applied in psychiatric and neurological conditions to restore neuronal activity as well as modulate brain local perfusion. Our aim was to test the safety, feasibility and efficacy of applying tES in patients with brain cancers to reduce intratumoral perfusion.

METHOD AND MATERIALS

Six patients with glioblastoma and two with metastasis underwent a single tES session (20 minutes) inside the MRI scanner before their scheduled surgery, while perfusion was assessed using pulsed Arterial Spin Labelling (ASL) MRI. Multichannel tES was applied with an MRI-compatible device according to individualized biophysical models based on manually traced tumor masks of the (i) necrotic core, (ii) solid tumor and (iii) edema region as per the RANO criteria (using T1w and T2-w MRIs). Tissue electrical conductivity values were assigned to each mask as well as to the healthy brain tissue according to existing literature. The electrical field (E-field) distribution was calculated for multiple multi-electrode solutions in order to maximize E-field over the solid tumor mass. Normalized Cerebral Blood Flow (CBF) was calculated using previously described equations (Alsop et al. 2015). CBF values were extracted from the three masks (i.e. edema, solid tumor, necrotic core) as well as from healthy control regions in the ipsilateral and contralateral hemisphere not affected by the stimulation.

RESULTS

No adverse effects were reported. Significant CBF reduction was found in the solid tumor masks (-36%, p.=0.001), ranging from -26% for glioblastoma to -45% in metastasis patients, while CBF changes for necrotic tumor core and the edema region were not significant (-8.9%, p.=0.294 and -5%, p.=0.328 respectively). Additionally, no significant CBF changes were detected in the control regions (i.e. ipsilateral regions: +5.7%, p.=0.194; contralateral ones: +5.4%, p.=0.502).

CONCLUSION

Pilot data demonstrate the safety and feasibility of using tES to noninvasively target and modulate intratumoral perfusion.

CLINICAL RELEVANCE/APPLICATION

If confirmed in larger samples, tES could be tested as a stand-alone therapy for selected brain tumor patients or as an adjuvant treatment in combination with chemo/radiotherapy.

Printed on: 10/29/20

SSK18

Physics (CT Protocols/Risk Reduction)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E353C

CT PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Tinsu Pan, PhD, Waukesha, WI (*Moderator*) Consultant, Bracco Group

Sub-Events

SSK18-01 Total Risk Index: A Mathematical Model for Decision Making Based on Clinical and Radiation Risk Assessment in CT

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E353C

Participants
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PURPOSE

Radiological risk is a combination of radiation and clinical risk (likelihood of not delivering a proper diagnosis), which together may be characterized as a total risk index (TRI). While many strategies have been developed to ascertain radiation risk, there has been a paucity of studies assessing the clinical risk. This knowledge gap makes impossible to determine the total radiological procedure risk and, thus, to perform a comprehensive optimization. The purpose of this study was to develop a mathematical model to ascertain TRI and to identify the minimum TRI (mTRI) in a clinical CT population.

METHOD AND MATERIALS

This IRB approved study included 21 adults abdomen exams performed on a dual-source single energy CT at two different dose levels (84 CT series). Virtual liver lesions were inserted into projection data to simulate localized stage liver cancer (LSLC). The detectability index (d') was calculated in each series and converted to percentage of correct observer answers (AUC) in a two-alternative forced-choice model. The AUC was converted into the loss of 5-year relative survival rate (SEER, NCI), considering an upper bound on patient's risk for a misdiagnosis of LSLC (false positive+false negative). Concerning radiation risk, organ doses were estimated using a Monte Carlo method and the Risk Index was calculated and converted in 5-year relative survival rate for cancer. Finally, the two risks were weighted equally into a combined TRI curve per each patient as a function of CTDIvol. The analytical minimum of each TRI curve provided the patient mTRI.

RESULTS

The mTRI for LSLC patients that underwent an abdominal CT exhibited a rapid rise at low radiation dose due to enhanced clinical risk of under-dosed examinations. Increasing dose offered less risk with mortality per 100 patients between 2.1 and 6.5 (mean 4.5) at CTDIvol=5mGy; between 1.1 and 5.9 (mean 3.5) at CTDIvol=10mGy; and between 0.5 and 5.4 (mean 3.0) at CTDIvol=20 mGy.

CONCLUSION

The clinical risk seems to play a more dominant factor in designing optimum CT protocols. The TRI may provide an objective and quantifiable metric of the interplay of radiation and clinical risks during the optimization of the CT technique for individual patients.

CLINICAL RELEVANCE/APPLICATION

CT risk-based Optimization can be made possible by first quantifying both radiation and clinical risk using comparable units, then calculating an overall risk, and finally minimizing the total risk.

SSK18-02 Repeated/Rejected Events in CT: A Study Quantifying their Frequency and Impact on Patient Dose

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E353C

Participants
Sean Rose, PhD, Madison, WI (*Presenter*) Nothing to Disclose
Ben Viggiano, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Timothy P. Szczykutowicz, PhD, Madison, WI (*Abstract Co-Author*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC; Medical Advisory Board, medInt Holdings, LLC; Consultant, General Electric Company; Consultant, Takeda Pharmaceutical Company Limited

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PURPOSE

We have developed and validated an algorithm for automated detection of repeat/reject CT scans. Here we use the method to identify high repeat rate protocols at two sites and estimate their associated excess dose. We additionally determine reference standard repeat rates for each protocol.

METHOD AND MATERIALS

The algorithm estimated repeat/reject rates from high-volume protocols at CT scanners from two sites using dose monitoring data collected over 3 years. The sites included a rural and an academic hospital, sites A and B, respectively. We only considered repeats consisting of additional overlapping helical/axial scans in this study. Effective doses were calculated from all exams performed with the ten highest repeat-rate protocols at each site. Site-wide reference repeat rates were identified for each protocol by pooling exams performed with similar protocols (e.g. abdomen/pelvis protocols for all patient sizes) at each site and taking the minimum aggregate repeat rate between the two sites. Reference repeat rates were used to identify protocols for which targeted training has the largest potential to reduce repeat rates.

RESULTS

Overall repeat rates were the same for both sites, 1.4% [1.2,1.6] and 1.4% [1.3,1.5] (95% confidence intervals shown in brackets). Among the ten highest repeat rate protocols, the median percent increase in mean effective dose between normal and repeat-containing exams was 107.5% (interquartile range [89.9,130.2]) for site A and 64.6% (interquartile range [44.4,88.8]) for site B. More multiphasic protocols were used at Site B relative to Site A, making the relative dose increase smaller. Using the site-wide reference repeat rate (i.e. best institution practice), we calculated Site A and B could have reduced their number of repeat exams by 55 and 42 respectively over a three year period.

CONCLUSION

Overall repeat rates at the two sites were similar, but the ten highest repeat rate protocols differed. Comparison to site-wide reference repeat rates suggests that protocol-specific intervention may be effective in reducing repeat rates at both sites.

CLINICAL RELEVANCE/APPLICATION

Our informatics based repeat/reject methodology for CT can be used to quantify excess dose delivered due to operator error and identify best practice scanning within an institution.

SSK18-03 One Size Does Not Fit All: Factors Associated With Increased Frequency Of Radiation Overexposure Alerts Based On Fixed Alert Thresholds

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E353C

Participants
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PURPOSE

To quantify the expected rate of CT radiation dose alerts for three body regions using accepted radiation benchmarks, and to assess key determinants of alert frequency.

METHOD AND MATERIALS

This IRB-approved retrospective cohort study evaluated 6 months of consecutive CT examinations performed within an academic medical system. CTDIvol x-ray tube output metrics were compared to the body-region-specific benchmark levels Achievable Doses (AD), Diagnostic Reference Levels (DRL), and Dose Notification Values (DNV), and simulated alerts were generated when benchmarks were exceeded. Frequency and proportion of events triggering alerts were calculated. A logistic regression model was fit for the outcome of simulated alert as a function of the independent predictors: scanner, body region, gender, weight, and age.

RESULTS

For 17,000 head, chest and abdomen exams, the proportion of events triggering alerts increased with weight for all scanners and body regions. Significant covariates were scanner, body region, patient weight, and age (all $p<0.0001$). Odds of alert generation for the AD, DRL, and DNV benchmarks increased by 3.3%, 3.0%, and 1.3% per pound, respectively, and by 0.8%, 1.1% and -2.7% per year of age (all $p < 0.0001$). Compared to the most highly optimized scanner, odds of alert generation varied by a factor of 595 for AD, 1126 for DRL, 13 for DNV.

CONCLUSION

Alert frequency was significantly correlated with weight, age, body region and scanner. Controllable factors include scanner functionality and associated protocol optimization. The patient factors driving alert frequency are predominantly weight, and to a lesser degree, age. Fixed dose threshold values can thus frequently produce false alerts in appropriately performed exams of large patients, while not triggering alerts in outlier scans of higher than expected dose in small patients.

CLINICAL RELEVANCE/APPLICATION

Factors influencing dose alert frequency were explored for a large cohort of CT scans in a multi-scanner environment. These have

implications to the utility of fixed dose threshold alert values.

SSK18-04 How to Use Lead Apron to Reduce Excess Radiation Dose Caused by Over-Scan in Computed Tomography Using 40mm Collimation: An Anthropomorphic Phantom Study

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E353C

Participants
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PURPOSE

The typical over-scan range with 40mm collimation in helical scans was about 25x2mm resulting in dose penalty, but the use of lead apron may be used to reduce the dose penalty. The purpose of this study was to explore the optimal way of placing the lead apron to maximize dose reduction for the over-scans without negatively impact image quality with 40mm collimation.

METHOD AND MATERIALS

We used an anthropomorphic phantom containing a pig liver, kidney, meat and a femur head in a water box to evaluate image quality with the apron placed at different distances to the imaging boundary. A scout was taken first without lead apron to determine the desired imaging range and set up the automatic tube current modulation before putting on the lead apron. The helical scan groups were designed as follows: group 1, without apron as a reference and groups 2-22 with the apron first placed at the imaging boundary and in 0.5mm increment away from the it. The scan techniques were kept the same for all scans at 40mm collimation, 120kVp, 10-740mA for a noise index of 7HU. Images were reconstructed at 5mm slice thickness and the image nearest the imaging boundary was used for analysis and comparison. 10 regions of interest (ROI, 5mm*5mm in size) of different tissues in the images were selected to measure CT value. Measurements in group 1 (without apron) were as reference standards. The CT values of the 10 ROIs in each group from groups 2-22 were compared with group 1 using Paired t-test and the CT value difference (dCT(i)=CT(i)-CT(1)) for each ROI in matched location was calculated to evaluate objective imaging quality by a boxplot. Subjective image quality was also evaluated in terms of image noise and shading artifacts.

RESULTS

In the Paired t-test, the p values were continuously greater than 0.05 for groups 13-22 (apron 5.5-10mm from the boundary) with the average dCT values smaller than 3HU . There was no difference in subjective image quality between groups 13-22 and group 1.

CONCLUSION

Placing lead apron at least 5.5mm from the imaging boundary when using 40mm collimation is recommended, reducing the over-scan dose penalty by 78%.

CLINICAL RELEVANCE/APPLICATION

Lead apron may reduce the dose penalty for the over-scans without negatively impact image quality and placing lead apron at least 5.5mm from the imaging boundary in 40mm collimation is recommended.

SSK18-05 Effect of Gonad Shields on the Automatic Exposure Control in Computed Tomography: Influence on the Development of Standard Operating Procedures

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E353C

Participants
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PURPOSE

To analyze the influence of a lead gonad shield on the automatic exposure control (AEC) of three different computed tomography (CT) scanner models to develop in-house standard operating procedures (SOPs).

METHOD AND MATERIALS

An anthropomorphic male Alderson phantom was scanned thrice with the standard abdomen/pelvis protocol on three different CT scanners (Somatom Definition Edge (1), Somatom Definition Flash (2), Somatom Definition AS (3), all Siemens Healthineers, Germany) in cranio-caudal direction. Per scanner, the phantom was scanned (a) without shield, (b) with added shield after the scout (Mavig gonad shield, 1mm Pb) and (c) scout and scan with shield, covering the entire abdomen/pelvis. Subsequently, the scan range was shortened at the cranial side with the following distances to the shield: (d) 0cm (scan range adjacent to shield), (e) 1cm, (f) 2cm and (g) 3cm. Exposure [mAs] per reconstructed slice was determined and averaged over the three repetitions.

RESULTS

Compared to scans without shield (acquisition a), inclusion of the gonad shield on the scout resulted in increased x-ray exposure: For all scanners, exposure increased adjacent to the shield for approximately one detector width (up to 15%). Along the caudal part of the shield exposure increased by up to 85%. Modulation along the cranial part of the shield varied per scanner: Exposure increased for scanner 1 (+10%), stayed similar for scanner 2 and decreased for scanner 3 (-20%). For scans without gonad shield in the scan range (acquisitions d-g), exposure still increased adjacent to the shield (up to 15%). Placement of the shield after the scout (acquisition b) did not change exposure considerably for all evaluated scanners.

CONCLUSION

Our results indicate that the FOV range needs to be adapted to the scanner's detector width when using gonad shields with AEC, or ideally, placement of the shield needs to be performed after acquisition of the scout scan.

CLINICAL RELEVANCE/APPLICATION

Even for the same vendor, the influence of gonad shields on the AEC varies per scanner model and needs to be assessed prior to the development of scanner- and protocol-dependent SOPs.

SSK18-06 An Organ Dose Calculation Tool for Fetus at Various Ages Undergoing Computed Tomography

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E353C

Participants
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PURPOSE

Pregnant patients may undergo CT in emergencies unrelated with pregnancy and potential risk to the developing fetus is of concern. It is critical to accurately estimate fetal organ doses in CT scans. We developed a fetal organ dose calculation tool using pregnancy-specific computational phantoms combined with Monte Carlo radiation transport techniques.

METHOD AND MATERIALS

We adopted a series of pregnancy computational phantoms developed at the University of Florida at the gestational ages of 8, 10, 15, 20, 25, 30, 35, and 38 weeks (Maynard et al. 2011). More than 30 organs and tissues and 20 skeletal sites are defined in each fetus model. We calculated fetal organ dose normalized by CTDIvol to derive organ dose conversion coefficients (mGy/mGy) for the eight fetuses for consequential slice locations ranging from the top to the bottom of the pregnancy phantoms with 1 cm slice thickness. Organ dose from helical scans were approximated by the summation of doses from multiple axial slices included in the given scan range of interest. We then compared dose conversion coefficients for major fetal organs in the abdominal-pelvis CT scan of pregnancy phantoms with the uterine dose of a non-pregnant adult female computational phantom.

RESULTS

A comprehensive library of organ conversion coefficients was established for the eight developing fetuses undergoing CT. They were implemented into an in-house graphical user interface-based computer program for convenient estimation of fetal organ doses by inputting CT technical parameters as well as the age of fetus. We found that the esophagus received the least dose whereas the kidneys received the greatest dose in all fetuses in AP scans of the pregnancy phantoms. We also found that when the uterine dose of a non-pregnant adult female phantom is used as a surrogate for fetal organ doses, root-mean-square-error ranged from 0.08 mGy (8 weeks) to 0.38 mGy (38 weeks). The uterine dose was up to 1.7-fold greater than the esophagus dose of the 38-week fetus model.

CONCLUSION

The calculation tool should be useful in cases requiring fetal organ dose in emergency CT scans as well as patient dose monitoring.

CLINICAL RELEVANCE/APPLICATION

The methods and tool we developed in this study should provide more accurate fetal organ dose estimations at various gestational ages, which should help radiologists and mothers to better understand the health impact of fetus undergoing CT.

SSK18-07 AEC- and Scan Time-Optimized Pediatric Body CT Protocols based on Size-Specific Dose Needs

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E353C

Participants
Megan Lipford, PHD, Madison, WI (*Presenter*) Nothing to Disclose
Timothy P. Szczykutowicz, PhD, Madison, WI (*Abstract Co-Author*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC; Medical Advisory Board, medInt Holdings, LLC; Consultant, General Electric Company; Consultant, Takeda Pharmaceutical Company Limited

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PURPOSE

We have developed a method for creating pediatric CT protocols. Currently, no methods exist for building a protocol that meets specific dose and scan time requirements for as a function of size/age.

METHOD AND MATERIALS

In our method, CT manuals and/or measurements define the maximum CTDIvol based on the tube limits and the range of available

collimations, pitches, rotation times, etc. Then, using aggregated clinical data from 210 pediatric CT body exams, we characterized the dose and scan length required as a function of patient size (AP+Lat). With these data, we created a spreadsheet having an input of acquisition parameters and scanner specific speed and dosimetry values. Combining the clinical data with the scanner input data, the spreadsheet output a maximum patient size and scan time. We demonstrate the method by building protocols for the GE Revolution and Siemens Force. For each, we build two sets of protocols: one optimized for scan speed but with limited patient size dynamic range (i.e. size bins spanning a couple years), and one clinically robust protocol that can span large size ranges with a single protocol (i.e. size bins spanning 5-10 years).

RESULTS

The speed optimized sets of protocols resulted in 5 protocols for the Force and 4 for the Revolution in order to span newborn to teenager. The clinically robust set only used 2 protocols to span newborn to teenager. Scan times for the speed optimized sets had a minimum of 0.26 s, but at that scan speed could only image to a patient size of 310 mm AP+Lat (i.e. 2 years). The clinically robust set of protocols allowed a minimum scan time of 0.48 seconds for newborns but with a dose dynamic range up to 430 mm AP+Lat (i.e. 12 years). Our results also show the scan times between these premium models were similar, with no scanner taking longer than 2 seconds to scan a pediatric abdomen.

CONCLUSION

With this method of creating protocols, it is easy to predict how parameter adjustments affect the scan time (i.e. breath hold) and range of appropriate patient sizes (i.e. ages). In our demonstration, running a scanner as fast as possible required more changes in rotation time and pitch as a function of patient size.

CLINICAL RELEVANCE/APPLICATION

Before our work, no method existed for predicting if a protocol will actually allow for enough dose or a short enough scan time on a patient size and indication basis.

SSK18-08 Diagnostic Reference Levels and Achievable Doses for Computed Tomography for EUCLID (European Study on Clinical DRLs) Defined Clinical Indications: Data from a Multinational Dose Registry

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E353C

Participants
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PURPOSE

Radiation doses for Computed Tomography (CT) examinations between patients, institutions, and countries are highly variable. Diagnostic reference levels (DRLs), and achievable doses (ADs) are often created to help reduce unnecessary variation. The European Society of Radiology has identified common indications for CT named EUCLID (European Study on Clinical DRLs) in order to create benchmarks for these examination types. We generated DRLs and ADs for these examinations.

METHOD AND MATERIALS

Standardized data from > 2.3 million CT examinations in adults 18 years of age and older were collected between January 2016 and December 2018 from 155 institutions across 7 countries in a large, multinational CT Dose Registry. Two dose metrics were evaluated: CT-dose index (CTDIvol), and dose-length product (DLP).

RESULTS

AD (50% in dose distribution) and DRL (75% in dose distribution) are summarized as follows (CTDIvol (mGy)/ DLP (mGy-cm), sample size n): chronic sinusitis (15 and 21 / 250 and 373, n= 57070), stroke to detect and exclude hemorrhage (47 and 53/ 872 and 1076, n= 14040), cervical spine trauma (19 and 30/ 450 and 962, n= 111397), pulmonary embolism (10 and 15/ 372 and 558, n= 112784), coronary calcium scoring (4 and 7/ 66 and 102, n= 22579), coronary angiography (21 and 31/ 497 and 915, n= 3176), lung cancer first and follow-up (11 and 15/ 556 and 858, n= 7064), hepatocellular carcinoma (9 and 14/ 1304 and 2016, n= 4289), colic/abdominal pain (10 and 14/ 519 and 773, n= 64724), and appendicitis/routine abdomen (11 and 16/661 and 1059, n= 721263). Most CT scans for clinical indications showed large differences in radiation dose compared to routine CT scans, e.g. sinusitis scans were >60% lower in both CTDIvol and DLP compared to routine head CT scans. Further, there were large differences in the DRLs and ADs across facilities.

CONCLUSION

DRLs and ADs for the clinical indications of EUCLID were presented and showed differences to routine CT scans. Dose metrics from large multi-center studies can help create representative DRLs and ADs that can be used for dose optimization, institutional evaluation, and indication-specific dose-optimized protocols.

CLINICAL RELEVANCE/APPLICATION

DRLs and ADs for clinical indications are essential due to high variation of CT radiation doses and for dose optimization, institutional evaluation, and indication-specific dose-optimized protocols.

SSK18-09 Reference Dataset for Benchmarking Organ Doses Derived from Monte Carlo Simulations of CT Exams

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E353C

Participants
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Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Abstract Co-Author*) Institutional research agreement, Siemens AG

PURPOSE

AAPM Report 195 contains reference datasets for the direct comparison of results between different Monte Carlo (MC) simulation tools but stops short of providing the necessary information for comparing organ doses. The purpose of this work was therefore to extend the efforts of AAPM Report 195 by providing a reference dataset for benchmarking absolute and normalized organ doses from MC simulations of CT exams.

METHOD AND MATERIALS

The reference dataset contains (1) scanner characteristics, (2) patient information, (3) exam specifications, and (4) organ dose results in tabular form. The scanner characteristics include descriptions of equivalent source spectrum, bowtie filtration profile, and scanner geometry information. Additionally, for MCNPX MC engines, normalization factors are provided to convert simulation results to units of absolute dose. The patient information was based on publicly available fetal dose models and includes de-identified image data; voxelized MC input files with fetus, uterus, and gestational sac identified; and patient size metrics in the form water equivalent diameter (Dw) distributions from the image data and from a simulated topogram. Exam characteristics include the scan length and imaging protocol specifications. For tube current modulation (TCM) simulations, an estimate of TCM is provided based on a validated method that accounts for patient attenuation and scanner tube current limitations. In this case, CTDIvol estimates were based on average tube current across the scan volume. Organ dose simulation results are given for each patient model and for TCM and fixed tube current (FTC) CT exam scenarios both in terms of absolute and CTDIvol-normalized fetal dose.

RESULTS

Results TCM and FTC simulations for absolute and normalized fetal dose are presented in tabular form with associated MC error estimates for benchmarking.

CONCLUSION

The reference dataset for MC benchmarking is now available. This will enable researchers to compare their simulations to a set of reference data.

CLINICAL RELEVANCE/APPLICATION

This dataset will for benchmarking dose management software results against MC simulations.

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SSK19

Physics (Dark-Field/X-Ray Phase Contrast Imaging)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E353B

PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Guang-Hong Chen, PhD, Madison, WI (*Moderator*) Research funded, General Electric Company
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Sub-Events

SSK19-01 Fast Data Acquisition for a Human-Compatible Multi-Contrast Breast Imaging System

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E353B

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PURPOSE

A major technical obstacle to bringing x-ray phase contrast and dark-field imaging to clinical use is the prolonged data acquisition time associated with the phase stepping procedure: the majority of the imaging time is spent accelerating-decelerating-stabilizing the x-ray grating instead of delivering the actual x-ray exposures. The purpose of this work was to introduce a fast data acquisition technique to a prototype multi-contrast breast imaging system so that the imaging time is identical to that of the clinical breast imaging procedure.

METHOD AND MATERIALS

The prototype system was constructed based on a Hologic Selenia Dimensions 3D Mammography system. During a multi-contrast image acquisition process, the diffraction grating traveled continuously along the direction parallel to the chest wall, and a train of 15 short x-ray pulses (42 ms each) was delivered by using the Zero-Degree Tomo mode (usually used for QC) offered by the Hologic system. Standard phase retrieval was applied to the 15 sub-images without spatial interpolation to avoid spatial resolution loss. The method was evaluated using both physical phantoms and a fresh mastectomy specimen (10 min post-surgery). For comparison, each object was also imaged by operating the same system under the conventional phase stepping mode.

RESULTS

The image acquisition time of the proposed method is 6 s and only limited by the scan time of the current version of the Zero-Degree Tomo mode. In comparison, conventional phase stepping took 106 s. Fringe visibility of both methods is 18±3%; spatial resolution of both methods is identical; mean glandular dose of both methods was matched at 1.9 mGy. No artifacts were observed in images produced by the proposed method.

CONCLUSION

The proposed continuous phase stepping acquisition method eliminated the overhead of imaging time imposed by the interleaved stepping motion in x-ray phase contrast imaging. A prototype multi-contrast breast imaging system equipped with this technique was developed; in this system, data acquisition, system geometry and radiation dose are all compatible with requirements of clinical breast imaging.

CLINICAL RELEVANCE/APPLICATION

The proposed fast phase stepping method eliminates the constraint on the imaging time of multi-contrast x-ray imaging, bringing this technology closer to clinical breast imaging applications.

SSK19-02 Scatter Artifact Reduction in Dark-Field X-Ray Imaging

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E353B

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PURPOSE

Dark-field X-ray imaging is a new technology to visualize the alveolar structure of lung tissue, which relies on coherent small-angle x-ray scattering. Incoherent Compton scatter overlaying the dark-field signal impedes image formation and thus hampers diagnostic interpretation. The purpose of this work was to develop and validate an algorithm to eliminate the contribution of Compton scatter to the dark-field signal.

METHOD AND MATERIALS

A slot-scanning gratings-based chest dark-field system was used to acquire raw data of phantoms and 10 human patients. Correction for Compton scattering was performed in a two-step approach. First, a conventional x-ray transmission and a dark-field image were generated by standard so-called phase-retrieval, which was implemented as a weighted least-squares fit. The conventional image was the input for a kernel-based scatter estimation method, which accounts for the system geometry, the slot width, the attenuation by the grating assembly, and the detector efficiency. Second, estimates for scattered intensity were calculated for each slot position and were accounted for as additional incoherent background radiation during a second-pass phase-retrieval.

RESULTS

The dark-field signal level is physically limited to the range from 0 to 100%. Dark-field images without scatter correction show artificial dark-field signal in areas with a large scatter fraction. This can be primarily observed in image areas of the backbone, heart, and abdomen. The developed scatter correction greatly reduces this artificial signal and allows for a better quantitative measurement of the true dark-field signal generated by lung tissue. Typically, the correction of the dark-field signal by application of the scatter correction algorithms is in the order of 20%-40% in areas of the backbone, 10% in the area of the heart, and 10-20% in the abdomen.

CONCLUSION

Quantitative dark-field signal processing is possible if the developed Compton scatter correction is applied during image processing.

CLINICAL RELEVANCE/APPLICATION

In previous preclinical small-animal studies, dark-field X-ray radiography has demonstrated the potential to detect early stages of various lung diseases. By using the proposed scatter correction method, more accurate dark-field images are obtained.

SSK19-03 Detection of Monosodium Urate Crystals in X-Ray Dark-Field Radiography

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E353B

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PURPOSE

To detect gout crystals in radiography by employing the X-ray dark-field signal caused by refractive index fluctuations of the

amorphous crystal structure.

METHOD AND MATERIALS

Monosodium urate (MSU) crystals were injected into mouse legs post mortem to simulate gout crystal deposition and then imaged in a preclinical X-ray grating interferometer setup with a rotating molybdenum anode operated at 50 kVp acceleration voltage and a photon counting detector with an effective pixel size of 166µm. All animal procedures were performed with permission of the local regulatory authority. Every image acquisition provides the dark-field image together with the conventional attenuation image at the same time. In a reader study with 3 experienced radiologists, 7 image sets of dark-field and attenuation images have been evaluated first separately and then with both images available for the reader.

RESULTS

The contrast to noise ratio (CNR) of the MSU crystals in the dark-filed image is more than a factor of 5 higher than in the conventional radiography. All readers correctly identified all three cases with injected MSU crystals and rejected most of the images without crystal injection in the dark-field images (sensitivity = 100%, specificity = 92%) but could not give a reliable diagnose based on the conventional attenuation images (sensitivity = 11%, specificity = 92%). Sensitivity, specificity and confidence level have been maximized when attenuation and dark-field image where presented simultaneously to the reader (sensitivity = 100%, specificity = 100%, confidence level = high).

CONCLUSION

Our ex-vivo study demonstrates the potential of gout detection in radiography with a grating interferometer. The simultaneous accessibility of the conventional attenuation image and the dark-field image allowed a 100% specific and sensitive diagnose in a reader study with mouse legs.

CLINICAL RELEVANCE/APPLICATION

X-ray dark-field imaging enables the detection of MSU crystals in a radiographic projection and has the potential to supersede invasive joint puncture for gout diagnosis.

SSK19-04 Variation of Darkfield Chest X-Ray Signal Strength with Breathing State

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E353B

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PURPOSE

To evaluate the lung signal strength of the first human dark-field chest X-rays with respect to the breathing state of the patient.

METHOD AND MATERIALS

We constructed a clinical prototype for grating-based dark-field chest radiography with a field of view of 37 x 37 cm², suitable for human chest imaging. It employs a scanning image acquisition procedure with an acquisition time of 7 s and a tube voltage of 70 kVp. The average effective dose for one posterior-anterior thorax radiograph is 0.04 mSv. So far, more than 60 patients have been examined in an IRB approved study in posterior-anterior orientation in two different respiratory states, viz. inspiration and expiration. From these images, the variation of the dark-field signal due to the micromorphological changes in the lung is assessed.

RESULTS

While the attenuation signal shows anatomical changes, the dark-field signal varies in strength due to underlying structural changes in the lung. In inspiration, the dark-field signal is quite homogeneous over the lung, which can be attributed to a homogeneous distribution of alveolar size and density. In expiration, the alveoli size is reduced and their packing density is increased, particularly in the lower parts of the lung. This leads to more air-tissue interfaces in the beam path, which cause small-angle scattering and thus produce a stronger dark-field signal. The variation strength naturally depends on patient cooperation, but mainly on his or her pulmonary health and ability to breathe. The difference in dark-field signal between the two breathing states allows to spatially identify regions that change micromorphologically and thus participate in the ventilation of the lung.

CONCLUSION

With this technique, it is possible to obtain spatial information about microstructural changes in the lung and thus the physiological activity of different lung regions between inspiration and expiration. The change in signal strength illustrates the origin of the dark-field signal and its sensitivity to the microstructure of the lung, promising a distinct diagnostic value of dark-field images for the assessment of lung diseases.

CLINICAL RELEVANCE/APPLICATION

The variation of dark-field signal with respect to respiration state is strong and thus motivates future investigations on its potential clinical benefit with regard to improved diagnosis and staging of lung diseases, including COPD.

SSK19-05 Grating-Based Spectral X-Ray Dark-Field Imaging for Correlation with Structural Size Properties

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E353B

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PURPOSE

Previous small-animal studies have revealed a decrease in X-ray dark-field signal for various structural lung pathologies (i.e. emphysema, fibrosis), which typically are characterized by destruction or densification of alveolar structure. In our studies we have characterized correlations between the structure size of complex samples closely resembling human lung tissue and spectral X-ray dark-field imaging with a polychromatic X-ray source.

METHOD AND MATERIALS

At a setup for grating-based X-ray dark-field imaging with a multi-threshold photon-counting detector (Direct Conversion AB, Danderyd, Sweden), various types of closed-cell foams and hollow glass microspheres were measured. By separating the incoming X-ray photons at the detector into energy intervals, two distinct correlations lengths were sampled and the according energy-dependent X-ray dark-field signal was recorded. A connection between both energy intervals was achieved by determination of the quotient of the resulting X-ray dark-field signals. The structure size of sample materials was defined using micro computed tomography scans and the subsequent calculation of mean chord length, a medically-approved measure for alveolar structure size, which is known to be affected by several structural lung diseases.

RESULTS

For increasing mean chord lengths of the sample materials, an increase of the quotient of energy-dependent X-ray dark-field signals was found. Our findings reveal the possibility to differentiate between objects based on varying structural properties in a single X-ray dark-field scan with a spectral detector. For future clinical X-ray dark-field lung imaging, this implies an increase of diagnostic power as information about destruction or densification of lung tissue are directly accessible.

CONCLUSION

A differentiation of objects with various structural properties is shown to be possible based on the approach of mean chord length and the use of spectral X-ray dark-field imaging, which forms a connection between a medical measure for alveolar structure and X-ray dark-field imaging.

CLINICAL RELEVANCE/APPLICATION

The demonstrated accessibility of information about structural properties using spectral X-ray dark-field imaging potentially increases the diagnostic power of future X-ray dark-field lung imaging.

SSK19-06 Motion Artifact Reduction in Dark-Field X-Ray Imaging

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E353B

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PURPOSE

Dark-field x-ray radiography is a new technology to visualize the alveolar structure of lung tissue. Dark-field images are generated from several x-ray exposures with a grating interferometer assembly in the beam. Motion between the exposures causes artifacts in the final dark-field image. The purpose of this work was to develop and validate an algorithm to reduce these motion artifacts.

METHOD AND MATERIALS

A slot-scanning grating interferometer was used to acquire dark-field images of 10 human study patients. Local illumination time was approximately 700 ms at total acquisition time of 7 seconds, which implies e.g. heart motion during exposure. In a first step, dark-field phase-retrieval processing based on a weighted least-squares fit was used to generate an x-ray transmission and a dark-field image. Motion artefact reduction processing relied on detection of motion-affected areas by analyzing the deviation of the weighted least-squares fit cost function from its expected value. For these areas, alternative dark-field images were generated by iteratively selecting a narrowed slot width and thus a shorter local illumination time. The selection criterion was to optimize the match of the cost function to its statistically expected value.

RESULTS

The dark-field signal level is physically limited to the range from 0 to 100%. Dark-field images generated with conventional processing revealed clearly visible motion artefacts, seen as horizontal stripes especially in the area of the heart, diaphragm, and aorta. The amplitude of these stripes reaches up to 50%. The newly developed processing achieved a substantial motion artifact reduction in dark-field images.

CONCLUSION

Local choice of a subset of exposures to generate a dark-field image can help to significantly reduce motion artefacts. Thus, the presented method enables a quantitative assessment of the dark-field signal strength in areas where lung tissue overlaps with moving objects like the heart.

CLINICAL RELEVANCE/APPLICATION

Motion artifact reduction is an important processing step if the dark-field image near moving objects like the heart is evaluated.

SSK19-07 Osteo-Articular X-Ray Phase Contrast Imaging Using Conventional Radiography Systems and a Random Modulator: Proof of Concepts on Human Fingers and Wrists

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E353B

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PURPOSE

X-ray Phase Contrast Imaging (PCI) has been introduced a few decades ago at synchrotrons. It has demonstrated an increased contrast that allows the visualization of all tissues in a single modality with high resolution. Applications of PCI on laboratory or clinical set-up often encounter various limitations due to the optics it requires. In this work we present medical results of a PCI approach on a conventional device with solely the addition of a random beam intensity modulator. We present a preliminary comparison of results between standard radiography and PCI at 80% of the conventional radiograph radiation dose.

METHOD AND MATERIALS

Phantoms and anatomical pieces (human finger and hands) were imaged. Two different X-ray commercially available devices were used: a C-arm Siemens ARCADIS Avantic and a radiography table Primax Clisis Exel. The samples were imaged using both the standard radiography and the PCI approaches at 60 kvp and with clinical compatible doses. For the PCI acquisitions, a single thin random modulator was included upstream of the samples. Before imaging the samples, a first radiograph of the modulator was taken. Then, by numerically processing the couples of images taken with and without the sample, we are able to map the phase shifts induced by the samples.

RESULTS

The phase maps of the samples were obtained using the conventional device. The image quality from X-ray PCI visually permits the visualization of features invisible to conventional X-ray imaging techniques such as Styrofoam ball, cartilage thickness, micro calcifications, bone microstructures.

CONCLUSION

The study shows that, with a simple beam modulator, phase maps can be retrieved on conventional devices. Here, the experimental complexity of PCI is translated in to the numerical processing side. Despite not yet being implemented in routine, the PCI improved visualization capabilities demonstrated so far suggests that healthcare could significantly benefit from a widespread application of PCI. These preliminary results combined with more recent technical developments let foresee the availability of the proposed PCI method on conventional sources in a close future.

CLINICAL RELEVANCE/APPLICATION

This study presents the results of medical PCI using conventional X-ray device modified with an additional simple random modulator. The results reveal some advantages of PCI over standard radiograph.

SSK19-08 Dosimetry for Combined Dark-Field and Attenuation Chest X-Ray Imaging on Patients

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E353B

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PURPOSE

To demonstrate that the applied effective dose for patient examinations at the first clinical X-ray dark-field chest radiography system is within a clinically acceptable dose range.

METHOD AND MATERIALS

A clinical setup for grating-based dark-field chest radiography was constructed which operates at an acceleration voltage of 70 kVp. The study was approved by the institutional review board and the national radiation protection agency. To obtain conversion coefficients relating effective dose to dose area product (DAP) at the dark-field system, thermoluminescent dosimeter (TLD) measurements were conducted using a phantom with approximately 200 TLDs, modeling the ICRP reference man with a body weight of 73.5 kg and a trunk length of 68 cm. The effective dose for the TLD measurements was calculated with weighting factors according to ICRP 103. For n = 53 patients, the DAP values for both posterior-anterior (pa) and lateral (lat) measurements were collected at the dark-field system and a conventional radiography system which is operated at 125 kVp. With the determined conversion coefficients, the respective effective dose was calculated.

RESULTS

The average effective dose for one measurement at the dark-field radiography system in pa orientation is determined to 44 µSv in the case of a typical patient as modeled by the anthropomorphic phantom. For the conventional system, an effective dose of 18 µSv was determined. For the examined patients, we obtain an average effective dose of pa: (40 ± 21) µSv (lat: (81 ± 34) µSv) at the dark-field system and pa: (13 ± 5) µSv (lat: (34 ± 31) µSv) for the conventional device. A strong variation in effective dose was observed, as patients of various weights and heights were imaged while targeting a fixed detector dose.

CONCLUSION

The effective dose at the clinical dark-field radiography system is about a factor of three higher compared to a conventional system. A potential diagnostic value provided by this novel contrast modality, which will be evaluated in further studies, could justify the higher dose.

CLINICAL RELEVANCE/APPLICATION

Dark-field chest radiography is compatible with clinical dose requirements, thus it qualifies as a potential mass screening tool for early detection of pulmonary disorders.

SSK19-09 Characterizing Cartilage Microarchitecture on Phase-Contrast X-Ray Computed Tomography - A Machine Learning Approach

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E353B

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PURPOSE

Phase-contrast x-ray computed tomography (PCI-CT) has been shown to achieve soft-tissue contrast with micrometer scale resolution for cartilage imaging. In this study, we investigate the ability of deep learning with convolutional neural networks (CNNs) to characterize and classify between chondrocyte patterns in healthy and osteoarthritic cartilage.

METHOD AND MATERIALS

A total of 842 regions of interest (ROI) were annotated from five osteochondral cylinders (7 mm diameter, 3 osteoarthritic, 2 healthy) extracted from post-mortem human patellae. Specimens were subject to high-resolution (voxel size 8 µm3, 26 keV, synchrotron source) phase-contrast x-ray CT imaging. ROIs were defined for capturing chondrocyte patterns in the radial zone of the cartilage matrix. The deep learning task was performed using a pre-trained CaffeNet neural network. We obtained representations from each of the eight layers of this network serving as input features for supervised machine learning. Random sub-sampling cross-validation was utilized in optimizing a support vector machine with a radial basis function kernel for classifying healthy and osteoarthritic cartilage. Additionally, ROIs from the same subject were not used for training as well as testing. Classification performance was evaluated by Area Under the Curve (AUC) for Receiver Operator Characteristics (ROC) analysis. Furthermore, we compared the results obtained with traditional first and second-level (measures from gray-level co-occurrence matrices) statistical features.

RESULTS

An AUC=0.81 was achieved for differentiating between healthy and osteoarthritic cartilage, when features were extracted from the first fully connected CNN layer. Interestingly, the best classification performance was observed for features extracted from the last fully connected as well as the last convolutional layer (AUC=0.91 for both). For comparison, conventional first and second order statistical features performed poorly (best AUC=0.78, $p<0.05$, Wilcoxon signed-rank test).

CONCLUSION

Features from internal layers of pre-trained CNNs achieve high classification performance and can serve as benchmarks for cartilage characterization, as they significantly outperform traditional statistical features.

CLINICAL RELEVANCE/APPLICATION

Deep learning approaches for cartilage pattern characterization on phase-contrast CT imaging can contribute to the development of diagnostic imaging biomarkers for osteoarthritis.

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SSK20

Radiation Oncology (Genitourinary)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S102CD

GU RO

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSK20-01 A PSMA-PET-Radiomics Signature Model for Characterization of Gleason Score in Patients with Prostate Cancer

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S102CD

Participants
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PURPOSE

To evaluate the performance of PSMA-PET-radiomics modelling for non-invasive characterization of Gleason score (GS).

METHOD AND MATERIALS

Twenty prostate cancer (PCa) patients, who underwent [68Ga]-PSMA-PET/CT followed by radical prostatectomy, were prospectively enrolled. Two PCa segmentations were performed: the PCa manually contoured by experts (GTV-Exp) and the coregistered histopathological PCa (GTV-Histo). 133 PET image features (IF) were computed. The study involved: (i) the comparison of IF derived from PCa and non-PCa ; (ii) the comparison of IF derived from both segmentations (GTV-Histo vs GTV-Exp); (iiii) the evaluation of the IF correlations with GS and (iv) the development of a radiomics signature model for GS characterization. Comparisons were analysed in terms of two-tailed Mann-Whitney U test for non-pairwise testing (i) and Spearman's correlation test (ii and iii). The incorporation of features into multivariable models (iv) was performed using logistic regression. Model development involved imbalance-adjusted bootstrap resampling in the following processes: IF selection, prediction performance estimation and computation of model coefficients.

RESULTS

Most IF discriminated significantly between PCa and non-PCa tissue: 76% for GTV-Histo and 81% for GTV-Exp. 82% of the IF derived from GTV-Expert showed significant strong correlation (r>0.8) with respect to the IF derived from GTV-Histo. For GTV-Exp, the best performance in GS characterization was observed for the IF short-zones-high-gray-level emphasis-after-quantization-resampling (QSZHGE) with area-unde-the-curve (AUC) of 0.91. In addition, a radiomics signature (5 IF) discriminated between GS 7 and >=8 (AUC=0.93 and sensitivity=0.90). Preliminary validation with an internal cohort of 20 additional patients (GTV_Exp_val) confirmed the results.

CONCLUSION

From our results it could be proved the feasibility of model development based on PSMA-PET radiomics for GS characterization.

CLINICAL RELEVANCE/APPLICATION

GS characterization has an impact on clinical decision making as it defines intermediate- and high-risk PCa patients which influences for example the duration of androgen deprivation therapy during radiation therap. Because of the fact that GS before primary therapy is based on biopsy tissue, a model derived from PSMA-PET radiomics could serve as an alternative for non-invasive GS characterization in the future.

SSK20-02 Pre-Treatment Quantitative Multi-Parametric MRI Can Predict the Biochemical Outcome of Prostate Cancer Patients Undergoing Radiotherapy

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S102CD

Participants
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PURPOSE

Up to one-third of men treated with radiation therapy (RT) for prostate cancer may experience biochemical failure, often identified beyond 5 years of follow-up. An earlier diagnosis of recurrent prostate cancer can better inform prognosis and treatment. This study evaluates whether quantitative multiparametric MRI (mpMRI) can be used to predict the biochemical outcome of prostate cancer (PCa) patients.

METHOD AND MATERIALS

Fifty-one patients with biopsy confirmed PCa underwent prostate mpMRI on 3T Philips MR scanner prior to RT with a median dose of 78 Gy. 51% had concurrent hormonal therapy for a median of 16.5 months. The index lesion was outlined by a radiologist and quantitative ADC, T2 and DCE parameters (Tofts model) were measured. The biochemical failure based on Phoenix criteria was associated with these values.

RESULTS

After a median follow-up of 65 months, 6 patients had biochemical failure, and 3 had distant metastasis. ADC had an area under the ROC curve of 0.71 for predicting RT outcome with significantly (*t*-test) lower ADC (0.78±0.17 vs 0.96±0.26 µm2/ms, p=0.04) found in patients showing biochemical failure. Ideal ADC cutoff point (Youdens index) was 0.96 µm2/ms which had a sensitivity of 47% and specificity of 100% for biochemical failure. Kaplan-Meier analysis showed that lower ADC values predicted for significantly lower freedom from biochemical failure (p=0.03, no failures out of 20 men if ADC >=0.96 µm2/ms; 7 of 31 with failures if ADC <0.96 µm2/ms). Quantitative T2 and DCE parameters were not associated with biochemical outcome.

CONCLUSION

This study demonstrates that quantitative mpMRI, and specifically ADC values, are associated with biochemical outcome in patients with PCa treated with RT. Lower ADC values were associated with biochemical failure.

CLINICAL RELEVANCE/APPLICATION

Quantitative MRI, specifically ADC values can predict biochemical outcomes in PCa patients undergoing RT, with lower ADC values associated with biochemical failure. mpMRI may improve risk stratification and help determine optimal treatment.

SSK20-03 Integrated Gene Expression Score in Circulating Tumor Cells to Predict Treatment Response in Muscle-Invasive Bladder Cancer

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S102CD

Participants
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PURPOSE

Muscle-invasive bladder cancer (MIBC) is often treated with radical cystectomy, but select pts can be treated with bladder-sparing trimodality therapy (TMT) with comparable long-term survival. There is an urgent need for reliable biomarkers to optimize treatment selection and detect disease recurrence early. Circulating tumor cells (CTCs) in the blood have potential as non-invasive, serial "liquid biopsies" to predict and monitor therapeutic response. The purpose of this study is to develop a CTC gene expression score (CTC-GES) to monitor response to TMT using microfluidic CTC isolation coupled with droplet digital PCR.

METHOD AND MATERIALS

Candidate genes were identified by differential expression analysis comparing RNA-seq data from MIBC (TCGA; n=67) to normal bladder (GTEX; n=11) and leukocytes (n=20). Primer/probe sets for each gene were validated using bladder cancer cell lines (RT4: luminal, HT-1376: basal) spiked into healthy blood. Blood is being collected from a discovery cohort of MIBC pts undergoing TMT (n = 11 to date, median age 73 yr) at several time points (baseline, on-treatment, two-month follow-up). CTCs were isolated using

the microfluidic CTC-iChip and the CTC-GES was computed as log(?(positive droplets/mL blood)+1).

RESULTS

Eight candidate genes (PPARG, UPK1A, UPK2, KRT14, EGFR, KRT19, TMEM129, DSG2) were analytically validated and comprised the CTC-GES. The assay lower limit of detection was 3 CTCs per 10 mL blood. The assay predicted recurrences >2 months prior to clinical detection. At a median follow-up of 20.3 weeks for the 5 pts to date with all time points collected, development of metastatic disease was associated with an increase in CTC-GES from baseline to on-treatment (n = 3), whereas a decline in CTC-GES was seen in 2 pts with no evidence of disease (average ΔGESmet = +2.61 vs. ΔGESNED = -0.43; p=0.048).

CONCLUSION

We have developed a novel CTC gene expression score for MIBC pts undergoing TMT. Our preliminary data suggests this biomarker can predict cancer recurrence more than two months prior to clinical detection. In contrast to circulating tumor DNA, CTC-GES does not require interpatient customization based on prior knowledge of specific mutations.

CLINICAL RELEVANCE/APPLICATION

With continued refinement and substantiation, the CTC-GES has potential as a universal biomarker in MIBC to predict early failures after TMT and enable treatment modification/intensification at a lower disease burden.

SSK20-04 Radium 223 Therapy in Hormone Refractory Metastatic Prostate Cancer: Clinical and Quality of Life Outcomes

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S102CD

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PURPOSE

Radium 223 (Ra 223) has been shown to improve survival in hormone refractory metastatic prostate cancer. However, the optimal duration of therapy and its true benefit in improving quality of life is not clear in patients who have already undergone extensive systemic therapy. We present the outcomes from a single community institution with mature follow-up.

METHOD AND MATERIALS

Fifty four patients with refractory metastatic prostate cancer were treated between August 2013 and April 2019. The median age of the patients was 76 years (range 49-100). The median number of chemotherapy regimens used proir to starting Ra 223 was 3 (range 1-7). The treatment plan was to use 6 monthly injections of Ra 223 at a dose of 1.49 microcuries.kg. The patients were followed regularly in both radiation oncology and medical oncology clinics to assess pain control, quality of life and overall survival.

RESULTS

The median follow-up was 18 months (range 1-48). The median survival time was 8.3 months (range 1-48). Twenty six (48%) of the patient completed all planned 6 monthly injections. The median survival for the patient who completed all 6 cycles of therapy was 16 months (range 7-48) as compared to 5.2 months (range 1-22) who received less than planned 6 cycles ($p<0.01$). Adequate pain relief was noted in 70% and improved ambulation was observed in 64% of cases, in patients who finished all planned therapy. Disease progression was the cause of early stoppage of Ra 223 therapy in 86% of cases. Fatigue was the most common symptom at the end of therapy in 72% of cases.

CONCLUSION

Only half of the patients who receive Ra 223 completed all planned 6 monthly injections. Improved survival, adequate pain relief and better ambulation was seen in patients who completed planned therapy. Earlier use of therapy may result in better treatment outcome as compared to delayed use in this patient population.

CLINICAL RELEVANCE/APPLICATION

Completion of all planned six cycles is necessary to have an improved survival, pain relief and quality of life in hormone refractory metastatic patients receiving Ra 223 therapy.

SSK20-05 Patterns of Failure by Gallium-68 PSMA PET For Biochemically Recurrent Hormone Sensitive Prostate Cancer Following Prostatectomy and Salvage Radiotherapy

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S102CD

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PURPOSE

Disease localization for patients who develop biochemical failure post radical prostatectomy (RP) and salvage radiotherapy (SRT) is critical for optimizing subsequent management strategies. The role of Gallium-68 PSMA PET is not established in this setting after SRT.

METHOD AND MATERIALS

We analyzed 70 non-castrate men with 71 total Gallium-PSMA PET scans obtained on a prospective imaging trial (NCT03204123) for PSA recurrence after prior RP+SRT. Men with known metastasis or castrate resistance were excluded. A PSMA scan was called positive if at least one avid site was interpreted as at least 'possibly' metastatic. For patterns of failure analyses, pelvic lymph nodes (PLN) included common iliac, internal/external iliac, obturator, perirectal and presacral.

RESULTS

Post RP, most had pT3/4 disease (73%), 26% had extracapsular extension, 30% had positive margins and 23% were pN1. Median time from RP to SRT was 1.6 years (IQR 0.6, 4.1). SRT fields included the prostate bed only (56%), prostate bed and PLN (41%) or unknown (3%) delivered to a median total prostate bed dose of 72 Gy (range 58-81). PSMA scans were performed a median of 4.4 years (interquartile range 2.3, 8.8) post SRT when median PSA was 1.1 ng/mL (IQR 0.4, 2.8). Overall, 51 scans (72%) were positive; positivity rates by pre-PSMA PSA levels of <0.5 (n=26), 0.5-2 (n=23) and >2 ng/mL (n=22) were 69%, 61% and 86%, respectively. Patterns of failure were heterogeneous (Figure). 9 scans (13%) had concern for prostate bed recurrence; with respect to SRT, 5 recurrences (7%) were in field, 3 (4%) were marginal and 2 (2%) were out of field. 27 scans (38%) had concern for PLN relapse, of these, SRT fields had included PLN in 9 (33%). Incidence of PLN relapse was not significantly lower (p=0.2) in men who received SRT to the pelvic nodes. 29 scans (41%) had at least one distant avid site. 20 (28%) had at least one PSMA avid site biopsied, of which 80% were positive.

CONCLUSION

There is predictive value in the use of PSMA PET for men with PSA recurrence after RP and SRT. Patterns of failure are heterogeneous but relapse in the irradiated prostate bed is rare. PSMA may be an important tool to identify men who remain salvageable post SRT.

CLINICAL RELEVANCE/APPLICATION

68Ga-PSMA PET identifies recurrence in the majority of men with PSA recurrence post prostatectomy and salvage radiotherapy and information regarding sites of residual disease would be critical for guiding further personalized treatment interventions.

SSK20-06 Assessment of Patterns of Failure with Gallium-68 PSMA PET for Early Biochemically Recurrent Prostate Cancer following Primary Prostate Radiotherapy

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S102CD

Participants
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PURPOSE

There is a lack of information regarding the value of PSMA PET scans for disease evaluation after definitive prostate radiotherapy (RT). Improved detection following RT will offer opportunities for targeted treatment and may improve disease-free survival outcomes.

METHOD AND MATERIALS

We analyzed 28 non-metastatic patients who underwent Gallium-68 PSMA PET scans after definitive prostate RT. All were enrolled

on an IRB-approved prospective imaging trial. Patients' initial PSA level was low (14%), intermediate (46%), and high (40%) and 4 (14%) had N1 disease. Definitive RT approaches were conventional EBRT (43%), brachytherapy-based regimens (46%), and hypo-fractionated EBRT (11%). Post RT, all had at least 2 consecutive PSA rises and 17 (60%) had nadir+2 relapse. A PSMA scan was considered positive if at least one avid site was noted as at least possibly metastatic. Pelvic lymph nodes (PLN) included common iliac, internal/external iliac, obturator, perirectal, and presacral. 22 (78%) had an available pelvic MRI for comparison to PSMA PET. Median time from RT to PSMA PET was 6 years.

RESULTS

Prior to PSMA PET, 4 (14%), 4 (14%) and 21 (75%) had PSA ranging between 0.5-1, 1-2, and >2 ng/mL, respectively. For these PSA ranges, the incidence of a positive PSMA scan was n=1 (25%), n=4 (100%), and n=18 (86%), respectively. Among the 23 patients with positive PSMA, local prostate/SV failure, PLN failure, and distant failure rates were n=14 (50%), n=7 (25%), and n=12 (48%), respectively. We observed prostate only, PLN only, and distant only failure in 8 (35%), 1 (4%), and 5 (22%) patients. 9 patients were initially treated with RT to the pelvis and only 1 (11%) of these patients failed in a PLN. Pelvic MRI revealed nodal recurrence in only 3 men (14%) but local recurrence in 11 men (50%). Discordant PSMA and MRI findings were noted in 22 (41%) cases. Based on PSMA results, 15 underwent further treatment, which included salvage RT to sites of PSMA avid disease (n=8).

CONCLUSION

PSMA PET provides information beyond other diagnostic studies routinely obtained for restaging. While MRI remains valuable for detecting intraprostatic relapses, PSMA was advantageous for detecting PLN and distant failures.

CLINICAL RELEVANCE/APPLICATION

PSMA PET identifies radiographic recurrence (mostly PLN) among patients whose PSAs demonstrate consistent rise after primary radiotherapy but prior to reaching nadir+2 biochemical relapse.

SSK20-07 SBRT Re-Irradiation Therapy for Locally Recurrent Prostate Cancer after External-Beam Radiation Therapy

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S102CD

Participants
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PURPOSE

The aim of this study is to evaluate the toxicity of re-irradiation with stereotactic body radiotherapy (SBRT) in pts with recurrent prostate cancer after external beam radiotherapy (EBRT) in order to assess the potential risk predictors of rectal and urinary toxicity.

METHOD AND MATERIALS

From Apr 2011 to Feb 2019, SBRT was delivered to 11 pts for isolated local recurrence of prostate cancer. 10 pts were high risk while a patient was an intermediate risk. The pts were previously treated with 3DCRT to a median dose of 76,6Gy (68-78Gy). After a median time of 40 mos (13-84 mos), the pts had recurrences confirmed by multiparametric MRI and 18Ffluorocoline PET-CT. Median PSA at the time of SBRT was 4,38 (2.5-9.9). The prescribed dose was 30 Gy in 3fx to 80% isodose in 9 pts and 30Gy in 6fx to 80% isodose in 2 pts. The PTV delineation was performed on CT-MRI fusion to limit normal tissue toxicity. The VMAT treatment was delivered by 6MV Linac. CBCT was employed to control patient set-up before each fraction. Toxicity was evaluated according to CTCAE v.4.0 and the treatment response was assessed by PSA. Dose to rectum and bladder (Dmax of EBRT+SBRT plans) were evaluated using DVH converted into NTD2Gy (a/ß ratio=3Gy for rectum and a/ß ratio=5Gy for bladder) to determine factors that predict toxicity.

RESULTS

Median follow-up was 8 mos (range 1-18). LC, defined by PSA returned to zero, was achieved in all treated pts. Two pts (18%) had a biochemical failure due to metastatic progression without local recurrence. 4 pts (36%) showed grade<=2 urinary toxicity and no grade>2 acute gastrointestinal or late toxicities were reported. Dmax was predictive for toxicity of bladder (98 Gy) and rectum (130 Gy).

CONCLUSION

SBRT re-irradiation of prostatic recurrences after EBRT showed favorable results in terms of LC. In our experience only two relapses occurs outside of prostate gland. Acute and late toxicity was mild. In our study a threshold Dmax (98Gy) for bladder may be related to a greater probability of low toxicity and confirms data already published in literature (Dmax=130 Gy) for rectum. The results need to be confirmed with more pts and longer follow up.

CLINICAL RELEVANCE/APPLICATION

Prostate re-irradiation with SBRT

SSK20-08 Constraining Rectal Dose to Attain Higher Dose Coverage to Prostate Volumes in Robotic SBRT Using Perirectal Hydrogel Spacer for Low- and Intermediate-Risk Prostate Cancer

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S102CD

Participants

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PURPOSE

Avoiding or minimizing acute and delayed rectal toxicities is a critical objective for safe dose-escalation in prostate SBRT. This retrospective study aims at examining if there is a dosimetric benefit in using perirectal hydrogel spacers for patients eligible for SBRT treatment per PACE Trial for low- and intermediate-risk prostate cancer.

METHOD AND MATERIALS

The study included 16 prostate cancer patients, 8 were planned with perirectal hydrogel spacer and the other 8 with no spacer. CT and T2-weighted MRI (when available) scans were used with SBRT plans optimized with the Volo Optimizer in a PrecisionTM TPS (2.0) utilizing MLC-based delivery on a CyberKnife M6 system. CTVs include prostate and 1.5-2.0 cm proximal seminal vesicles under the intermediate-risk prostate cancer scenario. PTV margins were 3-5 mm per PACE protocol with 36.25 Gy to PTVs and 40 Gy to prostate volumes and a mandatory rectum constraint V36 <= 1.0 cc. Comparisons are made for the volume overlaps between rectum and PTV, dose coverage to the prostate (V40) and PTV (V36.25), and absolute prostate sub-volumes receiving < 40 Gy. In addition, to examine if placing the spacer may lead to consistent rectal dose reduction, rectum DVH profiles are compared by requiring both V40 >= 95% for prostate and V36.25 >= 95% for PTV and no overriding priority for rectum V36 <= 1.0 cc.

RESULTS

In planning under the intermediate-risk case scenario, the mean rectum overlap with PTV was 2.0 cc (range 0.8 to 3.9 cc) in the no-spacer group, and 0.2 cc (range 0.0 to 0.4 cc) in the spacer group. The mean prostate V40 is 93.2% (range: 78.4% to 99.3%), the mean PTV V36.25 is 94.3% (range: 90.7% to 97.4%), and the mean prostate sub-volume receiving <40 Gy is 3.8 cc (range: 0.3 to 10.7 cc) in the no-spacer group; The mean prostate V40 is 98.9% (range: 96.6% to 100%), the PTV mean V36.25 is 97.5% (range: 94.9% to 99.9%) and the mean prostate sub-volume receiving <40 Gy is 0.8 cc (range: 0.0 to 2.3 cc) in the spacer group. By requiring both prostate V40 >= 95% and PTV V36.25 >= 95%, the mean rectum V36 is 1.5 cc (range: 0.2 to 2.8 cc), the mean V18.125, V29, V32.625 and V36.25 are 31.0%, 11.0%, 6.3% and 1.9% in the no-spacer group; and the mean rectum V36 is 0.5 cc (range: 0.0 to 1.0 cc), the mean DVHs values are 35.9%, 8.6%, 3.7% and 0.6% in the spacer group. Similar trends were observed for planning the low-risk prostate cancer scenario.

CONCLUSION

Significantly lower rectum overlaps with PTV are achieved by using perirectal hydrogel spacer. Preliminary results reveal a promising way to consistently lower the dose to the rectum while attaining higher specified dose coverage to the prostate volumes for low- and intermediate-risk prostate cancer.

CLINICAL RELEVANCE/APPLICATION

This study provides a first report on the dosimetric benefits of consistent rectal dose reduction while safely escalating dose to the clinical target volumes by using perirectal hydrogel spacer for prostate cancer patients eligible for SBRT under the international randomized PACE trial for treating low- and intermediate-risk prostate cancer.

SSK20-09 TraceIT: A Prospective Pilot Study Evaluating the Role of a Temporary Intravesical Fiducial Marker for Bladder Cancer Image-Guided Radiation Therapy

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S102CD

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PURPOSE

Daily anatomic variability of the bladder and challenging visualization of the bladder tumor bed limits the ability to offer image-guided radiotherapy (RT) for patients with muscle-invasive bladder cancer (MIBC). We hypothesized that TraceIT, an injectable biocompatible hydrogel, could offer a safe and feasible temporary bladder wall fiducial marker to guide RT planning and daily image guidance on cone-beam CT (CBCT) in patients undergoing definitive RT.

METHOD AND MATERIALS

We enrolled 12 patients in an IRB-approved prospective observational cohort study from 2017-2018. Eligibility included MIBC planned to receive definitive RT or chemoRT over at least 4 weeks of daily treatment. TraceIT hydrogel was injected around the circumference of the tumor bed during pre-treatment and/or midcourse transurethral resection of the bladder tumor. The primary endpoint was fiducial marker localization to assess interfraction motion on daily CBCTs. Van Herk (VH) margin equation was used to determine the planning target volume margin optimized for the clinical target volume receiving at least 95%-prescription dose in 90% of patients. Toxicities were measured by CTCAE v4.

RESULTS

12 MIBC patients underwent RT to a median total dose of 64.4 Gy [37.5-66.6]. Median TraceIT volume was 0.5cc [0.3-0.75] per site for a total of 4 [4-6] sites per patient with a total volume of 2cc [2-3]. All patients demonstrated 100% visibility of TraceIT on the initial simulation CT-scan and day 1 CBCT. Average visualization of TraceIT after the initial and boost phase of RT was 91.5% [40-100] and 82.5% [0-100%], respectively. For the initial phase, alignment to fiducials over bone anatomy allowed for reduced VH margins (0.95cm vs 1.57cm). This was due to decreased total systematic error from 0.64cm (bone) to 0.23cm (fiducial) (p=0.005). For the boost phase, the VH margin was similar between fiducial and bone alignment (1.06cm vs 0.95cm). No grade >=1 toxicity was observed related to TraceIT.

CONCLUSION

TraceIT serves as a feasible intravesical fiducial that can aid in target delineation for RT planning and daily image-guidance, which may allow for increasingly conformal margins to reduce toxicity and improve tumor control via dose escalation.

CLINICAL RELEVANCE/APPLICATION

For bladder cancer radiotherapy, TraceIT is a feasible intravesical fiducial marker for tumor bed visualization and image-guidance, allowing for reduced margins with the goal of decreased toxicity.

Printed on: 10/29/20

SSK21

Vascular/Interventional (Peripheral Arterial Disease)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E260

IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Dimitrios Filippiadis, MD, PhD, Athens, Greece (*Moderator*) Nothing to Disclose
Bora Peynircioglu, MD, Ankara, Turkey (*Moderator*) Nothing to Disclose
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Sub-Events

SSK21-01 Inguinal Lymphadenopathy as a Negative Prognostic Factor for Clinical Success after Technically Successful Endovascular Treatment in Patients with Critical Limb Ischemia

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E260

Participants
Daniel Raskin, Ramat - Gan, Israel (*Presenter*) Research Consultant, AIDOC
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Shmuel Balan, Ramat Gan, Israel (*Abstract Co-Author*) Nothing to Disclose
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Uri Rimon, MD, Tel-Hashomer, Israel (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the correlation between inguinal lymph node characteristic and ipsilateral primary amputation rates in patients with ischemic foot ulcers who had a technically successful endovascular treatment.

METHOD AND MATERIALS

A retrospective review of patients who were endovascularly treated for ischemic foot ulcers between January 2015 and May 2017 was performed. Two hundred and two limbs in 202 patients (135 male, 67 female; median age 72.8; range, 42.2-93.7 y) were technically successfully treated. Technical success was defined as occluded artery recanalization with residual stenosis < 30%, and ABI improvement by at > 0.2 after 24 hours. Unilateral lymph node size, contrast enhancement, necrosis and perinodular fat infiltration were assessed on a preprocedural computer tomography angiography (CTA). Primary end points were amputation and sepsis within six months. Independent-samples t-tests and chi-square test of independence were conducted to examine relation between lymph node characteristics and amputation or septic shock.

RESULTS

Forty-two (20.8%) patients had undergone amputation. Sepsis occurred in 6 out of 202 patients (3%). There was a significant difference in the scores of lymph node sizes between amputated and non-amputated limbs ($p = 0.000$). Relations between lymph node characteristics and amputation was significant ($p < 0.001$). Patients with perinodular fat infiltration or increased node size were 5.940 and 1.109 times (respectively) more likely to undergo limb amputation than those without. The relation between lymph node characteristics and septic shock was significant ($p < 0.05$).

CONCLUSION

Unilateral lymph node size and characteristics are associated with limb amputation in technically successful endovascular treatment of patients with ischemic foot ulcers. Moreover, increased lymph node size and perinodular fat infiltration predicted limb amputation.

CLINICAL RELEVANCE/APPLICATION

Lymph node size and characteristics are associated with limb amputation in critical ischemia patients who were successfully treated endovascularly.

SSK21-02 Exosomes from Endothelial Progenitor Cells Facilitate Vascular Endothelial Cell Repair through Transferring miR-21-5p to Suppress THBS1 Expression

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E260

Participants
Jungong Zhao, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

we sought to investigate the mechanisms of exosomes released from endothelial progenitor cell(EPC) mediated endothelial cell (EC) repair by studying their miRNA content and uptake

METHOD AND MATERIALS

The efficacy of EPC derived exosome-mediated reendothelialization was examined by histological examinations and Evans blue dye in the balloon-induced carotid artery endothelial injury model of rats in vivo. The effects of EPC-exosomes on human vascular endothelial cells (HUVECs) were also studied by the evaluation of growth rates, migratory ability and tube-formation activity. To dissect the underlying mechanisms, RNA-sequencing assays were performed to determine miRNA abundancy in exosomes and mRNA profiling in exosome-treated HUVEC. Meanwhile, by using specific miRNA inhibitors or siRNAs, the roles of the candidate miRNA and its target genes in exosomes induced regulation of function of HUVEC were assessed.

RESULTS

Administration of EPC-derived exosomes accelerated the reendothelialization in the early phase after endothelial damage in the rat carotid artery. The uptake of exogenous EPC-exosomes intensified HUVEC cells in the proliferation rate, migratory and tube-forming ability. Integrative analyses of miRNA-mRNA profiles and the following functional studies revealed that miR-21-5p was highly enriched in EPC-exosomes, which specifically suppressed THBS1 expression in the recipient vascular endothelial cells and contributed to the pro-angiogenic activities of EPC derived exosome.

CONCLUSION

Our study indictated that EPC-exosome delivered miR-21-5p into vascular endothelial cells to inhibit the expression of THBS1, and therefore promoted endothelial cell repair.

CLINICAL RELEVANCE/APPLICATION

EPC derived exosome mediated reendothelialization after vascular injury

SSK21-03 Impact of Calcification Modeling and Planning Circles with Fusion Imaging for the Chronical Total Occlusion of Iliac and Femoral Arteries

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E260

Participants
Nicolas Louis, Nimes , France (*Presenter*) Research Consultant

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PURPOSE

To examine the contribution of calcification modeling and planning circles with fusion imaging for the chronical total occlusion (CTOs) of iliac and femoro-popliteal arteries.

METHOD AND MATERIALS

We analyzed a cohort of 180 patients who were treated by endovascular means for iliac and femoro-popliteal arteries CTOs during a period of 3 years.The procedures were performed in a hybrid room equipped with the IGS 530 system (GE Healthcare). The pre-operative imaging fusion was edited on the dedicated workstation Advantage Windows 4.7 with vessel ASSIST. A centerline was manually adjusted inside the occluded artery. The planning circles were strategically positioned inside the calcifications edited by the centerline. The Workstation allows to combined in the the same volume the modeling of all the calcifications and the planning circles.The fusion technic was a fusion between 3D volume extracted from preoperative CT and 2D live fluoroscopy with bone registration. An arteriography was systematically achieved allowing to adjust if necessary the vascular ans calcifications volumes.

RESULTS

46 Iliac CTOs (mean length occlusion= 61.6 mm), and 84 femoro-popliteal CTOs (80.2 mm) were performed. The success of the recanalisation reach 94% (n=122/130). In 51.5% (n= 67/130) the recanalisation have been directly in transluminal inside the planning circles. In 35.3% (n=46/130) the recanalization have been subintimal and have been redirected in transluminal between two circles. In 6.9% (n=9/130) the subintimal recanalisation can't be redirected transluminal and an IVUS-guided re-entry catheter have been used.

CONCLUSION

The CTOs under fusion imaging with calcification modeling and planning circles is a reliable and reproductible technic. It allows to redirect easily between two circles inside the calcification. It might have an economic impact by reducing the use of re-entry device, and might have an impact on the radiation exposure.

CLINICAL RELEVANCE/APPLICATION

This new technic allows to navigate step by step in an occluded artery by knowing constantly when the guide wire is positioning compared to the calcifications and the good lumen.

SSK21-04 Long-Term Outcome of Percutaneous Coronary Intervention in Prediabetes and Normoglycaemia Patients: A Systematic Review and Meta-Analysis

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E260

Participants
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Yue Gao, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose

Li Jiang, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Prediabetes, an abnormal glucose metabolism before onset diabetes, was proven to be risk factor for coronary artery disease (CAD) in previous studies. However, whether prediabete would impact the long-term prognosis for CAD patients after percutaneous coronary intervention (PCI) remains controversial. Thus, the purpose of this study was to summarize the previous studies and to demonstrate the difference of long term prognosis between CAD patients with and without prediabetes after PCI.

METHOD AND MATERIALS

Pubmed and EMBASE were systematically searched, supplemented with manual searches of the included reference lists. Studies reporting long-term (>/=1 year) cardiovascular outcomes including all-cause mortality, myocardial infarction (MI), revascularization and other mentioned major adverse cardiac events (MACE) in prediabetes patients were included. Odds ratio (OR) with 95% confidence interval (CI) was used to express the pooled effect on discontinuous variables and the pooled analyses were performed with Stata 15.1.

RESULTS

Nine cohort studies were finally included in this meta-analysis consisting of a total of 10266 patients (3112 prediabetes, 3783 diabetes and 5171 normoglycaemia). In CAD patients treated with PCI, prediabetes individuals were found to have significantly higher long-term mortality and more MACE than normoglycaemia patients (odds ratio (OR):1.85;95% confidence interval (CI): 1.25-2.74; P=0.002;I^2 = 36.6%), (OR:1.43; 95% CI:1.05-1.94;P=0.022;I^2=69.3%) respectively. No statistical difference was found on MI and revascularization between the two groups (MI: OR:1.06;95% CI:0.86-1.31; P=0.561; I^2=0%) and (revascularization: OR:1.20; 95% CI: 0.88-1.63; P=0.242; I^2=31%) respectively.

CONCLUSION

The present meta-analysis suggests that following PCI, long-term rates of death and MACE were significantly higher in prediabetes. However, there were no difference on MI and repeat revascularization between prediabetes and normoglycaemia patients.

CLINICAL RELEVANCE/APPLICATION

The present meta-analysis provide evidence that health care practitioners should put emphasize on screening and management of abnormal glucose metabolism before and after PCI to combat adverse cardiovascular outcomes.

SSK21-05 Micro-Channel Recanalization with Orbital Atherectomy as a Viable Method to Failed Standard Recanalization of TASC-II D Aorto-Iliac Occlusive Disease

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E260

Participants
Roger T. Tomihama, MD, Loma Linda, CA (*Presenter*) Nothing to Disclose
Yuki Miura, MD, Loma Linda, CA (*Abstract Co-Author*) Nothing to Disclose
Ahmed Abou-Zamzam, MD, Loma Linda, CA (*Abstract Co-Author*) Nothing to Disclose
Sharon C. Kiang, MD, Loma Linda, CA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Endovascular treatment of TASC II D aorto-iliac lesions now an accepted form of revascularization. We sought to demonstrate that native micro-channel recanalization and orbital atherectomy is a successful recanalization method of TASC II D aorto-iliac lesions refractory to standard recanalization techniques.

METHOD AND MATERIALS

Four consecutive patients from 2016-2018 with symptomatic TASC-II D Aorto-Iliac Occlusive Disease (AIOD) prohibitive for open bypass and failed traditional prodding guidewire or device recanalization technique were identified and underwent advanced native micro-channel selection and subsequent orbital atherectomy. Native micro-channels were probed and traversed with a 0.014 wire. Orbital atherectomy is initiated with the 1.25 crown and continued until the micro-channel is sufficiently large to track a micro-catheter. Lesion characteristics, survival, limb salvage, patency, and change in clinical symptoms were analyzed.

RESULTS

Four patients underwent successful native micro-channel recanalization and orbital atherectomy of the CIA. There were no intra-operative ruptures or dissections. Three patients presented with rest pain and 1 with CLTI. Average age was 68, average Rutherford class was 3 and 2 of the patients smoked. All 4 patients presented with unilateral CIA occlusion with contralateral CIA stenosis. Average occlusion lesion length of the R CIA was 5.8 cm and of the L CIA was 6.2 cm. Kissing stent technique was used in all patients for reconstruction of the aortic bifurcation. Two of the patients had outflow lesions (SFA stenosis or occlusion) but had patent profunda arteries. At 30 days, all patients had improvement in pain and primary patency of 100%. Long-term follow up at 21.6 months noted continued improvement in symptoms and primary patency of 75%. The fourth patient died at 4 mo from lung cancer with occluded iliac stents by imaging at that time.

CONCLUSION

Native micro-channel recanalization with subsequent orbital atherectomy is an option in high-risk patients with TASC II D aorto-iliac disease whom have failed traditional prodding recanalization. Further work in proper patient selection and safe utilization of atherectomy devices in the CIA is needed.

CLINICAL RELEVANCE/APPLICATION

Native micro-channel recanalization with subsequent orbital atherectomy is an option in high-risk patients with TASC II D aorto-iliac disease whom have failed traditional prodding recanalization.

SSK21-06 Evaluation of Collateral Circulations for Therapeutic Effects in Chronic Leriche's Syndrome: A Preliminary Case-Control Study between Bypass Grafting and Intraluminal Stent Implantation

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E260

Participants
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PURPOSE

To investigate the changes in collateral arteries after bypass grafting or intraluminal stent implantation in chronic Leriche's syndrome, and to compare effects of the two operations.

METHOD AND MATERIALS

From January 2015 to December 2018, there were 26 patients diagnosed as chronic Leriche's syndrome. They were treated with bypass grafting (n=14, group A) or intraluminal stent implantation (n=12, group B). All the patients received aorta and common iliac CT angiography before and one month after the operations. CT angiography findings and clinical records were reviewed retrospectively. Sectional areas of the occlusive aorta before operation (a0), the systemic collateral pathways before (a1) and after (a2) operation, and the recanalization pathway (the grafts or the stent lumen) (ar) were manually measured at aortic bifurcation level by two experienced radiologists, and the mean values were admitted. The compensation rate before (C1) and after (C2) operation as well as the reduction rate of the systemic collateral pathways after operation (R) were defined as follow: C1=a1/a0; C2=(a2+ar)/a0; R=(a1-a2)/a1. The values of C1, C2 and R of both groups were calculated respectively, and independent sample *T*-test was performed.

RESULTS

C1 of bypass grafting group and intraluminal stent implantation group were 30.67%±16.77% and 31.35%±23.70% respectively, and there was no significant difference (P=0.933). C2 of bypass grafting group were significantly higher than those of intraluminal stent implantation group (98.83%±26.01% vs. 44.44%±7.62%, P<0.001), while R of both groups had no significant difference (81.98%±7.12% vs. 85.81%±5.95%, P=0.154).

CONCLUSION

According to the changes in collateral arteries after operation, intraluminal stent implantation was non-inferior to bypass grafting for patients with chronic Leriche's syndrome, although the recanalization pathway seemed much smaller.

CLINICAL RELEVANCE/APPLICATION

The changes in collateral circulation can reflect short-term effects of operation. And Intraluminal stent implantation could be the favorable treatment for patients with high risk of operation.

SSK21-07 To Evaluate the Role of FDG PET/CT in Assessing Disease Activity in Large Vessel Vasculitis

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E260

Participants
Sikandar M. Shaikh, DMRD, Hyderabad, India (*Presenter*) Nothing to Disclose

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PURPOSE

To evaluate the role of FDG PET-CT in the assessment of disease activity in large vessel vasculitis (LVV).

METHOD AND MATERIALS

54 PET/CT scans were performed in 19 pts with suspected and diagnosed LVV (giant cell arteritis, Takayasu arteritis or idiopatic aortitis). The amount of vascular uptake was graded using a 4-point scale (0=no uptake, 1=less than liver, 2=similar to liver, 3=higher than liver). Grade 0-1 was negative, 2 was moderately positive and 3 was markedly positive. This PET/CT was correlated with clinical indices of ITAS (Indian Takayasu Activity Score) and Kerr/National Institute of Health (Kerr/NIH), serum acute-phase reactants (ESR, C-reactive protein [CRP]) levels as well as interleukin-6 (IL-6) and the soluble IL-6 receptor (sIL-6R).

RESULTS

43% of 54 PET-CT were negative, 31% were moderately positive, and 26% were markedly positive. A significant correlation between the SUV uptake and both ESR and CRP levels was found and correlated. Significantly higher ESR values were observed in pts with markedly positive PET/CT (49.4 + 36.5 mm/1st h) compared with moderately positive (27+ 21 mm/1st h, p = 0.0001) and inactive scans (22.7 + 15.9 mm/1st h, p=0.0001). CRP levels were 0.8+1.0 mg/dL in pts with inactive scans, 1.3+ 2.2 mg/dL in pts with moderately positive (p=0.001) and 3.0 + 3.6 in patients with markedly positive scans (p = 0.0001). Higher levels of IL-6 resulted in patients with markedly positive scans (10.0 + 8.9 pg/ml) compared to those with inactive scans (8.1+18.5 pg/ml, p=0.013). We found no association between sIL-6R levels and vascular FDG uptake. There was a significant association between vascular FDG uptake and both ITAS and Kerr/NIH scores

CONCLUSION

The above findings of PET/CT is a very useful tool for evaluating disease activity in patients with LVV.

CLINICAL RELEVANCE/APPLICATION

The relevance of FDG PET-CT in evaluation of Large vessel vasculitis is having importnat and significant role.

SSK21-08 Spectral CT Imaging for the Assessment of Non-Calcified Plaque Compositions in Lower Extremity Atherosclerosis

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E260

Participants
Tingting Qu, Xian, China (*Presenter*) Nothing to Disclose
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Jianying Li, Beijing, China (*Abstract Co-Author*) Employee, General Electric Company
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Jian Yang, Xian, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the composition of non-calcified plaques in patients with lower extremity atherosclerosis using spectral CT imaging.

METHOD AND MATERIALS

Thirty-four patients with lower extremity atherosclerosis underwent CT angiography (CTA) with the dual-energy spectral imaging mode. Monochromatic images were reconstructed to measure CT values at 74keV and to generate spectral curve for calculating the slope: [(CT(40keV)-CT(110keV))/70] and the effective-Z for plaques; Material decomposition (MD) images of iodine-based and lipid-based were generated to measure the iodine and lipid density, respectively. Measurements for different plaque types were statistically compared.

RESULTS

A total of 116 non-calcified plaques were found in 34 patients, including 87 fibrous plaques, 21 plaques with intra-plaque hemorrhage and 8 plaques with lipid components with slopes of the spectral curve of 1.05±0.54, 0.36±0.26, and -0.20±0.20, and the effective-Z values of 8.21±0.30, 7.80±0.18 and 7.40±0.15, respectively. The iodine contents (in 100ug/ml) were 9.99±5.13, 3.42±2.60, and -1.97±1.95, and lipid contents (in 1mg/ml) were -755.12±387.89, -258.05±195.75, and 148.95±148.14, respectively for the fibrous plaque, intra-plaque hemorrhage and lipid plaque. There were statistical differences in all measurements between any two types of plaques (all $p<0.001$). CT values at 74keV was 54.54±14.16HU, 23.35±13.80HU and 28.88±11.69HU for these three groups. There was significant difference between fibrous plaque and the other two contents ($p<0.001$), but no significant difference between the intra-plaque hemorrhage and lipid plaque ($p=0.652$).

CONCLUSION

Fibrous plaque, plaque with intra-plaque hemorrhage and lipid components in non-calcified plaque have distinctive spectral imaging characteristics. The parameters of dual-energy spectral CT imaging can provide quantification information for the differentiation of fibrous, lipid and hemorrhage plaques.

CLINICAL RELEVANCE/APPLICATION

The use of imaging methods to distinguish stable plaques and unstable plaques can provide guidance for the selection of clinical pathways.

SSK21-09 Improving Diagnostic Accuracy for Inferior Genicular Arteries in Lower Extremity with Dual-Energy Spectral CT Imaging

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E260

Participants
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PURPOSE

Investigate the clinical value of improving diagnostic accuracy for inferior genicular arteries in the lower extremity with low energy images in spectral CT imaging.

METHOD AND MATERIALS

110 (mean age 67±10 years) and 72 (mean age, 65±13 years) patients underwent CT angiography (CTA) in the lower extremities using spectral and conventional (at 120kVp) imaging mode, retrospectively with similar radiation dose and contrast dose. The 50keV monochromatic images were reconstructed in the spectral CT group. CT value and standard deviation of vessels and psoas major muscle was measured to calculate to the signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) for vessels. Two independent observers assessed the subjective image quality of the lower extremities using a 4-point scale. The quantitative and qualitative image quality of the two groups were compared and the diagnostic accuracy for the degree of occlusion of the vessels (Each patient received one time DSA for 11 vessels) were also compared using DSA as the gold standard. Chi-square test, independent sample T test and Mann-Whitney test was used for counting data, quantitative measurement data and subjective image quality score, respectively.

RESULTS

The use of 50keV images in the spectral CT significantly increased the CT values in the abdominal iliac, femoral popliteal and lower knee segments (618.52±100.78 vs. 371.10±98.36 on average, p<0.001) and provided higher SNR (50.48±12.47 vs. 45.97±12.90, P=0.014) and higher CNR (44.08±11.45 vs. 38.86±12.35, P<0.01) compared with the conventional images. Mann-Whitney test showed that the subjective image quality of femoral popliteal in the spectral CT group was higher than in the conventional group (P=0.01), while there was no difference in the abdominal iliac segment (P=0.10) and lower knee segment (P=0.07). The spectral CT images also significantly improved the diagnostic accuracy for the vessels in the lower knee segment (92.05% vs. 84.03%, P<0.01).

CONCLUSION

The use of 50keV spectral CT images enhances the contrast in the lower extremity arteries and improves the diagnostic accuracy for the vessels in the lower knee segment, compared with the conventional CTA protocols.

CLINICAL RELEVANCE/APPLICATION

Low-energy images in spectral CT can improve the diagnostic accuracy of the lower knee arteries while achieving higher SNR and CNR.

Printed on: 10/29/20

SSM01

Breast Imaging (Functional Imaging)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E451B

BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Mami Iima, MD, PhD, Kyoto, Japan (*Moderator*) Nothing to Disclose

Sub-Events

SSM01-01 Role of 18F-FDG Uptake on PET/CT in Identifying Androgen Receptor Expression and Prognostic Factors in Triple-Negative Breast Cancer

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E451B

Participants
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So Yeon Ki, Jeollanam-do, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Hyo Soon Lim, MD, Gwangju, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jong Eun Lee, Gwangju, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

For information about this presentation, contact:

N/C

PURPOSE

To investigate the relationship between 18F-FDG uptake and androgen receptor (AR) expression in triple-negative breast cancer (TNBC).

METHOD AND MATERIALS

Between May 2015 and May 2017, 110 patients (mean age, 53.5 years) with primary TNBC (mean, 25.7mm; range, 4-75 mm) were retrospectively categorized into AR+ (n = 25) and AR- (n = 85) groups by using immunohistochemical staining and underwent 18F-FDG PET/CT for staging. Maximum standardized uptake (SUVmax) value on PET/CT and clinicopathologic features including age, size of tumor, lymph node metastasis, histological grade of tumor, histological type, Ki-67, associated ductal carcinoma in situ (DCIS) component, p53 overexpression, and basal marker (CK5/6, CK14, EGFR) expression by immunohistochemical staining were compared between the two groups. In addition, the correlation between SUVmax and prognostic factors was assessed.

RESULTS

Mean SUVmax was significantly higher in AR- (9.9 ± 5.5) group than in AR+ (7.2 ± 4.8) group (P = .025). AR- group was significantly younger (P =.001) and showed significantly more histological grade 3 (P = .025) and Ki-67 proliferation rate (>14%) of TNBC (P < .001). There were positive correlations between SUVmax and Ki-67 (Spearman's rho = 0.240, P = .012), histological grade (Spearman's rho = 0.252, P = .008), and the size of tumor (Spearman's rho = 0.455, P < .001). There were negative correlations between SUVmax and AR (Spearman's rho = -0.215, P = .024) and associated DCIS component (Spearman's rho = -0.261, P = .006). In a multiple regression analysis, the size of tumor (P = .001) was significantly associated with SUVmax.

CONCLUSION

18F-FDG uptake was significantly higher in AR- group than in AR+ group and correlated with larger tumor size in TNBC.

CLINICAL RELEVANCE/APPLICATION

Suspected from SUVmax on PET/CT before biopsy in terms of androgen receptor status could help to expedite management of triple-negative breast cancer.

SSM01-02 Investigation of Breast Cancer Detectability Using Total Breast PET Imager

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E451B

Participants
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PURPOSE

Whole-body PET/CT has low sensitivity in the detection of small breast cancers due to its limited image resolution and system sensitivity which led to the development of positron emission mammography(PEM) systems. Most PEM systems employ a planar or a ring geometry to surround a breast. A ring geometry provides high resolution and high sensitivity, but is incapable of imaging the axilla. The planar geometry provides more flexibility in detector placement but has lower sensitivity and image quality. In both cases, the sensitivity of the system approaches zero for tissues near or beyond the chest wall. To overcome this limitation, we propose a novel geometry that can image both breasts with high resolution and sensitivity with an extended imaging field-of-view (FOV) that also includes the entire torso and axilla.

METHOD AND MATERIALS

The scanner consists of a racetrack-like geometry that surrounds two breasts along with a rectangular front panel and a curved back panel. The detectors in the racetrack and front panel consist of 2x2x6 mm3 (double layer DOI) LSO crystals while the back panel consists of 3.95x5.3x25 mm3 LSO crystals. We used GATE to simulate this system and a GPU-based list-mode reconstruction program to characterize the system performance with Time-of-Flight (ToF) information.

RESULTS

The sensitivity images of standard PET system, ring and flat-type PEM systems and our proposed geometry are compared. Body phantom with different tumor sizes and contrast are reconstructed for different systems. Results show superior sensitivity for the latter and demonstrate a large imaging FOV that can detect all lesions with good image quality.

CONCLUSION

The proposed system has high sensitivity and can significantly improve resolution as compared to whole-body PET system and achieve a larger imaging FOV, including the entire torso and axilla, than typical PEM systems. Detailed system design and characteristics will be presented.

CLINICAL RELEVANCE/APPLICATION

Radiotracer-based molecular imaging can complement conventional breast imaging technologies such as mammography and MRI to improve the overall diagnostic accuracy.Total Breast PET Imager offers the benefits of conventional PEM system (high resolution and high sensitivity) and whole-body PET scanner (large imaging FOV) for improved detectability of breast cancer.

SSM01-03 Evaluation of Contrast Enhanced Digital Mammography in the Preoperative Staging of Breast Cancer: Large-Scale Single-Center Experience

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E451B

Participants
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PURPOSE

The aim of this retrospective study was to evaluate the diagnostic performance of Contrast-enhanced Digital Mammography (CEDM) in the preoperative staging of breast cancer and to evaluate the effects of this new technique on the surgical management of all patients and of the various subgroups.

METHOD AND MATERIALS

Data have been collected from a cohort of 326 patients affected by breast cancer who were diagnosed in our department between December 2016 and January 2019. All patients underwent CEDM and subsequent surgical excision (SE). The results of preoperative staging with CEDM and surgical management were correlated with histopathological results, considered as the gold standard. The diagnostic performance of CEDM in the identification of the index lesion and of additional homo and contralateral lesions was evaluated. The authors also analyzed any possible changes in surgical management of the patients due to CEDM findings and the diagnostic performance of CEDM in various subgroups i.e. women with age 50 or less and greater than 51; patients with dense breast (BI-RADS C and D) and non-dense (BI-RADS A and B), palpable index lesion or not.

RESULTS

CEDM sensivity in detecting index cancer was 98.8% (322/326). For detection of secondary cancer in the ipsilateral or contralateral breast CEDM sensivity, specificity, positive and negative predictive values and accuracy were 93%, 98%, 90%, 98% and 97% respectively. The ROC Curve comparing CEDM to the gold standard showed an area under the curve (AOU) of 0.955. CEDM changed type of surgery planned before the examination in 18.4% of the cases, 17,2% of these due to true-positive findings and 2,8% to false-positive findings. CEDM has led to 17,8% of additional biopsies, of these 53,5% proved to be malignant and 46,5% were benign.

CONCLUSION

Cedm has demonstrated a very high diagnostic performance in preoperative breast cancer staging and often leads to a more strict and appropriate surgical planning.

CLINICAL RELEVANCE/APPLICATION

This study supports the Cedm as a promising alternative to magnetic resonance imaging in the surgical planning of patients with breast cancer.

SSM01-04 Contrast-Enhanced Mammography: Does Acquisition Time Matter?

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E451B

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PURPOSE

The technique for contrast enhanced mammography (CEM) was developed based on subtraction angiography and temporal subtraction techniques. Our purpose was to determine at what time points cancers are best visualized on CEM based on already acquired cases, to drive a future larger prospective study refining CEM technique.

METHOD AND MATERIALS

This HIPAA compliant IRB approved reader study included 40 consecutive cancer containing CEM exams from February 17th 2016 to November 8th 2018. Cases were included if cancer was seen on both CC and MLO views, cancer was not yet biopsied, and only up to two sites of cancer were present. Bilateral CC and MLO recombined images were presented side-by-side to 4 fellowship-trained breast imagers. Radiologists provided interpretations of background parenchymal enhancement (BPE) and rated CC and MLO projections for cancer visibility, confidence in margins, and conspicuity of the finding as compared with BPE using a 5-point Likert scale. Objective measure of cancer conspicuity was determined using region-of-interest calculations of cancer versus BPE to determine a contrast-to-noise ratio (CNR).

RESULTS

Data from one reader is available for this abstract. CC views were performed first in all cases. After contrast administration, the median times for the CC and MLO views were 2:20 and 4:25, respectively. 15 patients (37.5%) had low (minimal and mild) BPE and 25 (62.5%) had high (moderate and marked) BPE. Mean visibility difference for CC (4.4 ±0.9) and MLO (4.1 ±1.2) views was significantly significant (p=0.008). Mean confidence in margins for CC (4.2 ±1.3) and MLO (4.0 ±1.3) was not significantly different (p=0.14). Mean conspicuity of cancer relative to BPE for CC (4.3 ±0.9) and MLO (3.9 ±1.2) was significantly different (p=0.002). CNR on CC (mean 3.9, median 3.5) and MLO (mean 4.0, median 3.8) were not significantly different (p=0.89).

CONCLUSION

There is improved cancer visibility and conspicuity of cancer relative to BPE on earlier CC views. This suggests post-contrast images may be optimized by imaging earlier after contrast administration. However, additional reader results are necessary and will be included in this presentation.

CLINICAL RELEVANCE/APPLICATION

There is improved cancer visibility and conspicuity of cancer relative to BPE on earlier CC views. This suggests post-contrast images may be optimized by imaging earlier after contrast administration.

SSM01-05 Are There Differences in 18F-FDG PET-MRI Imaging Biomarkers of Contralateral Healthy Tissue between Patients with Benign and Malignant Breast Lesions?

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E451B

Participants
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PURPOSE

To evaluate whether there are differences in multiparametric 18F-fluorodeoxyglucose positron emission tomography - magnetic resonance imaging (18F-FDG PET-MRI) biomarkers of contralateral healthy breast tissue between patients with benign and malignant breast tumors.

METHOD AND MATERIALS

In this IRB-approved HIPAA-compliant prospective single-institution study, 141 women with imaging abnormality on mammography or sonography (BI-RADS 4/5) were included and underwent combined 18F-FDG PET-MRI of the breast at 3T including dynamic contrast-enhanced MRI (DCE-MRI) and diffusion-weighted imaging (DWI). The following imaging biomarkers were recorded in all patients for the contralateral tumor-free breast: 18F-FDG breast parenchymal uptake (BPU), mean apparent diffusion coefficient (ADCmean), DCE-MRI background parenchymal enhancement (BPE) and amount of fibroglandular tissue (FGT), as well as BPU, BPE and FGT of the ipsilateral diseased breast. Appropriate statistical tests were used to assess differences in imaging biomarkers between patients with benign and malignant lesions.

RESULTS

There were 100 malignant and 41 benign lesions. BPE was minimal in 61, mild in 56, moderate in 19, and marked in 5 patients. BPE differed significantly (P<0.001) between patients with benign and malignant lesions, with patients with cancer showing decreased BPE in the contralateral tumor-free breast. A borderline significant difference was observed for FGT (P=0.055). BPU for patients with mild BPE was 1.5, for mild BPE 1.9, for moderate BPE 2.2, and for marked BPE 1.9. BPU differed significantly between patients with benign (mean, 1.9) and malignant lesions (mean, 1.8) (P<.001). ADCmean did not differ between groups (P=0.19). In both groups, no differences in imaging biomarkers between contralateral healthy and ipsilateral diseased breast were found, excluding a potential stealing phenomenon of the diseased breast with respect to vascularity and metabolic activity.

CONCLUSION

Differences in multiparametric 18F-FDG PET-MRI biomarkers, obtained from contralateral tumor-free breast tissue, exist between patients with benign and malignant breast tumors. Contralateral BPE, BPU, and FGT are decreased in breast cancer patients.

CLINICAL RELEVANCE/APPLICATION

BPE and BPU may potentially serve as imaging biomarkers for the presence and risk of malignancy.

SSM01-06 Evaluation of a Low-Dose Contrast-Enhanced Mammography System Compared to Contrast-Enhanced Breast MRI in the Assessment Setting

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E451B

Participants
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PURPOSE

To evaluate the diagnostic performance of a low-dose contrast enhanced mammography (L-CEM) in women with suspicious findings on conventional imaging, and compare it to contrast-enhanced magnetic resonance imaging (CE-MRI) of the breast.

METHOD AND MATERIALS

The ethics committee approved this prospective, single center study and all patients gave written informed consent. Women with suspicious findings on conventional imaging (mammography, tomosynthesis and ultrasound) and no contraindications for L-CEM or CE-MRI were invited to participate in the study. The L-CEM system performs the acquisition without anti-scatter grid and a sowtware based scattered correction is than applied to the images. Three off-site, blinded readers evaluated the images according to BI-RADS lexicon in a randomized order, each in two separate reading sessions. Histology served as a gold standard. Lesion detection rate, sensitivity, specificity, negative and positive predictive values (NPV, PPV) were calculated and compared with multivariate statistics. Average glandular dose per view was measured (AGD).

RESULTS

Included were 80 patients (mean age 54.3 years, standard deviation 11.2) with 93 lesions (32 benign, 61 malignant). Sensitivity (L-CEM 65.6%-90.2%; CE-MRI 83.6%-93.4%, P=0.086) and NPV (L-CEM 59.6%-71.4%; CE-MRI 63.0%-76.5%, P=0.780) did not differ. Specificity (L-CEM 46.9%-96.9%; CE-MRI 37.5%-53.1, P=0.001) and PPV were significantly higher with L-CEM (L-CEM 76.4%-97.6%; CE-MRI 73.3%-77.3% P=0.007). Detection rate was significantly higher with CE-MRI (92.5%-94.6%) compared to L-CEM (79.6%-91.4%, P=0.014). Variations between readers were significant for sensitivity and NPV, but not for specificity. Accuracy of L-CEM was as good as for CE-MRI (75.3%-76.3% versus 72.0%-75.3%, P=0.514). AGD dose per view ranged according to the breast thickness from 1,074 mGy to 2,49 mGy.

CONCLUSION

L-CEM showed a high sensitivity and accuracy in women with suspicious findings on conventional imaging. Compared to CE-MRI, L-CEM has the potential to increase specificity and PPV. Based on our results, low-dose CEM might help reducing unnecessary follow up and false positive biopsies while increasing cancer detection comparably to CE-MRI.

CLINICAL RELEVANCE/APPLICATION

L-CEM could help reducing unnecessary follow up and false positive biopsies, while increasing cancer detection in an extent

comparable to CE-MRI, with a dose up to 70% less than a full dose CEM.

SSM02

Breast Imaging (Radiomics)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E451A

AI BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Christiane K. Kuhl, MD, Aachen, Germany (*Moderator*) Nothing to Disclose
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Sub-Events

SSM02-01 Radiomics Signatures of DCE-MRI Combined with Clinicopathologic Characteristics for Preoperative Prediction of Axillary Lymph Node Metastasis in Breast Cancer

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E451A

Participants
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PURPOSE

To explore the use of noninvasive dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) and clinicopathologic risk factors based on radiomics for preoperative prediction of axillary lymph node metastasis (ALN) in breast cancer.

METHOD AND MATERIALS

The prediction model was developed in a primary cohort that consisted of 215 patients who was diagnosed with breast cancer(ALN Metastasis (+): 54; ALN Metastasis (-): 161). Radiomic features were extracted from the early and late stage of DCE-MRI of breast cancer. The primary cohort was randomly divided into two independent subsets: a training set (80%, 171 patients with 43 positive SLN) and a validation set (20%, 44 patients with 11 positive SLN). A total of 2058 candidate radiomics features(1029 for each stage) that were extracted from DCE-MRI images of the above two stages. 9 radiomics features were selected from 2058 features using 10-fold cross-validation LASSO model. We incorporated the radiomics signature and independent clinicopathologic risk factors. A random forest classifier was also built using union features. The performance of the classifier was assessed with the area under the ROC curve (AUC), sensitivity, specificity and precision of training set and validation set.

RESULTS

The prediction model using DCE-MRI radiomics alone achieved a AUC of 0.846(95% CI [0.740-0.935]), and the sensitivity, specificity and precision respectively were 0.64, 0.88, and 0.64 in the independent validation set. While the combination of DCE-MRI radiomic features with clinicopathologic characteristics achieved a high AUC of 0.912 (95% CI [0.819-0.979]) in the independent validation set, and the sensitivity, specificity and precision were 0.91, 0.88, and 0.71, respectively, which outperformed the prediction model using DCE-MRI radiomics alone.

CONCLUSION

This study presents a radiomics analysis based on DCE-MRI that incorporates the radiomics signature could be conveniently used to facilitate the preoperative individualized prediction of ALN metastasis in patients with breast cancer, especially when it combines with clinicopathologic characteristics can improved the prediction performance.

CLINICAL RELEVANCE/APPLICATION

The subsequent analysis of radiomics features can provide potential noninvasive biomarkers for clinical-decision support, it may be used to predict the axillary lymph node metastasis of breast cancer before operation.

SSM02-02 Do Preoperative Dynamic Radiomic Features Based on Pharmacokinetic Modeling Dynamic Contrast-Enhanced Magnetic Resonance Imaging Correlate with Prognostic Factors in Breast Cancer?

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E451A

Participants
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PURPOSE

To correlate preoperative dynamic radiomic features based on PK-DCE-MRI with prognostic factors of breast cancer.

METHOD AND MATERIALS

224 patients histopathologically proven breast cancer were retrospectively reviewed. 97 dynamic radiomic features including 22 pharmacokinetic quantitative parameters (Ktrans, Kep and Vp) with corresponding histogram features and 75 texture features were obtained. These features were compared using the Mann-Whitney U-test between every two groups defined of pathologic and immunohistochemical prognostic factors. Binary logistic regressions were applied to classify these prognostic factors, and ROCs were plotted to determine the performance.

RESULTS

4, 21, 4 of 97 radiomic features between DCIS versus IDC, LN metastasis negative versus positive, and histologic grade nonhigh versus high groups were statistically different respectively ($p<0.05$). The sensitivity and specificity of regression models for IDC, LN metastasis positive and histologic grade high identification were 55.2% and 84.2%, 77.5% and 45.9%, 64.7% and 58.7%. 22, 23, 33, 18, 6, 3 of 97 radiomic features were statistically different ($p<0.05$) between ER negative versus ER positive, PR negative versus PR positive, HER2 negative versus HER2 positive, Ki-67 low versus high, EGFR negative versus positive, and CK5/6 negative versus positive groups respectively. The sensitivity and specificity of comprehensive models for ER, PR, HER2, Ki-67, EGFR, CK5/6 identification were 39.9% and 84.8%, 46.1% and 71.1%, 57.8% and 82.1%, 59.6% and 71.7%, 92.3% and 68.2%, 51.5% and 72.2% respectively .

CONCLUSION

Dynamic radiomic features based on PK-DCE-MRI may serve as potential imaging biomarkers for prognosis prediction in breast cancer .

CLINICAL RELEVANCE/APPLICATION

(dealing with Radiomics based on DCE-MRI and breast cancer prognosis prediction) ' Preoperative dynamic radiomic features based on PK-DCE-MRI may serve as potential imaging biomarkers for prognosis prediction in breast cancer.

SSM02-03 Breast Cancer Molecular Subtype Prediction Using Radiomic Signature on Two-Dimensional Synthetic Mammography from Digital Breast Tomosynthesis

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E451A

Participants
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PURPOSE

To predict molecular subtype of breast cancer using radiomic signature extracted from two-dimensional synthetic mammography reconstructed from digital breast tomosynthesis (DBT).

METHOD AND MATERIALS

From December 2015 to July 2016, 150 patients with newly diagnosed pathologically confirmed breast cancer who had undergone preoperative DBT were identified and assigned to the training set. Specifically, 50 consecutive patients were enrolled in the training set for each molecular subtype (luminal A+B, luminal; HER2-positive, HER2; triple negative, TN). A temporally independent validation cohort consisted of consecutive 71 patients with breast cancer between August 2016 and September 2016 (50 luminal, 9 HER2, and 12 TN). Total of 129 radiomic features was extracted from the craniocaudal (CC) and mediolateral oblique (MLO) view of the synthetic mammography. The performances of three binary radiomic classifications for each subtype were measured using the area under the receiver operating characteristic curve (AUC). The radiomic classification model was built using the elastic-net with ten-fold cross-validation and validated in the independent validation cohort.

RESULTS

The three radiomic models were built from the selected 21 features for TN vs non-TN, 19 for HER2 vs non-HER2 and 67 for luminal vs non-luminal. In the training set, the radiomic models yielded an AUC of 0.834 for TN, 0.842 for HER2, and 0.941 for luminal subtypes. In the validation cohort, the radiomic models yielded an AUC of 0.838 for TN, 0.556 for HER2, and 0.645 for luminal subtypes. With the optimal cut-off value of radiomics signature, sensitivity, and specificity of the models in the validation cohort were 83.3% and 79.7% for TN, 11.1% and 79.0% for HER2, 44.0% and 66.7% for luminal subtypes, respectively.

CONCLUSION

The radiomic signature derived from the synthetic mammography from DBT showed high performance in distinguishing between TN and non-TN breast cancer. However, it showed poor performances in distinguishing the other subtypes.

CLINICAL RELEVANCE/APPLICATION

The radiomic signature from the synthetic 2D mammography of the DBT may serve as a biomarker to distinguish TN subtype of breast cancer and may affect the direction of treatment.

SSM02-04 Multiparametric MR Imaging Radiomics Predicts the Recurrence Risks Derived from Oncotype DX Gene Signatures in Estrogen Receptor Positive Breast Cancer

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E451A

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PURPOSE

The Oncotype DX score (ODX) plays a pivotal role for risk stratification in Estrogen receptor (ER) positive breast cancer patients, where only high-risk patients exhibit significant benefit from adjuvant chemotherapy. This study assessed how multiparametric MR imaging radiomics can be used to stratify ER positive breast cancer patients in high versus low (Exp-1), high versus intermediate to low (Exp-2), and low versus intermediate to high (Exp-3) ODX risks, respectively.

METHOD AND MATERIALS

This study was approved by the local IRB and written consent were obtained from 124 ER positive breast cancer patients who underwent research MR imaging. ODX predictors of the primary tumors were obtained from RNA microarray gene assay. Radiomic features were extracted from multiparametric MR images including T1 weighted images (WIs), pharmacokinetic maps derived from a perfusion sequence (4.49sec/phase for 75 phases), T2 WIs (post contrast T2, T2c), and DCE images (90sec/phase for 4 phases). Extreme gradient boosting (XGBoost) was used for the three prediction tasks (Exp 1 - 3). Leave-one-out cross validation and area under the receiver operating characteristic curve (AUC) were conducted to access classification performance.

RESULTS

There were 51 low, 26 intermediate, and 47 high ODX risk patients. Among all different combinations of sequences, T2c+DCE achieves the highest AUC for Exp-1 (0.83, 95%CI: 0.75-0.91), and Exp-2 (0.78, 95%CI: 0.69-0.85), respectively, whereas T2c yields the highest AUC for Exp-3 (0.74, 95%CI: 0.65-0.83). These results underscore the importance of T2c+DCE for stratifying high-risk from either low or intermediate/low-risk patients. In contrast, T2c alone enables the best prediction of low-risk from intermediate to high risk patients. The identified important features for risk stratification include T2 max signal, early and delayed enhancement texture. Comparing to previously reported results where only DCE was employed, adding T2c features improve the prediction performance of AUC by 11-15% in risk prediction.

CONCLUSION

Multiparametric MR radiomics with T2c and DCE sequences shows promise for recurrence risk prediction in ER positive breast cancer patients.

CLINICAL RELEVANCE/APPLICATION

In addition to DCE features, the inclusion of features extracted from T2W images further improve recurrence risk prediction in ER positive breast cancer patients.

SSM02-05 Diagnosis of Benign and Malignant Breast Lesions on DCE-MRI Using Radiomics and Deep Learning with Peri-Tumor Tissue

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E451A

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PURPOSE

To evaluate the diagnostic accuracy of lesions detected on DCE-MRI using ROI-based, radiomics and deep learning methods considering peri-tumor tissues.

METHOD AND MATERIALS

Retrospective cases from 91 malignant and 62 benign lesions were used for training. Fuzzy-C-means clustering and region growing were applied for tumor segmentation, and from which the tumor volume and mean DCE parameters were measured. DCE contained 6 frames, and three parametric maps (F2-F1, F3-F1, and F6-F3) were generated. A total of 99 texture and histogram parameters were calculated for each case, and 15 were selected using random forest to build a radiomics model. Deep learning was

implemented using ResNet50, evaluated with 10-fold cross-validation in training set. The tumor alone, smallest bounding box, and 1.2, 1.5, 2.0 times enlarged boxes were used as inputs to investigate the diagnostic impact of peri-tumor tissue. ROC curve was generated based on the predicted per-slice malignancy probability. For per-lesion diagnosis, the highest probability among all slices of one lesion was used. The developed models from the training set were tested in prospective cases collected in recent 6 months (48 malignant, 26 benign). In addition, T2 was used to replace F3-F1 in ResNet to investigate its diagnostic role.

RESULTS

The diagnostic accuracy was 76% using ROI-based, 84% using radiomics, and 86% using ROI+radiomics models. In deep learning using per-slice basis, the AUC was comparable for tumor alone, smallest and 1.2 times box (0.97-0.99), significantly higher than 1.5 and 2.0 times box (0.86 and 0.71, $p < 0.001$). For per-lesion diagnosis, the highest accuracy of 91% was achieved when using the smallest bounding box. The accuracy in the testing dataset were worse in per-slice basis, but when the results were combined to give per-lesion diagnosis, the accuracy only decreased slightly to 89%. When replacing F3-F1 with T2, the specificity was improved from 81% to 85%, and accuracy to 91%.

CONCLUSION

Deep learning using ResNet50 achieved a high diagnostic accuracy. Including small amount of peri-tumor tissue adjacent to tumor led to a higher accuracy compared to using tumor alone or larger boxes.

CLINICAL RELEVANCE/APPLICATION

Deep learning using ResNet algorithm by including adjacent peri-tumor tissue as input yielded a high differential diagnostic accuracy around 90%, and when T2 was considered specificity was improved.

SSM02-06 Quantitative versus Qualitative Ultrasonographic Feature Analysis in Associating with Clinicopathological and Immunohistochemical Characteristics of Triple-Negative Invasive Breast Carcinomas

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E451A

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PURPOSE

Ultrasonographic features are associated with clinicopathological and immunohistochemical characteristics of triple-negative breast cancer (TNBC). To predict the biological property of TNBC, the performance using quantitative high-throughput sonographic feature analysis was compared with that using qualitative feature assessment.

METHOD AND MATERIALS

We retrospectively reviewed ultrasound images, clinical, pathological and immunohistochemical data of 156 patients who were pathologically diagnosed as TNBC. According to the histological grade, Ki67 expression level and human epidermal growth factor receptor 2 (HER-2) score, all patients were divided to two groups. The qualitative sonographic features assessment included shape, margin, posterior acoustic pattern and calcification based on the Breast Imaging Reporting and Data System (BI-RADS). Quantitative sonographic features were acquired based on the computer aided radiomics analysis. The breast cancer masses were automatically segmented from the surrounding breast tissues by deep convolution neural network. From each ultrasound image, 460 radiomics features in terms of intensity, morphology, texture and wavelet decomposition were extracted. As shown in Figure 1, sparse representation and support vector machine (SVM) were used to determine the high-throughput sonographic features that were highly correlated to clinicopathological and immunohistochemical data of TNBC. The performance using sonographic features to predict biological property of TNBC was represented by area under curve (AUC) of the receiver operating characteristic (ROC) curve.

RESULTS

In the qualitative assessment, regular tumor shape, no angular or spiculated margin, posterior acoustic enhancement and no calcification were used as the independent sonographic features for TNBC. Using the combination of these four features to predict the histological grade, Ki67, and HER2, the AUC was 0.678, 0.717 and 0.668, respectively. The number of high-throughput features that are highly associated with biological properties was 40 for histological grade (AUC 0.794), 60 for Ki67 level (AUC 0.882), and 125 for HER2 score (AUC 0.978).

CONCLUSION

High-throughput ultrasonographic features are superior to qualitative ultrasound features in predicting biological behavior of TNBC.

CLINICAL RELEVANCE/APPLICATION

High-throughput ultrasonographic features have the potential to differentiate TNBCs with aggressive biological property.

SSM03

Cardiac (Myocardial Disease)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S401CD

CA MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Hajime Sakuma, MD, Tsu, Japan (*Moderator*) Research Grant, EIZAI; Research Grant, DAIICHI SANKYO Group; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Guerbet SA; Research Grant, Nihon Medi-Physics Co, Ltd;
Borek Foldyna, MD, Boston, MA (*Moderator*) Nothing to Disclose
Friedrich D. Knollmann, MD, PhD, Wynnewood, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSM03-01 Role of Cardiac Magnetic Resonance (CMR) Imaging for Early Detection of Myocardial Involvement in Patients Affected by Anderson- Fabry Disease (AFD)

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S401CD

Participants
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Gianluca de Rubeis, Rome , Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Cardiomyopathy is a complication of Anderson-Fabry Disease (AFD) with dramatic impact on morbidity and mortality; medical therapy is recommended in patients with evidence of cardiac involvement. However, early identification of cardiac involvement in AFD patients may be arduous at pre-hypertrophic stage. Our aim was to evaluate the role of Cardiac Magnetic Resonance (CMR) in early detection of cardiac involvement in AFD at pre-hypertrophic stage.

METHOD AND MATERIALS

16 biopsyproven AFD patients with normal maximal wall thickness at echocardiography (<11mm) underwent to CMR (1.5 T, Avanto, Siemens, Erlangen, Germany) with following sequence protocol: STIR T2w, cineMR, late enhancement and T1 mapping with MOLLI technique before and 15 minutes after injection of 0.15 mmol/Kg gadolinium (GdDOTA, Guerbet, Paris, France). Indexed LV volumes and mass, native T1 (nT1), extracellular volume fraction (ECV) and tissue tracking parameters were analyzed. Results were compared with 16 healthy age and gendermatched volunteers.

RESULTS

No significative differences were found in myocardial mass (Mass/BSA:45,61vs51,24 g/m2,p:0,27), ventricular volumes (EF:58,9vs60,62%,p:0,62) and left ventricular myocardial strain (Global radial strain:46,11vs42,75,p:0,65; global circumferential strain:-20,4vs-18,8,p:0,26; global longitudinal strain:-20,9 vs-18,7,p:0,09)between AFD and healthy subjects. No subjects had shown edema or LGE; nT1 was significantly lower (p=0,01) in AFD patients (988+/-58 ms) than healthy volunteer cohort (1024+/-63 ms); no significative differences was noted between the two groups in ECV values (23%vs24,2%,p:0,23).

CONCLUSION

Native T1 value appears the only marker of early myocardial involvement in pre-hypertrophic AFD patients.

CLINICAL RELEVANCE/APPLICATION

AFD patients should be treated as soon as early signs of organ injury occur (kidney, heart and/or neurological signs). Enzyme replacement therapy is the only specific treatment for AFD but is very expensive and limited to patients with demonstrated organ involvement. Native T1 mapping appear to be reliable and accurate to detect early cardiac involvement before hypertrophic phenotype expression.

SSM03-02 Impact of Myocardial Fibrosis on Left Ventricular Function Evaluated by Feature Tracking Myocardial Strain CMR in Competitive Male Triathletes with Normal Ejection Fraction

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S401CD

Participants
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PURPOSE

To analyze the impact of myocardial fibrosis on left ventricular (LV) function evaluated by feature-tracking strain analysis using cine cardiac magnetic resonance (CMR) in competitive male triathletes with normal ejection fraction.

METHOD AND MATERIALS

78 asymptomatic male triathletes with >10 weekly training hours (43±11 years) and 28 male age-matched controls were studied by late gadolinium enhancement (LGE) and cine CMR. Global and segmental radial, longitudinal and circumferential strains were analyzed using feature-tracking cine CMR. Focal non-ischemic LGE was observed in 15 of 78 triathletes (19%, LGE+) with predominance in basal inferolateral segments. LV ejection fraction was normal in LGE+ (62 ±6%) and in LGE- triathletes (62 ±5%, P=0.958). In contrast, global radial strain was lower in LGE+ triathletes with 40 ±7% compared to LGE- triathletes (45 ±7%, P<0.05). Reduced segmental radial strain occurred either in LGE+ segments or in directly adjacent segments. Strain analysis revealed regional differences in controls with highest radial and longitudinal strain in the inferolateral segments, which were typically affected by fibrosis in LGE+ triathletes.

RESULTS

Focal non-ischemic LGE was observed in 15 of 78 triathletes (19%, LGE+) with predominance of the basal inferolateral segments. LV ejection fraction was normal in LGE+ (62 ±6%) and in LGE- triathletes (62 ±5%, P=0.958). In contrast, global radial strain was lower in LGE+ triathletes with 40 ±7% compared to LGE- triathletes (45 ±7%, P<0.05). Reduced segmental radial strain occurred either in LGE+ segments or in directly adjacent segments. Strain analysis revealed regional differences in controls with highest radial and longitudinal strain in the inferolateral segments, which were typically affected by fibrosis in LGE+ triathletes.

CONCLUSION

Reduced global and regional radial strain suggests a negative effect of myocardial fibrosis on LV function in LGE+ triathletes with normal ejection fraction. The observed regional differences in controls with highest radial and longitudinal strains in the inferolateral segments may explain the typical occurrence of fibrosis in this myocardial region in triathletes.

CLINICAL RELEVANCE/APPLICATION

Non-ischemic myocardial fibrosis might cause subclinical impairment of LV systolic function in athletes.

SSM03-03 Multiparametric Cardiac Magnetic Resonance Detects Extensive Subclinical Myocardial Disease in Patients with Advanced Liver Cirrhosis

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S401CD

Participants
Alexander Isaak, Bonn, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

Liver cirrhosis is the end-stage of different chronic liver diseases and causes multi-systemic pathologies, leading to a high mortality level, especially in mid-age people. Cirrhotic cardiomyopathy (CCM) was defined as a cardiac involvement in patients suffering from cirrhosis, which can increase the risk for cardiac dysfunction and induce poor prognosis, especially in the context of other invasive procedures such as surgery, transjugular intrahepatic portosystemic shunt (TIPS) or liver transplantation. We aimed to determine the extent of cardiovascular involvement in patients with liver cirrhosis by a comprehensive cardiac magnetic resonance (CMR) approach.

METHOD AND MATERIALS

Patients with advanced cirrhosis (n=15; mean MELD-Score: 15±5), without known cardiac disease and preserved ejection fraction

as well as matched control subjects (n=15) underwent CMR. In the setting of a multiparamteric CMR protocol, cardiac function, T1 relaxation times, T2 relaxation times, visible myocardial edema, extracellular volume fraction (ECV) and late gadolinium enhancement (LGE) were determined.

RESULTS

Patients suffering from cirrhosis showed significant changes in myocardial tissue composition (native T1 relaxation times: 1018±48 ms vs. 953±32 ms, P<0.001; T2 relaxation times: 59±3 ms vs. 53±3 ms, P<0.001; ECV: 36.7±6.4 % vs. 29.2±5.7 %, P=0.002). Non-ischemic LGE indicating fibrosis was found in 6/15 (40%) patients (P<0.001). No differences in left ventricular ejection fraction were present between both groups (65±6% vs. 64±3 %, P=0.100).

CONCLUSION

Comprehensive CMR showed extensive myocardial alterations in patients with cirrhosis without history for cardiac disease or symptoms. The elevated markers for focal and diffuse myocardial fibrosis and inflammation indicate a high prevalence of subclinical myocardial disease in cirrhotic patients. Subclinical myocardial disease might be a precursor of CCM in patients with advanced liver cirrhosis.

CLINICAL RELEVANCE/APPLICATION

Comprehensive CMR revealed a high burden of cardiovascular disease in patients with advanced liver cirrhosis and might serve as a potential new screening parameter for CCM.

SSM03-04 Circulating microRNAs as Biomarkers for Myocardial Fibrosis in Hypertrophic Cardiomyopathy

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S401CD

Participants
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PURPOSE

Circulating microRNAs (miRNAs) are important regulators of a range of cellular processes and may represent novel biomarkers for myocardial disease. The purpose of this study was to evaluate whether miRNAs are differentially expressed in the blood of patients with hypertrophic cardiomyopathy (HCM) and whether they correlate with cardiac magnetic resonance imaging (MRI) findings.

METHOD AND MATERIALS

Thirty HCM patients (51.4±11.6 years, 80.0% male) and 10 healthy controls (38.9±12.6 years, 70.0% male) were prospectively recruited. Peripheral plasma levels of 11 miRNAs were assessed by quantitative real-time polymerase chain reaction and compared between HCM patients and controls. Cardiac MRI was performed at 3T including late gadolinium enhancement (LGE) and T1 mapping using a modified inversion recovery Look-Locker (MOLLI) sequence.

RESULTS

Sixteen HCM patients demonstrated LGE (53.3%), quantified at 9.5±7.3% of left ventricular (LV) mass. Native T1 values were significantly higher in HCM patients with LGE compared to those without (1281.5±62.4 ms vs. 1234.9±62.4 ms, p=0.017). Four miRNAs were significantly downregulated in all HCM patients (miRNA-10b, -17, -133, and -18a). Two miRNAs were significantly downregulated in HCM patients with LGE but not in those without LGE (miRNA-192, fold change -2.15, p=0.024 and miRNA-133, fold change -1.84, p=0.028) and one miRNA was significantly upregulated only in patients with extensive fibrosis (defined as LGE >15% of LV mass; miRNA-146, fold change 8.36, p=0.046), suggesting that these miRNAs may play a role in fibrotic HCM. miRNA-192 correlated significantly with quantitative LGE (r=0.328, p=0.047), whereas miRNA-146 and miRNA-193 correlated significantly with native T1 (r=-0.456, p=0.008 and r=-0.423, p=0.007, respectively).

CONCLUSION

Our data suggest that circulating levels of miRNAs are differentially expressed in the blood of patients with HCM. miRNA-192 is downregulated and miRNA-146 is upregulated in HCM patients with LGE. These miRNAs correlate with cardiac MRI markers of fibrosis, identifying them as potential non-invasive biomarkers for myocardial remodelling assessment in HCM.

CLINICAL RELEVANCE/APPLICATION

Circulating miRNAs are potential non-invasive biomarkers for myocardial fibrosis in HCM. These results support the necessity for future larger studies to confirm these findings and evaluate their prognostic significance.

SSM03-05 The Application Value of Multi-Modal MRI in Assessment of Myocardial Edema in Patients with End-Stage Renal Disease

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S401CD

Participants
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PURPOSE

ESRD patients are highly prevalent cardiovascular risk. ME occurred in various cardiovascular disease and precipitate myocardial fibrosis and arrhythmia in ESRD patients, and ultimately lead to heart failure or cardiac death. The study is to compare the

effectiveness of native T1 mapping,T2 mapping and conventional T2-weighted imaging (T2WI) in the detection of myocardial edema in patients with end stage renal disease, and further explore clinical value of ME in early diagnosis of myocardial injury.

METHOD AND MATERIALS

Seventy hemodialysis ESRD patients and 16 age- gender-matched healthy volunteers were prospectively enrolled and underwent CMR. All the parameters from CMR, including native T1 values,T2 values, T2 SI ratio, were measured (cmr42; Circle Cardiovascular Imaging Inc.; Calgary; Canada) and compared. Receiver operating characteristic analysis was performed to determine whether T2 values could be used in discriminating myocardial edema between ESRD patients and normal subjects.

RESULTS

The global T2 and native T1 values of ERSD patients were higher than normal controls (all P<0.05). But there was nosignificant difference in T2 SI ratios between two groups (p=0.146). The myocardial native T1 and T2 values of ESRD patients with preserved and decreased LVEF were both higher than those of normal controls (p<0.05), but there was no significant difference between the two groups in native T1 and T2 values. There was no significant difference between the three groups in T2 SI values (p=0.366). Moreover, the global T2 values of patients with MF and without MF were higher than normal controls (43.69±3.62, 41.82±3.43 v.s 38.79±3.69ms, respectively, all P<0.05). The global T1 values of ERSD patients with MF was highest among three groups (1286.12±52.60 v.s 1321.02±56.65, 1356.79±40.08ms, respectively, all P<0.05),but no statistical difference were found between normals and patients without MF. There were no significant difference in T2 SI ratios among three groups (p=0.311). In ESRD with MF , the proportion of left ventricular dysfunction (19, 52.8%) was higher than that in the ESRD without MF (8, 23.5%). By ROC analysis, T2 values exhibited a higher diagnostic accuracy for detecting ME than did native T1 or T2 SI values (0.83 vs. 0.67 and 0.63,all p<0.05). A cutoff value for global myocardial T2 of >= 41.94ms provided a sensitivity and specificity of 73.5% (52.0-85.8%) and 87.5% (61.7-98.4%) for ME in ESRD patients, respectively.

CONCLUSION

The myocardial pathological changes in patients with end stage renal disease were complex. The multiple cardiac magnetic resonance sequence demonstrated that myocardial edema exited in patients with ESRD patients. The CMR T2 mapping technique has a higher accuracy in quantifying the myocardial edema in patients with end stage renal disease compared with native T1 mapping and conventional T2WI.

CLINICAL RELEVANCE/APPLICATION

Early and accurate evaluation of ME in ESRD patients to evaluate the extent and scope of left ventricular myocardial tissue injury is greatly important for adjustment of clinical dialysis and medication intervention programs timely,combination of multiple sequence (includingT2 mapping, native T1 mapping, T2WI)will contribute to detection of diffused ME in ESRD patients.

SSM03-06 Multiparametric Cardiac Magnetic Resonance Imaging in Fabry's Disease Improves Diagnostic Accuracy Compared to T1 Mapping

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S401CD

Participants
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PURPOSE

Fabry's Disease (FD) is a hereditary, x-chromosomal linked storage disease that lead to accumulation of sphingolipids. Recently published work highlight the diagnostic potential of T1 Mapping in the detection of Fabry's disease. The aim of this study was to evaluate a combined diagnostic approach using basic cardiac parameters, T1 and T2 Mapping as well as left and right ventricular strain values.

METHOD AND MATERIALS

In this retrospective study, 61 patients in all phenotypic stages of Fabry's disease and 57 healthy volunteers were included. CMR was performed at 3T and incorporated CINE imaging, T1 and T2 Mapping as well as Late Gadolinium Enhancement imaging. In a post-processing manner, cvi42 (Circle, Calgary, Canada) was used to calculate global and septal T1 and T2 times as well as left and right ventricular function and Feature-tracking based strain parameters.

RESULTS

In univariate analysis, longitudinal strain parameters outperform conventional and mapping parameters in detection of Fabry's disease. Nevertheless, the combination of left and right ventricular global longitudinal strain (GLS) with T1 Mapping yielded the highest diagnostic accuracy with a sensitivity and specificity of 83.3 and 82.4% (Figure). The combined approach results in significant improvement of diagnostic accuracy compared to a univariate approach, demonstrated by increasing Youden's indexes (YI): YI (T1 Mapping) 0.468 vs YI (LV GLS) 0.623 vs YI (combination) 0.657.

CONCLUSION

A multi-parametric imaging approach incorporating FT strain parameters and T1 Mapping improved the diagnostic accuracy of CMR for detection of Fabry's disease in all stages of disease. Further research is needed to establish Strain imaging as a surrogate for prognosis and therapy.

CLINICAL RELEVANCE/APPLICATION

CMR with T1 Mapping is an important diagnostic method for diagnosis, initiation of therapy and estimation of prognosis in FD. Our work demonstrates the additive value of LV and RV FT strain imaging in FD.

Printed on: 10/29/20

SSM04

Cardiac (Anatomy and Function)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S404AB

CA MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Frandics P. Chan, MD, PhD, San Francisco, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSM04-01 Overdiagnosis of Late Gadolinium Enhancement by Cardiovascular Magnetic Resonance

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S404AB

Participants
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Rong Chen, Changsha, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the rate of overdiagnosis of late gadolinium enhancement (LGE) by cardiac magnetic resonance (CMR) in a large-scale comprehensive university hospital.

METHOD AND MATERIALS

This study is a retrospective review of all cardiac magnetic resonance examinations performed in a comprehensive university hospital over a 18-month period. Studies originally reported as positive for myocardial LGE were retrospectively reinterpreted by three subspecialty cardiovascular radiologists with more than 5 years' experience. A CMR was considered negative for LGE when all three cardiovascular radiologists were in agreement that the CMR study was negative for LGE. The location and potential causes for LGE overdiagnosis were recorded.

RESULTS

A total of 523 CMR studies were performed over the study period. LGE was diagnosed in the initial report in 126 of these cases (24.1%). There was discordance between the cardiovascular radiologists and the original radiologist in 32 of 126 (25.4%) cases. Discordance occurred more often where there were partial volume effects (46.9%, 15/32): in interventricular septum caused by RV deep intertrabecular recesses were mistaken for stria LGE (40.0%, 6/15); in lateral wall caused by non-compacted myocardium were mistaken for subendocardial LGE (33.3%, 5/15); in RV insertion point caused by RV cavity were mistaken for patchy LGE (26.7%, 4/15). Crypt and diverticulum (18.8%, 6/32) were mistaken for indramyocardial (50.0%, 3/6) or subendocardial LGE (50.0%, 3/6). Pericardial fat were mistaken for epicardial LGE (15.6%, 5/32); False positive LGE (12.5%, 4/32) as detected by original observers due to a wrong inversion time (TI). Lipomatous metaplasia were mistaken for LGE (3.1%, 1/32). Congenital aneurysm in apical wall were mistaken for transmural LGE (3.1%, 1/32).

CONCLUSION

When compared with the consensus opinion of expert cardiovascular radiologists, we found a high rate of overdiagnosis of LGE by CMR In routine clinical practice. Improvements in the quality of CMR examination and increased recognition of potential diagnostic pitfalls in CMR are recommended to minimize misdiagnosis of LGE.

CLINICAL RELEVANCE/APPLICATION

LGEs diagnosed by CMR are frequently overdiagnosed, which appeared to be due to a lack of recognition of the false positive LGEs. Increased education among radiography technologists, radiologists, and clinicians regarding these imaging pitfalls should be encouraged.

SSM04-02 Single and Multiframe Super-Resolution: Feasibility for Cardiac MRI

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S404AB

Awards
Trainee Research Prize - Medical Student

Participants
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Albert Hsiao, MD,PhD, La Jolla, CA (*Abstract Co-Author*) Founder, Arterys, Inc; Consultant, Arterys, Inc; Shareholder, Arterys, Inc;

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PURPOSE

Cardiac MRI (cMRI) is the clinical reference standard for visual and quantitative assessment of heart function. However, MRI suffers from long acquisition times, averaging over multiple heart beats, and a tradeoff between spatial and temporal resolution. We investigated the use of convolutional neural networks (CNN) to recover spatial resolution of subsampled MR images with the goal of accelerating cMRI.

METHOD AND MATERIALS

With HIPAA compliance and IRB waiver of informed consent, we retrospectively collected 200 short axis (SAX) cine SSFP from cMRI examinations performed at our institution. Spatial-subsampling was simulated by zeroing outer k-space. We simulated downsampling factors ranging from 2-32x. We employed CNNs to perform single-frame and multi-frame superresolution, called k-SRNet and kt-SRNet respectively, to predict full-sampling from subsampled images. We used 70% of cases for training, 20% for validation, and 10% for testing. We compared SRNet and traditional methods of bicubic interpolation and Fourier-based zero-padding (Z-pad) by calculating the Structural Similarity Index (SSIM) between fully-sampled ground truth and each method of upscaling. We report the mean and standard deviation of SSIM and determine statistical significance using paired Student's t-test with type I error threshold of 0.05.

RESULTS

For single frame spatial superresolution (k-SRNet), mean SSIM was 0.943±0.022 for 8x, 0.878±0.036 for 16x, and 0.810±0.052 for 32x upsampling. For multiframe spatiotemporal superresolution (kt-SRNet), mean SSIM was 0.941±0.021 for 8x, 0.886±0.035 for 16x, and 0.816±0.052 for 32x upsampling. In comparison, bicubic interpolation yielded mean SSIM of 0.827±0.054 for 8x and 0.723±0.076 for 16x upsampling. Z-pad yielded mean SSIM of 0.924±0.029 for 8x and 0.857±0.047 for 16x upsampling. SRNet significantly outperformed traditional methods at all upscaling factors.

CONCLUSION

CNNs can recover spatial resolution from spatially subsampled MR images. Multiframe kt-SRNet yielded comparable results to k-SRNet in recovering image quality from spatial undersampling. Both k-SRNet and kt-SRNet appear to be superior to traditional methods of image upsampling, especially for higher upsampling factors.

CLINICAL RELEVANCE/APPLICATION

Convolutional neural networks have potential to reduce the sampling requirements for resolving cardiac structures in cardiac MRI, and may complement other techniques used to accelerate MRI.

SSM04-03 Biventricular and Left Atrial Myocardial Strain Assessment by MRI Feature Tracking in T2DM Patients with and without Hypertension

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S404AB

Participants
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Heshui Shi, MD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The purpose of this study was to assess left atrium (LA), right ventricle (RV) and left ventricle(LV) strain in type 2 diabetes mellitus (T2DM) patients with and without hypertension using CMR feature tracking (FT) and their underlying relationships with clinical parameters.

METHOD AND MATERIALS

We recruited 20 T2DM patients without hypertension(T2DM-NHT) (mean age: 53 ± 7 years; 11 males) , 20 T2DM patients with hypertension(T2DM-HT) and 40 controls matched for gender, age, and BMI to undergo CMR examinations. The LA , LV and RV myocardial strains were evaluated with using routine cine images based on feature-tracking software. The clinical baseline parameters were collected before the CMR examination.

RESULTS

The T2DM-NHT patients had significantly reduced LA global longitudinal (GLS), circumferential (GCS), radial strain (GRS), and RVGLS compared with those in the controls(LAGCS: 27.6 ±3.6% vs 33.9 ±8.7%; LAGRS: -29.2± 4.7% vs -32.9±3.9%; LAGLS: 23.8 ±5.5% vs 30.9± 6.0%; RVGLS: -22.1 ±3.3% vs -26.0 ±7.4%, $p<0.05$ for all). The T2DM-HT patients had significantly greater LAGCS, LAGRS and LAGLS compared with those in T2DM-NHT patients (LAGCS: 39.4 ±12.7% vs 27.6 ±3.6%; LAGRS: -34.8± 7.3% vs -29.3±4.7%; LAGLS: 36.7 ±17.6% vs 23.8±5.5%, $p<0.05$ for all). However, the LA volume, the LV global systolic strain and routine cardiac function were similar between three groups. Moreover, in the diabetic patients, the LA GCS was independently associated with the microalbuminuria levels (standardized ß =-0.56, $p=0.023$), and the LA GLS was independently correlated with diuretic treatment (standardized ß =0.313, $p=0.027$).

CONCLUSION

T2DM-NHT patients with preserved LV function demonstrated impaired LAGRS, LAGLS, LAGCS and RVGLS compared with controls. Hypertension may compensatorily improve LA strain in T2DM patients, as opposed to the microalbuminuria levels. Diuretic treatment can help ameliorate LA function.

CLINICAL RELEVANCE/APPLICATION

In T2DM patients, the impact of hypertension, microalbuminuria levels and diuretic treatment on LA strain deserves further study.

SSM04-04 Association B-Type Natriuretic Peptide (BNP) of and Dialysis Vintage with CMRI- Derived Cardiac Indices in Stable Hemodialysis Patients with Preserved Left Ventricular Ejection Fraction

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S404AB

Participants
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PURPOSE

Cardiovascular disease (CVD) is a major cause of morbidity and mortality in (HD) patients. Native T1/T2 mapping and tissue-tracking strain analysis by cardiac magnetic resonance imaging (CMRI) are proved to be useful as early quantitative techniques for evaluating myocardial tissue and mechanical alterations in HD patients. We aim to assess the left ventricular myocardial native T1/T2 values and systolic strains and the associations with B-type natriuretic peptide (BNP) and dialysis vintage in HD patients with a preserved left ventricular ejection fraction (LVEF).

METHOD AND MATERIALS

Forty-three stable HD patients (mean age: 59±11 years; 28 males)with end-stage renal disease with a preserved LVEF (>=50%) and 28 healthy volunteers (mean age: 61±7 years; 14 males)matched for sex, age, and body mass index. The native T1/T2 values of the left ventricular myocardium were measured on the T1 and T2 maps. The left ventricular global systolic strain was evaluated on routine cine images using prototype postprocessing software. BNP was measured at the time of CMR measurements.

RESULTS

Compared with controls, the global native T1 and T2 values were significantly higher in the HD patients than in the controls (native T1: 1056±32 ms vs. 1006±25 ms, p<0.001; T2: 50±3 ms vs. 46±2 ms, p<0.001). The mean peak global circumferential strain (GCS) and global longitudinal strain (GLS) were both significantly reduced in the HD patients compared with the controls (GCS: -13±3 vs. -16±3, p<0.001; GLS: -12±4 vs. -15±3, p=0.001). However, no significant difference was found between two groups regarding LVEF(61±8 vs 64±8, p=0.057). In HD patients, a significant positive correlation was found between T2 value and BNP levels (r=0.402,p<0.001).The GLS was independently correlated with the dialysis vintage in HD patients (standardized ß=-0.321, p=0.044).

CONCLUSION

The HD patients with preserved LVEF have increased native T1/T2 value and decreased strain, while increased T2 values relates to high BNP. GLS may be improved in long-term HD patients.

CLINICAL RELEVANCE/APPLICATION

Multiple advanced CMR technologies, including native T1/T2 mapping and tissue-tracking analysis could detected early cardiomyopathy in HD patients without gadolinium-based contrast agents. The correlation of CMRI-derived cardiac indices with heart failure index BNP and dialysis vintage could help timely prevent cardiovascular disease and assess prognosis in HD patients.

SSM04-05 Preliminary Validation of Turbulent Kinetic Energy Measurement of HOCM by Using Multi-VENC 4D Flow MRI

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S404AB

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PURPOSE

In the patients with hypertrophic cardiomyopathy (HCM), the impairment of cardiac ejection efficiency due to the obstruction of left ventricle outflow tract (LVOT) relates to the HCM-related death. Recently, the turbulent kinetic energy (TKE) estimation based on 4D Flow MRI has been developed. Previous studies revealed that 4D Flow-based TKE measurement well correlates to the pressure drop at LVOT in the patients with aortic stenosis which has a similar physiological entity as HCM. The purpose of this study was to validate the clinical value of 4D Flow-based TKE measurement in the patients with HCM.

METHOD AND MATERIALS

From April 2018 to March 2019, we recruited consecutive 17 HCM patients. Based on echocardiography, they were assigned into obstructive HCM (HOCM) (9 patients, 67.0±9.9 years old, 4 males) or non-obstructive HCM (HNCM) (8 patients, 68.9±12.8 years old, 5 males). We also recruited 9 normal volunteers(30.9±3.0 years old, 6 males). The parameters of 4D Flow MRI were as follows; resplution=1.7*1.7*2.0mm; Triple VENC acquisition = 50-150-450 cm/s; k-t PCA (acceleration factor, 5 -7), free breath acquisition;

and acquisition time 8-15 min.). GT Flow (Gyrotools, Zurich, Switzerland) was used for analysis. The VOI from left ventricular to aortic arch was drawn semi-automatically. We defined TKEphase as the sum of entire VOI at each cardiac phase, and TKEpeak as the highest TKEphase in the all cardiac phase.

RESULTS

TKEpeak of HOCM is significantly higher than HNCM (p=0.008) or volunteers (p=0.002). TKEpeak correlated to max velocity (p=0.007, r=0.631) and maximum short dimeter of the valve orifice (p=0.006, r=-0.658). TKEpeak in the patients with systolic anterior movement (SAM) were significantly higher than without SAM (p=0.008). TKEpeak correlated to LV mass (p=0.035, r=0.514).

CONCLUSION

TKE measurement based on 4D Flow MRI can noninvasively detect the flow alteration induced not only by systolic flow jet but also by LVOT geometry such as SAM in the patients with HOCM. The elevated TKE correlates increasing LV mass. It may indicate that increasing cardiac load by the pressure loss due to turbulence induced the progression of LV mass. This physiology reaction is considered as the worse outcome.

CLINICAL RELEVANCE/APPLICATION

TKE measurement based on 4D Flow MRI can noninvasively detect the flow alteration in the patients with HOCM.

SSM04-06 T2 Mapping and Cardiac Stress Test to Detect and Monitor Myocardial Edema and Ischemia in Female Patients after Left-Sided Breast Cancer Radiation Therapy

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S404AB

Participants
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PURPOSE

To detect and monitor subclinical cardiomyopathy by cardiac magnetic resonance (CMR) in female patients with first-time diagnosis of left-sided breast cancer following radiation therapy.

METHOD AND MATERIALS

27 female patients (56 ±14 years) with newly diagnosed breast cancer underwent serial 3 Tesla CMR (Ingenia, Philips Medical Systems). Baseline (BL) CMR was performed 18 ±16 days before the start of a left-sided radiation. None of the patients received chemotherapy. First follow-up (FU1) CMR was 7 ±12 days and second follow-up (FU2) 12 ±1 months after completion of radiotherapy. A free-breathing, navigator-gated multi-echo sequence was used for short-axis T2 mapping. Cardiac stress test was performed at 400 µg regadenoson stress on 3 representative short axis slices (basal, midventricular and apical) using an ultrafast gradient echo sequence.

RESULTS

A mean radiation dose of 47 ±4 Gy was applied with a calculated mean cardiac dose of 2.4 ±2.3 Gy. High sensitive Troponin T increased immediately after radiation therapy (5 ±2 vs. 6 ±3 pg/ml, P<0.05) and declined to baseline values on FU2 (6 ±3 vs. 5 ±2 pg/ml, P<0.05). NT-proBNP and creatine kinase remained unchanged throughout the observation period. LVEF was constant between BL and FU1 (62 ±5 vs. 64 ±6%, P=0.218) and FU1 and FU2 (64 ±6 vs. 62 ±5%, P=0.171). LVEDV declined on FU1 (78 ±10 vs. 75 ±11 ml/m2, P<0.05) and remained decreased on FU2 (72 ±11 ml/m2, P<0.05). RVEDV declined between BL and FU2 (81 ±12 vs. 75 ±13 ml/m2, P<0.05). T2 relaxation times increased on FU1 (47 ±2 vs. 48 ±4 ms, P<0.05) and declined on FU2 (47 ±2 ms, P=0.092). On visual evaluation cardiac stress test did not detect any myocardial ischemia after radiation therapy.

CONCLUSION

Radiation treatment of female left-sided breast cancer can lead to development of myocardial edema and troponin increase in the early phase following therapy, which subside within the first 12 months. Both ventricular volumes decrease after radiation therapy. There is no evidence of myocardial ischemia development within the first 12 months post-radiation.

CLINICAL RELEVANCE/APPLICATION

Development of myocardial edema and decreased of ventricular volumes might be used as indicators for subclinical cardiomyopathy in patients with left-sided breast cancer undergoing radiation therapy.

SSM05

Chest (Dual-energy CT - Malignancy)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: N226

CH CT OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM05-01 Improved Differentiation between Primary Lung Cancer and Pulmonary Metastases by Combining Dual-Energy CT Derived Iodine Concentration and Conventional CT Attenuation

Wednesday, Dec. 4 3:00PM - 3:10PM Room: N226

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PURPOSE

To assess the clinical utility of dual-energy CT (DECT) derived iodine concentration (IC) in addition to conventional CT attenuation (HU) for the discrimination between primary lung cancer and pulmonary metastases from different primary malignancies.

METHOD AND MATERIALS

In this retrospective research ethics board approved study, we analyzed contrast-enhanced DECT scans in 79 patients with primary lung cancer (adenocarcinoma, n=45; squamous cell carcinoma (SCC), n=16; small-cell lung cancer (SCLC), n=18) and 89 patients with pulmonary metastases from primary breast (invasive-ductal adenocarcinoma, n=17), colorectal (adenocarcinoma, n=27), head and neck (squamous cell carcinoma, n=17), kidney (RCC) (clear-cell renal cell carcinoma, n=10) and pancreato-biliary (PBC) (adenocarcinoma, n=18) malignancies. Quantitative IC and conventional HU values were extracted and normalized to the thoracic aorta. Differences between groups were assessed by Kruskal-Wallis test with Dunn's post-hoc correction. Multivariate logistic regression was used to generate a diagnostic model. Diagnostic accuracy was evaluated by the area under receiver operator characteristic (ROC) curve (AUC).

RESULTS

Significant differences in conventional HU values ($p<0.001$) were found only between SCLC and metastases from RCC, with median HU [IQR] values of 57 [18] and 100 [35], respectively. Significant differences in IC ($p<0.05$) were noted for SCC (1.3 [0.71] mg/ml) and SCLC (1.2 [0.68] mg/ml) versus pulmonary metastases from RCC (2.8 [1.7] mg/ml) and PBC (2.1 [1.2] mg/ml). In multivariate analysis, both IC (odds ratio 0.16, $p<0.0001$) and HU (odds ratio 1.06, $p<0.0001$) were independent diagnostic features for the discrimination of primary lung cancer from pulmonary metastases. The corresponding multivariate model (AUC=0.73) significantly outperformed both single parameters in diagnostic accuracy (IC: AUC=0.57, $p<0.01$; HU: AUC=0.55, $p<0.001$), achieving a sensitivity and specificity (at maximum Youden index) of 65.82% and 76.40%, respectively.

CONCLUSION

A combined diagnostic model incorporating both DECT derived IC, and conventional CT attenuation values significantly improves the differentiation between primary lung cancer and pulmonary metastases.

CLINICAL RELEVANCE/APPLICATION

A combination of dual-energy CT derived iodine concentration, and conventional CT attenuation provides improved discrimination between primary lung cancer and pulmonary metastases.

SSM05-02 Improving Diagnostic Accuracy for Pulmonary Nodules with the Combination of Morphological Characteristics and Spectral CT-Specific Multi-Parameters

Wednesday, Dec. 4 3:10PM - 3:20PM Room: N226

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PURPOSE

To demonstrate the value of improving pulmonary nodules (PN) diagnostic accuracy by combining the morphological characteristics and spectral CT-specific parameters.

METHOD AND MATERIALS

173 patients with pulmonary nodules (61 benign pulmonary nodules (BPN) and 112 malignant pulmonary nodules (MPN)) underwent dual-phase contrast-enhanced spectral CT. Monochromatic and material decomposition images were reconstructed. The morphological characteristics of PN were observed on 70keV images, including location, size, bronchial truncation, density, shape, lobulation, spiculation, spinous sign, vessel convergence sign, boundary, cavity, necrosis, lymph node, pleural invasion, pleural effusion, enhanced pattern and vascular invasion. The CT values from 40keV to 140keV, Effective-Z, blood concentration (BC), iodine concentration (IC), water concentration (WC) of PN and the aorta at the same level were measured to calculate the slope of spectral HU curve (λ), normalized blood concentration (NBC), normalized iodine concentration (NIC) and normalized water concentration (NWC). The receiver operating characteristic (ROC) curve was drawn to evaluate the diagnostic performance of differentiating BPN from MPN.

RESULTS

The two patient groups were similar demographically (P>0.05). The incidence of bronchial truncation, irregular shape, lobulation, pleural effusion and vascular invasion in MPN was significantly higher than those in BPN (P<0.05). The CT values from 40keV to 90keV, λ40keV-90keV, λ100keV-140keV, λ40keV-140keV, BC, IC, NBC, NIC, Effective-Z values of BPN were significantly higher than those of MPN (P<0.05), while both lesions had similar CT values from 100keV to 140 keV, and WC and NWC values (P>0.05). The diagnostic accuracy in differentiating BPN and MPN (AUC 0.891) with combined morphological characteristics and spectral CT-specific parameters was significantly higher than that of only using morphological characteristics (AUC 0.726) or spectral multi-parameters (AUC 0.843).

CONCLUSION

Morphological characteristics with combination of spectral CT multi-parameters spectral CT can help to improve the diagnostic accuracy in differentiating pulmonary nodules.

CLINICAL RELEVANCE/APPLICATION

The morphological characteristics with combination of multi-parameters based on spectral CT can improve the diagnostic accuracy of pulmonary nodules.

SSM05-03 Comparison in Pulmonary Small Vessel Area and Association with Pulmonary Emphysema between Lower and Standard Energy Data Acquisition: Quantitative Assessment with Dual-Energy Computed Tomography

Wednesday, Dec. 4 3:20PM - 3:30PM Room: N226

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PURPOSE

To investigate the merit of lower energy data acquisition on computed tomography(CT) for the quantification of pulmonary smaller vessels and emphysema

METHOD AND MATERIALS

The institutional review board approved this study and consents from patients were waived because of retrospective study design. A hundred and fifty patients underwent chest CT by using fast kVp switching dual-energy scanner (80/140 kVp) with scan parameters to secure target standard deviation(SD) 11 (Revolution GSI, General Electric Medical Systems, Milwaukee, WI, USA). Scan data were converted to virtual monochromatic images (VMI) at 3 tube voltages; 40, 55 and 70 KeV. Low attenuation area < -950 HU (% LAA-950) was quantified with dedicated software as emphysema extent. By using a free software Image J, percentage

of cross-sectional area of pulmonary vessels < 5 mm2 to total lung field (%CSA<5) was calculated as pulmonary small vessel area at predefined 3 trans-axial levels; aortic arch, bronchial bifurcation and right pulmonary veins orifice, and SD in CT density in 10 mm-quadrangular region of interest inside descending aorta was measured as objective image noise (OIN) at the bronchial bifurcation level. %LAA-950 and %CSA<5 in total and each of the 3 levels were compared among the 3 tube voltages by using Friedman and Wilcoxon signed rank test. Spearman's rank correlation analyses were performed to assess the associations of the %LAA-950 and %CSA< 5, and analyses of covariance were performed to assess the similarity of slope of regression lines among the 3 tube voltages.

RESULTS

%CSA<5 on VMI at 40 KeV in total as well as the 3 levels was the largest (1.96±0.32), followed by that at 55 (1.34±0.30) and 70 KeV (0.85±0.27). %LAA-950 on VMI at 40 KeV was also the largest (14.6±8.9 %), followed by that at 55 (5.9±7.6 %) and 70 KeV (2.8±6.6 %). Negative correlation was found between %CSA<5 and %LAA-950 all in the 3 tube voltages (r = -0.529, p <0.001 at 40 KeV). Slope of regression line at 40 KeV was similar to that at 55 KeV irrespective of OIN increase.

CONCLUSION

Data acquisition at 40 KeV can be useful for quantification of pulmonary smaller vessels closely-associated with emphysema on CT.

CLINICAL RELEVANCE/APPLICATION

Data acquisition at 40KeV may be potential to play an important role for early detection of peripheral vessel impairment leading to pulmonary hypertension in combination with iterative reconstruction.

SSM05-04 Can Dual-Energy Derived Perfusion Parameters Provide Information on Tumor Hypoxia? Preliminary Experience in 49 Operable Non-Small Cell Lung Carcinomas

Wednesday, Dec. 4 3:30PM - 3:40PM Room: N226

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PURPOSE

To investigate potential relationships between DECT perfusion characteristics and prognostic histopathologic features.

METHOD AND MATERIALS

A two-phase DECT scanning protocol was obtained in the presurgical evaluation of 49 tumors (squamous cell carcinomas: n=12; adenocarcinomas: n=37), including (a) an early phase over the entire thorax (i.e., intravascular phase of tumoral perfusion); (b) completed by a delayed acquisition over the tumor, 50 s later (i.e., interstitial phase of tumoral perfusion). The first-pass and delayed iodine concentration (IC; mg/mL) and the arterial enhancement fraction (AEF=first pass IC/delayed IC x 100) were calculated over the entire tumor and within the most peripheral 2-mm thick tumor layer, automatically segmented. The expression of the membranous carbonic anhydrase IX (mCAIX), an immunohistochemical marker of hypoxia, was assessed in tumor specimens.

RESULTS

33 tumors were mCAIX positive (Group 1) and 16 mCAIX negative (Group 2), the former showing a statistically significantly larger volume (p=0.04). At the level of the whole tumor, the delayed IC was significantly higher than that at first pass (median: 1.53 vs 1.4; p=0.04), suggestive of extravascular leakage within the interstitial space; there was no difference in DECT perfusion parameters between the two groups. Compared to Group 2, the outer layer of Group 1 tumors had significantly higher median values of IC (0.53 vs 0.21; p=0.02) and AEF (102.6 vs 65.6; p=0.02) with a trend toward higher delayed IC (0.48 vs 0.39; p=0.34). The distribution of neovessel profile was significantly different between Groups 1 & 2 with a greater proportion of functional neovessels in Group 1.

CONCLUSION

DECT can provide insight into perfusion characteristics at the level of the tumoral invasion front.

CLINICAL RELEVANCE/APPLICATION

Hypoxia-induced neovascularization may contribute to tumor progression and metastasis. DECT can provide information on perfusion characteristics at the level of the tumoral invasion front.

SSM05-05 The Predictive Value of Energy Spectrum CT Parameters for Ki67 Expression of Lung Cancer

Wednesday, Dec. 4 3:40PM - 3:50PM Room: N226

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PURPOSE

To investigate the predictive value of energy spectrum CT parameters for lung cancer Ki67 expression.

METHOD AND MATERIALS

Between December 2018 and February 2019, 27 primary lung cancer patients confirmed by pathological examination enrolled this prospective cohort study. All patients underwent energy spectrum CT (ESCT) scan . ESCT parameters were derived from dual-energy virtual imaging in Siemens postprocessed workstation by a radiologist (M.Y.K.). All enrollment patients clinicopathological data derived from electronic record system. SPSS 19.0 were used for statistical analysis.Quantitive and qualitative data used X2, t and Rank test respectively.ROC curves were used for analysis predicting performance of the Ki67 expression. P<0.05 was considered statistically significant.

RESULTS

Tumor was larger in Ki67 high expression group than low group (P=0.046). The other demographic and clinicopathological characteristics of all enrollment patients showed no significant difference (Table 2). Venous phase iodine value (IV), iodine ratio (IR) and the slope of the 40-80 keV energy spectrum curve (SP) improved than arterial phase IV, IR and SP, respectively (Fig. 1). The arterial phase IV, IR, SP and venous phase IV are no significant difference in low and high Ki67 expression group (P value ranged from 0.105 to 0.182) (Table 3). There are significantly different in two groups for venous phase IR and SP (0.249±0.083, 0.360±0.162, P=0.033 in IR and 1.744±0.607, 2.562±1.236, P=0.037 in SP, respectively) (Table 3, Fig. 2). Venous phase IR ROC analysis showed boderline P value (P=0.056) with AUC, sensitivity (SE), specificity (SP) and cutoff value were 0.717, 92.86, 61.54 and <=0.347 respectively. The AUC, SE, SP and cutoff value were 0.698, 92.86, 53.85 and <=2.407 respectively (Table 4, Fig. 6).

CONCLUSION

Venous phase IR and SP based on single energy spectrum curve and iodine image may effectively stratify primary lung cancer Ki67 expression into low and high group. The efficacy of other energy spectrum parameters need further investigation.

CLINICAL RELEVANCE/APPLICATION

The baseline energy spectrum CT parameters may non-invasion predict Ki67 expression. And the results may use for stratification lung cancer patients and individulization treatment in some extent.

SSM05-06 The Application of Spectral CT Multi-Parameter in Differentiating Pathological Types of Lung Cancer

Wednesday, Dec. 4 3:50PM - 4:00PM Room: N226

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PURPOSE

To explore the application of spectral CT multi-parameter in differentiating pathological types of lung cancer.

METHOD AND MATERIALS

57 patients with lung cancer who underwent spectral CT imaging were collected,of which there were 24 cases with adenocarcinoma,18 cases with squamous cell carcinoma and 15 cases with small cell lung cancer.The dual-phase (aortic phase and pulmonary venous phase) enhanced scanning was used for all patients.The CT values of 40kev-90kev,iodine concentration(IC),water concentration(WC),effective-Z and the iodine concentration and water concentration of aorta at the same level were measured in the arterial phase,and the normalized iodine concentration(NIC) and the normalized water concentration(NWC) and the spectral curve slope were calculated.One-way ANOVA was used to compare the parameters.

RESULTS

The CT values of 40kev-60kev,iodine concentration,normalized iodine concentration,effective-Z and the spectral curve slope showed significant difference among three kinds of lung cancer(P<0.001).The CT values of 40kev-60kev,iodine concentration,normalized iodine concentration,effective-Z and the spectral curve slope in adenocarcinoma and squamous cell carcinoma were significantly different from small cell lung cancer(P<0.001).The CT values of 40kev-60kev,iodine concentration,normalized iodine concentration,effective-Z and the spectral curve slope in adenocarcinoma were higher than those in squamous cell carcinoma(P<0.001).

CONCLUSION

Spectral CT multi-parameter can be used to identify different pathological types of lung cancer,of which the iodine concentration,normalized iodine concentration,effective-Z,CT values of 40kev-60kev and spectral curve slope played a role in differential diagnosis.

CLINICAL RELEVANCE/APPLICATION

Spectral CT imaging can provide multi-parameter identification basis for the pathological types of lung cancer,which was helpful to determine the reasonable treatment plan and improve the prognosis.

Printed on: 10/29/20

SSM06

Chest (Infection/Incidental Lung Nodule)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: N227B

CH CT

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM06-01 Can Ultra-Low Dose Chest CT Accurately Detect Radiological Patterns of Fungal Infection in Immunocompromised Patients?

Wednesday, Dec. 4 3:00PM - 3:10PM Room: N227B

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PURPOSE

To compare the accuracy of ultralow dose (uLDCT) to low dose chest CT (LDCT) in detection of major and minor findings of fungal infection.

METHOD AND MATERIALS

IRB approved this prospective study and patient consent was obtained. 100 consecutive immunocompromised patient had 2 chest CT scans (135kV, 0.5s, 64x0.5mm) during a single breath-hold with LDCT (40mA, ~1mSv) and uLDCT (10mA, ~0.25mSv). Images were reconstructed using lung and mediastinal kernels at slice thickness/interval of 3.0/2.4mm. 3 board certified chest radiologists independently evaluated the studies in randomized and blinded setting, and qualitatively assessed 1) image quality, 2) diagnostic confidence for detecting fungal infection and 3) detection of EORTC major criteria (halo sign, cavitation, consolidation) and minor criteria (nodules: clustered or isolated nodules of 4-10mm diameter, GGO/atelectasis) for fungal disease using a 5-point Likert score. Discrepant findings were adjudicated by a senior thoracic radiologist. Patients were stratified by BMI (kg/m2): <=18.5, 18.5-25.0, 25.0-30.0 and >30.0. uLDCT results were compared to LDCT findings.

RESULTS

Image quality and diagnostic confidence: LDCT had median and mean scores >4.0. uLDCT had median and mean scores >3.4 for lung reconstructions; and the Wilcoxon-paired test demonstrated no statistical difference between LDCT and uLDCT scores ($p>0.45$). uLDCT mediastinum reconstruction images had median and mean scores >3.7 for diagnostic confidence in patients with BMI <25.0; but with BMI>25.0 there was suboptimal IQ and diagnostic confidence ($p<0.05$) compared to LDCT. Evaluation of fungal disease: uLDCT accuracy in detecting major radiological criteria: halo sign, cavitation, consolidation was 99, 100, and 98% respectively; and in detecting minor criteria: sub-cm nodules and GGO, was 88 and 86%, respectively. uLDCT had reduced accuracy for detection of small (4-6mm) nodules and small volume GGO due to increased image noise.

CONCLUSION

Thoracic uLDCT has high accuracy in detection of major radiological criteria for fungal disease and should be considered in immunocompromised patients with BMI <=30.0Kg/m2.

CLINICAL RELEVANCE/APPLICATION

Immunocompromised patients undergo multiple chest CT scans to rule out opportunistic infection. uLDCT has comparable diagnostic accuracy to LDCT for detecting major radiological criteria of fungal disease with 80% lower radiation dose and should be routinely used in these patients.

SSM06-02 Analysis of Alveolar Duct Network as Possible Collateral Ventilation and Spreading of Diseases by Magnified 3D Print of Lung Specimen by Micro CT

Wednesday, Dec. 4 3:10PM - 3:20PM Room: N227B

Participants
Hiroshi Natori, MD, PhD, Sapporo, Japan (*Presenter*) Nothing to Disclose
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Kensaku Mori, PhD, Nagoya, Japan (*Abstract Co-Author*) Developer, Olympus Corporation; Developer, Cybernet System Inc; Developer, Morita Mfg Inc
Hiroyuki Koba, MD,PhD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Study on architecture of peripheral lung beyond respiratory bronchiole is important as pathway of collateral ventilation and disease extension in peripheral lung. However, it is difficult to get 3-D view of alveolar duct area by series of microscopic histological slides, Establishment of naked eye visible 3-D view analysis method was attempted by magnified print of virtual image of the micro focus CT of the lung specimen.

METHOD AND MATERIALS

Virtual image data based on micro CT of the inflated fixed lung specimen was used to make 40 times magnified peripheral lung model by 3D printer. Virtual lung tissue image was displayed on the flat screen by originally created application micro-NewVES. Two identical models were printed by 3D printer to confirm artifacts at the printing procedures. Internal structure of the magnified 3D print model was shown by virtual image by MDCT data of the 3D print model.

RESULTS

By virtual bronchoscopic view, beyond the respiratory bronchiole, alveolar ducts divide and reached to the blind end with one alveolus in the center surrounded by 6 alveoli. Numbers of surrounding alveoli were 5 to 7, but mainly 6. However most of alveolar ducts continuously divide and connect to adjacent duct to make alveolar duct network. The ducts connected loop back to initial respiratory bronchiole. Loop constructions of ducts were frequently found. Occasionally space surrounded by hundreds alveoli, that suggest destruction of alveolar duct unit. Alveoli revealed many shapes as semi-spherical or variety of semi-polygonal types on the 40 times magnified 3D print model. Sizes of the alveoli preliminary measured at 286 SD 27 micrometers, n=120, by this method. More measurements are necessary and also absolute sizes may considered according to, an official research policy statement of the ATS/ERS. The pores of Kohn as inter-alveolar communicating passes were found by naked eye view. Ten to thirty micrometer in diameter of small pores and various shapes of larger inter-alveolar communications were found.

CONCLUSION

Establishment of the method may apply for analysis of COPD, and that realized the development of new research field in respiratory radiology. Present method may also give us new insight in radiology of COPD, multi-cystic lung diseases, interstitial lung diseases, and other lung manifestations.

CLINICAL RELEVANCE/APPLICATION

That may give us new insight in radiology of COPD and other peripheral lung diseases.

SSM06-03 Anaplastic Lymphoma Kinase Inhibitor Induced Pneumonitis in Patients with Non-Small Cell Lung Cancer: Clinical and Radiologic Characteristics and Risk Factors

Wednesday, Dec. 4 3:20PM - 3:30PM Room: N227B

Participants
Hye Jeon Hwang, MD,PhD, Anyang, Korea, Republic Of (*Presenter*) Nothing to Disclose
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Hye-Young Choi, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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Jae Cheol Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To investigate the clinical and radiologic characteristics and risk factors of anaplastic lymphoma kinase (ALK) inhibitor induced pneumonitis (ALK-IIP) in patients with non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

A total of 250 NSCLC patients who had been treated with ALK inhibitors from January 2015 to January 2018 were retrospectively enrolled. Clinical characteristics and clinical course were reviewed from the medical records. Chest CT of ALK-IIP was analyzed and classified into four CT patterns, i.e. organizing pneumonia (OP), hypersensitivity pneumonitis (HP), diffuse alveolar damage (DAD), and nonspecific interstitial pneumonia (NSIP), using the American Thoracic Society/European Respiratory Society classification of interstitial pneumonia. Clinical characteristics including toxicity grading according to the National Cancer Institute Common Terminology Criteria for Adverse Events and treatment course was analyzed in regarding to the classified CT patterns. Clinical characteristics were compared between patients with ALK-IIP and without ALK-IIP.

RESULTS

ALK-IIP was identified in 11 patients (4.4%). The most common CT pattern was the OP pattern (n = 7, 63.6%) and followed by the HP pattern (n = 2, 18.2%) and the DAD pattern (n = 2, 18.2%). ALK-IIP showed pneumonitis toxicity grade ranged from 1 to 3, and DAD pattern had the highest toxicity grade, followed by HP and OP patterns (median grade: 3.5, 2.5, 1). All of the patients with

the OP pattern were successfully treated, while half of patients with the DAD pattern died during treatment. The smoking history and extrathoracic metastasis were more frequent in patients with ALK-IIP ($P < 0.005$). The smoking history was associated with a higher incidence of ALK-IIP [odds ratio: 3.586, 95% confidence interval: 1.058-13.432, $P = 0.049$].

CONCLUSION

ALK-IIP showed a spectrum of chest CT patterns and various toxicity grades, and CT patterns reflected the toxicity grades of ALK-IIP. The OP pattern was the most common CT pattern of ALK-IIP, and patients with ALK-IIP of the OP pattern were successfully treated. The smoking history was a significant risk factor of ALK-IIP in NSCLC patients.

CLINICAL RELEVANCE/APPLICATION

A pattern approach in diagnosing ALK-IIP on chest CT is appropriate and effective in routine practice. ALK inhibitors should be used with caution in NSCLC patients with smoking history.

SSM06-04 Deep-Learning based Automated Detection Algorithm for Active Pulmonary Tuberculosis on Chest Radiographs: Diagnostic Performance in Systematic Screening of Asymptomatic Individuals

Wednesday, Dec. 4 3:30PM - 3:40PM Room: N227B

Participants
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PURPOSE

To validate deep-learning based automated detection (DLAD) algorithm for detection of active pulmonary tuberculosis (TB) and any radiologically-identifiable relevant abnormality on chest radiographs (CRs) in systematic screening setting.

METHOD AND MATERIALS

We performed out-of-sample testing of a trained DLAD algorithm, using CRs from 19,686 asymptomatic individuals (male: 19,475, female: 211; mean ± standard deviation: 21.3 ± 1.9 years) as part of systematic screening for TB between January 2013 and July 2018. Area under the receiver operating characteristic curves (AUC) of DLAD for diagnosis of TB and any relevant abnormalities were measured. Accuracy measures including sensitivities, specificities, positive predictive values (PPVs), negative predictive values (NPVs) were calculated at pre-defined operating thresholds (high sensitivity threshold, 0.16; high specificity threshold, 0.46).

RESULTS

Four individuals with five CRs were confirmed with active pulmonary TB, and 28 CRs were judged as having radiologically-identifiable relevant abnormalities in 26 individuals. All five CRs with active pulmonary TB were correctly classified as having abnormal findings by DLAD with specificities of 0.959 and 0.997, PPVs of 0.006 and 0.068, and NPVs of both 1.000 at high sensitivity and high specificity thresholds, respectively. With high specificity thresholds, DLAD showed comparable diagnostic measures for tuberculosis to the pooled radiologists (P values > 0.005). For the detection of any radiologically-identifiable relevant abnormality, DLAD showed AUC value of 0.967 (95% confidence interval, 0.938-0.996) with sensitivities of 0.821 and 0.679, specificities of 0.960 and 0.997, PPVs of 0.028 and 0.257, and NPVs of both 1.000 at high sensitivity and high specificity thresholds, respectively.

CONCLUSION

In systematic screening for TB in a low-prevalence setting, DLAD algorithm demonstrated excellent diagnostic performance, comparable to the radiologists in the detection of active pulmonary TB.

CLINICAL RELEVANCE/APPLICATION

DLAD algorithm can help radiologists detect active pulmonary TB on CRs in a time-efficient manner, and identify individuals for further clinical and diagnostic evaluation for active TB. In a resource-constrained environment, it may be utilized as a standalone screening tool for individuals with active pulmonary TB.

SSM06-05 Comparison of Radiologist and Natural Language Processing-Based Image Annotation For Deep Learning System for Tuberculosis Screening on Chest X-Rays

Wednesday, Dec. 4 3:40PM - 3:50PM Room: N227B

Participants
Paul H. Yi, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Tae Kyung Kim, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare 1) agreement between natural language processing (NLP) and radiologist-curated labels for possible tuberculosis (TB) on chest radiographs (CXR) and 2) performance of deep convolutional neural networks (DCNN) trained on images using the two sets

of labels for identification of TB.

METHOD AND MATERIALS

We obtained 10,951 de-identified CXRs from the NIH ChestX-ray14 database annotated for 14 thoracic conditions by NLP. Each CXR was labeled as positive for possible TB if they had any of the following: pneumonia, infiltrate, mass, nodule, or consolidation. A fellowship-trained thoracic radiologist blinded to image labels interpreted each image and labeled each as positive or negative for possible TB. Kappa coefficients were calculated to evaluate inter-rater agreement between radiologist- and NLP-curated labels. We created 5 datasets with progressively increasing numbers of images with roughly equal proportions of positive and negative cases based on NLP-curated labels: 996, 2994, 6033, 9955, and 10,951 images (Table 1). Each dataset was divided into training (80%) and validation (20%) splits. The ResNet-50 DCNN pretrained on ImageNet was trained and validated using each dataset and tested on an external dataset of 753 CXRs used to screen for TB in Montgomery County, MD (USA) [58 with TB, 80 normal) and Shenzhen, China (275 with TB, 340 normal). Receiver operating characteristic (ROC) curves with area under the curve (AUC) were used to evaluate the DCNNs; AUCs were compared between DCNNs using DeLong's parametric method.

RESULTS

There was poor agreement between NLP and radiologist-curated labels with regards to potential TB on CXRs (Kappa coefficient ranging from 0.33 to 0.37). DCNNs trained using radiologist-curated labels consistently had significantly higher performance than the algorithm trained using the NLP-labels, regardless of the number of the number of images used for training and validation (Table 1). The best-performing DCNN had an AUC of 0.88, which was trained on 11,000 images using the radiologist-annotated sets.

CONCLUSION

DCNNs trained on CXRs labeled by a radiologist outperformed those trained on the same CXRs labeled by NLP, highlighting the benefit of radiologists' determining groundtruth for machine learning dataset curation.

CLINICAL RELEVANCE/APPLICATION

DCNNs trained on CXRs labeled by a radiologist consistently outperformed those trained on the same CXRs labeled by NLP.

SSM06-06 Radiologists Improve Timeliness of CT Follow-Up for Incidental Lung Nodules with a Novel 'Tracker' System

Wednesday, Dec. 4 3:50PM - 4:00PM Room: N227B

Participants
Debra S. Dyer, MD, Greenwood Village, CO (*Presenter*) Nothing to Disclose
Pearlanne Zelarney, Denver, CO (*Abstract Co-Author*) Nothing to Disclose
Laurie Carr, MD, Denver, CO (*Abstract Co-Author*) Advisory Board, AstraZeneca PLC
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PURPOSE

Evaluate improvement in timeliness of follow-up chest CT for incidental lung nodules after implementation of a 'Tracker Phrase' system.

METHOD AND MATERIALS

In 2011, a system was implemented where dictating radiologists tagged chest CT reports with 'Tracker' phrases and text indicating the recommended follow-up for incidental nodules. An electronic registry for tracking patients with nodules was built using the Tracker phrases. The registry generated automated patient and provider reminders when scans were overdue. An EHR query found 41,692 chest CTs had been performed 2008 - 2016. A random sample of reports describing an incidental nodule were selected for retrospective review. Patient records before (n=448) and after (n=848) implementation of the Tracker system were examined for timeliness of follow-up. Timeliness was broadly defined as follow-up CT occurring within 13 months of the index CT. Patient age, gender, and risk of lung cancer were obtained. High risk was defined by a personal history of lung cancer, or diagnosed COPD, or at least two of the following: age>50 years, 20+ pack years of smoking, or first degree relative with lung cancer.

RESULTS

Age and gender did not differ significantly in the pre-Tracker vs. the post-Tracker groups. 58% of the pre-Tracker vs. 69% of the post-Tracker patients were high risk (p<.01). Fewer (42% vs. 54%) in the pre-Tracker group had timely follow-up compared to the post-Tracker group (p<.01). Adjusting for risk and age group, we found that patients whose CT report contained a Tracker phrase were 50% more likely to have a timely follow-up chest CT compared to those whose CT scans did not (OR = 1.55; 95% CI 1.23-1.96 p <.001). Being 'high risk' for lung cancer increased the likelihood of timely follow-up (OR = 1.89; 95% CI 1.50-2.40 p<.001), as did age of 65 years or older (OR = 1.39; 95% CI 1.11-1.74 p=.004) at the time of the index CT scan.

CONCLUSION

Timeliness of CT follow-up for incidental lung nodules significantly improved after the implementation of a Tracker phrase system. Older age and higher risk of lung cancer were also associated with more timely follow-up.

CLINICAL RELEVANCE/APPLICATION

A radiologist driven Tracker system can improve timeliness of CT surveillance for follow-up of incidental lung nodules.

SSM07

Emergency Radiology (Acute Care Imaging Utilization)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: N228

ER

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose
Felipe Munera, MD, Key Biscayne, FL (*Moderator*) Nothing to Disclose

Sub-Events

SSM07-01 Can AI Outperform a Junior Resident? Comparison of Deep Neural Network to First-Year Radiology Residents for Identification of Pneumothorax

Wednesday, Dec. 4 3:00PM - 3:10PM Room: N228

Awards
Trainee Research Prize - Resident

Participants
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Tae Kyung Kim, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Alice Yu, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To develop a deep learning system for identification of pneumothorax and compare its performance to that of two 1st-year radiology residents.

METHOD AND MATERIALS

We obtained 112,120 frontal chest radiographs (CXRs) from the NIH ChestX-ray 14 database, of which 4360 cases (4%) had been labeled as pneumothorax by natural language processing. We utilized 111,494 CXRs to train and validate the ResNet-152 deep convolutional neural network (DCNN) pretrained on ImageNet to identify pneumothorax. DCNN testing was performed on a hold-out set of 602 CXRs (176 with pneumothorax and 426 without), whose groundtruth was determined by re-interpretation by a cardiothoracic radiologist with 5 years of post-fellowship experience; images were presented at 1024 x 1024 resolution and had a mix of both subtle and more obvious pneumothoraces. Two 1st-year radiology residents (PGY-2) independently evaluated the same 626 test CXRs for the presence of pneumothorax using a 6-point Likert scale to reflect levels of confidence ranging from low to intermediate to high. Receiver operating characteristic (ROC) curves were generated for the DCNN and 2 residents with area under the curve (AUC) calculated to evaluate test performance. AUCs were compared using the DeLong parametric method (significance defined as $p<0.05$).

RESULTS

The best-performing DCNN achieved AUC of 0.841 for identification of pneumothorax at a rate of 1980 images/minute. In contrast, both 1st-year residents achieved significantly higher AUCs of 0.942 and 0.905 ($p<0.01$ for both compared to DCNN; Figure 1), but at a slower rate of 2 images/minute.

CONCLUSION

Our DCNN for pneumothorax identification achieved significantly lower test AUC than two 1st-year radiology residents. However, the DCNN was able to interpret images >1000x as fast. Further work is warranted to compare the relative performance of AI to radiologists of varying levels, and the relative benefits of image interpretation speed to accuracy, particluarly for use in time-sensitive settings like the Emergency Department.

CLINICAL RELEVANCE/APPLICATION

1st-year radiology residents outperformed a deep learning system for pneumothorax detection, but the deep learning system interpreted images >1000x faster.

SSM07-02 New Diagnoses of Torso Cancer Based on CT Imaging is Low in the Emergency Department

Wednesday, Dec. 4 3:10PM - 3:20PM Room: N228

Participants
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PURPOSE

Emergency department torso (chest, abdomen and/or pelvis) CT occasionally demonstrates cancer. It is unknown what the rate of new cancer diagnosis is based on torso CT is in this setting. The purpose of this study is to determine this rate.

METHOD AND MATERIALS

All reports for ED CT studies involving the chest, abdomen or pelvis or combinations of these were selected for the 2017 calendar year. Each report impression was searched for the following keywords: mass, tumor or cancer. Each report with a keyword was manually checked whether the text was reporting a lesion, absence of a lesion (e.g. There is no mass effect), or hedge for a lesion (ie favored a non-cancer diagnosis but suggested that an underlying mass could not be excluded). Among reports describing a lesion, the electronic medical record was used to determine whether it was an old lesion, new lesion or was indeterminate based on lack of follow up or workup. Each lesion was also categorized as being related to the chief complaint or as an incidental finding.

RESULTS

During the 2017 calendar year, there were 339,593 ED visits, by 203,412 unique patients. 19,496 CT exams including a portion of the torso were performed. Of these, 1606 included one of the keyword: 621 were known cases of cancer, 490 were describing the abscess of a mass, 231 hedged the presence of cancer, 60 were of subcentimeter lung nodules, 21 were indeterminate (as there was no workup or follow up), and 180 were confirmed new diagnoses of cancer. The breakdown of cancer types is demonstrated in the figure. This yielded a CT-based new torso cancer diagnosis rate of 9 new diagnoses per 1000 torso CTs and 0.5 diagnoses per day (based on our average daily CT volume of 53 exams). Among the 180 new cases of cancer, 122 (68 %) were, 38 (21%) were not, and 20 (11%) were possibly related to the presenting symptoms.

CONCLUSION

CT-diagnosis of a new torso cancer is uncommon in the ED setting. The top three diagnose were, gastrointestinal tract (mostly colorectal cancer), lung and genitourinary (mostly renal cell carcinoma). Most CT based new torso cancers will be related to the patient's presenting symptoms.

CLINICAL RELEVANCE/APPLICATION

This data provides new insight into the diagnostic makeup of patients undergoing CT in the emergency department. This may also have implications for ED radiologist staffing.

SSM07-03 Assessing Prior Neuroimaging Utilization to Identify Recidivistic Patients with Psychosocial Maladies

Wednesday, Dec. 4 3:20PM - 3:30PM Room: N228

Participants
Daniel Braga, MD, Jacksonville, FL (*Presenter*) Nothing to Disclose
Sukhwinder J. Sandhu, MD, Jacksonville, FL (*Abstract Co-Author*) Nothing to Disclose
Dinesh Rao, MD, Jacksonville, FL (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purpose of this study is to determine if a correlation exists between patients who undergo repeat computed tomography (CT) imaging of the brain on multiple separate emergency department (ED) visits with the presence of psychosocial illness such as mental health illness, substance abuse, or interpersonal violence.

METHOD AND MATERIALS

An IRB-approved retrospective chart review was performed on 27,004 patients presenting to the adult ED or trauma center at our institution from 2013 to 2017. Patients who had at least one CT of the brain as part of their diagnostic workup met inclusion criteria. The number of head CT's on separate ED visits was counted. ICD-9 and 10 codes were analyzed from admission data to identify diagnoses of mental health illness, substance abuse, and/or interpersonal violence for each patient. Statistical analysis was then performed to explore the correlation between the number of head CT's per patient and the presence of these underlying psychosocial maladies.

RESULTS

Linear logistic regression was used to determine whether the number of CT scans is associated with psychosocial illness. We found that with each additional CT, the odds of psychosocial diagnosis increases by 1.93 ($p < 0.0001$). The magnitude of the associations was described using odds ratio (OR), along with its 95% confidence intervals (CI). The level of significance was set at 5%. All analyses were done in SAS® for Windows Version 9.4.

CONCLUSION

Each additional unenhanced CT of the head performed on patients during separate distinct ED visits increases the likelihood of psychosocial illness with an odds ratio of 1.93. The presence of multiple head CT's in a patient's medical record may suggest the presence of mental health illness, substance abuse, or interpersonal violence.

CLINICAL RELEVANCE/APPLICATION

Assessment of prior neuroimaging in recidivistic patients with psychosocial illness could aid in diagnostic identification, prevent over-utilization of health care resources, and guide early interventions directed at this elusive patient population.

SSM07-04 Chest CT's During Immune Checkpoint Inhibitor Therapy in the Emergency Department: A Single Institute 9-Year Experience in 139 Patients

Wednesday, Dec. 4 3:30PM - 3:40PM Room: N228

Participants
Daniel A. Smith, MD, Cleveland, OH (*Presenter*) Nothing to Disclose
Ethan Radzinsky, Cleveland , OH (*Abstract Co-Author*) Nothing to Disclose
Kianoush Ansari-Gilani, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Amit Gupta, MBBS, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Sreeharsha Tirumani, MBBS, MD, Beachwood, OH (*Abstract Co-Author*) Nothing to Disclose
Christopher Hoimes, DO, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Nikhil H. Ramaiya, MD, Shaker Heights, OH (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess chest CT findings of oncology patients on immune checkpoint inhibitor (ICI) therapy who present to the emergency department (ED) with acute chest symptoms.

METHOD AND MATERIALS

A retrospective review was performed of 139 adult oncology patients on ICIs who presented to the ED and received chest CT imaging. These patients included adults >=18 years old at a single institution from 2010-2018 who received treatment with >=1 ICI. Chest CT findings were reviewed to evaluate tumor burden and assess immune-related adverse events (irAEs).

RESULTS

The 139 patients included 55% males and 45% females with a mean age of 65. The most common cancer types included lung (63%), melanoma (11%), and bladder/kidney (9%). 163 chest CTs were acquired at unique ED visits, with a median time of 50 days between first dose of ICI and ED visit. Common imaging indications included dyspnea (64%), chest pain (28%), cough (14%), and hypoxia (10%). 85% of chest CTs were ordered as pulmonary embolism (PE) protocols, with new PE detected in 7% of cases. Worsening tumor burden was identified in 60% of ED chest CTs at a median of 37 days after ICI initiation. 21 (13%) of chest CTs demonstrated immunotherapy-induced pneumonitis with a median duration of 60 days between initiation of ICI and ED presentation. These cases of ICI-associated pneumonitis included 6 reflecting radiation recall pneumonitis, with the remainder reflecting patterns of HSP (4), AIP/ARDS (4), bronchiolitis (3), COP (2), and NSIP (2). All but two (90%) of the 21 patients presenting with ICI-associated pneumonitis received high-dose steroids. 79% of ED encounters resulted in hospital admission after chest imaging. 63% of patients demonstrated clinical or radiographic improvement during their ED/hospital visits, whereas 37% experienced no significant clinical improvement, were discharged to hospice, or died during their admission.

CONCLUSION

60% of oncology patients on ICI therapy who present to the ED demonstrate worsening tumor burden on chest CT, with a median time of 37 days from ICI initiation to disease progression on ED chest CT. Immunotherapy-induced pneumonitis is the second most common chest CT finding in the ED setting, occurring in 13% of patients.

CLINICAL RELEVANCE/APPLICATION

This study provides insight into the radiographic findings on chest CT associated with acute presentations to the ED among oncology patients on immune checkpoint inhibitor therapy.

SSM07-05 Evaluation of the Effectivity and Therapeutic Impact of CT in ICU Patients with Unknown Focus of Infection

Wednesday, Dec. 4 3:40PM - 3:50PM Room: N228

Participants
Daniel Kuetting, MD, Bonn, Germany (*Presenter*) Nothing to Disclose
Julian A. Luetkens, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose
Anton Faron, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose
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Ron Martin, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the impact of computerized tomography (CT) on diagnosis and change of therapy in ICU patients with fever, systemic inflammatory response syndrome (SIRS) or sepsis with unknown focus of infection

METHOD AND MATERIALS

Non-ECG-gated chest/abdominal CT examinations of ICU patients (internal medicine, surgery, heart surgery, neurology/ neurosurgery) were prospectively analyzed for inflammatory foci. Both confirmation of and changes in the diagnosis or therapy based on CT findings were analyzed. Prior CT, X-Ray, MRI, bronchioalveolar lavage, urine analysis and ultrasound examinations, performed during the same ICU treatment but prior to the CT, were cross-checked to verify whether foci were actually new.

RESULTS

In 99 out of 112 (88,4 %) consecutively evaluated patients (34,8% female, mean age 64,8 years), a total of 147 possible foci (thoracic: n=92; abdominal: n=55) were detected. Of the 147 foci (58,5% defined as definite, 41,5% as questionable), prior examinations had suspected inflammatory focus in 64 cases, confirmed focus in 20 cases. CT diagnosis lead to 77 changes in therapy regimen in 58 of 99 Patients (59%): change/initiation of antibiotics: 52,7%, CT guided thoracic/abdominal puncture: 21,6%, operation: 8,1%, change in patient positioning: 8,1%; other: 9,5%.

CONCLUSION

CT examinations in ICU patients with unknown focus of infection leads to diagnosis in most cases as well as to adaption in therapy regimen and thus should be considered in patients with obscure clinical infection.

CLINICAL RELEVANCE/APPLICATION

CT is an effective diagnostic tool for the evaluation of patients with unknown focus of infection. CT should be considered a routine procedure in the workup of septic patients when other diagnostic evidence of infection is absent.

SSM07-06 CNN-Based Regression Model Learning the Abbreviated Injury Scale Predicts Respiratory Distress Syndrome in Polytraumatized Patients at Admission

Wednesday, Dec. 4 3:50PM - 4:00PM Room: N228

Participants
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PURPOSE

To automate lung-related risk stratification of polytraumatized patients based on chest computed tomography (CT) by training deep-learning models to predict abbreviated injury scale (AIS) scores for the thorax.

METHOD AND MATERIALS

The dataset used contains 123 polytraumatized patients, not younger than 18 years and with an assigned Injury Severity Score (ISS) of at least 15. Patients which died within 48 hours after admission, suffered burning injuries or had known oncologic or chronic inflammatory lung diseases were excluded. All scans were conducted on the same scanner and were conducted within one hour of the accident. We automatically extracted the lungs including pleural effusions via a U-Net convolutional neural network (CNN). After stripping of image areas outside the lung, we resampled the volumes to an isotropic voxel resolution of 1mm and cropped the images to the lung masks. Subsequently, we generated maximum intensity projections (MIP) in the axial and coronal direction and resampled the images to 200x200 pixels. We trained two independent CNNs (axial & coronal) to predict the AIS scores (thorax only) associated with the patients. Finally, the predictions of the two networks were averaged to receive the final risk score

RESULTS

To test whether the resulting risk scores have predictive power for lung complications, we used the score to predict acute respiratory distress syndrome (ARDS) according to the Berlin definition. Note, that the CNN was not trained to predict ARDS. However, after 5-fold cross-validation, using 99 patients for training and 24 for prediction, the resulting risk score yielded an area under the curve (AUC) of 0.76 for ARDS prediction compared to 0.68 and 0.66 when using the AIS score or ISS, respectively.

CONCLUSION

The AIS score encodes injuries with and without involvement of the lung and does not fully encode the lung specific extent of the injuries. By providing only image information of the lung and excluding the surrounding tissue, we forced the neural networks to learn lung related severity when predicting AIS scores. By this, we were able to disentangle the lung specific component of the AIS score and to learn an organ specific risk score without explicit training data available.

CLINICAL RELEVANCE/APPLICATION

By automatically extracting the organ specific component of overall scores such as AIS, risk stratification for complications related to the organ of interest can be optimized.

SSM08

Gastrointestinal (Liver Diffuse Disease: Iron, Fat)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E450B

BQ GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jeong Min Lee, MD, Seoul, Korea, Republic Of (*Moderator*) Grant, Bayer AG; Speaker, Bayer AG; Grant, Canon Medical Systems Corporation; Grant, Koninklijke Philips NV; Grant, General Electric Company; Grant, Guerbet SA; Speaker, Guerbet SA; Grant, Samsung Electronics Co, Ltd; Speaker, Samsung Electronics Co, Ltd; Grant, Bracco Group; Speaker, Siemens AG
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Sub-Events

SSM08-01 Accuracy of Viscoelasticity Measurement Using Ultrasound Shear Wave Elastography for Assessing Histologic Parameters in Patients with Nonalcoholic Fatty Liver Disease

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E450B

Participants
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PURPOSE

To investigate the accuracy of shear wave (SW) speed (related to viscoelasticity), dispersion slope (related to viscosity), and attenuation value (related to degree of steatosis) measurements obtained using a new ultrasound (US) elastography system in assessing steatosis, inflammation, and fibrosis in patients with suspected nonalcoholic fatty liver disease (NAFLD).

METHOD AND MATERIALS

Data was collected from 74 consecutive adults who underwent liver biopsy for suspected NAFLD from April 2017 through November 2018. A US-based SW imaging system (Aplio-i800; Canon Medical Systems) was used to measure three US parameters (SW speed [m/s], dispersion slope [(m/s)/kHz], and attenuation value [dB/cm/MHz]) immediately before biopsy. The biopsy specimens were scored by 1 blinded expert pathologist according to the Nonalcoholic Steatohepatitis Clinical Research Network criteria. Diagnostic accuracy was assessed using the area under the receiver operating characteristic curve (AUROC) for the categories of steatosis, inflammation, and fibrosis. The effects of these histologic parameters on attenuation value, dispersion slope, and SW speed were evaluated by multivariable analysis.

RESULTS

With biopsy results as the reference standard, attenuation value identified patients with steatosis with AUROCs of 0.8335 for S>=S2 and 0.8090 for S=S3. Dispersion slope identified patients with inflammation with AUROCs of 0.7677 for A>=F2 and 0.9179 for A=A3. SW speed identified patients with inflammation with AUROCs of 0.7907 for F>=F1, 0.8403 for F>=F2, 0.8694 for F>=F3, and 0.9625 for F=F4. Multivariable analysis showed that steatosis significantly affected attenuation value (P<.0001), fibrosis and inflammation significantly affected dispersion slope (P=.0026 and P=.0299, respectively), and fibrosis significantly affected SW speed (P<.0001).

CONCLUSION

Prospective analysis of patients with NAFLD showed that attenuation value, dispersion slope, and SW speed were useful for assessing liver steatosis, lobular inflammation, and fibrosis, respectively, with AUROCs ranging from 0.7677 to 0.9625. Both inflammation and fibrosis affected dispersion slope.

CLINICAL RELEVANCE/APPLICATION

Three US parameters (attenuation value, dispersion slope, and SW speed) can be used to noninvasively assess the histopathologic parameters steatosis, inflammation, and fibrosis in NAFLD patients.

SSM08-02 Precision Analysis of Fat and Iron Measures in the Liver and Pancreas: Repeatability and Reproducibility Analysis Using Different Quantification Methods

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E450B

Participants
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PURPOSE

Robust methods to measure fat and R2* exist, using proton density fat fraction(PDFF)Although PDFF is accessible, there are various comercial techniques available, which may impair the longitudinal assessment of patientsThe study seeks to evaluate PDFF precision (R2* and fat) with distinct methods through examinations performed in volunteers on 3T and 1.5T scanners at different times, using the same parameters.

METHOD AND MATERIALS

30 volunteers were recruited. Participants underwent a 3TMRI exam and were re-scanned on the same scanner using the same protocol, less than 1 week apart. They were also examined at a 1.5T scanner.Protocols were the same across devices, using 3 multi-gradient echo distinct sequences (MGE) to calculate PDFF. Philips Achieva 3T and Ingenia 1.5T scanners were used with surface coils. Post-processing techniques were made by 4 different vendors in the 3T and 2 different vendors at 1.5T.All measures were performed by the same radiologist (13 years of experience), using a ROI that encompassed the whole liver and pancreas area in a single slice. The measures repeatability on the 3TMRI was assessed through the within-subject coefficient of variation and the repeatability coefficient(RC). The agreement between different methods assessment was evaluated by ICC.

RESULTS

Fat-Fraction(FF) results:LiverFF achieved excellent RC with values between 1.55-3.45%Pancreas showed good RC, albeit lower, ranging between 2.26-5.54%The ICC for 3T scans was 0.94(liver) and 0.69(pancreas) in the first scan and 0.94 and 0.6 respectively for the last.Agreement between 3T and 1,5T measures for liver was excellent with ICC of 0.94(CI95%:0.8-0.97)ICC for pancreas was good, but with wide variation, with mean of 0.86(CI95%:0.26-0.95)Results R2*:LiverR2* showed good results, with mean RC of 9.18-13.08s-1Pancreas showed a RC of 9.66-15.53ICC for 3T scans was 0.97(liver) and 0.46(pancreas) in the first acquisition and 0.96 and 0.22 respectively for the second.

CONCLUSION

The study showed excellent reproducibility and repeatability for fat and iron measures in liver, using different scanners and techniques. The performance of pancreas was lower

CLINICAL RELEVANCE/APPLICATION

The study showed excellent precision for liver deposits measure with different techniques/scanners.Pancreas assessment should be used with caution. The morphology of the gland and the ROI methodology may have contributed to this results

SSM08-03 Validation of Different Measurement Methods of Fat and R2* in the Liver: Focus on Reproducibility

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E450B

Participants
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PURPOSE

-The development of robust methods to measure liver fat and R2*, such as proton density fat fraction (PDFF) techniques, made them the standard of care in hepatic deposit assessment. -Although PDFF is increasingly accessible, there isn't a clear rule to measure disease for a good correlation with biopsy or an acceptable variation among readers.-The study objective was to compare the correlation between readers with different experiences in abdominal imaging, using two distinct methods of measuring liver deposits, by placing regions of interest (ROI's) in the parenchyma.

METHOD AND MATERIALS

-100 consecutive patients who underwent MRI of the liver to evaluate steatosis and/or iron deposition were selected, searched retrospectively in our PACS. We include the first 100 that had an acceptable image quality with the use of a PDFF technique.-The patients were anonymized and 4 readers with different experiences in abdominal image analyse the images.Readers reviewed all exams independently using the following ROI placement rule:a) 4 circular ROI's (CR) deposited in the anterior and posterior region of the right liver lobe in different slices. 1 CR on the left liver lobe. We record the average value.b) 1 geographic ROI (GR) involving the entire liver area in a slice above the gallbladder, excluding vessels and artifact areas.-We calculate the ICC for the readers and both methods for fat and R2*. Bland-Altman plots were acquired.

RESULTS

-97 patients were included in the final analysis.-Fat deposits ranges from 1.6%-42.8%(Mean:12.6%/SD: 9.1%)-R2* ranged from 27s-1-171s-1 (Mean:52s-1/SD: 26s-1).>The ICC was very high for all readers with both analyses with the average --ICC for fat with the CR method was 0.983 (95%CI:0.977-0.988) / the GR method achieved an ICC of 0.958(95%CI:0.943-0.97).--ICC for R2* with CR was 0.983(95%CI:0.977-0.988) / the R2* with GR achieved a mean value of 0.983(95% CI:0.977-0.988).>The ICC between CR and GR also showed an excellent agreement with a mean ICC of 0.994(95% CI:0.993-0.995) for fat / and 0.992(95%CI:0.990-0.993)

CONCLUSION

- We showed an excellent correlation for hepatic iron and fat measurement between readers of different experience levels using

two distinct ROI placement methods.

CLINICAL RELEVANCE/APPLICATION

-Using either method described, one can achieve an excellent agreement between readers with different expertise levels.

SSM08-04 MRI Based Liver Iron Content Determination with Gradient EchoR2* versus Spin-Echo R2 Relaxometry

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E450B

Participants
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PURPOSE

To investigate correlation between liver iron content (LIC) determined with a reference method based on Spin-Echo (SE) vs. gradient-echo (GRE) R2*.

METHOD AND MATERIALS

117 patients suspected for liver iron overload were scanned between July 2014 and April 2018. 65 patients (25 f, 40 m, 24.5±13.1 years (mean±std.dev.), range 8.2 to 59.3 years) were assigned to the study group analyzed by two observers, the other 52 patients (26 f, 26 m, age 19.1±14.6 (mean±std.dev.), range 2 to 60.6 years) served as control group. All patients were examined on a 1.5 T MRI scanner (MAGNETOM Avanto, Siemens Healthcare, Erlangen, Germany). For the Ferriscan® method (Resonance Health, Burswood, Australia), transversal liver slices were acquired during free breathing using the appropriate protocol (five TEs ranging from 6 to 18 ms, single-echo acquisitions, eleven 5 mm thick slices, 100% gap, resolution 1.64x1.64 mm, acquisition time 16:20 min.). Results served as LIC reference values. With a prototype breath-hold GRE sequence, 40 partitions of 4 mm thickness at 2.5x2.5 mm voxel size were acquired in 18 sec. with parallel imaging in both phase and slice encoding direction, and in-line voxel-wise R2* calculation considering fat/water signal modulation. To obtain liver mean R2* values, regions of interest were manually placed in tissue free of vessels and/or artifacts. R2* was linearly correlated to reference LIC values. Results of the study group were used to calculate LIC for control group patients, further referred to as GRE-LIC. GRE-LIC was compared to reference LIC values.

RESULTS

Study group LIC values ranged from 0.5 to 27.3 mg/g liver dry wt. Linear correlation to R2* was excellent with coefficient of determination (R2) of 0.9. Slope values were 0.039±0.00016 mg*s/g and intercept was -0.85±0.38 mg/g. Observer results were identical within the confidence interval. For the control group, GRE-LIC values showed near-ideal concordance to LIC reference values with regression line close to identity (slope 1.04±0.05, intercept -0.64±0.83), R2 was 0.89.

CONCLUSION

Linear correlation of R2* to reference LIC in th e study group and concordance of LIC values determined from GRE to reference LIC values in the control group were both excellent. Also, we found good inter-observer agreement.

CLINICAL RELEVANCE/APPLICATION

The volumetric single breath-hold GRE sequence studied is suitable for reliable MR-based LIC determination.

SSM08-05 Multi-Point Dixon PDFF MRI for Fat Quantification: Cross Vendor and Field Strength Assessment

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E450B

Participants
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PURPOSE

To assess multi-point Dixon (PDFF) using multiple platforms for accuracy and reproducibility of fat quantification.

METHOD AND MATERIALS

Fat-water phantom sets (0, 10, 16, 35, 100 % fat) were evaluated using FDA-approved PDFF sequences, reconstruction and

analysis algorithms. Phantoms were imaged with subjects in the Visceral Adiposity and Physical Fitness in CKD study on 2 Siemens 3T Skyra, 1 Siemens 3T Prisma, 1 Siemens 1.5T Avanto, 1 GE Discovery 3T MR750, and 1 Philips 3T Ingenia systems. Technical performance metrics include cross-sectional bias (by weight), bias, linearity and reproducibility for the entire study, for each site, for each manufacturer and field strength.

RESULTS

392 subjects were scanned with phantoms on Siemens 1.5T (105), Siemens 3T (140), Philips 3T (68) and GE 3T (88). Overall, a linearity relationship was observed with negligible quadratic value and slope of 0.94 (95% CI: 0.938, 0.947). Mean bias was -3.8%, 1.5%, 1.8%, 0.3% and 2.4% for 100%, 35%, 16%, 10% and 0% fat fraction, with reproducibility standard deviation of 2.6%, 5.0%, 3.4%, 2.5% and 2.8% respectively. The mean bias differed significantly by vendor ($p<0.001$) and field strength ($p<0.001$). Siemens had the lowest overall bias and GE the highest. The bias was higher for field strength of 1.5T. Reproducibility differed by vendor ($p=0.021$) and field strength ($p=0.015$). Better precision (i.e. lower variance, thus higher reproducibility) was observed for GE, and worst precision (higher variance, thus poorer reproducibility) for Siemens. A field strength of 1.5T had better precision.

CONCLUSION

In general, PDFF is an excellent method of quantifying fat in vivo and is stable over time and across all fat fractions. However, the PDFF measurement is biased; slightly overestimated when the PDFF value is small and underestimated at higher PDFF values. The reproducibility coefficient (RDC) or %fat difference of 11.2% or larger, indicating a true difference when measured on different MR system vendors and field strengths and at different time points.

CLINICAL RELEVANCE/APPLICATION

Multi-point Dixon PDFF can quantify body fat accurately, however specific cutoffs for disease classification requires additional work and may depend upon vendor and field strength.

SSM08-06 Accuracy of Energy Spectrum CT Lipid Base Value in Quantitative Analysis of Non-Alcoholic Fatty Liver

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E450B

Participants
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PURPOSE

the accuracy of quantitative analysis and diagnosis of non-alcoholic fatty liver was assessed by comparing energy spectrum CT lipid matrix with magnetic resonance lipid matrix using magnetic resonance Q-dixon technique as a reference standard.

METHOD AND MATERIALS

Retrospective collection of patients who underwent both magnetic resonance quantitative Q-dixon sequence scan and energy spectrum CT scan within one week. After image acquisition, the average fat content of liver was quantitatively analyzed by placing region of interest (ROI). The method of sketching is to select ROI of two different hepatic lobes at the hepatic portal level, and one ROI from the hepatic portal level to the upper and lower levels, respectively, to record the liver fat fraction (FF) of each hepatic segment. Finally, the average fat fraction of the whole liver is obtained by the average method. Two doctors with rich experience in imaging diagnosis of liver diseases independently measured the lipid matrix and the corresponding ratio of liver to spleen on energy spectrum CT. The results were examined by a deputy director of imaging specialty. Finally, the differences among the groups were compared, and the correlation of MR fat fraction, fat matrix and liver-spleen ratio was analyzed. The diagnostic efficacy of energy spectrum CT fat matrix for mild fatty liver was tested by ROC curve.

RESULTS

This study total 80 cases. There was a positive correlation between FF on energy spectrum CT ($r = 0.959$, $P = 0.000$), and a negative correlation between liver-spleen ratio and fat fraction ($r=-0.848$, $P = 0.000$), as shown in Figures 1 and 2. ROC curve analysis showed that the sensitivity, specificity, cut-off point and area under curve were 95%, 100%, 351.19 and 0.990 respectively in the light fatty liver group, as shown in Figure 3.

CONCLUSION

Clinical evaluation of non-alcoholic fatty liver can refer to the fat content measured by CT fat matrix (the cut-off value is 351.19), and its correlation with the fat content measured by Q-dixon of 3.0T magnetic resonance is better than that measured by CT liver-spleen ratio. Energy spectrum CT lipid matrix can be used to quantitatively evaluate non-alcoholic fatty liver and has a good diagnostic effect for mild fatty liver.

CLINICAL RELEVANCE/APPLICATION

The fat concentration measurement in spectral CT can replace the Liver-Spleen CT Ratio as an imaging method for the diagnosis of fatty liver, and its accuracy is high.

Printed on: 10/29/20

SSM09

Gastrointestinal (Pancreas Focal Disease)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E351

GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM09-01 Detection of Pancreatic Ductal Adenocarcinoma and Liver Metastases: Comparison of Contrast-Enhanced MR Imaging with Hepatobiliary versus Extracellular Contrast Materials

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E351

Participants
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PURPOSE

To compare the detectability of pancreatic ductal adenocarcinoma (PDAC) and liver metastases between contrast-enhcanced magnetic resonance (MR) imaging with hepatobiliary and extracellular contrast materials (ECCMs).

METHOD AND MATERIALS

Two hundred seventy-two patients with suspected of having a pancreatic disease underwent contrast-enhanced MR imaging with Gd-EOB-DTPA (EOB group, *n = 79) or ECCMs (ECCM group, n = 193). The ECCMs included Gd-DTPA (n = 158), Gd-BT-DO3A (n = 28), Gd-DOTA (n = 5), and Gd-DTPA-BMA (n = 2). The signal intensities of pancreatic parenchyma, paraspinal muscle, PDAC if present, and background noise were measured, and then the signal intensity ratio (SIR) of the pancreas and tumor-to-pancreas contrast-to-noise ratio (CNR) were calculated. The conspicuity of PDAC was evaluated on the pancreatic parenchymal phase images, and that of liver metastases, if present, was also evaluated in all sequences. Qualitative and quantitative parameters were compared between EOB and ECCM groups.*

RESULTS

The SIR of the pancreas (P = 0.30) and CNR (P = 0.46) were comparable between EOB and ECCM groups. The sensitivity (97.1% vs 93.5%, P = 0.42) and specificity (100.0% vs 99.2%, P = 1.00) for the detection of PDAC were comparable between EOB and ECCM groups. In the lesion-by-lesion analysis, EOB group showed significantly greater sensitivity for detecting liver metastases compared with ECCM group (95.0% vs 84.5%, P = 0.04).

CONCLUSION

Gd-EOB-DTPA-enhanced MR imaging with was comparable with ECCMs-enhanced MR imaging in detecting PDAC and demonstrated better sensitivity in detecting liver metastases.

CLINICAL RELEVANCE/APPLICATION

Gd-EOB-DTPA-enhanced MR imaging is all that is needed to examine patients with PDAC and contribute to the reduction of medical costs.

SSM09-02 *The Stiffness as Obtained by Magnetic Resonance Elastography Correlates with the Stroma Proportion and Prognosis of Resectable Pancreatic Adenocarcinoma (PDAC)*

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E351

Participants
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PURPOSE

Abundant stroma is one of the most important features of PDAC that accounts for up to 90% of the tumor volume. The role of MRE in the prognostic prediction of PDAC remains unknown. Herein, our study was to investigate the value of the MRE-determined stiffness in evaluating the stroma proportion and the prognostic value of stiffness in resectable PDAC.

METHOD AND MATERIALS

A total of 146 resected PDAC patients were prospectively enrolled in this study from Jan 2016 to Dec 2018, all without preoperative chemotherapy or radiotherapy. Both sirius-red staining and H&E staining was used to evaluate the stromal proportion in PDAC. MRE examinations were performed on a 3.0T MR scanner (Signa HDX 3.0T system; GE Healthcare, Milwaukee).The imaging parameters were as follows: frequency=40Hz; TR/TE = 1375/38.8ms; phase offsets = 3; FOV = 40 cm; matrix = 96×96; number of signal averages = 1; frequency-encoding direction = RL; parallel imaging acceleration factor = 3; number of slices = 32; thickness = 3.5mm. Survival rates were calculated according to the Kaplan-Meier method and were compared using the log rank test. Multivariate analysis was performed with a Cox regression model.

RESULTS

PDAC showed significantly higher stiffness (3.11±0.61 kPa) than that of the non-tumor pancreatic parenchyma (1.22±0.24 kPa) (P<0.001). The average stromal proportion was 43.7±22.5%. The pancreatic stiffness was positively associated with the stromal proportion of resected PDAC (r= 0.811, P < 0.001). The pancreatic stiffness was also positively correlated with T stage and AJCC stage (AJCC 7th edition) (r= 0.713 and 0.692,both P < 0.001). High pancreatic stiffness (>3.19kPa) predicted unfavorable overall survival (OS) relative to low pancreatic stiffness (21.6 vs. 38.2 months, P= 0.011). The pancreatic stiffness was an independent prognostic factor for resected PDAC based on multivariate analysis (hazard ratio =5.174, 95%CI:2.41-11.07 P <0.001).Figure 1 showed 2 PDAC cases with 17% and 74% different stroma proportions as examples, respectively.

CONCLUSION

We demonstrated that the pancreatic stiffness obtained by MRE was positively associated with the stroma proportion in pancreatic cancer. Pancreatic stiffness can be a promising biomedical index for prognostic prediction in PDAC.

CLINICAL RELEVANCE/APPLICATION

MRE is a simple, fast and promising sequence that can be added in clinical routine pancreatic MR protocol, so as to help evaluate the stroma proportion of tumor and predict the prognosis of resectable PDAC for patients.

SSM09-03 Pancreatic Screening in High Risk Patients: Is Fast Non-Contrast MRI Protocol Feasible? A Proposal

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E351

Participants
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PURPOSE

To validate a non-contrast fast MRI protocol for high risk patients as a screening tool to detect pancreatic cancer (PC) in its earliest phase, compatible with an R0 resection.

METHOD AND MATERIALS

200 patients (>40yo) were selected from our radiological database. 100 were negative for pancreatic lesions, 50 were positive for cystic lesions and 50 were positive for solid lesions; all lesions were smaller than 28mm. Three readers with a high, medium and low experience analysed selected MRI sequences (single-shot T2w breath-hold on axial and coronal plans, GE T1w FS on axial plan, DWI and 2D/3D MRCP) independently, randomly and anonymously. Readers identified or excluded the presence of pancreatic lesion. Results of reading session were compared with the final diagnosis and divided into five different classes of lesion: cystic, solid (all), adenocarcinoma, PNET and solid excluding PNET; Mcnemar's test was used to compare. Inter-observer agreement was determined according to the kappa statistic.

RESULTS

All readers showed high sensitivity and NPV in the identification of ADK (R1 100%-100%, R2 89%-98% and R3 83%-97%), with a good agreement to detect pancreatic lesions (k=0.52), especially ADK (k=0.82), PNET (>10mm) (k=0.70) and cystic lesions(k=0.87).

CONCLUSION

A non-contrast fast MRI protocol can be proposed as a screening tool in high risk patients for PC, reducing the time lapse between the controls, giving more chances for an early diagnosis with a better outcome.

CLINICAL RELEVANCE/APPLICATION

Fast MR protocol is able to detect small pancreatic lesions with high sensitivity and it can be used as a screening tool in high risk patients for pancreatic cancer, in order to achieve an early diagnosis and thus a better survival

SSM09-04 Relationship between Radiomics and Risk of Lymph Node Metastasis in Pancreatic Ductal Adenocarcinoma

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E351

Participants
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PURPOSE

To explore the exact relationship between the arterial radiomics score (rad-score) and lymph node (LN) metastasis in pancreatic ductal adenocarcinoma (PDAC).

METHOD AND MATERIALS

A total of 225 patients with pathologically confirmed PDAC who underwent multislice computed tomography within one month of resection from December 2016 to August 2017 were retrospectively studied. For each patient, 1029 radiomics features of arterial phase were extracted, which were reduced using the least absolute shrinkage and selection operator (LASSO) logistic regression algorithm. Multivariate logistic regression models were utilized to analyze the association between the arterial rad-score and LN metastasis.

RESULTS

LN-negative and -positive patients accounted for 107 (47.56%) and 118 (52.44%) of the cohort, respectively. The rad-score, which consisted of 12 selected features of the arterial phase, was significantly associated with LN status (P<0.05). Univariate analysis revealed that the arterial rad-score and T stage were independently and positively associated with risk of LN metastasis (P<0.05). Stratified analysis showed that the impact of the arterial rad-score on LN metastasis was not affected by age, sex, BMI, CA19-9 level, tumor location, T stage, or grade of differentiation (P for interaction>0.05). The trend of increasing the arterial rad-score with higher likelihood of LN metastasis among age <59 years and >=66 years, sex, BMI, CA19-9 higher than 37ug/L, location, T2-4 stage and Well-moderately differentiation grade (P for trend <0.05). Multivariate analyses revealed a significant association between the arterial rad-score and the LN metastasis (p < 0.0001). Higher arterial rad-score was associated with LN metastasis (P for trend <0.0001).

CONCLUSION

The arterial rad-score is independently and positively associated with the risk of LN metastasis in PDAC.

CLINICAL RELEVANCE/APPLICATION

the arterial rad-score has significant association with the risk of LN metastasis in PDAC . A higher arterial rad-score is associated with a higher risk for LN metastasis. Thus, radiomics analysis may be a promising noninvasive method for assessment of LN metastasis.

SSM09-05 Time-intensity Curve Analysis of Endoscopic Contrast-Enhanced Ultrasound Can Help Discriminate Adenocarcinoma from Focal Pancreatitis

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E351

Participants
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PURPOSE

To evaluate the role of endoscopic contrast;enhanced ultrasound (CEUS) based time-intensity curve (TIC) analysis metrics in discriminating pancreatic ductal adenocarcinoma from focal pancreatitis.

METHOD AND MATERIALS

In this IRB approved study, we evaluated 13 patients with histopathology confirmed adenocarcinoma and 4 patients with focal pancreatitis. TIC were extracted from CEUS cine clips of focal pancreatic lesions following injection of 0.3 cc bolus of agitated perflutren lipid microspheres. The cine clips contained perfusion information for a minimum of 2mins post-injection and terminated once the characteristics enhancement patterns were obtained. 5mm circular ROI's were placed on the lesion by an experienced EUS expert and Intensity of contrast enhancement measured as an average were recorded from each image of the cine clip The ROIs were placed over homogenous regions of the lesion. In addition, surrounding normal tissue was used as a reference control). Using a customized MATLAB program, quantitative TIC analysis was performed on the extracted contrast-enhancement curves. Independent t-test was used to conduct exploratory univariate analysis of the TIC metrics to discriminate between lesion types and normal tissue and also to discriminate between lesion types. A significance threshold of 0.05 was used.

RESULTS

Among, the various TIC metrics, relative peak enhancement (PE) had the greatest utility to discriminate pancreatic ductal adenocarcinoma (PDAC) from focal pancreatitis. PDAC showed a significantly (p=0.003) lower PE of 0.46±0.22 compared to 0.99±0.27 for focal pancreatitis.

CONCLUSION

TIC analysis is a valuable evaluation tool for discriminating PDAC from focal pancreatitis which is a diagnostic dilemma.

CLINICAL RELEVANCE/APPLICATION

Improved differential diagnosis based on better discrimination of indeterminate solid pancreatic lesions will provide patient-specific care-management options.

SSM09-06 Incidental Multiple Intraductal Papillary Mucinous Neoplasms (IPMN): Imaging Findings that Predict Growth on Long-Term Follow-Up

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E351

Participants
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PURPOSE

To assess growth rate of incidental IPMNs on long-term imaging follow-up and to evaluate the association between baseline imaging features and rate of growth.

METHOD AND MATERIALS

This IRB-approved, retrospective study included incidental multiple IPMNs (diameter>=4mm); with baseline cross-sectional imaging between 2002-2015, and follow-up imaging performed at least 12 months apart. In each patient, up to five of the largest cysts were identified and measured at baseline and last follow-up. For IPMNs demonstrating size change, the estimated time to growth was determined by reviewing all the intermediate imaging. Cysts' growth was determined based on ACR criteria. For each cyst, location, cluster or solitary presentation, dominancy, and other characteristics of the background pancreas were determined. A cluster was defined as presence of >3 cysts in one anatomic location of pancreas. A cyst was defined as dominant when it was >50% larger than the second largest cyst in the pancreas. The association with growth was adjusted with time intervals using univariate Cox analysis.

RESULTS

95 cysts in 31 patients were followed for a median of 56 months (range, 12-170 months). The mean cyst growth rate was 0.46 mm/year. According to ACR-criteria, 22 cysts (24%) grew, 14 cysts (15%) decreased in size and 59 cysts (62%) remained stable on follow-up imaging. The median time to growth was 55 months (range, 12-133 months).13 cysts (14%) were identified as dominant. 44 cysts (46 %) were located in a cluster as compared to 51cysts (54%) with a solitary presentation. Clustered presentation was found to have significant association with occurrence and rate of growth in IPMNs (HR, 3.4; P= 0.035 & Coef, 0.59; p=0.002, respectively).

CONCLUSION

Clustered presentation was independently associated with growth in multiple IPMNs. This could be due to the presence of underlying pathology in a focal region of pancreas. Measuring the largest cyst may not be adequate in representing size change in all other cysts and other features of multiplicity need to be considered in multiple IPMNs surveillance.

CLINICAL RELEVANCE/APPLICATION

There is no specific recommendation regarding long-term follow-up in patients with multiple IPMNs. Our data might be useful for developing a more specific surveillance strategy for multiple IPMNs with regards to choosing the targeted cyst and identifying predictive parameters.

SSM10

Gastrointestinal (DECT Technique)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E352

CT GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSM10-01 Standardization of Dual-Energy CT Iodine Uptake of the Abdomen: Defining Reference Values in a Big Data Cohort

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E352

Participants
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PURPOSE

Despite a wealth of literature on dual-energy CT(DECT) iodine uptake in various pathologies, physiologic reference values for this technique for confident clinical application have not been defined to date. Therefore,we investigated the iodine uptake of healthy abdominal and pelvic organs in a big data cohort.

METHOD AND MATERIALS

Consecutive portal-venous abdominal DECTs were reviewed and unremarkable exams were included (n=520; white/asian=489; mean age=59±15,5 years; 265w/255m). ROI-measurements were performed in the following anatomical regions (number of ROIs): liver(9), pancreas(3), spleen(3), adrenal glands(2), kidneys(6), prostate(4), uterus(2), urinary bladder wall(1) and lymph nodes (3). Iodine uptake was compared among different organs and subgroup analysis was performed (young vs old/male vs female).

RESULTS

Overall mean iodine uptake values were as followed (mg/ml): liver=1.93±0.54, pancreas=2.06±0.57, spleen=2.55±0.65, adrenal glands=1.66±0.43, kidneys=6.28±1.36, prostate=1.11±0.52, uterus=1.07±0.74, bladder=0.69±0.29 and lymph nodes=0.75±0.21. Portal-venous iodine uptake was comparable between liver/pancreas and liver/adrenal glands (p>=0.119). Women showed higher iodine uptake for liver (2.07±0.58 vs 1.79±0.45mg/ml), pancreas (2.29±0.57 vs 1.83±0.47mg/ml), spleen (2.81±0.65 vs 2.30±0.53mg/ml), adrenal glands (1.76±0.49 vs 1.56±0.33mg/ml) and kidneys (6.74±1.36 vs 5.83±1.20mg/ml) than men(p<0.001). In older patients,iodine uptake increased for liver (1.98±0.52 vs 1.87±0.54mg/ml), spleen (2.48±0.65 vs 2.63±0.64mg/ml) and kidneys (6.11±1.24 vs 6.45±1.45mg/ml) compared to younger subjects (p<=0.040). Only the uterus showed lower values in older women (0.77±0.45 vs 1.35±0.84mg/ml, p<0.001).

CONCLUSION

Physiologic iodine uptake values show age- and gender-related differences for the liver, spleen and kidneys. Pancreas and adrenal glands show higher iodine perfusion in women. While prostate parenchyma seems unaffected throughout lifetime, iodine supply of the uterus decreases in elderly women. Lymph nodes and bladder are unaffected by demographic influences.

CLINICAL RELEVANCE/APPLICATION

We defined physiologic reference values for static perfusion of abdominal organs, as indicated by DECT iodine uptake in a big data cohort and described the related differences regarding age and gender, in order to facilitate more reliable clinical application of this technique and ultimately, potential implementation in future guidelines.

SSM10-02 Texture Analysis of Split-Filter DECT Virtual Monoenergetic Images of Pancreas and Liver Tumors and Healthy Tissue

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E352

Participants
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PURPOSE

The purpose of this work is to investigate the effect of energy on CT texture analysis (CTTA) of pancreas and liver tumors and healthy tissue using virtual monoenergetic images (VMIs) generated from split-filter dual-energy CT (DECT).

METHOD AND MATERIALS

Split-filter DECT data was acquired for pancreatic and liver cancer patients using the Siemens SOMATOM Definition Edge CT scanner for radiation treatment planning with 100 ml of iodinated contrast medium. VMIs at energies ranging from 40-90 keV in 5 keV increments were reconstructed in Siemens' Syngo.via (VB30) software. Based on radiation oncologist reviewed contours of tumor and healthy tissue, first order CTTA parameters of the pancreas and liver tumor and healthy tissue were extracted from MIMvista including mean CT number (MCTN), standard deviation (SD), skewness, and kurtosis. Statistical analysis was performed using ANOVA.

RESULTS

Among the CTTA parameters investigated, MCTN and SD showed a statistically significant decrease with increasing energy of VMIs for pancreas and liver tumor and healthy tissue ($p<0.0001$). On the other hand, skewness and kurtosis did not change with energy of VMIs for pancreas and liver tumor and healthy tissue ($p>0.7$). There was a statistically significant difference in MCTN between pancreas and liver tumor and healthy tissue for low-energy VMIs ($p<0.04$). Although kurtosis did not change with energy, there was a statistically significant difference between the kurtosis of pancreas tumor and healthy tissue for all VMIs investigated ($p<0.05$). This trend was not apparent for liver tumor and corresponding healthy tissue ($p>0.14$). Additionally, there was a statistically significant difference in SD between pancreas tumor and healthy tissue for all VMIs investigated ($p<0.04$). This trend was not apparent for the liver cases ($p>0.08$).

CONCLUSION

The energy of split-filter VMIs has no impact on skewness or kurtosis of pancreas and liver tumor and healthy tissue. The difference in MCTN between pancreas tumor and healthy tissue is greatest for low-energy split-filter VMIs. Kurtosis determined from split-filter VMIs was different between pancreas tumor and healthy tissue.

CLINICAL RELEVANCE/APPLICATION

Skewness and kurtosis are reliable CTTA parameters that do not change as a function of energy. MCTN, SD and kurtosis have the potential to differentiate tumor and healthy tissue on split-filter VMIs. These results can be used as a baseline for higher-order CTTA of pancreas and liver tumor and healthy tissue.

SSM10-03 Quantification of the Liver-Fat Content Using Multimaterial Decomposition (MMD) Algorithm and Material Decomposition Technique: A Vitro Experiment Study

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E352

Participants
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PURPOSE

Our first goal was to build in vitro liver-fat model to provide a phantom for fat content quantification in study. The second goal was to evaluate the difference of feasibility and accuracy of using MMD algorithm and dual energy CT material decomposition technique for fat content quantification to provide a basis for the precise fat quantification in clinical use.

METHOD AND MATERIALS

A total of 6 homogeneous liver-fat mixed samples with various fat volume contents from 0-50% (with an interval of 10%). Scanned by GE Revolution CT scanner using GSI mode with rapid tube voltage switching between 80-140 kVp. After the CT scan, reconstructed imaging data were processed with GSI imaging analysis software and MMD soft-ware currently not commercially available. Fat concentration (on fat-water bases) measured with consistent ROIs placed in the tube center. Each sample was recorded at 4 different regions for average and statistical analysis. A linear regression was performed using SPSS 19.0 software to analyze the relationship between the measured fat concentration and the actual fat concentration. P value less than 0.05 was considered to indicate a linear correlation.

RESULTS

(1) We had successfully developed the model in vitro for fat content quantification. With the designed concentration series, the gradient range covered clinical fat content in different body regions. And the model provided a novel way to investigate in vitro fat content. (2) Both algorithms showed good linear relationship between the measured fat concentration and actual concentration. MMD algorithm revealed a linear correlation equation of $y=1.498x-73.5$, $R^2 = 0.944$, $P=0.001$, $F=84.748$. For material decomposition technique, the linear correlation equation was $y=0.079x+30.52$, $R^2 = 0.983$, $P=0.001$, $F=234.397$.

CONCLUSION

Both of MMD algorithm and spectral CT material decomposition technique were demonstrated to provide accurate and reliable measurement of fat content for liver-fat model, which will contribute to the development of clinical fat content quantification assays.

CLINICAL RELEVANCE/APPLICATION

This study demonstrated the feasibility of using MMD algorithm and material decomposition techniques to precisely quantify the fat concentrations. The advantages of these quantification methods include reduced labor, high accuracy with no additional scanning required, which makes it attractive to be applied in future clinical tests and lipid metabolism studies.

SSM10-04 Virtual Non-Contrast Images from Contrast-Enhanced Dual-Layer Spectral CT for Pediatric Abdominal CT: Are They Different from Adults?

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E352

Participants
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PURPOSE

Virtual non-contrast (VNC) images from dual-layer spectral CT (DLSCT) might replace true unenhanced images for pediatric abdominal CT studies. We compared the accuracy of iodine subtraction in pediatric abdominal organs on VNC images obtained from contrast-enhanced DLSCT scans with that of true unenhanced (TU) images and assessed the difference between pediatric and adult patients.

METHOD AND MATERIALS

We included 10 child- (1-15 years, mean 8.7±4.4 year) and 40 adult patients (28-87 years, mean 56.4±17.6 year) who underwent unenhanced and contrast-enhanced DLSCT. Two radiologists assessed the image quality of all images on a 5-point scale. Venous-phase VNC images were generated and a region-of-interest (ROI) was placed on the liver, spleen, renal cortex, aorta, fat tissue, muscle and fiuid (gallbladder) on TU- and VNC images. The attenuation of each ROI in VNC image was subtracted from the corresponding attenuation of the TU image. The difference in attenuation between VNC- and TU images of children and adults was compared using the independent t-test and regression analysis.

RESULTS

In all 50 patients, there was no significant difference in the image quality of VNC- and TU scans (children: 4.8±0.4; adult: 4.5±0.5). The attenuation difference in the renal cortex between VNC- and TU images was significantly greater in adults than children (9.6±7.2 vs 1.2±8.2 HU, p=0.0046). The attenuation difference in the liver and spleen showed a similar tendency. With respect to fat tissue, attenuation was higher on VNC than TU images in almost all 50 patients. Scatter plots of the attenuatoin difference between VNC- and TU images versus the patient age showed a significant positive correlatoin only in the renal cortex (r=0.34, p=0.034).

CONCLUSION

VNC images derived from contrast-enhanced DLSCT showed iodine subtraction in abdominal organs more accurately on scans of children than adults.

CLINICAL RELEVANCE/APPLICATION

For the evaluation of abdominal contrast-enhanced CT scans, VNC imaging may be more useful in children than adults.

SSM10-05 Intra-individual Consistency of Spectral Detector CT-Enabled Iodine Quantification of the Intravascular and Renal Blood Pool

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E352

Participants
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PURPOSE

Recent studies revealed high diagnostic accuracy of iodine maps from spectral detector CT (SDCT); however, little is known on reproducibility of iodine measurements in vivo which is crucial for oncologic follow-up imaging. Hence, the objective of this study was to analyze the intra-individual, longitudinal consistency in patients that underwent multiple SDCT examinations.

METHOD AND MATERIALS

79 patients with 2 (53 patients) or 3 (26 patients) clinically-indicated, biphasic (arterial/venous) abdominal SDCT scans were retrospectively identified for study inclusion. HU attenuation in conventional images and iodine concentration in iodine maps were measured by an experienced radiologist who placed circular regions of interest (ROI) in the following areas (two ROI each):

abdominal aorta, inferior caval vein, portal vein, renal cortices. To investigate intra-individual consistency of iodine and HU measurements, modified variation coefficients (MVC) were calculated.

RESULTS

Variability of HU attenuation and iodine concentration was significantly higher in arterial phase than in venous phase images (p <= 0.05). Regarding arterial phase attenuation measurements, median MVC was -1.8 (-20.5-21.3) % within the aorta and -6.5 (-44.0 - 48.7) % within the renal cortex while in the portal venous phase it was 0.62 (-11.1-11.7) % and -1.6 (-16.2-10.6) %, respectively. Regarding iodine quantification, MVC of arterial phase measurements was -2.5 (-22.9-28.4) % within the aorta and -5.8 (-55.9 - 29.6) % within the renal cortex. Referring MVCs of the portal venous phase were -0.7 (-17.9-16.9) % and -2.6 (-17.6-12.5) %.

CONCLUSION

Intra-individual iodine quantification of intravascular and renal blood pool is most consistent in venous-phase images (overall MVC: ±15 %) whereas arterial phase measurements are subject to greater variability.

CLINICAL RELEVANCE/APPLICATION

For clinical application of SDCT-derived iodine quantification, a certain variability of venous phase images should be considered while particular care must be taken when calculating iodine thresholds from arterial phase images, e.g. in oncologic follow-up.

SSM10-06 Conventional versus Virtual Monoenergetic Images from Spectral Detector CT: Evaluation of Attenuation and Noise

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E352

Participants
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PURPOSE

The utilization of VMI in daily practice is limited as attenuation (HU) is quite different and extensive re-windowing may be required. We aimed to identify the VMI energy that closest represents conventional images (CI) in order to demonstrate that these images demonstrate improved image quality in terms of noise and Signal-to-noise ratio (SD/SNR) while attenuation values remain unaltered as compared to CI.

METHOD AND MATERIALS

60 and 30 patients with contrast-enhanced (CE) and non-enhanced (NCE) SDCT of the abdomen were included in this retrospective, IRB-approved study. CI and VMI of 66, 68, 70, 72 and 74keV as well as quantitative iodine maps were reconstructed (Q-IodMap). Two regions of interest were placed in each: aorta, liver, pancreas, renal cortex and psoas muscle. For each reconstruction, attenuation and standard deviation were averaged. ΔHU and Signal-to-noise ratio was computed (SNR=HU/SD) were calculated. Q-IodMap were considered as confounder for ΔHU.

RESULTS

In NCE studies, no significant differences for any region was found. In CE studies, VMI72keV images showed lowest ΔHU (HUliverCI/VMI72keV: 104±18/103±17, p>=0.05). Iodine containing voxels as indicated by Q-IodMap resulted in over- and underestimation of attenuation in lower and higher VMI energies. Image noise was lower in VMI images (e.g. muscle: CI/ VMI72keV: 15.3±3.3 / 12.3±2.9 HU, p<=0.05). Hence, SNR was significantly higher in VMI72keV compared to CI (e.g. liver 3.8±0.6 vs 3.0±0.8, p<=0.05).

CONCLUSION

VMI72keV show improved SD/SNR characteristics while the attenuation remains unaltered as compared to CI. These images possibly may be used as replacement for conventional images.

CLINICAL RELEVANCE/APPLICATION

The noise reduction enabled by VMI72keV may allow for a reduction of radiation dose. The CI-equivalent attenuation values may increase their clinical acceptance.

SSM11

Gastrointestinal (CT Diagnosis)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E353A

CT GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSM11-01 The Role of Dynamic Contrast-Enhanced CT in Diagnosis and Management of Patients with Sustained Bleeding After Liver Transplantation

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E353A

Participants
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PURPOSE

To investigate the role of dynamic contrast-enhanced CT (DCE-CT) in the diagnosis and management of patients with sustained bleeding after liver transplantation (LT).

METHOD AND MATERIALS

Between November 2013 and December 2017, we retrospectively identified 270 patients (52.8±9.8 years; 18-76 years) who underwent DCE-CT after LT with clinically suspected postoperative bleeding. DCE-CT images were analyzed with emphasis on contrast media extravasation (CME): bleeding source, volume, rate, and morphologic pattern (type I, focal or stippled pattern; type II, jet-like pattern). Recipients were classified into two groups by primarily-chosen treatment method; nontherapeutic intervention (NTI) trial and primary therapeutic intervention (TI) groups. NTI trial group was further subdivided into NTI success and NTI failure groups according to results of NTI treatment. The differences of CME volume, rate, and pattern among the three groups and between the subgroups were evaluated. The concordances of bleeding source determined by DCE-CT to actual bleeding source were analyzed.

RESULTS

Of the 270 patients with clinically suspected postoperative bleeding, 134 CME sites were identified in 116 (43.0%) patients. While most (94.8%, 146/154) of patients without CME was successfully managed by NTI, the proportion decreased in the order particularly on portal venous phase with type I (48.5%, 16/33) and type II (16.9%, 14/83) CMEs. The mean CME volume on both arterial and portal venous phases and the mean CME rate significantly increased in order of NTI success, NTI failure, and primary TI groups ($p<0.01$, respectively). In subgroup analysis of NTI trial group, type II CME on portal venous phase was significantly higher in NTI failure group than in NTI success group (86.7% [13/15] versus 46.7% [14/30], $p=0.01$). There was substantial agreement in localization of bleeding source between DCE-CT and surgery or angiography (Cohen Kappa=0.78).

CONCLUSION

DCE-CT is helpful in the assessment for need of TI and to determine the treatment of choice in recipient with postoperative bleeding after LT.

CLINICAL RELEVANCE/APPLICATION

DCE-CT is helpful in the assessment for need of therapeuric intervention and in decision of treatment method in recipient with postoperative bleeding after LT.

SSM11-03 CT Evaluation of Bowel Perforation: Diagnostic Performance and Correlation of Imaging Features According to Sites and Causes

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E353A

Participants
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PURPOSE

To evaluate diagnostic accuracy of CT and correlation of imaging features of bowel perforation, according to sites and causes

METHOD AND MATERIALS

239 patients (M;F = 190:49, mean age 56.2) confirmed as bowel perforation were included. We analyzed initial CT scan with 3-D reformation, and evaluated about pneumoperitoneum, ascites, bowel discontinuity, mechanical or paralytic ileus, active bleeding, hemoperitoneum, and localized peritoneal change like fecaloma, etc. according to sites and causes, by consensus of two abdominal radiologists, and reviewed medical record. Exclusion criteris were previous abdominal surgery or peritonitis or peritoneal carcinomatosis, liver cirrhosis, peritoneal dialysis, and more than 48 hours between CT scan and surgery.

RESULTS

97 patients were traumatic (gastro-duodenum [n=8], jejunum/ileum [n=67], colon/rectum [n=22]) and 142 non-traumatic (gastro-duodenum [n=126], jejunum/ileum [n=8], colon/rectum [n=8]) causes. Overall CT accuracy was 84.1%; higher in traumatic and non-traumatic gastro-duodenum (100% and 96.8%) and non-traumatic colon/rectum (100%), and lowest in traumatic perforation of jejunum/ileum (61.5%). CT analysis results with statistical significant difference (p<.05) were as follows; pneumoperitoneum in gastro-duodenum and colon/rectum more than non-traumatic jejunum/ileum, ileus in traumatic gastro-duodenum and jejunum/ileum more than the others, bowel discontinuity in traumatic cuase more than non-traumatic, localized peritoneal change in traumatic gastro-duodenum and non-traumatic causes, regional lymphadenopathy in non-traumatic colon/rectum, active bleeding or hemoperitoneum only in traumatic causes, and increased morbidity and mortality in older age regardless of sites or causes.

CONCLUSION

Diagnostic accuracy is good, highest in gastro-duodenal and non-traumatic colo-rectal perforation, and lowest in traumatic perforation of jejunum and ileum. Traumatic perforation of jejunum and ileum shows low diagnostic accuracy due to lower frequency of bowel discontinuity, pneumoperitoneum, and localized peritoneal change. Bowel discontinuity is more frequent in traumatic cause. Localized peritonel abnormality is more frequent in non-traumatic cause.

CLINICAL RELEVANCE/APPLICATION

CT with 3-dimentional reformation could show good diagnostic performance for bowel perforation and various imaging features according to sites and causes of perforation.

SSM11-04 Relative Sarcopenia with Excess Adiposity is an Independent Predictor of Survival After Transjugular Intrahepatic Portosystemic Shunt (TIPS) Creation

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E353A

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PURPOSE

To assess whether relative sarcopenia with excess adiposity is a risk factor for poor survival after TIPS.

METHOD AND MATERIALS

This single institution retrospective study included patients over 18 years of age who underwent TIPS creation and had abdominal CT scans performed within 100 days prior to or 30 days after TIPS. Subcutaneous fat, visceral fat and abdominal wall muscles were segmented at the inferior L3 endplate. Relative sarcopenia with excess adiposity was defined as the lowest gender specific quartile of muscle area divided by muscle plus fat area. Dates of death, liver transplantation, spontaneous occlusion or embolization of the TIPS, and post-TIPS hepatic encephalopathy (HE) were identified. Mortality was analyzed using competing risks survival analysis, and post-TIPS HE was analyzed using negative binomial regression and competing risks survival analysis

RESULTS

The cohort included 141 patients (mean age 56 years ±11, 91 men) who underwent CT an average of 17 days before TIPS (range 97 days prior to 26 days after). In univariate survival analyses, Model for End Stage Liver Disease (MELD) score (hazard ratio [HR]=1.09 per 1-point increase in MELD, 95% confidence interval [CI]=1.05-1.13, p<0.001) and relative sarcopenia with excess adiposity (HR=2.7, CI=1.55-4.69, p<0.001) were significant risk factors for shorter survival after TIPS. In a multivariate analysis both MELD score (HR=1.11, CI=1.06-1.16, p<0.001) and relative sarcopenia with excess adiposity (HR=2.46, CI=1.42-4.26, p=0.001) were significant predictors of survival. The C-index at 30 days was 0.71 for MELD, 0.72 for relative sarcopenia with excess adiposity, and 0.8 for a model including both. There was no association between relative sarcopenia with excess adiposity

and number of post-TIPS HE episodes (incidence rate ratio=1.08, CI=0.49-2.40, p=0.84) or time to first post-TIPS HE episode (HR=0.89, CI=0.51-1.54, p=0.67)

CONCLUSION

Relative sarcopenia with excess adiposity, defined as the lowest quartile of gender specific muscle area normalized to muscle plus fat measured by CT, is an independent risk factor for poor survival after TIPS and may supplement MELD score

CLINICAL RELEVANCE/APPLICATION

A deficiency in abdominal muscle mass relative to fat as assessed by CT is associated with poor survival after TIPS. This anthropometric index may improve the ability to predict outcomes in cirrhotic patients undergoing TIPS

SSM11-05 Value of Computed Tomography Finding in Evaluating the Acute Cellular Rejection of the Pancreas Allograft

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E353A

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PURPOSE

To investigate computed tomography (CT) findings in patients with or without acute cellular rejection (ACR) after pancreas transplantation

METHOD AND MATERIALS

Twenty-two pancreas allograft recipients (pancreas transplantation alone: 17, pancreas transplantation after kidney transplantation: 3, pancreas transplantation after liver transplantation: 1, simultaneous pancreas and kidney transplantation: 1) that underwent at least one follow-up CT examination were included in this study. Among them, 8 patients were diagnosed as ACR by percutaneous biopsy within 3 day from CT examination. Two radiologists analyzed pre-biopsy CT images of patients with ACR and the latest CT images of patients without ACR compared with early follow-up CT for graft swelling, perivascular soft tissue infiltration of graft arteries, change from acute to obtuse angle between graft SMV and splenic vein, graft enhancement on the delayed phase, fat strands or fluid around graft, and graft duodenal wall thickening. Intra-class correlation (ICC) was used to analyze inter-observer agreement of CT findings.

RESULTS

Mean interval between transplantation and CT examination was not significantly different between patients with ACR and patients without ACR (467.5±261.9 days vs 508.2±343.3 days, p = 0.838). Three patients with grade 1, and five patients with grade 2 ACR were noted by pathological analysis. Change from acute to obtuse angle between graft SMV and splenic vein (p = 0.001) and graft duodenal wall thickening (p < 0.001) were observed more frequently in patients with ACR. Other CT findings did not show significant difference between ACR and non-ACR group (p = 0.060-1.000). Inter-observer agreement for angle between graft SMV and splenic vein (ICC: 0.896), graft duodenal wall thickening (ICC: 0.945) were excellent, and fair to excellent agreements were noted for other CT findings (ICC: 0.456 - 1.000).

CONCLUSION

CT examination can be helpful to predict ACR in patients after pancreas transplantation using change of angle between graft SMV and splenic vein with excellent inter-observer agreement.

CLINICAL RELEVANCE/APPLICATION

CT findings including change of angle between graft SMV and splenic vein might be helpful for prediction of ACR as well as evaluation of postoperative complications in patients after pancreas transplantation.

SSM11-06 Diagnostic Accuracy of Multidetector CT in Detecting Juxta-Ampullary Duodenal Diverticulum in Symptomatic Patients

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E353A

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PURPOSE

To determine the diagnostic accuracy of 64-slice multidetector computed tomography (MDCT) in detecting juxta-ampullary duodenal diverticulum (JADD) in symptomatic patients.

METHOD AND MATERIALS

After being approved by the Ethics Committee of our university, a total of 100 patients with endoscopic retrograde cholangiopancreatography (ERCP)-confirmed JADD and 20 patients with extrahepatic biliary obstruction due to other reasons were enrolled in this study. All patients were evaluated by MDCT, as well. Without knowing the result of ERCP, two experienced radiologists reviewed MDCT images and accordingly, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of MDCT in detecting JADD, as the etiology of obstruction, were calculated.

RESULTS

The study group comprised 60 males and 60 females with the mean age of 68.83±12.71 years (range, 27-93) at the time of evaluation. The sensitivity, specificity, PPV and NPV of MDCT in detecting JADD were 76% (95% confidence interval, CI; 66%-84%), 100%, 100% and 45.5% (95%CI; 30%-61%), respectively. The only independent reason for missing a JADD on MDCT images was its small size (<10mm).

CONCLUSION

Abdominal MDCT is highly specific in detecting JADD as the underlying cause of obstruction in symptomatic patients. The accuracy increases when the diverticulum is larger than 10mm.

CLINICAL RELEVANCE/APPLICATION

64-slice MDCT is highly accurate in ruling in juxta-ampullary duodenal diverticula as the underlying cause of extrahepatic biliary obstruction.

Printed on: 10/29/20

SSM12

Genitourinary (Bi-Parametric versus Multi-Parametric Prostate MRI)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: N229

GU MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM12-01 The Added Value of Dynamic Contrast Enhanced Sequences for Detection of Clinically Significant Prostate Cancer: Results from the PROMIS Study

Wednesday, Dec. 4 3:00PM - 3:10PM Room: N229

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PURPOSE

Multiparametric MRI(MP-MRI) is now a well-established tool in the prostate cancer diagnostic pathway. Recently, the optimal combination of sequences has come into question with opposing views on the added value of dynamic contrast enhanced sequences (DCE). The main phase of the PROMIS (Prostate MRI Imaging Study) trial was adapted to provide a prospective analysis of the incremental value of diffusion (DWI) and DCE sequences in detection of significant cancer.

METHOD AND MATERIALS

497 biopsy naïve men underwent standardized MP-MRIs using T2, DWI (including a dedicated long b sequence) and DCE, followed by a detailed transperineal prostate mapping biopsy covering the whole prostate in 0.5cm intervals. In one sitting, the radiologist assigned a Likert score of 1-5 for the presence of significant tumour, in sequence, for the T2 images, then T2+DWI images , and finally T2+DWI+DCE images. For the primary analysis, a score of >/= 3 was considered positive for clinically significant cancer. Each combination was assessed against the primary PROMIS outcome measure of significance (>/= Gleason 4+3 tumour or >/=6mm maximum cancer core length) on biopsy.

RESULTS

The addition of DCE to T2+DWI resulted in a sensitivity of 95% vs 94%, specificity of 38% vs 37%, positive predictive value of 51% vs 51% and negative predictive value of 90% vs 91% respectively. Marginally more patients could avoid biopsy (score of 2/5 or less) with DCE (123/497 vs 121/497 patients). There was some evidence that contrast reduced the number of equivocal scores: 36% of positive patients were classified as equivocal (3/5) with addition of DCE compared to 42% on T2+DWI alone. The proportion of equivocal (3/5) and positive (4-5/5) cases showing significant tumour were similar (20% and 69 % with DCE, 23% and 71% with T2+DWI alone). None of these differences were statistically significant. No dominant Gleason pattern 4 disease or higher was missed with T2+DWI+DCE, compared to a single case with T2+DWI.

CONCLUSION

DCE did not significantly improve sensitivity or specificity. One dominant Gleason 4 tumour was missed using T2+DWI and none missed with DCE. Though not statistically significant, fewer cases were scored equivocal with the addition of DCE.

CLINICAL RELEVANCE/APPLICATION

The addition of DCE to T2+DWI in a prospective, multi centre study of prostate MRI did not result in convincing improvements in accuracy or a reduction in the number of men recommended for biopsy.

SSM12-02 Comparison of Biparametric and Multiparametric MRI in the Diagnosis of Prostate Cancer

Wednesday, Dec. 4 3:10PM - 3:20PM Room: N229

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PURPOSE

To compare the diagnostic accuracy of biparametric MRI (bpMRI) and multiparametric MRI (mpMRI) for prostate cancer (PCa) and clinically significant prostate cancer (csPCa), and to explore the application value of dynamic contrast-enhanced (DCE) MRI in prostate imaging.

METHOD AND MATERIALS

This study retrospectively enrolled 235 patients with suspected PCa in our hospital from 2016 to 2017. The lesions were scored according to the Prostate Imaging Reporting and Data System version 2 (PI-RADS V2). The bpMRI and mpMRI scores were recorded to plot the receiver operating characteristic curve (ROC). Area under the curve (AUC), accuracy, sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) for each method were calculated and compared. The patients were further stratified according to bpMRI scores for the application value of DCE MRI.

RESULTS

The AUC values of bpMRI and mpMRI for PCa were comparable (0.790 and 0.791, respectively). The accuracy, sensitivity, specificity, PPV and NPV of bpMRI for PCa were 76.2%, 79.5%, 72.6%, 75.8%, and 76.6%; and the values for mpMRI were 77.4%, 84.4%, 69.9%, 75.2%, and 80.6%, respectively. For the diagnosis of csPCa, the AUC values of bpMRI and mpMRI were similar (0.781 and 0.779, respectively). The accuracy, sensitivity, specificity, PPV and NPV of bpMRI for csPCa were 74.0%, 83.8%, 66.9%, 64.8%, and 85.0%; and 73.6%, 87.9%, 63.2%, 63.2%, and 87.8% for mpMRI. For patients with bpMRI score >= 3, the difference in DCE between PCa and non-PCa, and between csPCa and non-csPCa were both statistically significant (both P = 0.001). Further stratification analysis showed that for patients with bpMRI score = 4, DCE had statistically significant difference between PCa and non-PCa, and between csPCa and non-csPCa (P = 0.003, and P < 0.001, respectively).

CONCLUSION

The diagnostic accuracy of bpMRI is comparable with that of mpMRI in the detection of PCa and identification of csPCa. DCE is helpful in further identifying PCa and csPCa lesions in patients with bpMRI >= 3, especially bpMRI = 4, which may be conductive to achieve more accurate PCa risk stratification.

CLINICAL RELEVANCE/APPLICATION

For patients with suspected PCa, DCE may improve the tumor detection and aggressiveness classification. Rather than omitting DCE, we think further comprehensive studies are required for prostate MRI.

SSM12-03 Comparison of Bi-Parametric MRI Based Artificial Intelligence and Multi-Parametric MRI in Detection of Intraprostatic Lesions: A Multi-Reader Study

Wednesday, Dec. 4 3:20PM - 3:30PM Room: N229

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PURPOSE

To compare a bi-parametric magnetic resonance imaging (bMRI) based artificial intelligence (AI) system which provides proposed regions of interests (ROI) overlaid on T2 weighted (T2W) with multi-parametric MRI (mpMRI) using PI-RADSv2 guided interpretation.

METHOD AND MATERIALS

Case and control patients were collected from 5 institutions and 9 radiologists from 9 different institutions participated as readers: 3 highly, 3 moderately, 3 less-experienced in reading prostate MRI. Patients were consecutive at each institution and underwent 3T mpMRI (T2W, ADC map, b-1500, DCE MRI). Case patients had subsequent radical prostatectomy with pathology mapping available, control patients had negative MRI and negative systematic biopsy. Two interpretation arms were executed with readers blinded to pathology: an mpMRI-alone arm utilizing PI-RADSv2 guidelines, then after 4-week washout, a first-reader AI-assisted arm. Lesion detection sensitivity was calculated for whole prostate. Per-lesion specificity was calculated on the AI-assisted arm on a per-ROI level.

RESULTS

153 case and 84 control patients were included across 5 institutions. For mpMRI-alone interpretation, lesion-based sensitivity was 62.2%, 63%, 65.3% and 58.2% for overall, high, moderate and low-experienced readers, respectively. For bMRI based AI system assisted interpretation, lesion-based sensitivity was 66.5%, 67.8%, 71.7% and 59.9% for overall, high, moderate and low-experienced readers, respectively. At threshold of PI-RADS >=3, specificity of AI assisted bMRI were 81.1%, 86.3%, 70.2% and 86.8% for overall, high, moderate and low-experienced readers, respectively.

CONCLUSION

AI-assisted bi-parametric MRI reads demonstrated higher sensitivities compared to multiparametric MRI reads at all experience categories for radiologists.

CLINICAL RELEVANCE/APPLICATION

AI-assisted MRI reads can standardize and improve prostate MRI reporting.

SSM12-04 Value of Dynamic Contrast Enhanced (DCE) MR Imaging for Patients in PI-RADS 4 Category

Wednesday, Dec. 4 3:30PM - 3:40PM Room: N229

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PURPOSE

To assess the impact of dynamic contrast-enhanced imaging (DCE) in mp-MRI on prostate cancer (PCa) detection in a large patient cohort assigned to PI-RADS category 4.

METHOD AND MATERIALS

This prospective, single center cohort study includes 193 consecutive patients with PI-RADS assessment category 4 after mp-MRI (T2WI, DWI, DCE) at 3T with combined targeted plus systematic biopsy as reference standard. Prostate cancer detection with DCE and without inclusion of DCE upgraded lesions was compared.

RESULTS

Overall PCa detection rate in PI-RADS-4-patients was 62% (119/193) with DCE and 52% (101/193) without inclusion of DCE upgraded lesions; 48% (92/193) had clinically significant PCa (csPCa; Gleason score >=3+4=7) and 40% (78/193) without use of DCE. 38 of the 193 patients (20%) had peripheral lesions upgraded from PI-RADS category 3 to an overall PI-RADS category 4 due to focal positive DCE findings. Of these 38 patients 18 had PCa including 14 with a csPCa. Thus, 15% (18/119) of the patients with any prostate cancer and 15% (14/92) of the patients with csPCa were detected only based on additional DCE information.

CONCLUSION

DCE allows detection of a significant number of mostly csPCa in PI-RADS-4-patients and thus improves detection rates. The current PI-RADS decision rules regarding upgrading PI-RADS-3-lesions to overall category 4 due to positive DCE imaging are useful for PCa detection.

CLINICAL RELEVANCE/APPLICATION

Patients assigned to PI-RADS category 3 benefit from DCE for primary (early) tumor detection.

SSM12-05 Comparison of Standard Multiparametric and Unenhanced Biparametric MRI in Men with Elevated Prostate-Specific Antigen

Wednesday, Dec. 4 3:40PM - 3:50PM Room: N229

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PURPOSE

Multiparametric MRI (mpMRI) for prostate cancer (PCa) is usually composed of diffusion-weighted (DW), T2W and dynamic contrast enhancement (DCE) sequences. We compared biparametric MRI (bpMRI) composed of T2W and DW against mpMRI in patients with elevated prostate-specific antigen (PSA).

METHOD AND MATERIALS

1.5-T prostate MR was performed in 431 men (61.5+/-8.3 years) with PSA>4.0 ng/mL and included in a retrospective analysis. bpMRI and mpMRI were independently assessed in separate sessions >1 month apart in a random order by 2 readers with 5 (R1) and 3 years (R2) experience, using the PI-RADS2 criteria. Histopathology or >=2 years of follow-up served as a reference standard. PI-RADS score 3 was the threshold for a positive exam. Sensitivity and specificity were calculated with their 95% confidence interval (CI); McNemar and Cohen's K statistics were also used.

RESULTS

Population consisted in 195/431 (45,3%) histopathologically proven PCa, with 62/195 (31.8%) high-grade- (GS>=7b) and 133/195 (68.2%) low-grade-PCa. PCa could be excluded by histopathology in 58/431 (13.5%) patients and by follow-up in 178/431 (41.3%) patients. For bpMRI, sensitivity was 164/195 (84%, 95%CI 79-89%) for R1 and 156/195 (80%, 95%CI 74-86%) for R2; specificity was 182/236 (77%, 95%CI 72-82%) for R1 and 175/236 (74%, 95%CI 68-80%) for R2. For mpMRI, the sensitivity was 168/195 (86%, 95%CI 81-91%) for R1 and 160/195 (82%, 95%CI 77-87%) for R2; the specificity was 184/236 (78%, 95%CI 73-83%) for R1 and 177/236 (75%, 95%CI 69-81%) for R2. Omitting the DCE sequences (namely, using bpMRI) changed the PIRADS2 scores in 25/431 (5.8%) patients for R1 and in 35/431 (8.1%) patients for R2, when compared to mpMRI. PI-RADS score 3 increased by 5.3% for R1 and 7.4% for R2. bpMRI resulted in 4 more false negatives, compared to mpMRI, for both R1 and R2 and all of these were low-grade PCa. No high-grade PCa was missed with bpMRI. Not significant differences in accuracy were observed with both approaches by each readers (p>0.08). Interobserver agreement was substantial for both bpMRI (κ=0.802) and mpMRI (κ=0.787).

CONCLUSION

Diagnostic performance of bpMRI and mpMRI were similar, with no change in the detection of high-grade PCa

CLINICAL RELEVANCE/APPLICATION

bpMRI for PCa's detection could eliminate the adverse events and the retention of gadolinium, shorten time and reduce costs, possibly resulting in increased accessibility of MRI for men with elevated PSA

SSM12-06 Comparison of Measured Ultra-High b-Value ADC to Quantitative DCE for Enhancing Bi-Parametric (T2w and DWI) MRI Assessment of Clinically Significant Prostate Cancer

Wednesday, Dec. 4 3:50PM - 4:00PM Room: N229

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PURPOSE

To compare the added diagnostic value of measured ultra-high b-value (UHB) - derived apparent diffusion coefficient (ADC) to quantitative normalized DCE assessment for the enhancement of bi-parametric (T2w and ADC) MRI for the prediction of clinically significant prostate cancer (sPC).

METHOD AND MATERIALS

73 consecutive patients (67.2±7.7 years, PSA 10.7±18.1 ng/dl) underwent prostate MRI at 3T (Magnetom Prisma) with EPI-DWI images acquired at b=50/500/1000/1500 s/mm2 as well as at b=100/500/1000/2250/3000/4000 s/mm2. Extended systematic and targeted MRI/TRUS fusion biopsies based on prospective clinical reads were matched to a second, retrospective blinded read and MR lesions segmented manually. ADC, UHB-ADC100,4000, early arterial DCE lesion contrast to surrounding parenchyma (nDCE) and T2w intensity normalized to pectineus muscle (nT2w) were extracted from each lesion. Three logistic regression models were created for prediction of sPC defined as Gleason Grade Group (GGG) >= 2: Model A (nT2w, ADC), model B (nT2w, ADC, nDCE) and model C (nT2w, ADC, UHB-ADC). For evaluation of the models AUC was calculated from ROC curves and Chi-square analysis of deviance or Vuong's test were used to compare the models.

RESULTS

In 73 patients 55 MRI-detected retrospectively validated MR-lesions revealed no cancer in 23 lesions (42%), GGG=1 in 10 lesions (18%), GGG=2 in 12 lesions (22%), GGG=3 in 4 lesions (7%), GGG=4 in 4 lesions (7%) and GGG=5 in 2 lesions (4%). Model A yielded

an AUC of 0.810 (sensitivity 80%, specificity 73%), model B yielded an AUC of 0.840 (sensitivity 80%, specificity 79%) and model C yielded an AUC of 0.806 (sensitivity 80%, specificity 73%), indicating a slightly higher AUC for model B when compared to model A and C (p=0.04 and p=0.13) and a comparable AUC between model A and C (p=0.76).

CONCLUSION

Measured UHB-ADC achieved no improvement in predictive performance over bi-parametric assessment with ADC and T2w, whereas added quantitative normalized DCE did improve predictive performance.

CLINICAL RELEVANCE/APPLICATION

Measured UHB-ADC does not provide a contrast-free alternative to DCE for the enhancement of bi-parametric prostate MRI.

Printed on: 10/29/20

SSM13

Science Session with Keynote: Health Service, Policy and Research (Patient and Family Centered Care)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S404CD

HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSM13-01 Health Service, Policy and Research Keynote Speaker: Surprise Billing: What You Don't Know Could Really Cost You

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S404CD

Participants
Richard E. Heller III, MD, Chicago, IL (*Presenter*) Nothing to Disclose

SSM13-02 Financial Toxicity in Cancer Patients and their Caregivers: Correlation with Patient's Medication and Imaging Non-Adherence

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S404CD

Participants
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PURPOSE

To assess health-related financial toxicity in cancer patients and their caregivers and its correlation with financial coping strategies and care non-adherence.

METHOD AND MATERIALS

Dyads of adult cancer patients and their adult primary caregivers visiting outpatient oncology clinics were recruited. Financial toxicity at study entry was measured using the Comprehensive Score for Financial Toxicity (COST) score (ranging between 0-44, the lower the score, the worse the financial toxicity). Linear regression identified independent sociodemographic, clinical and insurance correlates of financial toxicity. Financial coping strategies, health-related quality of life (HRQOL) and care non-adherence were assessed.

RESULTS

34 dyads of cancer patients (57yo [95%CI,53-63]; 73% female; 79% White) and their caregivers (50yo [95%CI,43-67]; 60% female; 82% White) were recruited. 32% of patients had breast cancer, 32% genitourinary, 18% skin, and 18% other malignancies. Median months from diagnosis was 22(IQR,11-48). 53% of caregivers were spouses/partners; 26% parents and 14% children. Mean COST scores in patients and caregivers were 21(95%CI,17.5-25.3) and 23(95%CI,18.6-26.7) (Pearson coefficient 0.37;$p<0.05$). In response to financial burden, 41% of patients and 48% of caregivers used at least one financial coping strategy (see fig. 1). Medication and imaging non-adherence were reported by 15% and 3% of patients. In multivariable analyses, the key correlate of lower financial toxicity (e.g., higher COST score) in patients was higher financial self-efficacy (e.g., having more confidence in being able to manage money to last a lifetime) (coefficient 1.5 [95%CI,0.9-2.1];$p<0.001$). Key correlate of financial toxicity among caregivers was patient-caregiver relationship with spouses/partners reporting higher COST scores (coefficient 18 [95%CI,7.1-29]; $p<0.05$). Lower COST scores in caregivers correlated with lower caregiver HRQOL and higher patients' care non-adherence ($p<0.05$).

CONCLUSION

Spouses and partners experience lower financial toxicity as caregivers to cancer patients compared to parents or children. The degree of caregiver financial burden influences patient care non-adherence.

CLINICAL RELEVANCE/APPLICATION

Cancer impacts patient-caregiver dyads as a whole. The primary focus of interventions to improve health disparities resulting from financial burden should be shifted from the individual level to the dyadic level of patients and caregivers.

SSM13-03 Analysis of a Patient-Centered Ridesharing Program to Overcome Transportation Barriers in Access to Advanced Imaging Care

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S404CD

Participants
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PURPOSE

Transportation difficulties are a known barrier to receiving appropriate, timely care for many patients. These barriers tend to affect patients from low socioeconomic status (SES) and underrepresented racial/ethnic minority communities. Patient-centered interventions can help address some of these barriers to care. The purpose of this study was to evaluate a rideshare program developed to address transportation barriers to MRI appointments at an outpatient imaging center affiliated with an academic medical center.

METHOD AND MATERIALS

Single-institution, HIPAA compliant, IRB approved study with waiver of informed consent was performed to evaluate a rideshare program, through Circulation © and Lyft ©, at an outpatient imaging site of a quaternary academic medical center during a 9-month period (June 2018- February 2019). Any patient who spontaneously expressed a desire to cancel their MRI appointment due to transportation issues was offered this program. Primary outcomes included 1) proportion of patient-related appointment cancellations and 2) exam timeliness. Logistic and linear regression analyses were used to compare outcomes in patients who used the ride share program with patients who did not use the ride share program, adjusted for potential confounders.

RESULTS

During the study period, 318 encounters out of 11,581 total encounters utilized ride shares (2.67%). Female patients ($p = 0.042$), Medicare ($p = 0.008$) and Medicaid ($p = 0.042$) patients were more likely to use the ride share service while employed ($p < 0.001$) and Hispanic ($p = 0.001$) patients were less likely to use the ride share service. No statistically significant differences were found in appointment cancellations comparing patients using the ride share service compared with patients who did not use the ride share service (Adjusted OR 0.86, 95% CI 0.66, 1.13, $p = 0.286$). Patients using the ride share service were more likely to be on time for their appointment compared with patients who did not use the ride share service (Adjusted Coefficient 8.53, 95% CI 3.19, 13.86, $p = 0.002$).

CONCLUSION

A patient-centered ridesharing program assisted patients that were older and from lower SES in overcoming transportation barriers to MRI care while improving timeliness to appointments.

CLINICAL RELEVANCE/APPLICATION

Providing patient-centered programs in radiology can assist in overcoming access barriers to advanced imaging care, while improving operational efficiency.

SSM13-04 Patient Preferences for Properties of Gadolinium-Based Contrast Media in the Setting of Breast MRI Screening

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S404CD

Participants
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PURPOSE

To measure patient preferences toward individual properties of gadolinium-based contrast media (GBCM) when undergoing contrast-enhanced screening Breast MRI.

METHOD AND MATERIALS

This is an interim analysis at 17% accrual of an IRB-approved prospective multicenter discrete choice conjoint experiment, administered to at-risk patients, undergoing screening MRI at 2 institutions (7/31/2018-present). Five GBCM attributes were studied: sensitivity for cancer (80-95%), degree of intracranial gadolinium retention (1-100 molecules per 100 million molecules administered), severe allergic-like reaction rate (1-19 per 100,000), mild allergic-like reaction rate (10-1,000 per 100,000), and out-of-pocket cost ($25-$100). Attribute levels were selected to include the range of marketed GBCM values. Quantitative patient preferences were derived using Bayesian hierarchical modeling.

RESULTS

One-hundred and fourteen subjects (17% of 670) have been accrued at the time of this interim analysis. The questionnaire response rate was 93% (120/129) and completion rate was 95% (114/120). Cancer sensitivity (utility: 13.59/percentage point increase) was valued more than contrast-related risks (gadolinium retention utility: -0.73/molecule retained per 100 million administered; severe reaction utility: -5.11/reaction of 100,000 administrations; mild reaction utility: -0.09/reaction of 100,000 administrations) or out-of-pocket cost (utility: -0.53/dollar).

CONCLUSION

Interim results indicate that patients undergoing annual breast MRI screening prioritize cancer detection over GBCM-related risks. Each percentage point increase in sensitivity is valued similarly to 19 molecules of retained gadolinium (of 100 million administered molecules), 3 severe reactions (of 100,000 administrations), 147 mild reactions (of 100,000 administrations), or $25 in out-of-pocket cost.

CLINICAL RELEVANCE/APPLICATION

Gadolinium patient preference data has the potential to contribute to decision making for gadolinium formulary policies and guide industry creation of new gadolinium agents.

SSM13-05 Qualitative Analysis of Patient Perspectives and Priorities Regarding Artificial Intelligence in Radiology

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S404CD

Participants
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PURPOSE

To better understand patients' perceptions of artificial intelligence (AI) and patients' priorities for AI in radiology to inform the development and clinical implementation of AI in radiology.

METHOD AND MATERIALS

A patient engagement workshop was hosted with 17 participants from urban, rural, and remote communities. Facilitated roundtable discussions were conducted to better understand patients' perceptions of AI and patients' priorities for AI in radiology. Concepts from roundtable discussions were coded using NVivo 11 and analyzed using thematic analysis.

RESULTS

Patients' perceptions of AI were captured in the following three themes: fear of the unknown, trust (including uncertainty of what and whom to place trust in-AI or radiologists), and the importance of a human connection even when using AI. Enthusiasm and willingness for AI to be used in radiology were related to patient age, with greater enthusiasm among younger patients. Patients' priorities for improvements in radiology included improving communication, shortening time to diagnosis, reducing wait times, increasing diagnostic accuracy, empowering patients, and increasing access to diagnostic imaging and screening. Patients were comfortable with sharing de-identified imaging data for AI development as long as appropriate safeguards were in place. In addition to traditional diagnostic accuracy measures, participants wanted to ensure that downstream impacts of AI on patients' health and well-being were included in assessments of AI.

CONCLUSION

Patients' initial perceptions of AI-including fear of the unknown and uncertainty of what and whom to place trust in-may lead to patients' initial reluctance to accept AI in radiology, suggesting the need for patient education efforts. Patients identified numerous areas for improvement in radiology which could be enhanced through AI, potentially informing the prioritization of AI use cases.

CLINICAL RELEVANCE/APPLICATION

Patients' may initially be reluctant for AI to be used in their care due to a lack of familiarity; however, upon further education, patients identify numerous priorities for AI development which may inform prioritization of AI use cases.

SSM13-06 Patient Understanding of Abnormal Imaging Findings under Pennsylvania Act 112

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S404CD

Participants
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PURPOSE

Pennsylvania Act 112 of 2018 requires diagnostic imaging facilities to directly notify patients in writing for test results warranting follow-up medical care within three months. The law specifies the patient notification wording written at a 12th-grade reading level. Our objective was to determine if patient understanding varied by the reading level and visual presentation of notification text (i.e. letter or image-rich infographic).

METHOD AND MATERIALS

Using the Amazon Turk crowdsourcing internet marketplace, we surveyed United States adult volunteers. The software cycled repetitively between four different versions of the notification: 12th-grade and 6th-grade reading level versions of both a letter and an image-rich infographic. Respondents who answered 12 questions related to notification comprehension and sociodemographic data were paid $.10. Chi square analysis was used to compare differences in responses by question, reading level and visual presentation.

RESULTS

Among 340 survey respondents, most were female (61%), 26% self-identified as healthcare professionals and 59% had received at least a Bachelor's degree. There were no sociodemographic differences between the four notification groups. Respondents who viewed letters rather than infographics were more likely to correctly identify the notification subject as diagnostic imaging (90% and 81%, respectively) ($p<.0001$); no differences were observed between reading levels ($p=.888$). Respondents who viewed either notification type at a 6th-grade rather than a 12th-grade reading level were more likely to correctly identify the next best step as contacting the ordering provider as soon as possible (83% and 73%, respectively) ($p=.032$); no differences were observed by visual presentation ($p=.0914$). Reading level and visual presentation did not affect correct comprehension of the notification as abnormal. Most respondents strongly agreed (27%) or agreed (53%) that the notification text made them feel worried; no differences were observed by reading level or visual presentation ($p=.920$ both).

CONCLUSION

Notification reading level and visual presentation can impact patient understanding of abnormal imaging test results and follow-up, but do not address patient anxiety.

CLINICAL RELEVANCE/APPLICATION

Patient understanding of abnormal imaging test results and follow-up may be optimized through adjusting reading level and offering image-rich infographics rather than letters.

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SSM14

Informatics (Artificial Intelligence: Generative Adversarial Networks)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E353C

AI IN

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM14-01 Multimodal CT Image Super-Resolution via Transfer Generative Adversarial Network

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E353C

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CONCLUSION

The experimental result indicates that transfer-GAN can effectively improve the resolution of multimodal CT images, thus, provides a practical solution for multimodal CT image quality enhancement.

Background

Multimodal CT scans including none-contrast CT (NCCT) and CT Perfusion (CTP) are widely used in acute stroke protocols. While each imaging modality has its own advantage in disease diagnosis, the varying image resolution of different modalities hinders the ability of the radiologist to discern subtle suspicious findings. Besides, higher image quality requires a high radiation dose, leading to increases in health risks such as cataract formation and cancer induction. Thus, it is highly crucial to develop an approach to improve multimodal image resolution and to lower radiation exposure. Based on the hypothesis that multimodal CT imaging of the same patient is highly correlated in structural features, the integration of the shared and complementary information from different modalities is beneficial for achieving high diagnostic image quality.

Evaluation

We present a novel transfer learning technique for the generative adversarial network (GAN) to improve the spatial resolution in multimodal medical imaging. Our method is evaluated on 4,111 images collected from nine patients, including 415 NCCT and 3,696 CTP slices. We down-sample the images into a quarter of the original size to generate the low-resolution images. We train the network for different modalities with and without transfer learning to compare the performance. The visual comparison and quantitative evaluation including peak-signal-to-noise-ratio (PSNR) and structural similarity (SSIM) index demonstrate the effectiveness and accuracy of the proposed method.

Discussion

We perform one-tailed paired t-tests with alpha = 0.05 to compare the performance improvements of PSNR and SSIM for CTP images. Through transfer learning of GAN, there is a significant improvement for both PSNR and SSIM for transferred from NCCT to CTP images than directly training for CTP images. We also compare our model with the model pre-trained on natural images, and our model achieves significantly higher results. Details are shown in Figure 1.

SSM14-02 Synthetic Training Data Augmentation for Assisting CT Liver Lesion Classification with Generative Adversarial Networks

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E353C

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CONCLUSION

Our GAN-DA method has high potential to be applied to various medical image classification problems as well as liver lesion classification in CT images. (This work was supported by the NRF grant funded by the Korea government (MSIP) (2017R1D1A1B03029631))

Background

The small dataset problem due to the limited acquisition of medical images is one of the major challenges in deep learning-based medical image classification. Data augmentation (DA) through scaling and rotation of the training images have been performed to avoid the overfitting caused by the small dataset problem, but this conventional DA has limitations in diversifying data patterns and improving learning efficiency. Thus, we propose a generative adversarial network (GAN) based DA method and apply it to the deep learning classification of liver lesions in CT images to verify its performance.

Evaluation

Our method was evaluated on a dataset consisting of 502 abdominal CT scans including 676 cysts(C), 130 hemangiomas(H), and 484 metastases(M). Each lesion was contoured by the radiologist. To train a CNN classifier, the DA is performed to increase the amount of given training data to avoid overfitting. In classic DA, the augmented images were generated by randomly scaling or rotating an image patch. In GAN-DA, the augmented images were generated by training GAN on the given image patches to create synthetic training images. This GAN-DA can generate synthetic data with a novel pattern by combining the imaging characteristics of given images. The AlexNet CNN was then trained with the augmented training data to classify the unseen test data. In experiments, our method of combining two DA methods achieved the accuracy of 74.59% where the classic DA and GAN-DA each achieved the accuracies of 74.36% and 66.45%, respectively.

Discussion

In deep learning of small dataset, the classic DA plays a role in extending the amount of training data, but is limited to repeating the given pattern. The proposed GAN-DA can further complement the pattern distribution of given data by diversifying the data patterns. As a result, training CNN with combined two DA-generated data can achieve the most improved performance in liver lesion classification.

SSM14-03 Abnormal Chest X-Ray Identification with Generative Adversarial One-Class Classifier

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E353C

Awards
Trainee Research Prize - Fellow

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PURPOSE

To develop an automatic system of abnormality classification on chest radiographs that allows reporting focusing more on pathology analysis of abnormal CXRs, requiring only normal chest X-ray images as input in the training stage. The intuition of using only normal images for training is that it is not always possible to include or annotate all kinds of abnormalities for large scale training because some forms of anomaly are very rare.

METHOD AND MATERIALS

We propose an end-to-end architecture for abnormal chest X-ray identification using generative adversarial one-class learning, by training solely from normal CXRs. The proposed architecture is composed of three main modules: a U-Net autoencoder, a CNN discriminator and an encoder, which compete to learn while collaborating with each other for the target task. The adversarially trained generative model is capable of reconstructing the normal CXRs while performing poorly on reconstructing the abnormal ones, since only the normal CXRs are involved in training and those with various anomalies are unseen by the model. Such reconstruction differentiation enables the proposed model to identify abnormal CXRs. We design four different loss functions from pixel level to feature level, to joinlty optimize the whole network.

RESULTS

The proposed method is evaluated on two subsets of the NIH ChestX-ray14 dataset. For normal versus abnormal classification, our method achieves an AUC of 0.841, compared to 0.627 without using adversarial learning. For normal versus pneumonia classification, our method achieves an AUC of 0.802 (0.592 for non adversarial learning). Since the network has learned from distribution of normal images in the training stage, it knows the characteristics of normal distribution and it is able to reconstruct normal CXR of good quality in the testing stage. Since the abnormal CXRs are unseen in the training stage, the network is not able

to reconstruct abnormal CXRs of good quality in the testing stage.

CONCLUSION

The differentiation of reconstruction behaviors between normal and abnormal chest X-rays enables the model to distinguish abnormal CXRs from normal ones in this adversarial one-class setting. The proposed method could be extended and applied to other medical image modalities.

CLINICAL RELEVANCE/APPLICATION

This one-class learning may reduceing the need for manual annotations, thereby accelerating the development of automated CXR diagnosis software for radiologists.

SSM14-04 Generative Neural Networks: Synthesizing a Complete Tomographic Study from a Single Frontal Radiograph

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E353C

Participants
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PURPOSE

Chest radiography encodes a three-dimensional image in a unique two-dimensional domain, which offers unique challenges even for the most experienced radiologists, as many critical findings are superimposed, often resulting in error or further imaging. In recent years, deep generative models have emerged as powerful models in generating realistic synthetic images. In this study a generative model was applied to synthesize tomographic views from a single frontal chest radiograph, which could improve diagnostic accuracy and potentially reduce the need for further unnecessary imaging.

METHOD AND MATERIALS

An anonymized noncontrast CT chest database, containing 20,000 (512x512) images, with orthogonal views for 229 patients in PNG format. Synthetic chest radiographs (input scout) were generated by taking the mean over the coronal CT slices per patient, which were then mapped to a three-dimensional volume, 128 x 128 x 128 pixels. An encoder-decoder approach with residual connections was utilized to synthesize the tomographic slices, which was inspired by the 3D-R2N2 model. The frontal view of the radiograph was encoded into a lower dimensional space, using a convolutional neural network, and later decoded into a 3D grid of CT slices. Training took approximately 5 hrs, with a batch size of 16, and 450 epochs, utilizing a p3.8x large instance. Images were reviewed by 3 board-certified radiologists.

RESULTS

Qualitative analysis of the initial results demonstrate the superstructure of the thorax, but lacking some of the details in the ground truth CT, such as the pulmonary vasculature (see figure). This is promising because shape is arguably one of the more difficult challenges due to the fact that a 2D shape may have many different 3D representations, i.e. a circle to a sphere, cylinder, etc.

CONCLUSION

The described method can synthesize a tomographic study from a frontal radiograph, using a generative neural network. The results retain the structural information from the ground truth CT, but lack some of the fine detail, due to hardware limitations and dataset size.

CLINICAL RELEVANCE/APPLICATION

In what we believe is groundbreaking work, we demonstrate the synthesis of a 3D tomographic study from a single radiographic view is technically feasible. This could significantly improve diagnostic accuracy and reduce unnecessary imaging, providing additional 3D information.

SSM14-05 pix2surv: A Generative Adversarial Network Model for Prediction of Survival in Patients with Interstitial Lung Diseases

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E353C

Participants
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PURPOSE

To develop a novel survival analysis model for images, called pix2surv, based on a conditional generative adversarial network

(cGAN), and to evaluate its performance based on chest CT images of patients with idiopathic pulmonary fibrosis (IPF).

METHOD AND MATERIALS

The architecture of the pix2surv model has a generator network based on a U-net model which is trained to generate survival-time images from chest CT images of each patient, and a discriminator network based on a patch-based fully convolutional network which is trained to differentiate the "fake pair" of a chest CT image and a generated survival-time image from the "true pair" of an input CT image and the observed survival-time image of a patient. For evaluation, we retrospectively collected 171 IPF patients with high-resolution chest CT and pulmonary function tests from the Lung Tissue Research Consortium. The survival predictions of the pix2surv model on these patients were compared with those of an established clinical prognostic biomarker known as the gender, age, and physiology (GAP) index by use of a two-sided t-test with bootstrapping by 500 replications. Concordance index (C-index) and relative absolute error (RAE) were used as measures of the prediction performance.

RESULTS

Bootstrap evaluation yielded a C-index value of 57.4% [95% confidence interval (CI): 48.7, 66.2] and RAE value of 33.3% [95% CI: 28.7, 38.1] for the GAP index and C-index value of 87.4% [95% CI: 80.7, 94.0] and RAE value of 17.8% [95% CI: 13.3, 22.5] for the pix2surv model. The improvement in survival prediction by the pix2surv model was statistically significant (P<0.0001).

CONCLUSION

The pix2surv model yielded a significantly higher performance than GAP index in the prediction of the overall survival of IPF patients. Thus, it could be used to provide an effective imaging-based biomarker for the prediction of the overall survival of patients with IPF.

CLINICAL RELEVANCE/APPLICATION

There are few established imaging-based predictors for the survival of patients with IPF. Deep learning that can automatically predict survival from lung CT images could provide an effective prognostic imaging biomarker for precise management of patients with IPF.

SSM14-06 Reality of Body CT Images Generated by Generalized Adversarial Network (GAN): Classification Test of Real or Fake CT Images

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E353C

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PURPOSE

This study aims to determine whether generalized adversarial network (GAN) can create far most realistic-looking body CT images or not.

METHOD AND MATERIALS

Using 11775 normal chest and/or abdominopelvic CT scans (172,249 chest slices and 301,584 abdominopelvic slices), we implemented a progressive growing of GAN (PGGAN) to create artificial images. Validation set consisted of total 300 axial body CT images (150 real and 150 fake images), which were composed of contrast-enhanced chest CT images with lung (Chest-L) and mediastinal window setting (Chest-M), and contrast-enhanced abdominopelvic CT images (AP-CT). Ten radiologists independently judged whether each CT images is real or not after analyzing images in visual manner without any time limits. Diagnostic accuracy, sensitivity, specificity and inter-reader agreement were calculated and compared among subgroups (thorax, thoracoabdominal junction, mid-abdomen and pelvis).

RESULTS

For total images, mean accuracy, sensitivity, specificity were 59.4%, 66.9%, 51.9%. There was no significant difference in accuracy between three image groups (Chest-L, 59.5%; Chest-M, 61.5%; and AP-CT, 57.1%, P = 0.33). Inter-reader agreements were poor for total images (k = 0.11) and poor for each three image group (k = 0.04 - 0.13). In subgroup analysis, thoracoabdominal junction level showed significantly higher accuracy (74.3%) than other subgroups (52.4% - 60.2%, P = 0.003), and had highest inter-reader agreement (k = 0.31).

CONCLUSION

GAN can generate realistic-looking body CT images, which cannot be easily distinguished from real images by radiologists. However, to increase the realism of body CT images, it is necessary to strengthen the learning of thoracoabdominal junction level.

CLINICAL RELEVANCE/APPLICATION

This is a first reported study to systematically evaluate reality of GAN-generated synthetic body CT images. Realistic images creation is the first step in applying GAN in various medical fields.

SSM15

Informatics (Image Sharing, Data, Security, Quality)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E353B

IN SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM15-01 Development of Good Practice Compliant Clinical Trial Imaging Management System for Multi-Center Clinical Trials

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E353B

Participants
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PURPOSE

As utilization of imaging in multi-center clinical trials has rapidly increased, the amount of data and work flow complexity also increased, requiring a dedicated computerized system, a clinical trial imaging management system (CTIMS). Recently, the US FDA emphasizes the Good Clinical Practice compliance of the CTIMS. Thus, we aimed to develop a comprehensive CTIMS with intention to thoroughly meet the current regulatory guidelines and various functional requirements.

METHOD AND MATERIALS

Key regulatory and functional requirements of CTIMS were extracted thorough review of many related regulations/guidelines including ICH-GCP E6, FDA 21 CFR Part 11 and 820, Good Automated Manufacturing Practice (GAMP®), Clinical Data Interchange Standards Consortium (CDISC). Based on these requirements, the system architecture was designed by multidisciplinary team including radiologists, engineers, clinical trial specialists, regulatory medicine professionals. Computerized system validation of the developed CTIMS was performed internally and externally.

RESULTS

Our CTIMS was developed based on two-layer design composed of the server system and the client system, which is efficient to meet the regulatory/functional requirements. The server system manages system security, data archive, backup, audit trail, etc. The client system provides various functions including de-identification, image transfer, image viewer, image quality control, electronic record, etc. Computerized system validation internally using V-model and externally by global quality assurance company demonstrated that CTIMS meet all regulatory/functional requirements. Currently, our CTIMS system has been successfully implemented into more than 20 pharmaceutical multi-center clinical trials since 2017.

CONCLUSION

In the era of bigdata, the use of CTIMS is crucial in multi-center clinical trials to deal with the large amount of image data and complexity of imaging management process. CTIMS must meet the both regulatory and functional requirements of the clinical trial, enhancing work flow efficiency and more reliable data/outcomes.

CLINICAL RELEVANCE/APPLICATION

The Good Practice compliant CTIMS with comprehensive functions is an essential part of multi-center clinical trials to generate high quality data and minimize protocol violation.

SSM15-02 Tofu: For Stir-Fry and Ultrasound Procedural Training

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E353B

Participants
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CONCLUSION

Firm tofu is a cheap US training medium that trainees at all reported improved their skills and confidence at minimal cost. Use of these blocks in a standard curriculum may be of benefit early on in resident education.

Background

Despite the availability of commercial simulations, training new residents in procedures has traditionally been on patients who present with a need for treatment. This "trial-by-fire" experience, can be stressful for supervising physicians and trainees, and often deleterious to patients. Commercial ultrasound (US) phantoms are extremely costly for limited utility. We postulated that a cheap non-anatomic simulation could still greatly improve procedural skills and trainee confidence at a low cost in time and money. Based on prior publications, the use of tofu was suggested as a tissue simulation due to similar propagation speed to soft tissue. Internal echogenicity was noted to be similar to some soft tissues.

Evaluation

Blocks of tofu were initially evaluated by both an attending interventional radiologist and a diagnostic radiologist to establish parameters. 11 trainees of varying levels of experience were asked to fill out a survey documenting their perceived experience, level of training and comfort with ultrasound guided procedures on a 10-point scale before completing testing. Trainees were randomized to initial testing on a tofu model or a commercially available phantom, and then completed a survey asking to evaluate change in the previously evaluated findings on a -5 to 5 point scale. Testing consisted of basic ultrasound guidance tasks including identification of target in multiple projections along with real-time needle guidance. Participants then underwent testing on the other model followed by a second survey.

Discussion

Although no statistically significant trend could be identified on pre-testing surveys, trainee confidence demonstrated an overall positive improvement after use of the tofu-based model by 3.4 points. Use of the commercial phantom resulted in an improvement of 2.2 points, with most of the trainee concerns raised by more experienced residents, including excessive stiffness and residual tracts from prior training.

SSM15-03 Protecting Patients from Cyber-Attacks on CT's Using Machine Learning Methods

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E353B

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PURPOSE

Today, security methods for protecting medical imaging devices (MIDs) from cyber-attacks mainly focus on hospitals' network and endpoint security level; such methods are limited and are often breached (e.g., the WannaCry attack) as they rely on constantly installing regular security updates, a challenging task in a clinical setting with numerous devices. Moreover, cyber attacks that target internal components of MIDs ecosystem are harder to detect and protect; such attacks are potentially more dangerous and can potentially affect patients' health. For example, once the internal control unit of the MID is compromised, it is possible to manipulate its behavior and potentially jeopardize scans, device mechanics, and even patients safety.

METHOD AND MATERIALS

We recorded over 10,000 scan commands sent from a computed tomography (CT) scanner host control unit to the gantry. Each record contains various technical parameters of the scan, including lables such as the body part being scanned, the scan protocol, etc. Furthermore, we recorded, with the assistance of radiologists and technicians, potentially malicious commands on real CT device (while no patient was present). We then applied different machine learning methods (e.g., Random Forest) to create an anomality detection model that can distinguish between normal and malicious scans, with respect to the scan labels.

RESULTS

We were able to classify scan commands to the appropriate scan labels (i.e., body part, scan protocol, and study description) with 90-98% accuracy (depending on the specific scan label) and detect all synthesized malicious commands. Furthermore, our anomaly detection model can also help notify and protect anomalies resulting from human error.

CONCLUSION

Scan commands, often ignored or only used for maintenance purposes, contain important information about the scan process. By utilizing this information, we were able to study and define normal commands structure, and consequently detect scenarios in which anomalous commands where sent maliciously or by mistake.

CLINICAL RELEVANCE/APPLICATION

Using machine learning methods can help detect cyber-attacks, as well as other anomalies such as human error, and by that protect patients from potential harm and improves safety.

SSM15-04 Deploying Deep Learning for Quality Control: An AI-assisted Review of Chest X-Rays Reported as 'Normal' in Routine Clinical Practice

Wednesday, Dec. 4 3:30PM - 3:40PM Room: E353B

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PURPOSE

Quality control in radiology has thus far been restricted to performing random double reads or collating information about clinical correlation - both tedious and expensive activities. We present a novel use-case for AI to double read Chest X-Rays (CXRs) and indicate a list of cases where the radiologist may have erred.

METHOD AND MATERIALS

This study on the feasibility of deploying deep learning algorithms for quality control was conducted on pooled data from four out-patient imaging departments. The radiology workflow included a 'report approval' station where a simple, high level, binary label - 'normal' or 'abnormal' - was applied by radiologists. All adult CXRs marked 'normal' were prospectively analyzed through a deep learning algorithm (LUNIT Insight, S. Korea) tuned for automated normal vs abnormal classification. Note that the algorithm used was not trained on data from the institutes and country of testing. It provided an 'abnormality score' (range 0.00 - 1.00) and all images marked as 'abnormal' in high sensitivity setting (threshold = 0.16) were reviewed by a sub-specialist chest radiologist with 8 years' experience.

RESULTS

A total of 708 CXRs were marked 'normal' by radiologists during the one-month period of the study. 46 / 708 (6.49%) of CXRs were labelled 'abnormal' by the algorithm. Upon review of these 46 CXRs, 12 showed true abnormalities upon review. These 12 cases included four with lung opacities, three with significant blunting of costophrenic angles, two with apical fibrosis, one with a cavity, one with a nodule and one case with cardiomegaly. Appropriate corrective and preventive actions were taken, and feedback was provided to radiologists who reported these cases.

CONCLUSION

We demonstrate AI algorithms' ability to quickly parse through large datasets and help identify errors by radiologists. This is a fast and effective method to deploy AI algorithms in clinical practice with no risk (from AI) to patients, and clear measurable positive impact.

CLINICAL RELEVANCE/APPLICATION

Radiologists work flow supported by a parallel, second read AI would allow for faster reporting as it can help reduce errors in radiology reports, improving patient-care in the process. Importantly, this quality assurance study on CXR reporting, demonstrates the potential for AI to both personalize and prioritize training modules for radiologists.

SSM15-05 Informatics Challenges and Solutions to Host an Ultra-High Resolution Computed Tomography System

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E353B

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CONCLUSION

HRCT and other high-resolution imaging systems are now on the market and may test the limits of legacy informatics infrastructure for image transfer, storage, and display. Hospital IT must anticipate these future clinical needs and account for the large data challenges as imaging systems continue to advance.

Background

The acquisition of a high resolution CT (HRCT) scanner presents several challenges for data transfer & retrieval, storage and rendering. Unlike a conventional CT system with a standard image slice matrix of 512x512 and a minimum slice thickness of ~0.6 mm, the HRCT system acquires 1024 and 2048 matrix sizes with a minimum slice thickness of 0.25 mm. This results in CT acquisition

series 4 to 19 times larger than a conventional CT series.

Evaluation

Several aspects of the imaging informatics chain were evaluated in advance of installation and continued to be monitored once the system went live. 1. The timing of data transfer as a function of infrastructure lines and matrix size was examined to ensure that it met the requirements of the clinical workflow. 2. The adequacy of existing display hardware and software for image interpretation was assessed. 3. The data storage requirements were estimated and monitored.

Discussion

(1) Data transfer has proven to have a negligible workflow impact on a10 Gbps fiber (under 7 sec for a13 GB 2048x2048 study). However, transfer of the same study extended to 20 min on a shared 100 Mbps network. Data transfer times were under 10 sec for the 6GB 1024x1024 studies, demonstrating performance variability, particularly on shared networks. (2) A 5MP display is recommended to display a full 2048 image set at full resolution. Otherwise, clinicians must enable zoom and pan within the image slice. Anecdotally, the exams with 0.25 mm slice thicknesses are best navigated with a cine loop and a scout localizer to avoid excessive scrolling. Jerky scrolling became obstructive when viewing 2048 images on computers where caching or RAM was limited (e.g. <8 GB). (3) Within the first 2 weeks of installation, data storage remains stable despite the accelerated use of storage space due to a strategic contract with the PACS vendor.

SSM15-06 A Real-Time Gaze Tracking System to Analyze Spatial and Temporal Attention Characteristics of Radiologists

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E353B

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PURPOSE

To develop a real-time attention tracking system that can handle dynamic back-and-forth scrolling through a series of images without any hardware or software intrusion while the radiologist interpreting a study.

METHOD AND MATERIALS

The system framework was built on the Open Health Imaging Foundation's open-source medical image viewer with integration of a Tobii 4C Eye Tracking camera. Spatial and temporal coordinates of the series of images are automatically recorded and the corresponding attention heapmaps are generated. For attention and search patent analysis, the commonly used eye-tracking metrics are analyzed including area of interest (AOI), time to first fixation, total fixation duration, fixation duration on AOI, number of fixations on AOI, dwell time ratio, and saccade length on each image. Furthermore, 3D dynamic analysis of attention characteristics are studied including total time of the scan, slice of interest (SOI), fixation duration on SOI, number of fixations on SOI, number of scrolling (scrolling back-and-forth while focusing on different areas), number of drilling (scrolling back-and-forth while focusing on one area). The system's performance was tested using the data from 4 radiologists while interpreting 30 CT studies from the LUNA16 dataset.

RESULTS

The system successfully captured the attention data in all interpretation sessions (n=120) without any software or hardware failure. The accuracy of the gaze tracking is 0.4º which is about 3.5-7 mm on the computer screen at a distance range of 0.5-1 m between the observer and the camera. The analysis of the attention heatmaps showed spatial and temporal variations in the 3D dynamic attention characteristics of 4 radiologists, indicating unique search patterns among different observers.

CONCLUSION

The proposed system can be used as an objective tool to study unique search patterns among human observers. These data can be further used to develop more interactive human-computer interfaces for artificial intelligence applications.

CLINICAL RELEVANCE/APPLICATION

As artificial intelligence applications advance, there is an increasing need to develop seamless human-computer interfaces that can capture the radiologists' attention. Such systems allowing artificial intelligence algorithms to operate more interactively with the human observers in real time could significantly expedite adoption of artificial intelligence in clinical practice.

SSM16

Molecular Imaging (Oncology)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S505AB

MI OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM16-01 Prospective Evaluation of the First Integrated PET/Dual-Energy CT System in Patients with Lung Cancer

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S505AB

Awards
Trainee Research Prize - Resident

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PURPOSE

The aim of this study was to prospectively evaluate the first integrated positron emission tomography (PET)/ dual-energy computed tomography (DECT) system in patients with small-cell lung cancer (SCLC) or non-small-cell lung cancer (NSCLC).

METHOD AND MATERIALS

In this single-center HIPAA compliant prospective trial, we included 25 patients (age range, 41-84 years; median age, 62 years) with NSCLC (n=21) or SCLC (n=4) who were referred for a PET/CT study between May 2017 and June 2018. All patients received contrast-enhanced imaging on a clinical PET/DECT system 70 min after the administration of 5MBq/kg of 18F-fluorodeoxyglucose (18F-FDG). Data analysis included PET-based standard uptake values (SUVmax) and DECT-based iodine densities of tumor masses and lymph nodes. Results between the different parameters were compared using Pearson correlation analysis and receiver operating characteristics (ROC) analysis.

RESULTS

SUVmax and iodine density parameters were measured in 33 malignant lung masses (15.0 and 2.3 mg/mL, respectively) and 56 enlarged mediastinal or hilar lymph nodes (8.4 and 2.2 mg/mL, respectively). A moderate correlation was found for SUVmax and iodine density values in tumor masses (r=0.53). SUVmax and iodine density values of lymph node metastases showed a weak correlation (r=0.36). Additionally, iodine quantification analysis provided no added value for the differentiation of malignant from benign lymph nodes with an area under the curve (AUC) of 0.52 using PET-based SUVmax analysis as the reference standard.

CONCLUSION

The integration of PET/DECT information in lung cancer staging can provide additional insights in the assessment of primary lung cancer and on the correlation between tumor vascularization and metabolic activity, offering an alternative for tumor characterization improvements. However, the weak correlation between SUVmax and iodine density in malignant lymph nodes suggest that iodine density alone has a limited value for lymph node characterization.

CLINICAL RELEVANCE/APPLICATION

This is the first clinical study on an integrated PET/DECT which provides additional insights in the assessment of lung cancer, offering an alternative for tumor characterization improvements.

SSM16-02 Deep Learning for Prostate Cancer Lymph Node Staging: Balance and Location Matter

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S505AB

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PURPOSE

To evaluate if PSMA-PET lymph node status can be predicted using deep convolutional networks (CNN) from CT imaging alone and assess the influence of class balancing and anatomical context on classification results compared to radiologists' performance.

METHOD AND MATERIALS

549 patients, who had received 68Ga-PSMA PET/CT examination, were included. 2616 lymph nodes (LN) were segmented on CT, the corresponding status was determined from PSMA-PET/CT. Two training datasets were used: The first set ('naively balanced', NB) was created by balancing the infiltration status alone. The second set ('location balanced', LB), was created by additionally balancing within each anatomical region. 130 nodes were set aside for independent testing, leaving 732 (NB) and 548 nodes (LB) after balancing. Three CNNs were created, the first two trained with contrast-enhanced CT images and segmentations of either NB or LB test sets respectively, while the third received masked CT images of the NB set (xMask). All networks were analysed for their test set performance (vs. two radiologists) and heatmap patterns.

RESULTS

The NB trained CNN performed best, with an AUC of 0.955 (95% CI 0.923-0.987). The LB and xMask trained CNN performed comparably well, with AUCs of 0.858 (LB, 95% CI 0.793-0.922) and 0.863 (xMask, 95% CI 0.804 - 0.923). The radiologists achieved an average AUC, sensitivity, specificity and accuracy of 0.81, 65%, 96% and 81% respectively. Analyzing the heatmaps, activation patterns suggest, that CNNs learn features within the lymph nodes but also, and more troublingly, outside of the lymph nodes, which correlate to the infiltration status. It is critical to note that our best performing model appears to rely on features outside of the lymph node in question, such as the skin/air border often found in the inguinal region, which are rarely infiltrated.

CONCLUSION

Deep Learning systems are prone to learning unknown bias present in data, and efforts should be made to prove that classification systems perform as intended. Nevertheless, our results show that CNNs are capable of determining the 68Ga-PSMA PET/CT infiltration status from PCa on contrast-enhanced CT scans alone.

CLINICAL RELEVANCE/APPLICATION

Careful training of CNNs to predict the PSMA/PET lymph node status from CT alone could add value to non-PET staging examinations.

SSM16-03 18F-FMISO PET May Be Applicable in The Evaluation of Colorectal Cancer Liver Metastasis

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S505AB

Participants
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PURPOSE

Positron emission tomography (PET) imaging is a non-invasive functional imaging method used to reflect tumor spatial information, and to provide biological characteristics of tumor progression. The aim of this study was to focus on the application of 18F-fluoromisonidazole(FMISO) PET quantitative parameter of maximum standardized uptake value (SUVmax) ratio to detect the liver metastatic potential of human colorectal cancer in mice.

METHOD AND MATERIALS

Wound healing assays were performed to examine the ability of cell migration in vitro. 18F-FMISO uptake in CRC cell lines was measured by cellular uptake assay. 18F-FMISO-based micro-positron emission tomography imaging of colorectal liver metastasis and tumor-bearing mice was performed and quantified by tumor-to-liver SUVmax ratio. The correlation between the 18F-FMISO SUVmax ratio, liver metastases number, hypoxia-induced HIF-1a and serum starvation-induced GLUT-1 was evaluated using Pearson correlation analysis.

RESULTS

Compared with HT29 and HCT116, LoVo-CLM mice had significantly higher liver metastases ratio and shorter median survival time. LoVo cells exhibited stronger migration capacity and higher radiotracer uptake compared with HT29 and HCT116 in in vitro. Moreover, 18F-FMISO SUVmax ratio was significantly higher in both LoVo-CLM model and LoVo-bearing tumor model compared to models established using HT29 and HCT116. In addition, a linear regression analysis revealed a significant correlation between 18F-FMISO SUVmax ratio of CLM-mice and number of liver metastases larger than 0.5cm, as well as between 18F-FMISO SUVmax ratio and HIF-1a or GLUT-1 expression in tumor-bearing tissues.

CONCLUSION

18F-FMISO parameter of SUVmax ratio may provide useful tumor biological information in mice with CRC liver metastasis, thus allowing for better prediction of CRC liver metastasis and yielding useful radioactive markers for predicting liver metastasis potential in CRC.

CLINICAL RELEVANCE/APPLICATION

Better prediction of CRC liver metastasis and yielding useful radioactive markers for predicting liver metastasis potential in CRC.

SSM16-04 Comparison of 18F-DCFPyL-PSMA PET/CT and PET/MR for Detection of Prostate Cancer Biochemical Recurrence: Additive Value of PyL PET with Pelvic MRI for Salvage Radiation Therapy Planning

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S505AB

Participants
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PURPOSE

To evaluate prostate specific membrane antigen (PSMA)-based 18F-DCFPyL(PyL) PET in prostate cancer (PC) biochemical recurrence (BCR) and benefit for salvage radiation therapy (RT) planning.

METHOD AND MATERIALS

Patients with PC history, prior prostatectomy, and planned RT for BCR were prospectively recruited. Three PyL PET studies were done - whole body PET/CT (wbPET/CT) on a Discovery 710, [pelvic PET/MR (pPET/MR) with multiparameteric pelvic MR (mpMRI), and whole body PET/MR (wbPET/MR) on a Discovery 710 and Signa scanner [GE, Waukesha, WI] respectively. Patients then underwent salvage RT. Two readers independently used two proposed PSMA PET evaluation methods (PSMA-RADS v1, PROMISE) for PET evaluation followed by third reader adjudication. Separately, the mpMRI was evaluated for local or pelvic lymph node (LN) recurrence and proposed post-PET treatment was compared to a standard plan using clinical risk and mpMRI. PET positive sites were evaluated in relation to the actual radiation field.

RESULTS

12 patients (mean age, 61.8 yrs; median pre-RT PSA, 0.92 ng/mL) had 29 PET sites of suspected recurrence. Eight of 12 patients (66%) had a positive PyL PET with suspected disease confined to the pelvis (n=5) or with distant disease (n=3). Positive sites had consensus PSMA-RADS scores of 5 (n=15), 4 (n=1), and 3 (n=12) as well as PROMISE miPSMA expression scores of 3 (n=5), 2 (n=12), and 1 (n=10). Median maximum standardized uptake value (SUVmax) was 9.5, 6.3, and 5.4 for reader 1 and 9.5, 5.9, and 6.1 for reader 2 on pPET/MR, wbPET/MR, and wbPET/CT respectively. pPET/MR detected all PET positive sites within the pelvis. Compared to PyL PET, mpMRI detected 2/4 sites of suspected local recurrences and 1/16 PET positive LNs. Five of 12 patients would have had a proposed treatment plan change based on PyL PET. One RADS-5 LN and 5 equivocal targets (LN, n=2; rib lesion, n=3) were outside the actual radiation field. Additionally, two RADS-5 LNs were at the edge of the field and would have resulted in extended coverage.

CONCLUSION

PSMA-based PyL PET detected suspicious sites in 66% of BCR patients with highest median SUVmax on pPET/MR. PyL PET results would have theoretically changed management in 42% (n=5) patients.

CLINICAL RELEVANCE/APPLICATION

PyL PET was positive in two-thirds of BCR after prostatectomy. PyL PET improves detection of suspected sites of PC recurrence and could impact patient management and RT treatment field planning.

SSM16-05 Real-Time 3D Thermography in a Liver Tumor Ablation Model Using Magnetic Particle Imaging

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S505AB

Participants
Johannes M. Salamon, MD, Hamburg, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

Evaluation of the feasibility of visualizing the temperature course during a thermal ablation in an in vitro liver tumor phantom using MPI and different iron oxide tracers.

METHOD AND MATERIALS

In vitro liver tissue phantoms with different iron oxide tracers (L93, Bayer-Schering; LS008, Load Spin Labs; MM4, TOPASS GmbH, concentrations of 0.1-0.5 mg/ml) were generated in Eppendorf-Tubes using a 1:1 volume mixture of protein and water (Chicken White Protein, Sigma Aldrich). The phantoms were heated by means of an inserted copper wire (1 mm diameter) and MPI-induced eddy currents. The resulting signal changes of the phantom were simultaneously imaged by MPI. As an in vitro liver tumor ablation model, tracer-free protein (pseudotumor) was embedded in protein (pseudo-liver tissue) mixed with L93 (CFe = 0.356 mg/ml). The pseudotumors were heated by means of an inserted copper wire with simultaneous detection of the MPI signal of the surrounding pseudo-liver tissue. All experiments were carried out on a commercial MPI system (Philips/Bruker) using a FoV of 37.3 x 37.3 x 18.6 mm3 and a frame rate of 46 frames/s.

RESULTS

Corresponding to the heating, MPI signal increase could be detected in all tracers. L93 showed the highest temperature changes/sensitivity. In the liver tumor ablation model, the ablation of the pseudo-liver tissue was visualized in 3D in real time by MPI signal changes.

CONCLUSION

MPI is suitable for visualizing temperature distribution and changes in a liver tumor ablation model. The sensitivity depends decisively on the used tracer. A temperature monitoring of healthy tissue for optimized MPI-guided tumor ablation in real time and 3D is feasible.

CLINICAL RELEVANCE/APPLICATION

Real time temperature measurement using MPI in the course of an ablation procedure might emerge as a powerful tool for exact monitoring of ablation success.

SSM16-06 Study of Hypoxia in Pancreatic Cancer Patients Using Dynamic [18F]-FAZA PET

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S505AB

Participants
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PURPOSE

To estimate kinetic parameters of [18F]-FAZA in highly hypoxic pancreatic cancer and determine the sensitivity of these parameters in distinguishing normal tissue from hypoxic cancer.

METHOD AND MATERIALS

Twenty patients with pancreatic ductal adenocarcinoma underwent 55 min of dynamic [18F]-FAZA scan. The tissue time activity curve (TAC) was analysed using graphical methods - Patlak and Logan plot to determine the reversibility of binding and using standard two tissue compartment model (S2TCM) as well as our bespoke kinetic model, the flow modified two tissue compartment model (F2TCM) to estimate the kinetic parameters. F2TCM models mean transit time through blood vessels, which could significantly affect parameter estimations. Multivariate logistic regression was used to find the optimal parameter set for distinguishing normal tissue from hypoxia tumor.

RESULTS

Graphical analysis showed that the tracer was reversibly bound and distribution volume (DV) determined by S2TCM and F2TCM was correlated to that of Logan plot. F2TCM fitted TACs better than S2TCM according to the Akaike Information Criteria. Logistic regression determined that DV and dissociation rate constant (k4) classified normal tissue from hypoxic tumor with sensitivity, specificity and negative predictive value (NPV) of 57%, 95% and 92% respectively while it is lower - 43%, 79 % and 67% for Logan's DV.

CONCLUSION

Contrary to the accepted notion that [18F]-FAZA is irreversibly bound, both graphical and kinetic analysis showed that the binding is reversible. The proposed mechanism for the reversibility is that the reduced metabolite, amino-FAZA, is conjugated to glutathione (amino-FAZA-GS) which is usually trapped in cells due to its hydrophilicity, however, in the presence of elevated multidrug resistance protein (MRP-1) in pancreatic tumor, amino-FAZA-GS can be 'pumped' out of the cells leading to radioactivity washout or reversible binding. Besides distinguishing normal pancreatic tissue from hypoxic tumor, kinetic modeling allows evaluation of k4 which can be associated with MRP-1 activity, while the binding rate constant (k3) can be associated with nitroreductase and glutathione activity.

CLINICAL RELEVANCE/APPLICATION

Non-invasive monitoring of MRP-1 activity and hence drug resistance for hypoxic tumor with [18F]-FAZA could lead to personalization of cancer treatment.

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SSM17

Musculoskeletal (Shoulder)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S105AB

MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Christine B. Chung, MD, Solana Beach, CA (*Moderator*) Nothing to Disclose
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Sub-Events

SSM17-01 Saline versus Gadolinium Shoulder MR Arthrography: Contrast Agent or Joint Distention?

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S105AB

Participants
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PURPOSE

Compare the diagnostic performance of saline and gadolinium shoulder MR arthrograms (MRA) in the detection of labral and rotator cuff injury with arthroscopic findings as a reference standard.

METHOD AND MATERIALS

In this IRB approved retrospective study, consecutive patients presenting over an 18 month period for a shoulder MRA who subsequently had shoulder arthroscopy were enrolled. No patients were excluded. An MSK radiologist reviewed each study to confirm whether saline or gadolinium was injected. The reports from the MRA and the surgery were reviewed. For the rotator cuff and the long head of the biceps tendon, status was designated as full thickness tear, partial thickness tear, tendinosis/low grade fraying or normal. For the labrum, status was designated as tear, fraying/blunting/degeneration or normal. A chi square analysis was performed to compare the correlation between the MRA and the surgical reference. Items were categorized in binary groups (no tear versus tear and normal versus abnormal) and the diagnostic performance of each contrast agent was calculated. Kappa values were calculated to correlate diagnosis of tear between MRA and arthroscopy.

RESULTS

There were a total of 34 gadolinium arthrograms and 24 saline arthrograms. When compared to the reference standard, saline was non-inferior to gadolinium in the diagnosis of tears of the supraspinatus (accuracy 0.88 vs 0.74, respectively) and infraspinatus (accuracy 0.88 vs 0.65, respectively) tendons. Regarding labral tears, saline was non-inferior in the diagnosis of anterior/anterior inferior, posterior and superior tears (accuracy 0.79 vs 0.76, 0.71 vs 0.62 and 0.58 vs 0.56, saline vs gadolinium, respectively). When superior labral fraying was considered a tear, gadolinium outperformed saline (accuracy 0.71 vs 0.54, respectively). In terms of agreement between MRA and the diagnosis of surgically reported tears, saline was non-inferior to gadolinium.

CONCLUSION

Saline performed at least as well as gadolinium for the diagnosis of surgically proven rotator cuff tears. Saline was non-inferior in the detection of anterior and posterior labral tears. If fraying was not considered a tear, saline was non-inferior to gadolinium in the diagnosis of superior labrum tears.

CLINICAL RELEVANCE/APPLICATION

In this series, saline was non-inferior to gadolinium shoulder MRA. This could translate to cost savings by reducing scan times and the need for gadolinium.

SSM17-02 Fully Automated MRI Bone Segmentation of the Glenoid and Humeral Head Using Deep Convolutional Neural Networks

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S105AB

Participants
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PURPOSE

To present and evaluate a fully automated humeral head and glenoid segmentation using a deep learning method based based on two-dimensional deep convolutional neural networks (CNNs).

METHOD AND MATERIALS

The study received institutional review board approval. A retrospective dataset of MR images of the shoulder from 100 subjects for different clinical reasons, including 27 cases with history of previous dislocations, were manually segmented by experts. A 2D CNN architecture was trained with multiple initial feature maps and layers. Its segmentation performance was then tested against the ground truth of manual segmentation using a four-fold cross-validation scheme.

RESULTS

Automatic segmentation of the proximal humerus achieved a mean average precision for object detection of 0.99, a dice similarity score of 0.96, a segmentation precision of 0.96, and recall of 0.96. The Hausdorff distance was 23.8 mm, the mean surface distance of 0.5 mm, and the residual mean square distance of 1.3 mm. For the glenoid, automatic segmentation achieved a mean average precision for object detection of 0.92, a dice similarity score of 0.86, a segmentation precision of 0.88, and recall of 0.86. The Hausdorff distance was 20.7 mm, the mean surface distance of 0.8 mm, and the residual mean square distance of 1.8 mm. On average, the time for manual segmentation ranged between 90 to 120 minutes per imaging study. The time needed to train each epoch was around 14 minutes for the 2D CNN, and to calculate the segmentation masks using trained models takes around 4 seconds.

CONCLUSION

Using CNNs, we were able to accurately segment the humeral head and glenoid on MRI. Our results serve as an important initial step towards the automatic diagnosis and quantification of Hill-Sachs lesions and glenoid bone loss and determination of on/off track status. This, in turn, has the potential to provide consistently accurate imaging information that can be used to guide the selection of the most appropriate initial treatment for the anterior shoulder instability patient population.

CLINICAL RELEVANCE/APPLICATION

Using CNNs, we were able to accurately segment the humeral head and glenoid on MRI. Our results serve as an important initial step towards the automatic diagnosis and quantification of Hill-Sachs lesions and glenoid bone loss and determination of on/off track status.

SSM17-03 Identification of Glenoid Labral and Rotator Cuff Tears: Diagnostic Accuracy of Dual Energy CT versus Standard CT Arthrography of the Shoulder

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S105AB

Participants
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PURPOSE

To compare the diagnostic accuracy of dual-energy Computed Tomography arthrography (DECTA) and standard computed tomography arthrography (CTA) of the shoulder in depicting glenoid labral tears (GLT) and rotator cuff tears (RCT).

METHOD AND MATERIALS

This prospective institutional review board-approved study included 32 consecutive patients (18 males and 14 females; mean age of 34.5, range 18-60 years) studied between January 2018 and January 2019. Articular cavity was distended with anterior approach by using a mixture of saline and iodinate contrast material before DECT exam (80 kV and tin filter 150 kV). DECT data were postprocessed on a dedicated offline workstation (SyngoVia®). Standard virtual blended 120 kVp images were obtained, representing CTA. Moreover a three-material decomposition algorithm was applied to generate DECT maps. Mono-energetic application was employed to choose the best kV values in order to enhance the vividness of contrast material and to reduce metal artifacts in previously operated shoulders. Two radiologists (26 and 12 years of experience, respectively), blinded to clinical data, evaluated the presence of GLT and RCT on CTA and DECTA images. Surgical findings served as standard of reference. Diagnostic accuracy values were calculated. Inter-observer and intra-observer agreement were calculated with k-statistics. A value of $p<0.05$ was considered statistically significant.

RESULTS

MRI revealed the presence of GLT in 24/32 patients (75.0%) and a RCT in 10/32 patients (31.2%). The sensitivity, specificity, PPV and NPV and accuracy of DECTA were 91.6, 100,100, 81.8 and 91.1%, and 100, 100, 100, 100, and 100%, as regards GLT and RCT, respectively. The sensitivity, specificity, PPV and NPV and accuracy of CTA were 91.6, 90.0, 95.6, 81.1 and 91.1%, and 90.0,

100, 90.0, 95.6, 85.7 and 96.8%, as regards GLT and RCT, respectively. By using McNemar test, the difference of accuracy between DECTA and CTA was not significant (p=0.23). The interobserver and intraobsever agreement were near perfect (k=0.82 and k=0.86, respectively).

CONCLUSION

DECTA can identify GLT and RCT with higher accuracy with respect to CTA.

CLINICAL RELEVANCE/APPLICATION

DECTA arthrography is an accurate imaging method for demonstration of glenoid labrum and rotator cuff tears. The increase of conspicuity of contrast material injected within the articular cavity may represent a key factor for the identification of subtle tears.

SSM17-04 Qualitative and Quantitative Analysis of Glenoid Bone Stock and Version: Inter-Reader Analysis and Correlation with Rotator Cuff Atrophy

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S105AB

Participants
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PURPOSE

Glenoid bone stock and morphology and rotator cuff muscle quality and tendon integrity affect the outcome of total shoulder arthroplasty. We hypothesized that glenoid bone loss severity correlates with rotator cuff tendinopathy and severity of rotator cuff muscle fatty infiltration (FI) and atrophy.

METHOD AND MATERIALS

Fourty-three 3-D CT scans and MRIs of 43 patients (mean age 62 years; SD 13 years; range 22 to 77 years) referred for primary shoulder pain without recent trauma or prior surgery were evaluated. Measurements of glenoid bone stock, version, and joint line medialization were assessed on an axial CT image reconstructed in the true scapular plane. Measurements utilized the Friedman line to approximate the pre-pathologic surface. Glenoid morphology was assigned by modified Walch classification. Rotator cuff FI, atrophy, and tendon integrity were assessed on corresponding MRIs.

RESULTS

Glenoid version, anterior and posterior bone loss among modified Walch subtypes was statistically significant ($p<0.0001$, <0.01 and <0.01 respectively). There was a very strong negative correlation between increasing glenoid version and posterior humeral subluxation index (HSI) ($r=-0.908$; $p<0.0001$). There was a moderately negative correlation between anterior bone loss and HSI ($r=-0.562$; $p<0.0001$) and a moderately positive correlation between posterior bone loss and HSI ($r=0.555$; $p<0.0001$). Subscapularis muscle FI correlated moderately with increased anterior and central bone loss and increased humeral head medialization ($r=0.512$, $p<0.05$; $r=0.479$, $p<0.05$; $r=0.494$, $p<0.05$; respectively). Inter-observer reliability (intra-class correlation coefficient [ICC] and kappa) was good to excellent for all measurements and grading.

CONCLUSION

Glenoid anteversion, anterior and posterior bone loss are associated with humeral head subluxation. Subscapularis muscle FI, not the tendon integrity, correlates to anterior and central glenoid erosion. The study adds to the body of knowledge that neither rotator cuff tendinopathy, nor muscle atrophy showed a significant relationship to anterior or posterior humeral head subluxation. Anterior or central bone loss may indicate the need to strengthen the subscapularis muscle pre-operatively for potentially improved outcome.

CLINICAL RELEVANCE/APPLICATION

CT measurement of glenoid bone stock and MR measurement of rotator cuff pathology significantly impacts pre-operative planning of total shoulder arthroplasty.

SSM17-05 Addition of the RAVER View to Standard Shoulder Radiographs for Calculation of the Acromial Index and Prediction of Rotator Cuff Tears

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S105AB

Participants
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PURPOSE

Rotator cuff disease is a common indication for subspecialty orthopaedics referral. MRI and US are definitive diagnosing rotator cuff tear (RCT), but patient selection for advanced imaging remains difficult. Arthroscopic studies have shown osseous hypertrophy at the anterosuperior humeral head is a frequent finding in patients with RCT. We sought to trial a novel radiographic view to allow for measurement of osseous features that predict RTC, and serve as a guide to direct patients appropriately for advanced imaging referral.

METHOD AND MATERIALS

Consecutive patients referred to a surgeon for RCT underwent a novel radiographic resting, abduction view in external rotation (RAVER), in conjunction with the standard shoulder series. Osseous prominence at the anterosuperior humerus was measured on the RAVER and an Acromial Index (AI), was calculated with the ratio of the prominence and distance between the acromion and the footprint. MRI, ordered based upon established practice protocol, was correlated the RAVER measurements. Non-parametric tests and logistic regression were used for data analysis.

RESULTS

113 subjects had a RAVER view and 48 (42.9%) subjects underwent MRI, of which 35 had rotator cuff tears. The mean AI in the RCT tear group was 1.15, whereas the mean AI in subjects without MRI or without tear at MRI was 2.53 and 1.82 respectively. The AI was significantly associated with RCT tear (p=0.003), independent of gender and age. 3 MSK trainees reviewed 18 cases independently to assess reliability of AI, and an intraclass correlation coefficient was 0.96 (95% CI: 0.92-0.98, p<0.001), showing high concordance and little variation in scoring.

CONCLUSION

The acromial Index is an easily reproducible, reliable radiographic predictor of rotator cuff tears and can be calculated with the addition of a single, novel RAVER radiographic view. The addition of this resting, abduction, external rotation view should be validated with larger scale implementation, particularly in shoulder clinics and in a patient population where suspected rotator cuff tears are prevalent.

CLINICAL RELEVANCE/APPLICATION

Once validated, tthe RAVER view and AI measurement can allow clinicians to more effectively select patients who would benefit from advanced imaging with MRI or US for rotator cuff tear, ultimately improving imaging efficiency, adding value, and expediting optimal outcomes.

SSM17-06 Imaging and Clinical Outcomes Following Superior Capsular Reconstruction for Massive Irreparable Rotator Cuff Tears

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S105AB

Participants
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PURPOSE

Superior capsular reconstruction (SCR) has been recently developed as an arthroscopic treatment option for massive irreparable rotator cuff tears. The purpose of this study is to determine early imaging, clinical, and functional outcomes of SCR.

METHOD AND MATERIALS

Patients having undergone SCR at a single institution were included. Pre-operative and post-operative radiographs and MRIs were evaluated for acromiohumeral interval (AHI), superior subluxation distance (SSD), glenohumeral cartilage loss, cuff muscle atrophy, and graft integrity. Postoperative outcomes including range of motion (ROM), muscle strength and clinical outcomes scores were collected.

RESULTS

24 SCRs were included. Mean clinical follow-up was 21.3 months. MRI was obtained in all patients at mean 9.4 months postoperatively. There were 12 intact grafts (50%) and 12 grafts (50%) with tear at least at one location. The most common location of tear was from the glenoid attachment (50%), followed by the posterior side-to-side attachment (25%), the anterior attachment (18%), and greater tuberosity (7%). There was a significant improvement of American Shoulder and Elbow Surgeons (ASES) (p = 0.003) and visual analog scale (VAS) pain scores (p = 0.012). Significant improvement was observed in forward elevation ROM (p = 0.021). There was no significant difference in functional outcomes or range of motion between patients with torn graft and those with intact graft. The severity of preoperative cartilage loss or rotator cuff muscle fatty atrophy were not associated with graft tear. There was a significant difference in the SSD between patients with complete tear of the graft at least in one location and those without tear on postoperative MRI. SSD greater than 7.9 mm had a 79% sensitivity and 91% specificity for a complete tear of the graft.

CONCLUSION

SCR using human dermal allograft had a 50% tear rate mostly from the glenoid in the current series despite that it results in significant improvements in short term function and range of motion in patients with massive irreparable rotator cuff tears. The chronicity of this procedure's action to depress the humeral head remains in question, as well as the time this procedure provides to delay reverse total shoulder arthroplasty.

CLINICAL RELEVANCE/APPLICATION

SCR using human dermal allograft results in significant improvements in short term function and range of motion in patients with

massive irreparable rotator cuff tears.

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SSM18

Nuclear Medicine (Head and Neck/Thyroid Nuclear Medicine and PET)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S504CD

HN NR NM

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Amy M. Fowler, MD,PhD, Madison, WI (*Moderator*) Institutional research support, General Electric Company; Author with royalties, Reed Elsevier

Sub-Events

SSM18-01 What is the Incidence of Malignancy in Small Hypermetabolic Pulmonary Nodules?

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S504CD

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PURPOSE

FDG-PET/CT is often utilized to differentiate between benign and malignant indeterminate lung nodules. Throughout the literature, the sensitivity of FDG-PET/CT in this setting is quite high, however, the vast majority of studies focused on nodules generally larger than 1 to 2 cm in diameter. Our study focuses on the potential role of PET/CT imaging in small FDG-avid lung nodules. We define "small" nodules as those measuring 1 cm or smaller in greatest dimension.

METHOD AND MATERIALS

Our study is both prospective and retrospective. Over a four-year interval, we obtained histopathological follow-up of those patients whose PET/CT scans demonstrated a clearly visible FDG-avid lung nodule measuring up to 1 cm in greatest diameter, in whom there were final pathology results from wedge resection.

RESULTS

A total of 39 patients met the above criteria, 24 men and 15 women. One of these patients was proven to have a benign lung nodule, namely a granuloma measuring 9mm in greatest diameter with an SUV max of 0.94. Of the remaining 38 patients with proven malignant nodules, 23 had adenocarcinoma, 14 had squamous cell tumors, and one patient had Non-Hodgkins lymphoma. The least metabolically-active lung nodule, a squamous cell tumor, measured 5 mm in greatest diameter with an SUV max of 0.73 (background SUV max=0.38). The most active lung nodule, an adenocarcinoma, measured 1 cm with an SUV max of 2.60.

CONCLUSION

Thirty-eight of the 39 patients in our series had small FDG-avid lung nodules measuring up to 1 cm, that were subsequently proven to be malignant. This yields a positive-predictive value of 97.4%, despite the limitations imposed by the so-called partial volume effect, which potentially underestimates the SUV max. FDG-PET/CT is therefore highly sensitive and specific in diagnosing malignancy in such small lung nodules; perhaps this modality's potential has been overlooked in this subgroup of hypermetabolic lung nodules.

CLINICAL RELEVANCE/APPLICATION

Any lung nodule measuring up to 1 cm in greatest dimensions that is FDG-avid on PET/CT should be highly concerning for malignancy.

SSM18-02 FDG PET/CT May Predict Clinical Course in Radioiodine-Negative Lung Metastases from Differentiated Thyroid Cancer

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S504CD

Participants

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PURPOSE

There is a considerable variety in the clinical course of radioiodine negative lmetastasis from differentiated thyroid cancer (DTC). The aim of this study was to determine whether PET/CT with F-18 FDG was valuable in predicting prognosis of radioiodine-negative lung metastasis from DTC.

METHOD AND MATERIALS

This study included 39 patients who had lung metastases from DTC (PCA/FCA 35/4. age 33-86yrs.) that did not avid I-131 on the post therapy whole body scan and SPECT/CT after high-dose radioactive iodine therapy (RAI). Two out of 34 patients had bone metastasis and another 19 patients had lymph node metastasis in addition to lung metastasis. PET/CT imaging was performed 5-16 mos after the latest RAI using a dedicated scanner .Uptake of FDG in the metastatic tumor was visually evaluated by 2 independent radiologists. When a tumor showed FDG activity stronger than that in the mediastinum on the whole body MIP images, FDG uptake was defined as positive. Based upon FDG uptake, patients were classified into 2 subgroups: Positive FDG uptake (n=21), and negative FDG uptake (n=18) .Follow up period ranged from 45 to 147 mos(median:92mos.). Patents did not receive additional treatment for lung metastases except for TSH suppression, pleurodesis, or radiotherapy. Anatomical imaging and Tg measurement were performed at a regular interval to evaluate Tg-doubling time (TgDT) and longitudinal changes in tumor diameter (as a rule, based on RECIST1.1) during the follow- up period. Additionally, progression-free survival (PFS) was determined using Kaplan-Meier plot.

RESULTS

Short TgDT (< 1 yr) was more frequently seen in positive FDG uptake group than in negative FDG uptake group (67% vs 17%,p<0.005). The median PFS (mos.) in the positive FDG uptake group vs. the negative FDG uptake group was 40 vs. NA (p<0.001), respectively.

CONCLUSION

FDG positive lung metastases had a increased risk for shorter TgDT or shorter PFS than those with FDG negative ones , while FDG negative lung tumor were associated with stable clinical course. FDG uptake may be predictive of clinical core and prognosis of radioiodine negative lung metastasis from DTC.

CLINICAL RELEVANCE/APPLICATION

Early differentiation of patients with possible unfavorable prognosis from those with favorable prognosis should be helpful in planning an adjunctive treatment to RAI. FDG-PET/CT may be valuable in optimizing the management of radioiodine- negative lung metastases from DTC.

SSM18-03 Is 30mCi of I-131 Inadequate for Adjuvant Therapy for Postsurgical Thyroid Cancer?

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S504CD

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PURPOSE

2015 ATA management guidelines recommend 100-150 mCi of I-131 for adjuvant therapy (AT) for postsurgical differentiated thyroid cancer. However, so far, number of patients in our country had been given 30mCi of I-131 for the purpose of AT. The aim of this study was to determine whether 30mCi of I-131 was inadequate for AT in patients with increased risk for recurrence.

METHOD AND MATERIALS

This study was retrospective analysis of 58 patients with thyroid cancer (M/F 19/39, PCA54/FCA4, age:59.8 ±13.7 yrs.), who underwent total thyroidectomy and were followed by rhTSH-aided RAI with 30mCi. Inclusion criteria were: a) clinicopathological finding by TNM 8th edition was either stage II of pT3 and pN positive (n=25), stage III (n= 24),or stage IVA (n=9), and b) there was no lymph node suspicious for metastasis on neck ultrasound (US) after surgery. Patients followed a low iodine diet (< 100μg/day) from 7 days before to 3 days after RAI. I.m. injection of rhTSH(0.9mg) was done for 2 consecutive days. Patients were given 30 mCi of I-131 on the day after 2nd rhTSH injection. Post therapy I-131 SPECT/CT was imaged 72- 96 hrs. after RAI. Response assessment was done 6-12 mos. after RAI by combination of diagnostic dose I-131 SPECT/CT, neck US, and stimulated Tg. Eleven patients with positive TgAb values were additionally underwent FDG-PET/CT. Fulfillment of negative I-131 uptake, no suspicious mass on anatomical imaging, and stimulated Tg value < 1.0 (ng/ml) was considered as complete response (CR). Patients were further followed up for 19-82mos. (median 44).

RESULTS

Seven patients were excluded from analysis because structural disease was depicted by post therapy imaging. In the remaining 51, CR was achieved in 35 (75%), while 16 showed incomplete response. Thirteen out of those 16 pts. underwent 2nd RAI with 30mCi. CR was additionally achieved in 7 (54%). Among 42 pts who attained CR, structural disease developed in 6 (14%) during the follow up period.

CONCLUSION

CR was achieved in more than 80% of patients after rhTSH-aided RAI with 30 mCi of I-131. Once CR was attained, prevalence for new structural disease was less than 15%. Although the impact on the long-term prognosis remains uncertain, 30 mCi of I-131 is not inadequate for AT in post-surgical thyroid cancer patients with increased risk for recurrence.

CLINICAL RELEVANCE/APPLICATION

30mCi of I-131 seems feasible for adjuvant therapy and thus, can be considered for selected patients.

SSM18-04 Defining Metabolic Heterogeneity Thresholds with FDG PET/CT for Head and Neck Tumors Can Help Predict Patient Risk of Death

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S504CD

Participants
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PURPOSE

Disease risk stratification is a corner stone of precision oncology, with radiomic feature analysis being recognized as an important determinant of tumor behavior and overall prognosis. Accordingly, this study sought to quantify and define tumor metabolic heterogeneity thresholds predictive of patient mortality in the setting of head and neck cancer.

METHOD AND MATERIALS

This is a retrospective study examining 298 histologically proven head and neck cancer FDG PET/CT's (and associated clinical data) within the Cancer Imaging Archive data base from April 2006 to November 2014. Segmentation analysis of the most FDG avid lesion from each pre-treatment PET scan was performed. Tumor heterogeneity was defined by the standard deviation and skewness of the tumor pixel intensity distribution. These values were then segregated into ten equal groups (deciles) for further analysis. COX regression was used to model the relative risk (RR) of patient mortality with respect to tumor metabolic heterogeneity as defined by the standard deviation and skewness deciles. Patient age was also included in the regression model as a covariate - the only clinical variable independently associated with risk of death in univariate analysis.

RESULTS

Larger standard deviation and negative skewness define greater degrees of heterogeneity. Serial time dependent multivariable models identified head and neck tumors with PET data demonstrating pixel standard deviation above the eighth decile (27.39) and pixel skewness below the third decile (0.00) to be associated with increased risk of death (RR 2.4, P=0.022) compared to patients with tumor PET data not meeting any or only meeting one of these heterogeneity thresholds.

CONCLUSION

By defining standard deviation and skewness thresholds for head and neck cancer we have been able to identify a sub-set of patients with an increased risk of death based on analysis of pre-treatment FDG PET/CT scans. Inclusion of radiomic data in risk stratifying head and neck tumor patients may have important clinical implications, such as altering time to follow-up and the aggressiveness of treatment strategy.

CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of pre-treatment head and neck cancer heterogeneity with FDG PET data (Radiomics) can be used to identify patients with increased risk of death.

SSM18-05 Interpretation of Response Assessment PET-CT in Head and Neck Carcinoma: Comparative Analysis of 4 Qualitative Interpretative Criteria in a Large Patient Cohort

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S504CD

Participants
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PURPOSE

There is no clear consensus regarding the optimal interpretive criteria (IC) for Fluorine-18 fluorodeoxyglucose (FDG) Positron

There is no clear consensus regarding the optimal interpretive criteria (IC) for Fluorine-18 fluorodeoxyglucose (FDG) Positron Emission Tomography - Computed Tomography (PET-CT) response assessment following (chemo)radiotherapy (CRT) for head and neck squamous cell carcinoma (HNSCC). The aim of this study was to compare the accuracy of 4 IC (NI-RADS, Porceddu, Hopkins, Deauville) for predicting local control, regional control and progression free survival (PFS) in a large patient cohort.

METHOD AND MATERIALS

All patients with histologically-confirmed HNSCC treated at a specialist cancer center between August 2008 and May 2017 who underwent baseline and response assessment FDG PET-CT 4 months post CRT were included. Metabolic response was assessed using 4 different IC harmonised into 4-point scales (complete response, indeterminate, partial response, progressive disease). IC performance metrics (sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy) were compared. The Kaplan-Meier method and Cox proportional hazards regression analyses were used for survival analysis.

RESULTS

562 patients were included (397 oropharynx, 53 hypopharynx, 48 larynx, 64 other/unknown primary). 420 patients (75%) received CRT and 142 (25%) had radiotherapy alone. Median follow-up was 26 months (range 3-148). 156 patients (28%) progressed during follow-up. All IC were accurate for prediction of local (primary tumor) outcome (mean NPV 85.0% (84.6-85.3), PPV 85.0% (82.5-92.3), Accuracy 84.9% (84.2-86.0)) and regional (nodal) outcome (mean NPV range 85.6% (84.1-86.6), PPV 94.7% (93.8-95.1), Accuracy 86.8% (85.6-88.0)). Number of indeterminate cases for NI-RADS, Porceddu, Deauville and Hopkins were 91, 25, 20 and 13. PPV was significantly reduced for indeterminate uptake across all IC (mean PPV primary tumor 36%, nodes 48%). Survival analyses showed significant differences in PFS and OS between response categories classified by each of the four IC ($p < 0.001$).

CONCLUSION

All four analysed IC had similar diagnostic performance characteristics although Porceddu and Deauville provided the best trade off minimising indeterminate scores whilst maintaining a high NPV.

CLINICAL RELEVANCE/APPLICATION

FDG PET-CT accurately predicts complete response or disease progression post-CRT in HNSCC. Porceddu and Deauville IC offer the best combination of high NPV and low indeterminate scores.

SSM18-06 Comparison Between 18F-FDG PET and DWI Data for Prediction of Therapy Response of Soft Tissues Sarcoma Under Neoadjuvant ILP

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S504CD

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PURPOSE

To evaluate and compare the clinical utility of simultaneously obtained quantitative 18F-FDG PET and DWI datasets for the prediction of therapy response of soft tissue sarcomas (STS) under neoadjuvant isolated limb perfusion (ILP).

METHOD AND MATERIALS

A total of 39 patients with confirmation of a STS of the extremities underwent a 18F-FDG PET/MR examination before (1st scan) and after (2nd scan) ILP with melphalan and alpha-TNF. For each patient, the maximum tumor size, metabolic activity (SUVs) and diffusion-restriction (ADC-values) were measured in pre- and posttherapeutic examinations and percentage changes during treatment were calculated. A Mann-Whitney-U test was used and ROC analysis was performed to compare the results of the different quantitative parameters to predict therapy response. Histopathological results after subsequent tumor resection served as reference standard and patients were categorized as responders/non-responders based on the grading scale by Salzer-Kuntschik.

RESULTS

Histopathological analysis categorized 25 (64%) patients as therapy responders (Grade I-III) and 14 (36%) patients as non-responders (Grade IV-VI). Tumors in the responder group showed a reduction in size of -8.6% and metabolic activity (SUVmax: -51.1%; SUVpeak: -56.3%) as well as an increase of the ADC values (ADCmin: +30.3% and ADCmean: +23.7%) under treatment. Percentage changes in the non-responder group amounted to: maximum tumor size -3.9%; SUVmax: -12.7%; SUVpeak: 13.3%; ADCmin: +11.8% and ADCmean: +10.5%. Differences of SUVs between histopathological responder and non-responders were significantly different (< 0.05), whereas differences in tumor size and the ADC values did not reach significance level (>0.01). The corresponding AUCs were 0.63 (tumor size), 0.83 (SUVmax), 0.81 (SUVpeak), 0.65 (ADCmin) and 0.68 (ADCmean), respectively.

CONCLUSION

Our study demonstrates the superiority of 18F-FDG PET data over MR-derived quantitative imaging parameters for response assessment of STS under neoadjuvant ILP.

CLINICAL RELEVANCE/APPLICATION

18F-FDG PET data may be highly valuable when implemented into diagnostic algorithms for monitoring neoadjuvant treatment

18F-FDG PET data may be highly valuable when implemented into diagnostic algorithms for monitoring neoadjuvant treatment strategies of STS. However, considering the importance of MRI data for presurgical evaluation, integrated PET/MRI could serve as a valuable tool for therapy planning and monitoring of neoadjuvant treatment strategies of STS.

Printed on: 10/29/20

SSM19

Neuroradiology/Head and Neck (General)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S501ABC

HN NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM19-01 Analysis of Programmable Valve Setting Changes Due to Exposure to the MRI Environment

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S501ABC

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PURPOSE

Most patients with ventriculoperitoneal (VP) shunts undergo frequent magnetic resonance imaging (MRI) for various indications. It is a known fact that there may be unintentional valve setting changes due to interaction with the MRI magnetic field. Therefore, in many institutions, including ours, patients with a programmable VP shunt valve who undergo MRI receive skull radiographs before and after the MRI to check for any induced setting change. Based on empirical observation, we hypothesized that MRI related setting changes occur more frequently with some commercially available shunt valve types. This is a retrospective study to determine the rates of unintended, MRI related, programmable VP shunt valve setting changes for each commercially available programmable shunt valve type used at our institution.

METHOD AND MATERIALS

The study population consisted of patients with programmable shunt valves who underwent at least one MRI study with pre and post MRI radiographs in 2018. After IRB approval, the institutional radiology search tool 'Primordial' was used to extract the skull radiograph reports containing the words 'shunt' or 'setting', and the shuntogram reports containing the word 'setting'. Using the institutional electronic medical record system, a chart check was performed for each study to determine the ones that were performed following an MRI.

RESULTS

Our search revealed 89 post MRI radiographs from 73 patients, with an age range of 1 month to 88 years (Median: 40). For patients with more than one shunt valve, each valve was included separately in the analysis. Overall, setting change occurred in 45.2% of the studies. The setting change rates for individual valve types were as follows: 17 of 29 Strata NSC® (58.6%), 17 of 20 Strata II® (85%), 8 of 40 Codman-Hakim® (20%), 0 of 2 Codman Certas, and 0 of 2 Polaris Sophysa. Statistical analysis was performed on the most common three shunt valves. Student's T-test revealed a statistically significant difference between all three groups ($p<0.05$ for Strata NSC vs Codman-Hakim; and for Strata II vs Codman-Hakim; $p=0.04$ for Strata NSC vs Strata II).

CONCLUSION

VP shunt valves change settings occur frequently, especially for Strata NSC and Strata II.

CLINICAL RELEVANCE/APPLICATION

MRI related shunt valve setting changes are common. Post MRI manual reprograming of the commonly affected valves without obtaining radiographs could reduce radiation exposure and the cost to patients.

SSM19-02 Predictors of Positive Brain MR Imaging in Patients with New Daily Persistent Headache

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S501ABC

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PURPOSE

The aim of our study is to evaluate the predictors of positive neuroimaging in patients with New Daily Persistent Headache (NDPH)

METHOD AND MATERIALS

All patients aged >=18 with documented NDPH were identified from a 10-year institutional database. Patient charts were reviewed using electronic medical records. NDPH characteristics, temporal profile, coexistent migraine, history of recognized trigger (eg. viral infection), and history of vascular comorbidities were included. Individual brain MRI and head CT at baseline evaluation were read. All tests were significant at P<0.05

RESULTS

Altogether 200 patients (mean age, 53.6 years+/-15.1) were diagnosed with NDPH (141 women and 58 men). Predominant headache locations included hemicranial in 21% (42/200), bilateral in 13% (26/200), holocranial in 9%(18/200), and side-changing in 7%(14/200). They were characterized by pressure-like stabbing pain in 37.5%(75/200) and throbbing in 11%(22/200) patients. Median baseline and median peak headache pain intensity were 5 (range, 2-8) and 8 (range, 2- 10) respectively. About 11.5% (23/200) had comorbid migraine with aura and 32.5% (65/200) did not have aura. About 59%(118/200) had positive history of a trigger prior to the onset of their headache. Additionally, 16%(32/200) patients with NDPH had history of a hypermobility disorder (Ehler-Danlos syndrome, Marfans syndrome, or isolated cervical hypermobility). Overall, a total of 59 patients had a positive MR brain imaging finding, with the majority of positive findings being dural meningiomas (15/59), subdural hemorrhages (13/59), and intracranial aneurysms (10/59). Patients with a positive history of trigger and comorbid dyslipidemia at baseline were associated with a positive brain MR imaging finding (P=0.02 and P=0.05 respectively). Other comorbidities including migraine, hypertension, vascular disorders, and thyroid disorders did not significantly predict MR brain imaging positivity. Data on brain CT imaging was insufficient

CONCLUSION

To date, this is the largest population study evaluating factors predicting positive neuroimaging finding in NDPH. Our results show that patients with a positive history of a trigger prior to NDPH and those with comorbid dyslipidemia are associated with a positive finding on brain MR

CLINICAL RELEVANCE/APPLICATION

Detecting predictors of positive neuroimaging will help triage a sub-cohort of NDPH patients with potentially reversible causes for early management

SSM19-03 An Observational Study to Evaluate the Management of Patients with Chronic Headache with Referral from Primary Care to Direct Access to Magnetic Resonance Imaging (MRI) Compared to Neurology Services

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S501ABC

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PURPOSE

To evaluate two existing clinical pathways used in the management of patients with chronic headache based on referral from General Practitioners (GPs) for a Neurologist appointment or direct access to Magnetic Resonance Imaging (MRI) brain scan.

METHOD AND MATERIALS

A pragmatic, non-randomised, prospective single-center study compared the two clinical pathways used in the management of chronic headache following referral from GPs that differed in the first appointment, either a Neurology appointment or a MRI brain scan. Subsequent participants' use of health care services and costs were estimated using primary and secondary care databases and questionnaires at baseline, 6 and 12 months post-recruitment. Cost analyses at 6 and 12 months were compared using generalized linear models (GLM). Secondary outcomes assessed access to care, headache burden and self-perceived quality of life using headache-specific (MIDAS, HIT-6) and general questionnaires (EQ-5D-5L).

RESULTS

The MRI group improved access to care (39.2 and 70.4 days from referral to MRI scan and report, respectively) compared to the Neurology group (110 days) (p<0.001). The Neurology group was associated with a trend (p>0.05) of better self-perceived quality of life using a generic questionnaire and an opposite trend from headache-specific questionnaires, exhibiting a trend (p>0.05) of

higher headache burden (HIT-6 score, MIDAS score and headache days). Mean (SD, n) cost up to 6 months post-recruitment per participant was £578 (£420, n=128) for the Neurology group and £245 (£172, n=95) for the MRI group, leading to an estimated cost difference of £333 (95% CI £253 to £413, p<0.001). The cost difference at 12 months increased to £518 (95% CI £401 to £637, p<0.001). This cost difference derives from the lower utilization of participants in the MRI group of both GP visits (1.8 vs 1.2, p=0.006) and hospital appointments (2.5 vs 0.3, p<0.001) and despite the higher utilization of MRI scans (0.6 vs 1.1, p<0.001).

CONCLUSION

Direct referral to brain MRI from Primary Care led to cost-savings and quicker access to care compared to the management of chronic headache with referral to Neurology services.

CLINICAL RELEVANCE/APPLICATION

Direct referral to MRI for the management of chronic headache should be incentivized for a subset of patient population more likely to be reassured by a negative brain scan.

SSM19-04 Oral Contraceptive Use Is Associated with Smaller Hypothalamic Volumes in Healthy Women

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S501ABC

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PURPOSE

There is limited evidence on the structural and functional effects of hormonal contraceptives on the brain. In particular, these effects on the hypothalamus are not known. In this study, we aim to identify alteration of hypothalamic volume associated with oral contraceptive pill (OCP) use in healthy women.

METHOD AND MATERIALS

We acquired high-resolution MR images of the brain at 3T for a prospective cohort of 50 healthy women. Psychometric tests (Cogstate and PROMIS) were administered at the time of imaging. 21 participants took OCPs at the time of imaging while 29 did not. After training and validation, 5 raters independently performed manual segmentation of the hypothalamus using ITK-SNAP. Total intracranial volume (tICV) was determined using FreeSurfer. The intraclass correlation was calculated for a subset of 20 randomly-selected cases to assess inter-rater reliability. A general linear model was fit to test for the association of OCP use with hypothalamic volume, with tICV and birth control used as covariates. Additional exploratory analyses assessed associations with menstrual cycle phase and with cognitive and health measures.

RESULTS

The inter-rater ICC was 0.86. Total hypothalamic volume in participants taking OCPs was smaller than those not taking OCPs (b=-63.4 ± 22.2, p=0.006). There was a significant association of hypothalamic volume with greater anger (p=0.02) as well as a strong correlation with depression (p=0.09). However, no significant correlation was found between hypothalamic volume and cognitive testing results.

CONCLUSION

Our hypothalamic segmentation method is highly reliable. OCP use is associated with smaller total hypothalamic volume, which may be related to interference with known trophic effects of sex hormones and provide a structural mechanism for OCP-mediateed inhibition of folliculogenesis as well as potential functional effects.

CLINICAL RELEVANCE/APPLICATION

Characterizing effects of OCPs on the hypothalamus provides a bridge to understanding functional alterations associated with OCP use that may impact selection of contraceptive method.

SSM19-05 Blood-Brain Barrier Water Permeability Disruption in Major Depressive Disorder

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S501ABC

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PURPOSE

Major depressive disorder (MDD) is the most prevalent and disabling form of depression. Blood-brain barrier (BBB) disruption has been implicated in the development and progression of MDD. The purpose of this study was to investigate differences in BBB integrity between patients with MDD and healthy subjects using the recently developed Intrinsic Diffusivity Encoding of Arterial

Labeled Spins (IDEALS) MRI technique.

METHOD AND MATERIALS

14 healthy subjects and 14 MDD patients were recruited with IRB approval and informed consent. Depression symptom severity was assessed with the Beck's Depression Index (demographics in Table 1). All studies were performed on a Siemens 3T Prisma MRI with 64-channel head/neck coil. IDEALS images were acquired according to (Wengler et al. NeuroImage, 2019) for mapping of cerebral blood flow (*CBF*), water extraction fraction (*Ew*), and water permeability (*PSw*). High resolution T1w images were acquired for segmentation and spatial normalization. Four regions of interest (ROIs) implicated in MDD were evaluated: anterior cingulate cortex (ACC), amygdala, dorsolateral prefrontal cortex (DLPFC), and hippocampus. ROIs were selected using WFU Pickatlas. Analysis of covariance (ANCOVA) was used to evaluate group differences between BBB water permeability parameters within the 4 ROIs while controlling for age and gender; $p < 0.05$ was considered significant.

RESULTS

Figure 1 displays the group averaged IDEALS parameter maps. Box plots with individual data points for *PSw*, *Ew*, and *CBF* within ROIs are shown in Figure 2. Figure 3 displays the mean values after adjusting for age and gender. No significant differences in *CBF* between healthy subjects and MDD patients were. Significantly lower *Ew* was observed in the amygdala, ACC, DLPFC, and hippocampus of MDD patients compared to healthy subjects. Significantly lower *PSw* was observed in the amygdala and hippocampus of MDD patients compared to healthy subjects.

CONCLUSION

With active trans-membrane water cycling pathways, such as NaK-ATPase, accounting for a large fraction of water exchange, the lower BBB water permeability observed in MDD patients suggests BBB disruption and cerebral metabolic deficits.

CLINICAL RELEVANCE/APPLICATION

Despite its societal impact, the mechanisms underlying major depressive disorder (MDD) are not well understood. This study uses the IDEALS MRI method to probe BBB water permeability disruption in MDD.

SSM19-06 Redundant Neurovascular Imaging: Who's to Blame and What's the Value?

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S501ABC

Participants
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PURPOSE

Redundant neurovascular imaging (RNI) studies such as Doppler ultrasound (DUS), CTA, MRA, and DSA add cost to the evaluation of patients with new neurologic deficits. We sought to determine to what extent such redundant studies are generated by radiologists' recommendations and the agreement rates between modalities in this setting.

METHOD AND MATERIALS

The radiology reports of 200 consecutive patients admitted for acute stroke were reviewed to determine how often 1) there was a recommendation for another study, 2) it was suggested by the radiologist, not the clinician, and 3) the agreement rates between these RNI studies.

RESULTS

Among 89/200 (44.5%) patients with RNI there were 116 redundant studies. These included 45/116 RNI studies after CTA, 64/116 after MRA and 7/116 after DUS. The radiologist recommended another vascular study in 19/89 (21.3%) patients, the rest by clinicians. When radiologists recommended additional radiological studies, 15/19 (78.9%) occurred following an MRA and 4/19 (21.1%) occurred after CTA. There was a significant difference between the number of second imaging ordered by radiologists after MRA ad CTA (P-value: 0.049). The second study agreed with the first in 52.6% of cases recommended by radiologists and 74.2% recommended by clinicians (P-value: 0.06). CTA agreed with MRA, Carotid DUS, and DSA in 67.1%, 90%, and 77.8% respectively. MRA agreed with DUS and DSA in 65% and 71.4% respectively.

CONCLUSION

Of cases with RNI, the majority were generated by clinicians, but radiologists recommended RNI in 21.3% of patients; 78.9% occurred following the MRA. Most second studies (70.7%) confirmed the first study's findings. Such low-value-same-result RNIs were more common when clinicians ordered them (74.2%) than radiologists (52.6%). Such redundancy should be discouraged. Some combinations (CTA/DUS) had 90% concordance, while the greatest discrepancy rate across modalities resided between MRA and DUS (35%).

CLINICAL RELEVANCE/APPLICATION

Neurovascular redundant imaging should be addressed at a national level to reduce healthcare costs and could benefit from order entry feedback loops.

SSM20

Neuroradiology (Vascular, Non-Stroke)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S502AB

ER NR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM20-01 Intracranial Aneurysms In Hereditary Hemorrhagic Telangiectasia

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S502AB

Participants
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PURPOSE

Hereditary hemorrhagic telangiectasia (HHT) is an autosomal dominant disease induced by mutation of genes involved in angiogenesis' regulation, around 10-20% of patients may have cerebral vascular malformations. Intracranial aneurysms (ICA) are acquired vascular lesions, with prevalence of 3-5% in general population. HHT has not been specifically linked to ICA. Our purpose is to describe the frequency of ICA in population with HHT diagnosis in a reference center.

METHOD AND MATERIALS

We performed a cross sectional study. We included patients with HHT who had performed an angiographic study: MR angiography, CT angiography or digital angiography from 2010 to 2018, with available images for interpretation. We recorded the location, the geometric characteristics and the presence of other cerebral vascular malformations. We evaluated the result of genetic test when available and it's association with ICA.

RESULTS

We included 151 patients with an angiographic studies, 96 female and 55 male. The average age was 47,7 years old (SD 18,3). We found 24 ICA in 22 (14,5%) patients. The location of aneurysms were: middle cerebral artery 7/24 (29,2%) ophthalmic artery 5/24 (26,1%), intracavernous carotid artery 3/24 (12,5%), posterior communicating artery 3/24 (12,5%), anterior communicating artery 2/24 (8,3%), 1/24 (4,2%) in basilar tip and 1/24 (4,2%) anterior cerebral artery. The mean diameter of ICA was 3,4mm (SD 1.18mm). Genetic test was available in 65 patients, we found ICA in 9 of them. No statistical association was found between the presence of ICA and genetic mutations. We found cerebral AVMs in 43 patients (28,5%), in this subgroup 12 patients also had ICA, (association between both vascular malformations p=0,004). The odds ratio of having both ICA and cerebral AVMs was 4,2 (CI 95%=1,6-11,4)

CONCLUSION

We found a frequency of ICA in HHT (14,5%). This finding may be related to arterial wall disorders induced by known genetic mutations in this disease. According to this findings, the risk of having an ICA increases approximately 3 to 5 times in patients with HHT compared to general population and its presence is associated with cerebral AVMs.

CLINICAL RELEVANCE/APPLICATION

There is an increased risk of having an intracranial aneurysm in patients diagnosed with HHT. This is important because it requires increasing suspicion in this patients for the diagnosis and treatment of the aneurysms.

SSM20-02 Readmission and Retreatment after Elective Treatment of Unruptured Cerebral Aneurysm: A Nationwide Readmission Database Analysis

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S502AB

Participants
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PURPOSE

Mortality rates following treatment of unruptured cerebral aneurysm (UA) have decreased over the past decades, which may be due to use of modern microsurgical and endovascular techniques as well as overall increased volumes of UA treatment. However, treatment of UA harbors a small but finite risk, and resulting readmission and retreatment rates have not been well described.

METHOD AND MATERIALS

Adult patients who underwent elective coiling or clipping of UA were extracted from the Nationwide Readmission Database spanning 2010 to 2015. Primary diagnosis for non-elective readmission within 30 and 90 days were identified and readmission and retreatment rates for coiling vs clipping were compared. To calculate 30 and 90-day readmission and retreatment rates, we included patients within the first 11 and 9 months of each year, respectively. Poisson regression was performed using generalized estimating equations and adjusted risk ratio (aRR)s were obtained for factors associated with 30 and 90 day readmission and retreatment. The adjusted model included terms for patient- and hospital-specific factors, comorbidity scores and disease severity.

RESULTS

Of 61,894 UA patients treated and discharged alive, 5.98% and 8.99% patients were readmitted and 0.14% and 0.33% patients were retreated within 30 and 90 days, respectively. The most common primary diagnoses for readmission within 30 and 90 days, respectively, was ischemic or hemorrhagic stroke (16.13%, 21.82%). The 30 and 90-day readmission rate for coiling vs clipping was 4.87% vs 8.68% ($p<0.001$) and 7.82% vs 11.87% ($p<0.001$), respectively (figure). The 30 and 90-day retreatment rates for coiling vs clipping were 0.18% vs 0.04% ($p<0.001$) and 0.37% vs 0.22% ($p=0.007$), respectively. Patients undergoing clipping had a higher adjusted risk of 30 and 90 day readmission (aRR=1.68; 95%CI, 1.49-1.90; $p<0.001$ and aRR=1.40; 95%CI, 1.27-1.54; $p<0.001$) but a lower adjusted risk of 30 day retreatment (aRR=0.33; 95%CI, 0.12-0.89; $p=0.029$) than patients having coiling.

CONCLUSION

The most common primary diagnoses for 30 and 90 day non-elective readmission after treatment of UA is stroke. Readmission rates are higher for clipping, but retreatment rates are higher for coiling.

CLINICAL RELEVANCE/APPLICATION

Patients undergoing clipping of UA have higher readmission rates but lower retreatment rates. These data may help patients and clinicians in selection of treatment modality for UA.

SSM20-03 Management of Tiny Unruptured Intracranial Aneurysms: A Cost-Effectiveness Analysis

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S502AB

Participants
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PURPOSE

To evaluate the effectiveness, costs and incremental cost of routine treatment (aneurysm coiling) versus 3 different strategies for imaging surveillance in relation to no preventive treatment or routine follow-up of tiny UIAs.

METHOD AND MATERIALS

A decision-analytic model-based cost-effectiveness analysis was constructed using inputs from the medical literature. Five different management strategies for tiny unruptured intracranial aneurysms (UIAs) were evaluated - annual magnetic resonance angiography (MRA) screening, biennial MRA screening, MRA screening every 5 years, coiling and follow-up and, no treatment or preventive follow-up. Markov decision model for lifetime rupture was constructed from a societal perspective per 10,000 patients with incidental, tiny UIAs. Outcomes were assessed both in terms of cost and quality-adjusted life years (QALYs). Incremental cost-effectiveness ratio (ICER) and net monetary benefit (NMB) for each strategy were evaluated. Probabilistic, one-way, and two-way sensitivity analyses were performed.

RESULTS

The base-case calculation shows no treatment or preventive follow-up to be the most cost-effective strategy. Among the imaging follow-ups, MRA every 5 years is the best strategy with the next highest effectiveness. The conclusion remains robust in probabilistic and one-way sensitivity analyses. No routine follow-up remains the optimal strategy when the annual growth rate and rupture risk of growing aneurysms are varied. When the annual rupture risk of non-growing UIAs is <2.1%, no follow-up is the optimal strategy. If annual rupture risk is >2.1%, coiling should be performed directly.

CONCLUSION

Given the current literature, no preventive treatment or imaging follow-up is the cost-effective strategy in patients with aneurysms <=3 mm, resulting in better health outcomes and lower healthcare spending. More aggressive imaging surveillance for aneurysm growth or preventive treatment should be reserved for patients with high risk of rupture.

CLINICAL RELEVANCE/APPLICATION

Given our findings, we need to critically evaluate the appropriateness of our current clinical practices, and potentially determine

Given our findings, we need to critically evaluate the appropriateness of our current clinical practices, and potentially determine specific guidelines to reflect the most effective management strategy for patients with incidental, tiny UIAs.

SSM20-04 Multi-Modal Convolutional Neural Networks with 2D and 3D Information Can Improve It's Sensitivity and Specificity for Detecting Cerebral Aneurysms in MR Angiography

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S502AB

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PURPOSE

Convolutional neural networks (CNN) with two-dimensional inputs for detecting cerebral aneurysm in magnetic resonance angiography (MRA) images have been proposed. The CNN can archive high sensitivity, although its outputs contain a large number of false positives. Various efforts for reducing false positives were implemented so far, but techniques applying three-dimensional information have not been reported. The purpose of this study was to develop multi-modal CNN taking advantage of both 2D and 3D information, and to investigate the performance improvement of aneurysms detection. As the 2D and 3D streams extract different features from inputs, we hypothesized multi-modal CNN could obtain new feature representations different from CNN with 2D input only.

METHOD AND MATERIALS

This study included 142 aneurysms (mean size, 4.1 mm ± 1.7 [standard deviation]; range, 1.3 - 9.7 mm) in 125 patients (76 men and 49 women; mean age, 67.6 years; range, 13 - 86 years). MRA were acquired with 81 1.5-T and 44 3.0-T MRI units, respectively. Two radiologists delineated volumes of interests (VOI) of each aneurysm on MRA with consensus. Multi-modal CNN with two streams, 2D and 3D CNNs was developed. Maximum intensity projection (MIP) images around VOI were input into 2D CNN, and a box containing VOI was directly used as the input voxel of 3D CNN. 4-fold cross validation was performed to calibrate generalization ability of the model. The new model was compared with conventional CNN with only 2D input using free-response receiver operating characteristic (FROC) analysis.

RESULTS

The average sensitivities of the 2D CNN and multi-modal CNN to detect aneurysms were 92.4% and 95.2% in eight positive candidates. Although the best sensitivity of 2D CNN was 92.4% at 6.7 false positives per image (FPI), multi-modal CNN achieved the same sensitivity as above at 5.7 FPI. In particular, the number of true positives increased at the middle cerebral artery using the proposed model.

CONCLUSION

Multi-modal CNN using 3D appearance information in addition to conventional 2D shape information improved sensitivity and specificity for detecting cerebral aneurysms compared with conventional CNN with 2D input only.

CLINICAL RELEVANCE/APPLICATION

Adding an auxiliary three-dimensional information can improve sensitivity and specificity of convolutional neural networks-based system for detecting cerebral aneurysms in MR angiography.

SSM20-05 Increased Diagnostic Accuracy of Giant Cell Arteritis Using Three-Dimensional Fat-saturated Contrast-Enhanced Vessel-Wall Magnetic Resonance Imaging at 3 Tesla

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S502AB

Participants
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PURPOSE

To compare the diagnostic accuracy of 3D versus 2D Contrast-Enhanced Vessel-Wall (CE-VW) MRI in the diagnosis of GCA.

METHOD AND MATERIALS

This prospective two-center study was approved by a national research ethics board and included 79 patients (51 GCA and 28 non-GCA) from December 2014 to October 2017. Two neuroradiologists, blinded to clinical data, individually analyzed 2D and 3D CE-VW MRIs separately and in random order. Discrepancies were resolved by consensus by a third neuroradiologist. The primary judgment criterion was the presence of GCA-related inflammatory changes, determined by arterial wall thickening and mural enhancement of extracranial arteries. Secondary judgment criteria included inflammatory changes of intracranial arteries and the presence of artifacts. A McNemar's test was used to compare 2D to 3D CE-VW MRIs.

RESULTS

3D CE-VW was significantly more sensitive and specific than 2D CE-VW when showing inflammatory change of extracranial arteries: 80% versus 70% (p= 0.03) and 100% versus 85% (p= 0.04), respectively. 3D CE-VW showed higher sensitivity when detecting inflammatory changes of intracranial arteries: 20% versus 8% (p=0.01).Interobserver agreement was excellent for both 2D and 3D CE-VW MRI: K = 0.84 and 0.82 respectively. There was a negative correlation between CE-VW MR diagnostic accuracy and a longer corticosteroids-MRI delay with an optimal threshold of 3 and 5 days for 2D and 3D CE-VW respectively.

CONCLUSION

3D CE-VW MRI supported more accurate diagnoses of GCA than 2D CE-VW. MRI should be performed as soon as possible, ideally before or within the first five days after corticosteroid therapy.

CLINICAL RELEVANCE/APPLICATION

3D Contrast-enhanced Vessel-wall Magnetic Resonance Imaging is a highly precise non-invasive tool that might compete for time to complete a temporal artery biopsy when Giant Cell Arteritis is suspected.

SSM20-06 Diagnostic Accuracy of Routine Non-Contrast MRI Sequences for Dural Venous Sinus Thrombosis

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S502AB

Participants
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PURPOSE

To determine what routine non-contrast MR imaging (MRI) sequence or combination of MRI sequences is most useful for the diagnosis of dural venous sinus thrombosis (DVST).

METHOD AND MATERIALS

This multicenter study included 81 DVST patients (39 men, 42 women; age range 20-91 years; mean age 50 years) who underwent routine non-contrast 1.5- or 3T MRI within 14 days of digital subtraction angiography (DSA), contrast-enhanced MR venography, and/or CT venography. The controls were 243 age- and sex-matched individuals without DVST. They also underwent routine 1.5-or 3T MRI before- or within one month after DSA. The DVSTs were located in the transverse-, sigmoid-, and/or superior sagittal sinus. Three independent, blinded observers separately evaluated T1-, T2-, diffusion-, T2*-, and susceptibility-weighed images (T1WI, T2WI, DWI, T2*WI, and SWI) and FLAIR images for the presence or absence of DVST. The area under the receiver operating characteristics curve (AUC) was calculated for each MRI sequence. Fleiss κ statistics were applied to assess interobserver agreement. Univariate and multivariate analyses were performed to evaluate the predictive value of the sequences.

RESULTS

The overall accuracy for the diagnosis of DVST was 0.592 for T1WI, 0.914 for T2WI, 0.874 for FLAIR, 0.871 for DWI, 0.792 for T2*WI, and 0.673 for SWI. T2WI and DWI were most predictive of DVST [odds ratio (OR): 41.0; 95% confidence interval (CI) 7.8 - 216.3 and OR 75.1; 95% CI 15.6 - 361.6, respectively]. The combined use of T2WI and DWI yielded significantly better diagnostic performance than each sequence alone ($p<0.05$); the AUC was 0.802 (95% CI, 0.749 - 0.856). Interobserver agreement was good for T1WI (κ=0.681), T2WI (κ= 0.795), FLAIR (κ=0.719), and T2*WI (κ=0.745). It was moderate for DWI (κ= 0.600) and fair for SWI (κ= 0.351).

CONCLUSION

Among the examined routine non-contrast brain MRI sequences, the combined use of T2WI and DWI was the most predictive of DVST.

CLINICAL RELEVANCE/APPLICATION

Routine non-contrast brain MRI sequences, especially T2WI and DWI, were useful for evaluating DVST.

SSM21

Neuroradiology/Head and Neck (Gadolinium)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S504AB

HN NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Sub-Events

SSM21-01 Analysis of Retention of Gadolinium by Brain, Bone and Blood Following Linear Gadolinium-Based Contrast Administration in Rats with Gram-Negative Endotoxin-Induced Experimental Sepsis

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S504AB

Participants
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PURPOSE

Linear gadolinium-based contrast agents (GBCA) used for MR imaging may undergo dechelation, leading to deposition of Gd3+ in the brain. This could be theoretically worsened by blood brain barrier (BBB) disruption. In a lipopolysaccharide (LPS) sepsis model in rats, we have previously demonstrated secondary neuroinflammation and sustained blood brain barrier permeability (to 6 weeks). In LPS treated and control rats, brain, blood and bone levels of Gd were compared at 24h, and at 1, 3 and 6 weeks post linear GBCA injection.

METHOD AND MATERIALS

Male Sprague Dawley rats (250 g) were injected intraperioneally with 10 mg/kg LPS. Control animals received no injection. 24h later, 0.2 mmol/kg of gadobenate dimeglumine (MultiHance®) MRI contrast medium was injected by tail vein. The brain, blood and bone were harvested at 24 h, 1 week, 3 weeks and 6 weeks post GBCA administration. Gd content was measured by inductively coupled plasma mass spectroscopy (ICP-MS).

RESULTS

There was a rapid decrease in Gd in the blood between 24h and 1 week, and thereafter was undetectable. There was no significant difference in Gd content in the blood of LPS vs control rats. Brain levels of Gd were significantly higher in LPS than control rats at all time points (4.3-fold at 24h, 2.4-fold at 1 week, 2.9-fold at 3 weeks and 3.2-fold at 6 weeks) with significant retention over time (~40% of 24h levels at 6 weeks). Bone levels of Gd were 10-fold higher than brain levels at 24 h (per kg), slightly but significantly higher in LPS than control rats (~1.3 fold), with significant retention over time (~60% of 24h levels at 6 weeks).

CONCLUSION

When GBCA was administered intravenously to rats under LPS-induced septic conditions, there was a significantly higher deposition of Gd in the brain compared to control rats. In both LPS and control rats, the brain retained substantial Gd even at 6 weeks post GBCA injection. The magnitude of findings could not be explained by differences in blood or bone levels, suggesting that BBB disruption may play a role. However, even in control rats, significant and sustained Gd occurred in the brain following linear GBCA. Comparisons to macrocyclic GBCA are warranted.

CLINICAL RELEVANCE/APPLICATION

Consideration should be given for avoidance of linear GBCA in septic patients, possibly because of enhanced vulnerability to Gd deposition due to blood brain disruption.

SSM21-02 Long-Term Retention of Gadolinium in the Cerebellum: Comparison of a Gadopiclenol, a New High-Relaxivity Macrocyclic Gadolinium-Based Contrast Agent, with Gadobutrol and Gadodiamide in a Rodent Model (Total Gd Quantification and Speciation)

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S504AB

Participants

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PURPOSE

To evaluate the long-term brain elimination kinetics and gadolinium species in healthy rats after repeated injections of gadopiclenol, a new high relaxivity gadolinium-based contrast agent (macrocyclic GBCA, currently under clinical trials) or gadobutrol (macrocyclic GBCA) as compared to gadodiamide (linear GBCA).

METHOD AND MATERIALS

N=80 healthy rats received five doses of 2.4 mmol/kg of gadopiclenol, gadobutrol or gadodiamide over 5 weeks (total dose of 12 mmol/kg), or the equivalent volume of saline. Animals were sacrificed at 1 or 5 months (M1, M5) after the last injection (n=10/group). Cerebellum was sampled to determine the total gadolinium concentration by using inductively coupled plasma mass spectrometry (ICP-MS, lower limit of quantification LLOQ=0.02 nmol/g). For the M5 group, gadolinium speciation analysis was performed after mild extraction using size exclusion chromatography coupled to ICP-MS. Elementary Gd concentrations are expressed as the remaining % of Gd per gram of wet tissue (%ID/g). Differences were evaluated with a Student t-test (significance for $p<0.05$).

RESULTS

Gadolinium content was stably retained in the cerebellum 1 and 5 months after the last injection of the linear GBCA gadodiamide (0.691±0.121 and 0.683±0.077 %ID/g*10^-6 respectively), with binding of water soluble gadolinium to macromolecules at M5, as shown in previous published studies. For the macrocyclics GBCAs gadopiclenol and gadobutrol, level of Gd were 27-fold lower than after gadodiamide at M5 (0.025±0.007 and 0.026±0.021 %ID/g*10^-6 respectively, NS except $p<0.0001$ as compared to gadodiamide group), with a 73% and 66% decrease from M1 to M5 (0.094±0.027 and 0.078±0.016 %ID/g*10^-6 at M1 for gadopiclenol and gadobutrol respectively, NS): see Figure. For macrocyclic GBCAs, only intact chelate is detected in the soluble fraction. No Gd was detected in the saline group at both delays (below the LLOQ).

CONCLUSION

After repeated administration of gadodiamide, a large portion of gadolinium was retained in the brain, with binding of soluble gadolinium to macromolecules. After repeated injections of gadopiclenol or gadobutrol, only traces of the intact chelated gadolinium were observed after 5 months, as expected for macrocyclic GBCA.

CLINICAL RELEVANCE/APPLICATION

In cerebellum, gadopiclenol, a new macrocyclic GBCA currently in clinical trials, shows massive clearance of the intact chelate, as for macrocyclic GBCA gadobutrol.

SSM21-03 Dose Finding Study of Gadopiclenol - A New Macrocyclic Gadolinium-Based Contrast Agent (GBCA) - In MRI of Central Nervous System

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S504AB

Participants
Benjamin P. Liu, MD, Chicago, IL (*Presenter*) Speakers Bureau, Guerbet SA Research Grant, Guerbet SA Research Grant, Bayer AG

PURPOSE

To determine a safe and effective dose of gadopiclenol, a new high relaxivity macrocyclic GBCA, based on the Contrast to Noise Ratio (CNR) as compared to gadobenate dimeglumine at 0.1 mmol/kg body weight.

METHOD AND MATERIALS

This double-blind, randomized, dose-parallel group and cross-over study included patients with known or highly suspected focal areas of disrupted blood brain barrier. Patients were randomized to one of four doses of gadopiclenol (0.025, 0.05, 0.1, 0.2 mmol/kg) and to one series of two MRIs: gadopiclenol and then gadobenate dimeglumine or vice versa, separated by a wash out period ranging from 2 to 14 days. Three independent off-site blinded readers performed the signal intensity measurements. Adverse events were collected up to one day post second MRI.

RESULTS

The study population included 272 patients (58.5% females) with a mean (SD) age of 53.8 (13.6) years. The superiority of gadopiclenol over gadobenate dimeglumine was statistically demonstrated at 0.2 and 0.1 mmol/kg for all three readers with an increase in CNR>30%. At 0.05 mmol/kg, gadopiclenol showed a similar CNR as gadobenate dimeglumine (Figure 1). The relationship between CNR and doses of gadopiclenol was linear for all three readers. Similar results were observed for lesion to brain ratio (LBR) and contrast enhancement percentage. Rates of adverse reactions were comparable with gadopiclenol (11.7%) and gadobenate dimeglumine (12.1%).

CONCLUSION

Gadopiclenol at 0.1 mmol/kg led to significant higher CNR, and at 0.05mmol/kg showed similar CNR magnitude as compared to gadobenate dimeglumine at 0.1 mmol/kg. A good safety profile was observed for both doses.

CLINICAL RELEVANCE/APPLICATION

Gadopiclenol, as macrocyclic GBCA with very high relaxivity, is a valuable contrast agent, owing to its improved diagnostic

performance and less concerns about potential free gadolinium toxicity.

SSM21-04 The Use of Artificial Intelligence to Evaluate Differences in Contrast Enhancement between Two Macrocyclic Gadolinium Agents in Patients with Glioblastoma Multiforme

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S504AB

Participants
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Douglas H. Patriarche, BSC, Bellevue, WA (*Abstract Co-Author*) President, A.I. Analysis, Inc
Gianpaolo Pirovano, MD, Princeton, NJ (*Abstract Co-Author*) Employee, Bracco Group
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PURPOSE

The use of gadolinium based contrast agents for MRI in patients with glioblastoma multiforme (GBM) is well known. Interest in the use of macrocyclic agents is increasing due to greater awareness of gadolinium retention issues. Macrocyclic agents vary in concentration and there has been controversy related to the efficacy of using traditional concentration (0.5 mmol/ml) versus higher concentration (1 mmol/ml) agents. We have employed the use of advanced artificial intelligence/machine learning techniques to better evaluate contrast enhanced brain MRI for patients with GBM, each of whom received both gadoteridol and gadobutrol.

METHOD AND MATERIALS

32 patients with pathologically proven GBM qualified for this study. Each patient received 0.1 mmol/kg of both gadoteridol and gadobutrol within a 2-10 day time period using a double-blind, randomized crossover technique. The images were evaluated in a blinded fashion using artificial intelligence change detection software. Enhancement characteristics for both agents were processed and the differences for each set of image pairs were calculated and analyzed. A 90% confidence interval of the mean of the difference in enhancement was calculated with a zone of equivalence defined to be from -0.2 to +0.2.

RESULTS

27 of the patients with GBM were evaluable. Five patients were excluded because of the absence of enhancement on both of their studies. The artificial intellience/machine learning software demonstrated no statistically significant difference in enhancement characteristics between the traditional concentration gadoteridol and the higher concentration gadobutrol. The p-value from paired t-test was p=0.3126. The Pearson correlation coefficient between the normalized gadoteridol and gadobutrol was 0.958 ($p<0.0001$). For all 27 image pairs, the 90% confidence intervals were within the zone of equivalence.

CONCLUSION

Artificial intelligence/machine learning software demonstrates no statistically significant difference in the evaluation of GBM when using equal doses of gadoteridol or gadobutrol. Both agents were determined to be equivalent.

CLINICAL RELEVANCE/APPLICATION

The use of artificial intelligence processes support the hypothesis that despite concentration differences, 0.1 mmol/kg of gadoteridol and gadobutrol demonstrate equivalent contrast enhancement and are equally efficacious in the evaluation of patients with GBM.

SSM21-05 Where is Retained Gadolinium Localized in the Dentate Nucleus? Simultaneous Detection of Gd and Structural Proteins by Using Metal-Tagged Antibodies and LA-ICP-MS

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S504AB

Participants
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Gregor Jost, PhD, Berlin, Germany (*Abstract Co-Author*) Employee, Bayer AG
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PURPOSE

The precise localization of gadolinium (Gd) within the deep cerebellar nuclei (DCN) is not fully understood. This study aims to co-localize Gd with the cellular environment such as blood vessels or astrocytes by combining high-resolution laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) with metal-tagged immunohistochemistry in the rat brain after repeated exposure to gadolinium-based contrast agents (GBCA).

METHOD AND MATERIALS

Rats received 8 intravenous injections of gadodiamide or gadobutrol at a dose of 1.8 mmol Gd/kg body weight and were sacrificed 35 days post injection. The spatial Gd distribution in brain sections was quantified and analyzed simultaneously with the endothelial marker von-Willebrand-factor (vWF) and the astrocytic marker GFAP detected by metal-tagged antibodies using LA-ICP-MS.

RESULTS

The immunohistological LA-ICP-MS approach was validated by comparison to classical immunofluorescence imaging. A spatial resolution of 2x2 µm2 was achieved, which enabled the co-visualization of Gd with the cellular environment. In animals treated with gadodiamide, the Gd distribution pattern was not altered after the washing and staining procedures and the DCN contained Gd

concentrations up to 10nmol/g. The Gd pattern in the DCN only partially overlapped with the endothelial marker vWF while most Gd spots did not co-localize with vWF and GFAP. In gadobutrol animals, we observed an almost complete wash out of the residual Gd during the staining procedure with the Gd present after staining being localized only in blood vessels.

CONCLUSION

An immunohistological LA-ICP-MS approach was used to reveal the spatial context of Gd in the rat brain following GBCA administration. We observed differences between linear gadodiamide and macrocyclic gadobutrol. Whereas in gadobutrol animals, the remaining Gd traces were located in the vasculature, this was only a minor fraction of Gd in gadodiamide animals. It needs to be elucidated whether the major fraction of Gd co-localizes with other histological markers.

CLINICAL RELEVANCE/APPLICATION

In stained rat brain sections, Gd from linear gadodiamide but not macrocyclic gadobutrol was found outside of the vascular system.

SSM21-06 Gadolinium-induced Hypophosphatemia Does Not Correlate with Gadolinium Deposition in the Brain in Multiple Sclerosis Patients Undergoing Monthly Triple-Dose Gadopentetate Dimeglumine CE-MRI

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S504AB

Participants
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Reshma Munbodh, PHD, New Haven, CT (*Abstract Co-Author*) Research support, Guerbet SA
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PURPOSE

The researchers have previously shown hypophosphatemia and increased T1 signal intensity (SI) after serial gadolinium administration. Transmetallation of gadolinium and co-precipitation with phosphate, with subsequent deposition as an insoluble gadolinium species, could help to explain these abnormalities. This would be a first-of-its-kind correlation of abnormal SI changes in the brain due to gadolinium deposition manifesting contemporaneously with a metabolic abnormality that could serve as a pathophysiologic link and/or inexpensive biomarker of this recently discovered phenomenon.

METHOD AND MATERIALS

The study cohort consisted of 75 patients with MS or Clinically Isolated Syndromes typical of MS who were randomized ~1:1 to Betaseron or Copaxone as part of the BECOME trial. Monthly follow-up MRI using off-label triple-dose gadopentetate dimeglumine (0.3mmol/kg) for up to 24 months included pre-MRI blood and urine samples for maintenance of protocol safety. ROI creation using a boundary approximation manual segmentation technique was performed from the MRI data to establish potential SI changes due to gadolinium deposition as represented by increased T1 SI. C/N ratios established average SI change over the first 12 months of the study, defined as: C/N = [Gray Matter Structure - White Matter Reference Structure] / Air. Phosphate levels were analyzed using the general estimation equation; type 3 test of fixed effects was performed to correlate phosphate and SI changes.

RESULTS

Increased T1 SI changes were seen in all grey matter structures analyzed: caudate head: C/N = 0.037 (S.E. 0.0037, $p<0.0001$); putamen: C/N = 0.031 (S.E. 0.0034, $p<0.0001$); globus pallidus: C/N = 0.046 (S.E. 0.0035, $p<0.0001$); thalamic pulvinar: C/N = 0.026 (S.E. 0.0027, $p<0.0001$); dentate nucleus: C/N = 0.098 (S.E. 0.0070, $p<0.0001$). Incidence of hypophosphatemia (<2.5 mg/dl) increased significantly over the course of the study in both treatment arms with an odds ratio of 1.267 (1.198, 1.344, $p<0.001$). No significant difference for any grey matter structure was seen between hypophosphatemic and normophosphatemic groups.

CONCLUSION

There is no correlation between hypophosphatemia and increased T1 signal of grey matter due to gadolinium deposition.

CLINICAL RELEVANCE/APPLICATION

Hypophosphatemia should be monitored and corrected in any patient undergoing serial CE-MRI, but its role in the pathophysiology of gadolinium deposition in the brain appears equivocal.

SSM22

Pediatrics (Neuroradiology and Fetal Neuroimaging)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S103AB

NR OB PD

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Beth M. Kline-Fath, MD, Cincinnati, OH (*Moderator*) Nothing to Disclose
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Sub-Events

SSM22-01 Assessment of Normal Fetal Brain Development with No Biased-Apparent Diffusion Coefficient Values: A Prenatal MR Study

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S103AB

Participants
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PURPOSE

Fetal imaging is often perturbed by artifacts affecting the quality of Diffusion Weighted Imaging (DWI), with biased ADC measurements. In this context, the purpose of our study was to investigate the potential of denoising DWI to ameliorate the reliability of ADC values in the study of normal fetal brain maturation.

METHOD AND MATERIALS

36 normal pregnancies underwent fetal MR at 1.5T, using a normal fetal brain protocol including DW-Spin Echo EPI with three b-values (50, 200, 700 s/mm²). Seven ROIs were manually placed in Frontal White Matter (FWM), Occipital WM (OWM), Thalamus (TH), Basal Ganglia (BG), Cerebellum (CH), Pons and Cerebral Spinal Fluid (CSF). Raw data were denoised and DWI were segmented to eliminate CSF. Differences of ADC values occuring in II and III trimester with and without DWI denoising were calculated. Signal-to-Noise Ratio (SNR) was obtained with and without denoising correction. The correlation between ADC in different ROIs and GA was obtained.

RESULTS

SNR considerably increased with denoising correction. Significant differences in ADC mean values of CH, Pons, FWM and TH calculated in II and III trimester were found ($p<0.01$). ADC values of TH, CH and Pons show a progressive decline in mean diffusivity ($p<0.001$), depicting a decrease of anisotropy. Positive correlations were found between ADC and GA in FWM ROI ($p<0.05$). In particular, a bi-quadratic fashion in FWM ROI was found: during the II trimester the ADC increase, with a descending trend during the III trimester.

CONCLUSION

Due to the high amount of imaging artifacts in fetal imaging, denoising DWI is desireable to obtain reliable ADC values and charachterize normal fetal brain development. In our sample, no biased ADC parameters showed statistically significant changes in mean values of different fetal brain ROIs: this highlights the physiological heterogeneous microstructural changes occurring during normal fetal brain development, in terms of proliferation, migration and myelination processess.

CLINICAL RELEVANCE/APPLICATION

The study of denoised DW imaging of normal fetal brain is relevant in clinical practice since it allows the measurement of no biased ADC values of physiological brain maturation. The knowledge of normal ADC parameters represent a non-pathological comparison base and a helpful prenatal diagnostic tool to improve the complicated prenatal diagnosis of suspected fetal brain anomalies.

SSM22-02 Asymmetry of Superior Longitudinal Fasciculus Microstructure in Preterm Human Brain Revealed by Diffusion Tensor Imaging

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S103AB

Participants
Hong Zhu, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Language laterization in the human was one of the earliest observations of brain asymmetry. The influence of age on language laterization is unknown during the 3rd trimester. We employed diffusion tensor imaging (DTI) to investigate the white matter (WM) microstructure of language associated tract, superior longitudinal fasciculus (SLF), in preterm- and term-born neonates. We hypothesized that there is an age-related increase of asymmetry of SLF microstructure during 3rd trimester.

METHOD AND MATERIALS

High resolution (1.5x1.5x1.6 mm3) diffusion weighted imaging data with b values of 1000 s/mm2 were acquired from 61 neonates with ages of 31-42 postmenstrual weeks (PMW). Correction for eddy current distortion, tensor fitting, and deterministic diffusion tractography of SLF were conducted in DTIStudio. Specifically, the fiber tracing was terminated when the fractional anisotropy (FA) value was below 0.15 or the turning angle was greater than 50 degrees. An asymmetry index of FA in SLF was calculated as (Left FA - Right FA) / (Left FA + Right FA). A positive value indicated a leftward asymmetry.

RESULTS

Dramatically morphological changes of SLF from 31 to 42 PMW were observed. In addition, FA values in both left ($r=0.794$, $p<0.001$) and right ($r=0.758$, $p<0.001$) SLF significantly increased with age, suggesting WM microstructural maturation in SLF. Compared right SLF, left SLF was characterized with lower initial FA values and faster FA increase. Age-related growth trend lines of FA for left and right SLF intersected around 36 PWM. Interestingly, the asymmetry index of FA in SLF significantly increased with age ($r=0.330$, $p<0.01$), reflecting a transition toward a leftward structural asymmetry. All neonates were categorized into 3 age groups based on their scan ages to further explore the development of language lateralization. The asymmetry index of FA in SLF from groups aged 34-38 PMW and 38-42 PMW were significantly larger ($p<0.05$) than that of the youngest group (30-34 PMW) ($p<0.05$).

CONCLUSION

During the 3rd trimester, we observed age-related increase of leftward asymmetry in the WM microstructural maturation in language associated tract SLF.

CLINICAL RELEVANCE/APPLICATION

Age-related increase of leftward-laterization in language associated tract during 3rd trimester was found. This may serve as an anatomical substrate that enables the following language production.

SSM22-03 Early Fetal Brain Sulcation: Reassessing Initial Detection Age in Fetal MRI

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S103AB

Participants
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PURPOSE

To re-evaluate early brain sulcation patterns in MRI, focusing on early midline sulci

METHOD AND MATERIALS

Out of the 658 fetal MRI's performed in our referral hospital over two years, 321 cases were performed before 20weeks. In 67 fetuses normal brain MRI was confirmed with normal post-delivery outcome as assessed with ASQ questionnaires. The sylvian sulcus (SS), also the calcarine (cal), and parietooccipital (POF) fissures were assessed subjectively by two radiologists with 9 and 8 years of experience in neuro and fetal imaging. The sulci were evaluated in standard orthogonal planes, but also in non-orthogonal nonstandard planes. We also included the axial view of proximal calcarine sulcus previously described in a previous study on postmortem fetal MRI at 7T and also postmortem pathology studies. The SS was graded based on the grading by Pretorius et al (0-5).Other sulci were assessed by the method of Van der Knaap et al (0-6)

RESULTS

The mean scores for SS was 1, 1, 1, and 1.14 in fetuses with GA's of 16, 17, 18 and 19 respectively. The right POF mean scores was 0.66, 0.50, 0.22 ,and 0.97 in fetuses with GA's of 16, 17, 18 and 19 respectively. The left POF mean scores were 0, 0.50, 0.27,and 0.76 in GA's of 16,17,18 and 19 respectively.The mean scores for right Cal in the standard coronal plane was 0, 0,0.27,and0.15 in GA's of 16,17, 18 and19 weeks respectively, While the mean scores for the proximal Cal in axial images was1, 0.5, 0.44, and 1.36.The mean scores for left Cal in the standard coronal plane was 0, 0, 0.16, and 0.10 in GA's of 16,17,18 and 19 weeks respectively while mean scores for the proximal Cal in axial images was 0.66, 0.25, 0.44, and 1.33. The axial and oblique axial images could detect a higher number of Cal's comparing to the standard coronal view.

CONCLUSION

Early midline sulci may be consistently visible in fetal MRI earlier than previously believed. For earlier detection these sulci should be sought not only in the standard orthogonal views, but also in non-orthogonal views.

CLINICAL RELEVANCE/APPLICATION

With more frequent and earlier use of fetal MRI, also with time restrictions imposed by legal abortion dates in many countries, a better understanding of the appearance of the early brain development has become necessary. Without a thorough understanding of the normal appearance, abnormal patterns cannot be recognized accurately.

SSM22-05 In-Utero Diffusion Weighted Imaging with Denoising Correction in the Study of Fetal Brain Microstructure in Isolated Ventriculomegaly

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S103AB

Participants
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PURPOSE

To investigate the potential of denoised DW imaging to study fetal brain affected by Venticulomegaly (VM) and to obtain improved ADC values for the characterization of fetal brain microstructure impairment.

METHOD AND MATERIALS

Fetal MR with Diffusion-weighted imaging (DWI) was performed in 48 fetuses at 1.5 T. The fetal brain MR protocol included a DW-Spin Echo EPI with three b-values (50, 200, 700 s/mm²). Dwidenoise tool and Unring software were used to denoise and correct diffusion imaging. Eight ROIs were manually placed in both normal and VM fetal brains in Centrum Semiovale (CSO), Frontal White Matter (FWM), Occipital WM (OWM), Thalamus (TH), Basal Ganglia (BG) Cerebellum (CH), Pons and Cerebral Spinal Fluid (CSF). In some VM cases, ROIs could not be placed in FWM, BG, TH, OWM, CH due to the severity of VM. ADC values were measured voxel-by-voxel with a MATLAB fitting procedure. Differences in ADC measurements of normal and VM fetal brains and their correlation with Gestational Age (GA) were calculated.

RESULTS

In VM fetuses, ADC measurements were statistically significant different than normal brain, especially in CSO, TH and CSF ROIs ($p<0.02$), with different ADC values in II and III trimester of normal ($p<0.001$) and VM fetuses ($p<0.05$). In VM fetal brains, ADC values in CSO in the III trimester were higher than normal and in TH ROI statistically significant lower ADC values were found in the II trimester. Negative correlation were found between ADC values and GA in CSO, TH, CH and Pons ROIs, both VM and normal brains, showing a progressive decline in diffusivity.

CONCLUSION

The knowledge of reliable ADC values through denoising correction is a helpful tool able to better discriminate microstructural impairment occurring in fetal brain tissue during prenatal life. Our results showed differences in ADC measurement obtained in VM and normal fetal brains, in particular the increasing of ADC values in CSO may reflect the increment of anisotropy occurring in an impaired and non-ordered white matter affected by VM.

CLINICAL RELEVANCE/APPLICATION

In clinical practice, fetal DWI is often complicated by low imaging quality due to fetal motion artifacts. Denoising correction is crucial to allow a proper ADC measurement, providing a correct in vivo characterization of microstructural brain impairment in fetuses affected by VM, being helpful in the prenatal management of those pregnancies.

SSM22-06 Fetal Optic Structures: A Postmortem MRI Study

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S103AB

Participants
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Gerlinde Gruber, Vienna, Austria (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To establish normal values for fetal MRI of optic structures and to identify pathologies in order to supply basic information for future in vivo studies.

METHOD AND MATERIALS

Fifty-eight cases (16 - 42 gestational weeks), consisting of 33 fetuses with normal development of the optical structures and 25 fetuses with pathologies, were included. The pathological group was composed of: complex malformations (15), premature rupture

of membranes (4), twin-associated problems (3), intrauterine growth restriction (2), and stillbirth (1). Postmortem MRI was obtained within 24 hours of fetal demise using a 3T MR scanner (Siemens Trio) and an eight channel knee coil. Measurements were performed on axial T2-weighted images (TR 300ms, TE 140ms, isovoxel 0.4mm CISS 3D sequence) using Image J software. The following measurements were taken and correlated with gestational age: optic nerves: maximum diameter at retrobulbar and intracranial location; total length; angle between optic nerves; and optic chiasm: minimum transverse diameter.

RESULTS

Total optic nerve length increased from 10.5 mm to 29.4 mm within 26 weeks and correlated significantly with GA ($r=0.885$, $p<0.001$). Retrobulbar optic nerve diameter increased from 0.83 to 2.13 mm (right side) and 0.860 to 2.108 mm (left side) within 25 weeks, and correlated significantly with gestational age (right: $r=0.852$, $p<0.001$; left: $r=0.843$, $p=<0.001$). The angle of the optic nerves in front of the optic chiasm became considerably more acute with increasing age (111.49 - 75.04 degrees from 16 to 36 gestation weeks, correlation with gestational age $r=-0.741$, $p<0.001$). The course of the optic nerves altered with gestation. In young fetuses, the optic nerves had a U- evolving to a V-shape with higher gestational age. Fetuses in the pathologic group showed significant aberrations in one to three of the above-described parameters.

CONCLUSION

As sizes of fetal optic structures correlate with gestational age, and the shape of the optic chiasm changes from a U- to a V-form from early to late gestation, developmental deviations of the optic nerves and chiasm that may be part of malformative or acquired conditions, can be detected sensitively in postmortem MRI.

CLINICAL RELEVANCE/APPLICATION

Normal values of optic fetal structures obtained in this study allow the sensitive detection of developmental deviations that may be part of malformative or acquired conditions.

Printed on: 10/29/20

SSM23

Physics (Radiation Therapy/Outcome Modeling/Image Processing)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S102CD

PH RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Carri Glide-Hurst, PHD, Detroit, MI (*Moderator*) Researcher, ViewRay, Inc; Research Consultant, Koninklijke Philips NV; Researcher, Koninklijke Philips NV; Researcher, Modus Medical Devices Inc; Equipment support, Medspira, LLC; Equipment support, QFix
Cem Altunbas, PhD, Aurora, CO (*Moderator*) Nothing to Disclose

Sub-Events

SSM23-01 Normalizing the Response of a Fixed Geometry EPID Using a Flattening Phantom on a Ring Gantry Linear Accelerator

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S102CD

Participants
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CONCLUSION

Based on our results, it is possible to characterize pixel variations by designing a phantom that flattens the beam at the EPID. In the near future, this phantom will be milled to validate the flatness of the beam at the level of the EPID. Finally, the EPID response under this flattening phantom can be directly used as the new "flood field" to correct the pixel response variations.

Background

Previous solutions that calibrated the variations of pixel response for the EPIDs on-board C-arm linacs used either a flat beam or a movable EPID panel. However, the Halcyon (Varian Medical Systems, Palo Alto, CA) is a ring gantry linac with a 6 MV flattening-filter-free (FFF) beam and an EPID rigidly fixed to the gantry. Therefore, this study introduces a strategy to design a beam flattening phantom, which is intended to calibrate the variations of pixel response while preserving the beam dosimetry features on EPID images derived from the Halcyon linac.

Evaluation

EPID images were acquired by irradiating a set of rectilinear solid water phantoms with various thicknesses (0-15 cm). Each solid water phantom was placed at the same position on the couch with a fixed source-to-couch distance (100 cm) and an open field set at the maximum size of 28 cm x 28 cm. Based on the EPID response as a function of solid water thickness, a quadratic form of the attenuation equation was fit with 2D parameter maps, a(x,y) and ß(x,y), which represent the first- and second- order attenuation of a poly-energetic beam. With the 2D attenuation coefficient maps and the ratio of ideal EPID response of the 6FFF beam to a flattened beam, a 2D phantom thickness map was derived.

Discussion

On the central-axis, the beam required 66% attenuation for the flattening phantom. The final flattening phantom design had an overall conical shape with a maximum thickness of 5.6 cm, making it economical and lightweight. Regression values for the linear fits used in our approach ranged between 94% and 95% with a maximum absolute fit error of 0.0083.

SSM23-02 Proton-Induced Acoustic Computed Tomography for Online Proton Beam Range Verification

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S102CD

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PURPOSE

To localize the proton Bragg Peak by measuring the acoustic emissions generated by a pulsed proton spill from a clinical synchrocyclotron, ideally in real-time and noninvasively during patient treatment.

METHOD AND MATERIALS

A proton-induced acoustic computed tomography system based on 1MHz two-dimensional matrix array ultrasound probe with 256-elements, a 256-32ch switch and a parallel data acquisition system has been developed. The matrix array will now be placed in a water tank in front of the proton nozzle which enables rendering of the proton-induced acoustic images without mechanical scanning. The data acquisition will be synchronized by a trigger signal provided by the MEVION S250i Hyperscan proton therapy system. The digitized data will then be sent to the computer for real-time processing to generate proton-induced acoustic images with a full-field 3D filtered back-projection algorithm.

RESULTS

Hyperscan system has pulse width modulation from 0.5 to 20 us. On average, a full energy (230 MeV) pulse of 6.5 us produces 8 pC (~5x 10^7 protons) and deposits 3.2 cGy under Bragg peak. The total dose distribution of scanned proton pencil beams was simulated. The maximum spatial resolution of the proton-induced acoustic computed tomography was calculated to be about 1 mm, which is much better than the current range verification techniques proposed, for example, positron emission tomography and prompt gamma imaging. In addition, the proton-induced acoustic computed tomography system can obtain 50 frames of images per second without scanning, which means real-time in vivo images could be obtained during treatment to ensure the delivered dose distribution is as expected.

CONCLUSION

These results highlight the excellent prospect of the proton-induced acoustic computed tomography in clinical transformation providing the Bragg peak location, and monitoring proton dose distribution during radiation therapy.

CLINICAL RELEVANCE/APPLICATION

Proton-induced acoustic computed tomography provides real-time feedback with the possibility of adjustment during the treatment which reduces proton range uncertainty and improves the treatment output.

SSM23-03 Improving CBCT Quality to CT Level for Adaptive Radiation Therapy Using Deep-Learning with Generative Adversarial Network

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S102CD

Participants
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PURPOSE

To apply a deep-learning based algorithm to improve CBCT image quality and HU accuracy for extended clinical applications, especially for adaptive radiotherapy for proton and photon treatments.

METHOD AND MATERIALS

Data from 150 pelvic patients with paired planning CT and CBCT were used in this study. All CT images were collected in GE LightSpeed VCT scanner and CBCT images were acquired with Varian Truebeam. A 2.5D pixel to pixel generative adversarial network (2.5D GAN) model with feature matching (FM) loss was trained to translate from a source domain (CBCT) to a target domain (dCBCT). Image pre-processing including denoising and suppressing non-uniformity by a non-local means method. Registration was applied to map the planning CT to CBCT using Velocity and worked as the ground-truth CT. A total of 10800 slices were used for training and validating the GAN-based model, while 1200 slices of CT and CBCT were used for testing. The obtained deep-learning based CBCT were compared to ground-truth CT in terms of mean absolute error (MAE) in Hounsfield Unit (HU) and peak signal-to-noise ratio (PSNR), and compared with other deep learning methods, including U-net, 2D GAN without FM, 2.5D GAN without FM, 2D GAN with FM.

RESULTS

A 10-fold cross-validation was used to evaluate the deep-learning algorithm. The mean MAE improved from 26.1±9.9 HU (CBCT vs. CT) to 8.1±1.3 HU (dCBCT vs. CT) for all 1200 test slices and the PSNR also increased from 16.7±10.2 (CBCT vs. CT) to 24.0±7.5 (dCBCT vs. CT). The experiments were performed on a GPU-optimized workstation with a single NVIDIA GeForce GTX Titan X (12GB, Maxwell architecture) and written in Python 3.5. After training the model, each slice took 11-12 ms to process and a 3D-volume of the dCBCT (80 slices) could be generated in less than one second.

CONCLUSION

We presented a deep-learning based algorithm to improve CBCT image quality close to the level of CT in a time efficient manner

which opens up the possibility for online CBCT-based adaptive radiotherapy.

CLINICAL RELEVANCE/APPLICATION

The presented method is also promising as the improved quality CBCT scan can achieve close HU density to CT, thus have the potential to be used for adaptive planning.

SSM23-04 Evaluating the Complimentary Role of Pseudo-STIR in Assessment of Hyperintense Marrow Lesions as Compared to T2-STIR

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S102CD

Participants
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PURPOSE

T2W weighted images contain inherent T1W weighted contrast. Pseudo-STIR images are generated by a simple post processing technique of subtracting T1W images from the T2W images. In this study we probe the diagnostic value of Pseudo-STIR to identify hyperintense marrow lesions in comparison with T2 STIR sequences.

METHOD AND MATERIALS

117 spine MR cases with sagittal T1FSE (n=85) or T1 FLAIR (n=32), T2W and STIR images from studies performed on 1.5T and 3.0T machines were extracted from PACS. The Pseudo-STIR images were created on an Osirix workstation by using the subtraction tool. The resulting 234 sets of STIR and Pseudo-STIR images were anonymized and blindly read by three independent Radiologists (R1, R2, R3 with 13 years, 16 years and 32 years of experience) with respect to the number of hyperintense lesions seen. The quality of study, and the confidence level of the observer in rating the lesions were also encoded. Accuracy for each Pseudo-STIR case was determined based on the observers' ability to match their independently reported count of the corresponding STIR Image.

RESULTS

The accuracy of the observers in reporting the count of hyper intense lesions in the Pseudo-STIR cases was reasonably good (R1: 69 %, R2: 78 %, R3: 64 %). The accuracy increased when the observers reported on cases where they assigned the highest image quality rating of three. All three reporters were more accurate while reporting cases that they gave the highest confidence rating of three (R1: 75 %, R2: 80 %, R3: 69%). It was observed that only two out of 117 cases (both T1 FLAIR derived Pseudo-STIR) were incorrectly marked by all three observers. Additionally, there was no significant bias in quality rating (at the highest rating of three) with respect to the Pseudo-STIR origin, with R1 (76% / 24 %), R2 (77 % / 23 %) and R3 (69 % / 31 %) scoring in line with the data distribution (73% / 27%). Finally, statistical testing for difference in accuracy based on Pseudo-STIR origin (T1FSE / T1 FLAIR), revealed no difference in each of the three observers.

CONCLUSION

These results point to the value offered by including STIR sequence in an MSK protocol. In the absence of a specific view plane, a Pseudo-STIR provides supporting evidence.

CLINICAL RELEVANCE/APPLICATION

In this study, we demonstrate potential complimentary value offered by a simple post processing technique especially in situations where the STIR sequence is not obtained prospectively

SSM23-05 Prediction of Cervical Nodal Metastasis Using Primary Head and Neck Cancer Tumor Deep Features Extracted from Dual-Energy CT Color Iodine Maps

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S102CD

Participants
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PURPOSE

Establish whether convolutional neural networks (CNNs) pre-trained on everyday color images can be repurposed for prediction of lymphadenopathy based on primary tumor characteristics alone, using dual-energy CT color iodine maps.

METHOD AND MATERIALS

The dataset comprised 84 patients with head-and-neck squamous-cell-carcinoma. DICOM images of the central tumor slice (8 bits in each RGB channel) were converted to PNG format. The part of each image outside the tumor was made black. Images were cropped to the sizes appropriate for use with pre-trained CNNs. Three feature extraction methods (a method being defined by a CNN and a layer within it) were used: Alexnet 'fc6', Alexnet 'fc7', and Resnet18 'pool5'. This produced 4096, 4096, and 512 features, respectively. In all 3 cases, LASSO (variable selection and model building using L1 regularization) was used to choose a minimal set of features that are combined linearly to build a prediction model. The chosen λ parameter minimized the mean-squared-error (MSE). Performance metrics based on 4-fold cross validation were obtained. The reduced feature was fed to the t-distributed Stochastic Neighbor Embedding (t-SNE) algorithm to reduce dimensionality to 2 and illustrate the patients with positive and negative outcomes using a scatter plot.

RESULTS

LASSO chose 3 features for Alexnet 'fc6', 11 features for Alexnet 'fc7', and 7 features for Resnet18 'pool5'. Alexnet 'fc6' had accuracy = 0.76, sensitivity = 0.74, specificity = 0.79, and AUC = 0.86. We report the performance of the most parsimonious model (3 features) as it is least likely to suffer from over-fitting. The left figure shows how the λ parameter was chosen. The right figure shows the 2D representation of the cohort as obtained using the t-SNE algorithm. The hand-drawn line shows a separation accuracy consistent with what was reported.

CONCLUSION

To the best of our knowledge, this is the first demonstration that color iodine maps can be analyzed using pre-trained CNNs to for tumor characterization beyond what is currently done in clinical practice. The results need to be corroborated with external validation.

CLINICAL RELEVANCE/APPLICATION

This first successful demonstration of using iodine maps as color images to produce a quantitative biomarker using deep learning could lead to superior utilization of these maps.

SSM23-06 Imaging-Based Survival Prediction of Liver Cancer Patients Using Cox Proportional Hazard Models with Quantitative Texture and Shape Features

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S102CD

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CONCLUSION

Our method can be applied to construct the imaging feature-based staging system which can predict the survival rate more accurately than the conventional TNM staging. *(This work was supported by Radiation Technology R&D program through the NRF of Korea (NRF-2017M2A2A7A02070427))*

Background

Prediction of survival period of liver cancer patients is an important task for treatment and therapy planning of patients. However, most of the current survival prediction depends on clinical information such as tumor size and metastasis. In this work, we propose a survival prediction system for liver cancer patients using quantitative imaging features including texture and shape features of tumors. In addition to the validation of the feasibility of imaging features for survival prediction, we analyze the key imaging features significantly affecting the survival of patients.

Evaluation

Our method was evaluated on a CT dataset acquired from 171 liver cancer patients with survival period recordings. All tumors were manually segmented by the clinical expert. From the tumor ROI images, the quantitative imaging features of 128-dimensions consisting of 119 texture features and 9 shape features. The Cox proportional hazard function was then fitted with those imaging features and survival periods. From the fitted Cox model, the features with the highest exponent weights were considered as key features for the survival. In experiments, the survival function was marginally fitted with the imaging-feature-based Cox model, which indicates the imaging features have a potential for survival prediction. In addition, the texture features including LBP and GLRLM low run features and the shape features including solidity and eccentricity were selected as the key features for the patient survival.

Discussion

The proposed method investigates the usefulness of quantitative imaging features instead of conventional patient information to predict time-variant survival in liver cancer patients. Throughout the Cox model fitting with imaging features, it was observed that the entropy-related texture features and size-related shape features have a significant effect on the prediction of the survival period.

SSM24

Radiation Oncology (Head and Neck, Skin)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S104A

HN NR RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

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Stuart E. Samuels, MD, Miami, FL (*Moderator*) Nothing to Disclose

Sub-Events

SSM24-01 Merkel Cell Carcinoma Recurrence Risk Increases with Delay of Post-Operative Radiation Therapy

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S104A

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PURPOSE

Merkel cell carcinoma (MCC) is a rare, aggressive skin cancer often treated with surgery followed by post-operative radiation therapy (PORT). Many factors affect the time interval between definitive surgery and initiation of PORT. The importance of minimizing this interval in MCC is unclear. We therefore evaluated the relationship of local-regional recurrences (LRRs) with the time interval between definitive surgery and initiation of PORT (time to PORT, TTP).

METHOD AND MATERIALS

We used an IRB-approved, prospective MCC registry to evaluate 125 patients with stage I/II (AJCC 8th edition) MCC. All patients had received definitive surgery and PORT that was initiated within 6 months of diagnosis. LRRs were defined as local, in-transit, and/or regional recurrences. Fine & Gray competing risk regression models were used to evaluate associations between the TTP and LRR, with distant recurrences and death treated as competing risks.

RESULTS

The cohort consisted of 125 patients with a median TTP of 41 days [8-125 days]. All were node negative (84% pN0, 16% cN0) and 14% had positive margins following definitive surgery. Median total dose and fractionation of PORT was 50 Gy [42-67 Gy] in 25 fractions [20-37 fractions]. 14% of patients experienced LRR, with a median follow-up of 1622 days [34-4703]. LRR at 5 years was markedly increased for TTP >=8 weeks (25% LRR) as compared to TTP <8 weeks (10% LRR; p=0.049). There was a significant increasing trend toward higher risk of LRR with longer time delays to PORT, with a hazard ratio of 1.17 per 1-week increase in TTP (p=0.003). Importantly, 15 of 17 LRRs (88%) occurred outside the radiation field (specifically, 2 of 3 locally, 5 of 6 in-transit, and 8 of 8 in regional lymph nodes).

CONCLUSION

In this cohort, TTP of >=8 weeks correlated with increased LRRs compared to <8 weeks in patients with stage I/II MCC. In the 4 to 10 week range of TTP, each subsequent week was associated with a 17% increase in LRRs. The majority of LRRs occurred outside the radiation field, suggesting that delay in PORT may allow MCC cells within the surgical bed to spread.

CLINICAL RELEVANCE/APPLICATION

Our data suggest that minimizing time delay to post-operative radiation therapy in patients with localized Merkel cell carcinoma reduces the risk of local-regional recurrence.

SSM24-02 High Dose Rate Brachytherapy in Elderly Patients with Non-Melanoma Skin Cancer - Clinical and Cosmetic Outcome

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S104A

Participants
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PURPOSE

High dose rate brachytherapy (HDRBT) is a well-recognonized, but little used form of therapy for early stage non-melanoma skin cancer of the head and neck region. It offers a shorter course of therapy in the elderly population making it an attractive alternative to conventional electron therapy or surgical resection.We present a large series of patients treated with HDRBT using superficial molds with mature follow-up at a single community institution.

METHOD AND MATERIALS

Seventy patients with 81 lesions of either Basal cell carcinoma (BCC, n=53) or Squamous cell carcinoma (SCC, n=28) were treated between August 2013 and April 2019. The sites included nose (n=37), face (n=11), forehead/scalp (n=9), ear (n=8), neck (n=2), and legs (n=14). The median age of the patients was 85 years (range 70-100). The mean size of the lesion was 10 mm (range 3-26mm). Customized Liepzig applicators were used to treat the lesion with a 4 mm margin. A fractionation regimen of 700 cGy per fraction for 6 sessions over two weeks was used. The dose was prescribed at 3 mm depth. The patients were followed regularly in both radiation oncology and dermatology clinics.

RESULTS

The median follow-up was 24 months (range 1-48). The local control was 98% for BCC and 96% for SCC respectively. Two patients, 1 each with SCC and BCC recurred at 3 and 6 months from the time of therapy respectively. Both the recurrences were >2cm in size and involved lower extremity. The cosmetic outlook was excellent in 90% of all cases. Minor late effects in 6 patients included Hypopigmentation (n=3), Hyperpigmentation (n=2), telangiectasia (n=2) and atrophy of the skin (n=1). Two patients experienced wound breakdown 12 and 14 months after completion of therapy. No cases of cartilage necrosis was seen.

CONCLUSION

HDRBT using customized mold applicators offer an alternative option to Mohs surgery in elderly patients with early stage non-melanoma skin cancers with excellent local control and cosmetic outcome.

CLINICAL RELEVANCE/APPLICATION

High dose rate brachytherapy using customized superficial mold applicators offer an alternative strategy to Mohs surgical resection for elderly patients presenting with early stage basal and squamous cell carcinoma of the skin in the head and neck region.

SSM24-03 Prior Attentions Constrained Convolutional Neural Network-Based Organs Segmentation for Nasopharyngeal Carcinoma Radiotherapy

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S104A

Participants
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PURPOSE

To develop a spatially prior attention constrained convolutional neural network for the accurate organs at risk (OARs) segmentation in nasopharyngeal carcinoma (NPC) radiotherapy.

METHOD AND MATERIALS

To achieve OARs segmentation for NPC radiotherapy, a stepwise segmentation refinement(SSR) framework is proposed, which includes three segmentation steps: OARs groups, large/easy OARs and small/difficult OARs segmentation. 41 OARs are included in this segmentation task. Firstly, all OARs are divided as four groups, and segmented on the down sampled image via 3D ResUNet (UNet with residual shortcut connections). With the segmented mask of each OAR group, a smaller region of interest (ROI) is obtained for the large volume or easy OARs segmentation. Considering the previous rough segmentation as a spatial prior, we developed a prior attention constrained UNet (termed as PAUNet), in which, the feature maps extracted by double convolution is multiplied with the spatial attention combined from the prior and channel averaged feature map. The small/difficult OARs group is also regarded as one target and segmented in this step. Similarly, the small OARs(such as optical nerve, pituitary, etc.) are also segmented by a specifically trained PAUNet on the corresponding ROIs. The segmentation accuracy of the proposed stepwise segmentation refinement framework is evaluated on 139 CT images from NPC patients. 112 patients are used for training, and the rest are for testing. The segmentation accuracy is quantitatively evaluated by the Dice's coefficient (DSC). Higher DSC indicates more accurate OAR segmentation.

RESULTS

With the SSR framework, the PAUNet achieved superior performance than UNet with mean DSC improved from 50.3%~91.7% to 55.9%~93.7% for all OARs. For the OARs with small volume or low contrast, the proposed method improves the mean DSC from 65.9(±9.9)%, 66.4(±9.3)%, 52.5(±13.7) and 50.3(±35.8)% to 76.3(±7.7)%, 75.9(±5.4)%,60.3(±14.2) and 55.9(±33.2)% for right optical nerve, left optical nerve, chiasm and pituitary, respectively. Figure 1 illustrates the segmentation result of a test case.

CONCLUSION

41 OARs are segmentated accurately based on the proposed PAUNet based SSR framwork, whcih is superior over the UNet.

CLINICAL RELEVANCE/APPLICATION

The accurate quantitative evaluation results demonstrate the PAUNet based SSR framework is effective in OARs segmentation for NPC radiotherapy, which is also suitable for H&N radiotherapy.

SSM24-04 The Prognostic Significance of Post-Treatment FDG-PET/CT after Definitive Chemoradiation Therapy in Oropharyngeal Squamous Cell Carcinoma

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S104A

Awards
Trainee Research Prize - Medical Student

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PURPOSE

To determine if 3-month post-therapy PET/CT with F-18 fluorodeoxyglucose (FDG) can predict clinical outcomes in patients with oropharyngeal squamous cell carcinoma (OPSCC) treated with definitive chemo-radiation therapy (CRT).

METHOD AND MATERIALS

An IRB-approved retrospective database was used to identify patients with OPSCC treated with definitive CRT between 2004 - 2016. Patients receiving any surgery and RT alone were excluded. The 3-month post-CRT FDG-PET/CT studies were reviewed for complete response (CR), presence of residual FDG uptake (RD), and increase in FDG uptake and/or new areas of FDG uptake (i.e. progressive disease, PD). Patient- and treatment-specific factors including age, race, stage, HPV/p16 status, smoking status, type of chemotherapy, RT dose, and treatment response by post-CRT PET/CT were analyzed using multivariable cox proportional hazards method to evaluate factors associated with locoregional control (LRC), distant control (DC), and overall survival (OS). Kaplan-Meier method and log-rank statistics were used to compare LRC, DC, and OS between patients with CR, RD, and PD.

RESULTS

A total of 96 patients were included. The median follow-up was 44.7 months. The median age at diagnosis was 57.7 (range: 38.5-87.2) years. HPV/p16 status was positive in 34.4%, negative in 18.8%, and not assessed in 46.9% patients. Concurrent cisplatin chemotherapy was used in 76% patients. On multivariate analysis, HPV/p16 positivity was associated with an improved OS (HR 0.19, 95% CI 0.06 - 0.63, P = 0.01). Patients who had RD (HR 5.20, 95% CI 2.25 - 12.02, P<0.001) and PD (HR 12.25, 95% CI 4.48 - 33.48, P<0.001) on post-CRT PET/CT had a worse OS compared to patients with CR. Smoking history, T- and N- Stage, and gender were not associated with OS. The 4-year OS was 87.0% in patients with CR, 32.8% in patients with RD, and 0.0% in patient with PD (P<0.001) on post-CRT PET/CT (Fig 1). Similarly, the 4-year LRC and DC was 93.3% and 97.8% in patients with CR, 65.6% and 71.3% in patients with RD, and 41.7% and 12.5% in patients with PD (P<0.001).

CONCLUSION

Patients with CR on 3-month post-CRT FDG-PET/CT have improved clinical outcomes compared to those with RD or PD.

CLINICAL RELEVANCE/APPLICATION

Three-month post-treatment PET/CT can help predict clinical outcomes and is recommended after definitive chemoradiation therapy of oropharyngeal squamous cell carcinoma to guide further treatment.

SSM24-05 NBTXR3 Hafnium Oxide Nanoparticles Activated by IMRT for the Treatment of Locally-Advanced HNSCC in Frail and/or Elderly Patients: A Phase I/II Study

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S104A

Participants
Christophe Le Tourneau, Paris, France (*Presenter*) Advisory Board, DSD; Advisory Board, BDS; Advisory Board, GSK ; Advisory Board, F. Hoffmann-La Roche Ltd; Advisory Board, Nanobiotix; Advisory Board, Celgene Corporation; Advisory Board, Mvaitis
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PURPOSE

Elderly head and neck squamous cell carcinoma (HSNCC) patients (pts) ineligible for standard of care treatment require new therapeutic approaches. NBTXR3, hafnium oxide nanoparticles, may represent such an option. NBTXR3 is activated by radiotherapy, enhancing its effects, leading to physical destruction of cancer cells. A Phase I/II trial [NCT01946867] is underway to evaluate NBTXR3 in elderly (>=70 years) or frail pts with HNSCC of the oral cavity and oropharynx ineligible for cisplatin or intolerant to cetuximab.

METHOD AND MATERIALS

Pts received a single intratumoral injection of NBTXR3 and intensity modulated radiation therapy (IMRT; 70 Gy/35 fractions/7 weeks). The study was a 3 + 3 dose escalation to test the NBTXR3 dose equivalent to 5, 10, 15, and 22% of baseline tumor volume, followed by a dose expansion. Primary endpoints include Recommended Phase 2 Dose (RP2D) determination and early dose limiting toxicities (DLT). Presence of NBTXR3 in surrounding healthy tissues and efficacy (RECIST 1.1 principles) were also evaluated.

RESULTS

Enrollment for the dose escalation phase was completed at all dose levels: 5% (3 pts), 10% (3 pts), 15% (5 pts), and 22% (8 pts). No early DLT or SAE related to NBTXR3 or injection were observed. One G1 AE (asthenia; 22%) related to NBTXR3 and four AEs (G2 oral pain, G1 tumor hemorrhage, G1 asthenia, and G1 injection site hemorrhage) related to injection were reported. RT-related toxicity was as expected. The RP2D has been determined to be 22%. CT-scan assessment demonstrated absence of NBTXR3 in surrounding tissues. Among 13 evaluable pts treated at doses >=10%, 9 achieved complete response of the injected lesion. The final dose escalation safety results will be presented herein.

CONCLUSION

NBTXR3 was well tolerated at all tested doses and demonstrated a good safety profile. A dose expansion phase has started with the identified RP2D. NBTXR3 is currently being evaluated in a phase II/III trial in soft tissue sarcoma [NCT02379845] and phase I/II trials in prostate [NCT02805894], liver [NCT02721056] and rectal [NCT02465593] cancers.

CLINICAL RELEVANCE/APPLICATION

The results of this study highlight the potential of NBTXR3 as a novel treatment option for elderly and/or frail pts with locally advanced HNSCC and address an unmet medical need.

SSM24-06 Image-Guided Radiotherapy with Multimodal Gold Nanoconstructs Improves the Radiation Response of Head and Neck Tumor Xenografts

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S104A

Participants
Gayatri Sharma, PhD, Milwaukee , WI (*Presenter*) Nothing to Disclose
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Carmen R. Bergom, MD, PhD, Okauchee, WI (*Abstract Co-Author*) Nothing to Disclose
Meetha Medhora, Milwaukee, WI (*Abstract Co-Author*) Nothing to Disclose
Michael H. Flister, Milwaukee, WI (*Abstract Co-Author*) Nothing to Disclose
Amit Joshi, Milwaukee , WI (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Image-guided radiotherapy (IGRT) is the state of the art treatment for Head and Neck Cancer (HNC) patients. MRI and CT are the preferred imaging modalities for planning IGRT. Here, we report the use of 100nm theranostic nanoparticles (TNPs) with combined X-ray and MR contrast that can enable pre-procedure radiotherapy planning, as well as enhance radiation treatment efficacy.

METHOD AND MATERIALS

TNPs were synthesized on Au nanorods core by depositing epilayers of Gd2O3:Yb/Er, resulting in particles with optical, X-ray, and MR contrast. X-ray contrast was calibrated at 60kV on a Pxinc's X-RAD SmART scanner, and MR contrast was determined on a Brukur 9.4T small animal and GE 7T human scanners. Human HNC cell (OSC-19-luc) were orthotopically implanted in the tongue of immune compromised rats. The efficacy of TNPs in enhancing radiation therapy response was tested via both intra-tumoral (1*1014 TNPs) and systemic (tail vein) delivery (1µL/g of 1*1013 TNPs). Rats bearing tumors were randomized to saline+radiation (n=4) or TNP+radiation (n=7) groups. 8-Gy single dose radiation under CT or MRI guidance was provided immediately for intratumoral delivery, and 4h post tail vein injection for systemic delivery. Rats were followed via bioluminescence imaging for 4 weeks.

RESULTS

TNP demonstrated both X-ray and MR contrast in a dose linearly dependent manner. Tumors were clearly delineated in MRI images after i.v. injection of TNPs (Fig. 1A). MRI images showed optimal tumor-to-background ratio at 4h post injection (Fig. 1B). CT images also clearly identified the enhancement post-intratumoral injection of TNPs (Fig 1C). Following IGRT treatment, tumors in both intravenous and intratumoral TNP treated rats' responded superior to radiation therapy controls (Fig. 1D). Rats treated with TNPs and radiation experienced reduced tumor growth (Fig. 1E and F) and lung metastasis while rats treated with radiation alone increased tumor growth. These results indicate the therapeutic efficacy of TNPs in combination with IGRT.

CONCLUSION

TNPs allow an accurate demarcation of the tumor and also increase efficiency of radiation treatment.

CLINICAL RELEVANCE/APPLICATION

Theranostic nanoparticles with combined X-ray and MR contrast can enable pre-procedure radiotherapy planning, as well as enhance radiation treatment efficacy.

Printed on: 10/29/20

SSM25

Vascular/Interventional (Mixed Oncology/Embolization Science)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S403B

IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Paul M. Haste, MD, Indianapolis, IN (*Moderator*) Research support, Boston Scientific; Consultant, Boston Scientific
Claire Kaufman, MD, Salt Lake City, UT (*Moderator*) Nothing to Disclose

Sub-Events

SSM25-01 Novel Performance Descriptor for Contrast-Free Ultrasound Microvascular Imaging Based on Spatio-Temporal Correlation of the Doppler Ensemble

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S403B

Participants
Rohit Nayak, PhD, Rochester, MN (*Presenter*) Nothing to Disclose
Mostafa Fatemi, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
Azra Alizad, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Despite effective clutter filtering, presence of motion in ultrasound microvascular imaging (USMI) can lead to incoherent integration of the Doppler ensemble (DE), resulting in poor blood flow visualization. A motion corrupted DE can lead to over- or under-estimation of blood vessels [1], resulting in misleading diagnosis without any indication or forewarning. We hypothesize that the proposed spatiotemporal correlation matrix as a reliable indicator of coherency of the DE to (1) determine in real-time if the acquired DE is corrupted by motion, (2) identify frames in the DE that needs motion correction (MC) or rejection, and (3) determine the efficacy of MC of *in vivo* patient data, where ground truth is unavailable.

METHOD AND MATERIALS

We conducted in vivo USMI on 10 thyroid nodules -- prone to motion due to its proximity to the pulsating carotid artery. Thyroid displacements were estimated using normalized 2D cross-correlation and were motion corrected [1]. The pixels associated with the thyroid nodule in the DE were rearranged in the Casorati form and their correlation matrices were estimated [2]. [1] Non-contrast agent based small vessel imaging of human thyroid using motion corrected power Doppler imaging. Scientific Reports, 2018. [2] Non-invasive Small Vessel Imaging of Human Thyroid Using Motion-Corrected Spatiotemporal Clutter Filtering. UMB, 2019.

RESULTS

Visualization of the blood vessel substantially improved upon MC (Fig.1a-d). Correspondingly, the mean correlation of the DE (e,f) increased by 33 % upon MC, which is important for coherent integration of the DE [2]. Further, the frames 1580 - 1848 displayed relatively lower correlation even after MC, which indicated out-of-plane motion that cannot be motion corrected, and thus should be rejected prior to integration of the DE. Further, a mean-correlation-image estimated using overlapping 3x3 kernels was useful in assessing the quality of USMI, and in identifying regions that lacked visualization of the blood flow signal due to incoherency of the DE.

CONCLUSION

These preliminary results were encouraging for large-scale *in vivo* validation.

CLINICAL RELEVANCE/APPLICATION

Non-invasive, contrast-free USMI could be invaluable in detection and monitoring of diseases and cancerous masses. This technology addresses a key issue of obtaining robust, real-time feedback on if the absence of microflow signal in USMI is accurate and quantifies its degree of trustworthiness.

SSM25-02 Comparison of High-Resolution Cone-Beam CT and Multi-Detector Computed Tomography for Abdominal Post-Embolization Imaging: Effect on Image Quality, Workflow, Radiation Dose, and Accuracy of Lesion Volumetry

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S403B

Participants
Leona Alizadeh, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose
Thomas J. Vogl, MD, PhD, Frankfurt , Germany (*Presenter*) Nothing to Disclose
Moritz H. Albrecht, MD, Charleston, SC (*Abstract Co-Author*) Speaker, Siemens AG
Richard D. Maeder, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess latest-generation intraprocedural cone-beam computed tomography (CBCT) versus multi-detector computed tomography (MDCT) after conventional transarterial chemoembolization (cTACE), regarding visualization of ethiodized oil distribution, image-quality, effective-dose, and tumor volumetry in patients with hepatic malignant tumors.

METHOD AND MATERIALS

114 patients (64 female, mean age 57 ±14 years) who had undergone TACE followed by CBCT and MDCT of the upper abdomen were included. Image quality scores were compared for both efficacy and complications and overall image quality between CBCT and MDCT images by two blinded readers using 4-point Likert-scales. Lesion volume was measured in both modalities and compared to values from pre-interventional T2-weighted MRI. In addition, we performed effective dose measurements for CBCT and two MDCT protocols using an anthropomorphous phantom.

RESULTS

CBCT outperformed MDCT in terms of efficacy and complications (mean score, 3.2±0.7 versus 2.6±0.4, p=0.01X). Overall image quality was inferior for CBCT (mean score, 2.8±0.7 versus 3.1±0.4 for MDCT, p<0.001). The 4-second CBCT protocol showed a higher mean effective dose of 4.7 mSv compared to MDCT, we measured 2.5 mSv with a scan-length of 22.6 cm and 2.1 mSv for a shorter length of 17.3 cm, corresponding to the shorter CBCT field-of-view. No significant differences were found regarding volumetry of malignant lesions compared to MRI (mean volume on CBCT, 26.98 ± 17.43 mm2 and on MDCT: 26.75 ± 16.00 mm2, p=0.661).

CONCLUSION

Latest-generation CBCT facilitate sufficient image quality levels for the performance of this procedure in the post-interventional assessment in patients undergoing TACE at higher, yet acceptable effective dose levels compared to MDCT, while potentially improving the patient safety and clinical workflow . Both CBCT and MDCT can be robustly used for volumetric measurements.

CLINICAL RELEVANCE/APPLICATION

Latest CBCT may be preferentially chosen to MDCT for post lipiodol TACE evaluation as image quality, worklfow and treatment safety benefit from having an intraprocedural feedback, while giving the ability to immediately adjust therapy and react to complications if necessary.

SSM25-03 Survival after Local Therapies for Stage IA/B Renal Cancer: Subgroup Analysis Based on Tumor Histology

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S403B

Participants
Johannes Uhlig, Goettingen, Germany (*Presenter*) Nothing to Disclose
Hyun S. Kim, MD, New Haven, CT (*Abstract Co-Author*) Boston Scientific Corporation; Galil Medical Ltd ; Sirtex Medical Ltd

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PURPOSE

To assess the effectiveness of local ablation techniques and surgical resection for treatment of stage IA/B renal cell cancer (RCC).

METHOD AND MATERIALS

The 2004-2015 National Cancer Database was searched for stage IA/B RCC. Inclusion criteria were clear cell or papillary RCC, surgical resection (partial or radical nephrectomy), radiofrequency/microwave ablation (RFA/MWA) or cryoablation (CRA), age > 18yo, and complete follow up. RFA/MWA, CRA and surgical resection patients were 1:1:1 propensity score matched to account for confounders, separately for each histology. Overall survival (OS) was compared in the matched cohorts using Kaplan-Meier plots, log-rank tests, and Cox proportional hazards models.

RESULTS

162,640 patients met inclusion criteria: n=153,729 receiving surgical resection (94.5%), n=5,574CRA (3.4%) and n=3,337receiving RFA/MWA (2.1%). Ablation patients were older, had more comorbidities and were more likely treated at academic centers for smaller diameter papillary RCCs. After multivariable adjustment, overall survival was comparable for papillary RCC and clear cell RCC (HR=0.97, 95% CI: 0.93-1.01, p=0.13). After propensity score matching, two separate cohorts with balanced distribution of patient- and tumor-related confounders were obtained (ccRCC n=6,168; papillary RCC n=1,899). For papillary RCC, OS was comparable for CRA and surgical resection (survival difference p=0.86; 1-year OS: 98 vs 98%; 3-year OS: 91 vs 90%; 5-year OS: 83 vs 83%), but inferior for RFA/MWA (p=0.024; 1-year OS: 97%: 3-year OS: 84%; 5-year OS: 76%). For ccRCC, OS was superior following surgical resection compared to both CRA and RFA/MWA (p<0.001). No statistically significant OS difference was evident comparing CRA and RFA/MWA in ccRCC patients (p=0.523).

CONCLUSION

Utilization of ablation versus resection for stage IA/B RCC varies with patient and tumor characteristics. There is evidence that tumor histology may affect ablation effectiveness, with higher survivals observed for CRA in papillary RCCs.

CLINICAL RELEVANCE/APPLICATION

In stage IA/B papillary RCC, CRA shows comparable survival to surgical resection and superior outcomes over RFA/MWA. CRA may be considered as preferential ablation technique in these cases.

SSM25-04 Image-Guided Percutaneous Thermal Ablation of Gynecologic Cancer Metastasis: A 10-Year Experience of Patient Survival, Technique Efficacy, and Safety Profile

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S403B

Participants
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Sindy Wei, MD, PhD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
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Steven S. Raman, MD, Santa Monica, CA (*Abstract Co-Author*) Consultant, Johnson & Johnson; Consultant, Bayer AG; Consultant, Merck & Co, Inc; Consultant, Amgen Inc; Consultant, Profound Medical Inc

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PURPOSE

To assess the safety and efficacy of percutaneous thermal ablation treatment of metastatic GYN cancers.

METHOD AND MATERIALS

With IRB exemption and HIPAA compliance, we derived a study cohort of 42 consecutive women with metastatic GYN cancers treated with radiofrequency or cryogenic ablation from over 2800 ablations performed from 1/30/2001-1/11/2019. All efficacy parameters were reported according to the 2014 International Working Group on Image-guided Tumor Ablation. The technical success rate was defined as complete ablation of the targeted tumor on post-intervention imaging. Primary effectiveness was defined as the percentage of tumors successfully eradicated during the initial course of treatment. Secondary effectiveness was defined as successful eradication by repeated ablation of local tumor progression after complete necrosis was achieved. Major complications were defined as those necessitating unplanned hospitalization, prolonging hospital stay, or additional interventions.

RESULTS

In our study cohort of 42 women (mean age 59.3) with 126 metastatic lesions, the median follow-up was 9 months (range 1- 4022 days). The primary tumor types that were treated are ovarian (stage I-IV), endometrial (stage I, III, IV), uterine (stage II-IV), cervical (stage IB), and vaginal (stage II-III) cancers. Liver, lungs, kidney, peritoneum, lymph nodes, and abdominal soft tissues were targeted sites of metastasis. After the initial ablation session, 92.1% (n= 116/126) of the patients achieved complete tumor necrosis confirmed by contrast-enhanced MRI or CT. On follow-up scans, 7.9% (n= 8) of the previously ablated lesions developed local progression, which resulted in the primary treatment effectiveness of 94.7% (n= 107/113). Five lesions underwent repeated ablation due to local tumor progression with a mean size of 2.78 (SEM +/- 1.16; range 1.5 - 7.4 cm). Of these lesions, 4/5 achieved complete tumor eradication ensuing secondary effectiveness of 80%. Overall technique effectiveness was 94.1% (111/118). The median overall survival from first ablation was 22 months (49 - 4240 days) and the 1, 3, 5, & 10-year survival were 62.9%, 35.7%, 5.7% & 2.9%. The major complication rate was 4.8%.

CONCLUSION

In the largest reported series, thermal ablation was safe and effective for local control of metastatic GYN cancers.

CLINICAL RELEVANCE/APPLICATION

Image guided thermal ablation achieved excellent local control of metastatic GYN lesions.

SSM25-05 Adaptive Suppression of Time Gain Compensated (TGC) Noise Bias for Contrast-Free Ultrasound Microvascular Imaging

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S403B

Participants
Rohit Nayak, PhD, Rochester, MN (*Presenter*) Nothing to Disclose
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PURPOSE

Recent advances in contrast-free ultrasound microvascular imaging (USMI) has considerably improved the sensitivity of detecting blood flow. However, suppression of tissue clutter exposes the ramp-shaped time-gain-compensated (TGC) noise bias that noticeably degrades the visualization of the flow signal [1]. We hypothesize that background equalization of USM images based on the noise bias estimated from the entire clutter-filtered singular value (SV) spectrum can considerably improve the visualization of blood vessels, compared to currently existing techniques [1].

METHOD AND MATERIALS

We conducted *in vivo* experiments on 20 patients with suspicious breast lesions. Its efficacy in imaging deeper organs (6-10 cm) was tested through imaging of hepatic and renal microvasculature in 4 healthy volunteers. All USM images were acquired using a clinical ultrasound scanner, implemented with ultrafast imaging, and singular value decomposition (SVD) based spatio-temporal clutter filtering. The TGC-based noise bias was estimated from the clutter filtered Doppler ensemble based on its local spatio-temporal correlation combined with low rank matrix estimation, which was subsequently used for background suppression of USM images.

RESULTS

USM images obtained after clutter filtering were corrupted with ramp-shaped TGC noise bias that increased with depth. The noise bias signal was visible in both superficial breast lesions (<3.5 cm) and deep-seated hepatic and renal (4-9 cm) USM images. The noise equalized USM images obtained using the proposed technique substantially improved the visualization of the blood flow signal [Fig. 1]. The noise bias in the background equalized USM images (b,d,f) were ~ 0dB, invariant of depth, which otherwise varied over 14 dB (a,c,e), respecitvely.

CONCLUSION

The preliminary results demonstrate the ability of using the proposed technique to improve the visualization of small vessel blood flow in contrast-free USMI. 1.Song, Noise Equalization for Ultrafast Plane Wave Microvessel Imaging.TUFFC 2017.

CLINICAL RELEVANCE/APPLICATION

Non-invasive, contrast-free ultrasound microvascular imaging can be clinically invaluable in early detection and monitoring of angiogenesis in cancerous masses. This technology addresses a key issue of improving the detection of the blood flow signal in USMI, which are poorly visualized at increased depth due to signal attenuation and TGC based amplification of channel noise.

SSM25-06 The Clinical Outcome of Utilizing Prophylactic Covered Stent in Patients with Sentinel Hemorrhage After Pancreaticoduodenectomy

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S403B

Participants
Yuan-Mao Lin, MD, Taipei, Taiwan (*Presenter*) Nothing to Disclose
Ethan Y. Lin, MD, Sugar Land, TX (*Abstract Co-Author*) Nothing to Disclose
Rheun-Chuan Lee, MD, Taipei, Taiwan (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the clinical outcomes of prophylactic covered stent placement of common hepatic artery (CHA) in patients with sentinel hemorrhage (SH) after pancreaticoduodenectomy (PD) without positive image finding.

METHOD AND MATERIALS

Between July 2006 and September 2018, 27 patients (mean age, 61.3 y) with SH after PD underwent prophylactic covered stent placement of CHA (n = 18) or conservative treatment (n = 9) without positive image finding were enrolled in this retrospective study. All patients received CT angiography (n = 11) or digital subtraction angiography (n = 25) before the treatment. Overall survival, clinical outcome and complications were compared between the groups. Clinical success was defined as sustained cessation of hemorrhage; failure was defined as requiring additional management. Chi-square analysis and Kaplan-Mayer curve were used to analyze each group's result.

RESULTS

The clinical success rates were 55.5 % (5/9), and 88.8% (16/18) ($p < .05$) in conservative treatment and covered stent groups, respectively. The covered stent group had superior overall survival than conservative group ($p < .05$). In conservative group, delayed massive hemorrhage occurred in four patients: two died of recurrent bleeding with gastroduodenal artery pseudoaneurysm within sixteen days, and two had intraluminal hemorrhage within five days. In the covered stent group, one had inferior pancreaticoduodenal artery pseudoaneurysm one day after the placement of covered stent, and one patient had recurrent bleeding due to duodenal ulcer within 14 days. A late complication of stent related pseudoaneurysm was observed in one patient eight months after the procedure. There was no stent thrombosis, bile duct necrosis, or intrahepatic artery injury observed on follow-up CT.

CONCLUSION

The prophylactic covered stent placement of CHA can be performed safely and reduced delayed massive hemorrhage and mortality in most patients with SH after PD without positive image finding.

CLINICAL RELEVANCE/APPLICATION

The prophylactic covered stent placement of CHA can be performed safely and reduced delayed massive hemorrhage and mortality in most patients with SH after PD without positive image finding.

SSM26

Vascular/Interventional (Liver Cancer Basic Science)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: S403A

GI IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Nadine Abi-Jaoudeh, MD, Orange, CA (*Moderator*) Research collaboration, Koninklijke Philips NV; Research collaboration, Teclison Cherry Pharma Inc; Research support, SillaJen, Inc; Intellectual property and Owner, Bruin Biosciences Inc
D. T. Johnson, MD,PhD, South San Francisco, CA (*Moderator*) Inventor, Thunar Medical, Inc

Sub-Events

SSM26-01 Comparison Between HSV-TK Gene Therapy and Oncolytic Virotherapy for Radiofrequency Hyperthermia-Enhanced Treatment of Orthotopic Hepatic Cancer

Wednesday, Dec. 4 3:00PM - 3:10PM Room: S403A

Awards
Trainee Research Prize - Fellow

Participants
Shanshan Gao, Seattle, WA (*Presenter*) Nothing to Disclose
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Xiaolin Wang, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Fu Xiong, PhD, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare the efficacies between intratumoral herpes simplex virus-thymidine kinase (HSV-TK)/ganciclovir (GCV) gene therapy and oncolytic virotherapy for image-guided radiofrequency hyperthermia (RFH)-enhanced treatment of orthotopic liver cancer.

METHOD AND MATERIALS

Luciferase-labeled rat hepatocellular carcinoma (HCC) cells and 36 rats with orthotopic HCCs were treated in 6 groups: (1) combination therapy with oncolytic viruses (T-VEC) plus RFH; (2) T-VEC alone; (3) HSV-TK/GCV gene therapy plus RFH; (4) gene therapy alone; (5) RFH alone; and (6) saline. For in-vitro experiments, confocal microscopy, MTS assay and bioluminescence optical imaging were used to evaluate cell viabilities and proliferation. For in-vivo validation, HSV-TK or T-VEC were directly infused into HCC masses through a multi-modal perfusion-thermal RF electrode under imaging guidance, followed by RFH at 42 °C for 30 minutes. For gene therapy groups, GCV was intraperitonially administrated daily for 14 days. Optical imaging and ultrasound imaging were used to follow up bioluminescence signal and size changes of tumors, followed by pathology confirmation.

RESULTS

Confocal microscopy showed the significant decreases of cell viabilities and bioluminescence signal intensities in the combination therapy of HSV-TK with RFH or T-VEC with RFH, compared to other monotherapy groups (n=6/group, P <.05). Ultrasound and optical imaging showed that both combination therapies of HSV-TK or T-VEC with RFH caused decreases of average tumor volume and bioluminescence signal intensity, compared to groups with monotherapy (n=6/group, P <.05). However, no statistically significant differences were found between the two combination therapy groups. Pathology examination with apoptosis analysis further confirmed these imaging findings.

CONCLUSION

Both intratumoral HSV-TK/GCV gene therapy and oncolytic virotherapy combined with RFH have the synergistic therapeutic effect on hepatic cancers, but no efficacy difference was found between these two combination therapies, which indicates RFH-enhanced oncolytic virotherapy is favorable for managing hepatic cancers, since the oncolytic virus, T-VEC, has been approved by FDA for human cancer treatment.

CLINICAL RELEVANCE/APPLICATION

RFH-enhanced oncolytic virotherapy is favarable for hepatic cancers, since the oncolytic virus, T-VEC, has been approved by FDA for human cancer treatment.

SSM26-02 Yttrium-90 Radioembolization as a New Treatment for Brain Cancer: Proof of Concept in a Canine Spontaneous Brain Tumor Model

Wednesday, Dec. 4 3:10PM - 3:20PM Room: S403A

Participants
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Clifford R. Weiss, MD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG Research Grant, Merit Medical Systems, Inc Research Grant, BTG International Ltd Medical Advisory Board, Clear Guide Medical LLC Founder, Avasys, LLC Officer, Avasys, LLC

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PURPOSE

To evaluate Yttrum-90 (Y90) radioembolization (RE) as a minimally invasive treatment for brain cancer in a canine model.

METHOD AND MATERIALS

Three healthy research dogs (R1-R3) and two patient dogs with spontaneous intra-axial brain tumors (T1-T2) underwent transarterial RE with Y90 glass microspheres. Both tumors enhanced on pre-treatment MRI and were compatible with high-grade glioma. Y90RE was performed on research dogs from unilateral MCA, PCA or ICA while both dogs with tumors were treated from the ICA. Post-treatment Y90 PET/CT was performed along with serial, weekly neurological exam by a veterinary neurologist. One month after treatment, a post-treatment MRI was obtained on all animals.

RESULTS

Average absorbed-dose for dogs R1-R3 calculated from Y90 PET/CT were: 20.2±2.8 Gy to the whole treated hemisphere, 52.5±23.5 Gy to the perfused tissue region and doses to the basal ganglia/thalamus ranging from 10.2-67.2 Gy depending on the treated territory. Dog T1 received 8.4 Gy to uninvolved brain and 35.0 Gy to tumor, while dog T2 received 13.2 Gy to uninvolved brain and 115.2 Gy to tumor. Transient changes in neurological exam lasting between 1-3 weeks before resolution were found in dogs R1, R2 and T1 and included unilateral delayed proprioception, postural reaction, decreased facial sensation and vision. Post-treatment MRI on dogs R1-R3 demonstrated absence of cortical atrophy or microinfarction. At 1-month post-therapy, MRI of dog T1 showed an 83% reduction in tumor volume, resolution of perilesional edema and falx shift as well as absence of contrast enhancement. Dog T2 demonstrated a 59% reduction in tumor volume also with resolution of falx shift and perilesional edema. Cortical atrophy was not appreciated in either tumor bearing animal. T1 and T2 are currently clinically asymptomatic with an unremarkable neurologic exam and are scheduled for repeat MRI imaging at 3 months post-therapy.

CONCLUSION

Y90RE is technically feasible in a canine model. Critical normal brain structures tolerated up to 67.2Gy with complete resolution of symptoms. A favorable dosimetric distribution with increased uptake in tumor is possible even with hemispheric (ICA) treatment. Initial clinical outcomes are positive, however, additional data on safety and efficacy is required.

CLINICAL RELEVANCE/APPLICATION

Y90 radioembolization has shown initial promise in the treatment of spontaneous brain tumors in a canine model.

SSM26-03 Prognostic Significance of Pretreatment Inflammatory Markers in Uveal Melanoma Liver Metastases Undergoing Hepatic Chemoperfusion

Wednesday, Dec. 4 3:20PM - 3:30PM Room: S403A

Participants
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PURPOSE

To evaluate inflammatory markers (CRP, neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR) and systemic inflammatory index (SII)) as a pretreatment prognostic factors in patients with unresectable uveal melanoma liver metastases undergoing a structured transarterial hepatic chemoperfusion (THC) protocol.

METHOD AND MATERIALS

56 patients (median age: 61 years, 44% male) were retrospectively assessed. A median of 3 (range: 1-11) THC sessions were performed with melphalan replaced by Fotemustin when progressing. Inflammatory markers were calculated as follows: SII: (platelets/nl × neutrophils/nl)/ (lymphocytes/nl), PLR: (platelets/nl)/(lymphocytes/nl), NLR: (neutrophils/nl)/(lymphocytes/nl).

Kaplan-Meier for median overall survival in months (OS;95%CI) and Cox Proportional Hazard Model for uni- (UVA) & multivariate (MVA) analyses (Hazard ratio;95%CI) were performed.

RESULTS

Median OS of the study cohort was 7.7 (6.3-10.9) months. Overall survival was prolonged for lower values of CRP (non-elevated: 13.5; 7.2-20,6 vs. elevated: 5.2; 3.9-7.7; p=.0003), PLR (<150: 15.8; 6.4-. versus >150: 7; 4.7-8.2, p=.003), SII (<1000: 11; 7.2-20.6 versus >1000: 5.6; 3.9-7.8, p=.0005) and NLR (<3.5: 11.1; 7,1-20.6, vs.>3.5: 6.3; 3.5-7.8, p=.004). MVA confirmed non-elevated CRP (0.37; 0.17-0.78; p=.008) and PLR <150 (0.39; 0.13-0.95p=.038) as independent predictors for longer overall survival. Combining significant values from in MVA improves survival prediction: Patients with non-elevated CRP and low PLR survived the longest (median not reached) vs. patients with either CRP or PLR elevation (11,1; 7-13.5) vs. elevated CRP and PLR (4.8; 3.4-7.5), p<.0001. Difference between each group was statistically significant in UVA.

CONCLUSION

Pretreatment inflammatory markers (CRP, NLR, PLR, SII) play a prognostic role in patient survival with uveal melanoma liver metastases treated with THC. Utilizing pretreatment CRP and PLR as independent predictors may help to identify patients potentially profiting from therapy.

CLINICAL RELEVANCE/APPLICATION

Inflammatory markers play a pivotal role in predicting overall survival and may provide information on treatment effectiveness and to estimatie life expectancy. This can help informed clinical treatment decision making and is of great value for patients and their relatives to set expectations regarding transarterial hepatic chemoperfusion as treatment option for patients with uveal melanoma liver metastases.

SSM26-04 Comparison of Parallel and Crossed Placement of Multiple Radiofrequency Electrode in the Treatment of Liver Tumor: An Animal Experiment

Wednesday, Dec. 4 3:30PM - 3:40PM Room: S403A

Participants
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PURPOSE

The purpose of this study was to investigate the effect of parallel and crossed needle placement with radiofrequency ablation in liver.

METHOD AND MATERIALS

The experiment was performed in ex vivo bovine liver with the radiofrequency generator (Celon) and two electrode needles (200T30). Parallel and crossed needle placements were designed in our experiment. The electrode needles were placed in the shape of '=' in the parallel group and in the shape of 'x' in the crossed group. The ablation zones were compared when the shortest distances of the electrodes (2cm, 2.5cm, 3cm) or the output powers (20W, 25W, 30W) were different.(n=6 for each group). At 2 hours after ablation, the gross pathological specimens were stained with TTC. The long-axis diameter and the short-axis diameter were measured and the coagulation area of ablation zones were compared.

RESULTS

When 25W power was applied and the shortest distances of the electrodes were 2cm, 2.5cm and 3cm, the ablation zones in the two groups were quasi-circular and increased with distance. When the shortest distances were fixed, there was no significant difference in the coagulation area between the two groups (2cm: 4.6x3.7cm vs. 4.8x3.9cm, P=0.369; 2.5cm: 4.8x4.3cm vs.5.0x4.5cm, P=0.661; 3cm: 5.0x4.5cm vs. 5.3x4.6cm, P= 0.339). When the shortest distance was 3.5cm, the coagulation zone could not be fused and was lobulate-shaped. When the shortest distance was 2.5cm and the outputs were 25W and 30W, the coagulation areas were quasi-circular and did not increase with higher power. There was no significant difference. (25W: 4.8x4.3cm vs. 5.0x4.5cm, P=0.452; 30W: 5.1x4.5cm vs. 5.1x4.7cm, P= 0.894). When the output was 20W, the coagulation zone could not be fused in parallel group, while an effective coagulation area was produced in the crossed group (4.4x3.9cm).

CONCLUSION

The traditional opinion is that the crossed placement of electrodes was limited in coagulation area. Our study showed that the ablation zone of the two groups were similar when the shortest distance was the same and the maximum distance no more than 3cm. When the output was reduced, the fusion effect of coagulation area in crossed group was better than that in parallel group. These data provided helpful information for the design of needle placement in radiofrequency ablation of liver tumors.

CLINICAL RELEVANCE/APPLICATION

Radiofrequency ablation is one of the most widely used techniques in tumor ablation.

SSM26-05 A Novel Approach to Liver-Directed Therapy for Metastatic Well-Differentiated Neuroendocrine Tumor: Efficacy of Concurrent Everolimus with Hepatic Transarterial Bland Embolization (EveroEmbo)

Wednesday, Dec. 4 3:40PM - 3:50PM Room: S403A

Participants
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PURPOSE

Liver-directed embolizarion have been the mainstay for locoregional metastatic tumor control. There continues to be considerable controversy around the optimal protocol. Recent studies suggested long-term hepatotoxicity of transarterial radioembolization (TARE). RADIANT-3 and -4 reported Everolimus resulting in median progression-free survival (PFS) of 11 months, while TAE resulted in median hepatic PFS (hPFS) of 15 months. TAE induces ischemic cell injury, yet ischemia- induced activation of vascular endothelial growth factor (VEGF) leads to neovascularization, a known cause of resistance. Everolimus is an mTOR kinase inhibitor shown to inhibit the response of vascular endothelial cells to stimulation by VEGF. Everolimus is typically held 2-4 weeks before and after embolization to minimize toxicity. We hypothesize that the concurrent use of Everolimus with TAE (EveroEmbo) would result in prolonged local liver tumor control compared to either therapy alone.

METHOD AND MATERIALS

Review of all consecutive patients who underwent EveroEmbo between 9/2016 and 12/2018 at the ----------. Inclusion criteria included systemic Everolimus for >= 1 month before embolization. For median hPFS analysis, only patients with > 12 months post-TAE imaging were included. An independent radiologist reviewed all baseline and subsequent post-therapy imaging and assessed liver-specific treatment response according to RECIST 1.1 criteria

RESULTS

63 EveroEmbo procedures in 38 consecutive patients were performed. 58% (22/38) were females while 42% (16/38) were males, with mean age of 57.8 $\pm$ 12.8 years. Only 40 procedures had sufficient post-procedural imaging to apply RECIST 1.1. Imaging showed 82.5% with partial response and 17.5% with stable disease; no patient had disease progression. The percentage change in liver tumor burden was -46.3% + 18.3%. Among the 63 EveroEmbo procedures, 21 had > 12 months follow-up imaging; no patients progressed to date and their median hPFS was 17 months.

CONCLUSION

Concurrent EveroEmbo is a promising approach for local hepatic disease control with a median hPFS of 17 months. Longer follow-up is needed to assess the true median hPFS in metastatic well-differentiated NETs.

CLINICAL RELEVANCE/APPLICATION

Concurrent EveroEmbo resulted in partial response in 82.5% of patients with a mean of 46% reduction in tumor burden and 17 months median hPFS. To date, none of our patients have evidence of disease progression

SSM26-06 The Inhibiting Effect of All-Trans Retinoic Acid on Liver Cancer Stem-Like Cells after Insufficient RF Ablation

Wednesday, Dec. 4 3:50PM - 4:00PM Room: S403A

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PURPOSE

To investigate the role of tumor stem-like cells (TSCs) in recurrent HCC after insufficient RFA and the effect of combination treatment with all-trans retinoic acid (ATRA) in human HCC models.

METHOD AND MATERIALS

Methods: First, the self-renew ability of HepG2 cells was assessed in vitro at 37°C or 42°C. Second, mice bearing HepG2 liver adenocarcinomas were randomized into two groups: (a) no treatment, (b) treatment with insufficient RFA. Tumor size were monitored every 2 days and mice was sacrificed when the tumor was 2cm in diameter. Flow cytometry was used to analyze the percentage of CD133+ and CD326+ cells from the tissue samples of the two groups. Third, HepG2 mice were randomized into four groups: (a) RFA followed by IP ATRA (10mg/kg), (b) RFA followed by IP ATRA (20mg/kg), (c) RFA followed by IP ATRA (40mg/kg), (d) RFA alone. The tumor sizes at day 20 were compared among different groups by analysis of variance. Additionally, pathological staining, western blot and flow cytometry were used for analysing the TSCs and tumor apoptosis. Fourth, the subsequently transplanted formation rate of TSCs was evaluated.

RESULTS

First, in vitro, HepG2 cells which incubated at 42°C water bath displayed significantly higher sphere-forming efficiency compared with the cells incubated at 37°C (43±6% vs 8.7±3%, p<0.01). In vivo, the HepG2 tumor model after insufficient ablation grew up faster compare with no treatment group(p=0.021), and the percentage of CD133+ cells (39.3%) and CD326+ cells (42.7%) was higher than no treatment group (17.1%, 18.4%). The combination of ATRA and RFA decreased the tumor sizes at day 20 with different doses (0mg/kg: 774.2±158.6mm3 vs 10mg/kg: 369.7±106.5mm3 vs 20mg/kg: 152.8±113.7mm3 vs 40mg/kg:143.3±94.8mm3, Overall P<0.001). The combination of RFA and ATRA had the best survival outcome compare with RFA group. In addition, the combined treatment with ATRA showed less TSCs and more intensive cell apoptosis compared to RFA alone. The transplanted formation rate of TSCs after combination treatment was lower than no treatment group(P<0.001).

CONCLUSION

TSCs might had close relationship to the recurrent HCC after RFA. ATRA could significantly improve the effect of RFA, partially attributed to ATRA effectively induced differentiation of TSCs.

CLINICAL RELEVANCE/APPLICATION

Combining with ATRA could enhance the effects of RFA and reduce a part of promention of recurrent HCC involved in the TSCs after insufficient RFA.

Printed on: 10/29/20

SSQ01

Breast Imaging (Radiomics and Radiogenomics)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S406B

AI BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSQ01-01 Radiomics Analysis of Textural Kinetics Features and Enhancement Parameters for Prediction of the Malignity in an Ultrafast Breast DCE-MRI Sequence

Thursday, Dec. 5 10:30AM - 10:40AM Room: S406B

Participants
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PURPOSE

To evaluate the performance of radiomic analysis of ultrafast breast MR sequence to distinguish benign from malignant breast lesions.

METHOD AND MATERIALS

117 women (mean age= 54 years old (28-88)) who underwent breast MRI including ULTRAFAST sequence between July 18th 2016 and March 31st 2017 in whom an abnormal enhancing lesion was identified with subsequent pathological analysis (n=174: 68 benign, 7 borderline and 99 malignant lesions) were retrospectively and consecutively included. Two readers classified lesions according to the Breast Imaging Reporting And Data System (BIRADS) on a FAST protocol (T1W, T2W, T1W-fat saturated 2min after injection) and a FULL standard protocol. They independently determined if any lesion was visible on the ultra-fast sequence and what was its time to Enhancement (TTE). Semi-quantitative enhancement parameters were extracted using the Matlab software (n=7) and texture parameters (n=57) and their temporal evolution across each phase of the ULTRAFAST sequence (n=11) (kinetic texture parameters) were calculated using Pyradiomics. Statistical analysis by LASSO-logistic regression and cross validation were performed to build a model.

RESULTS

Regression analysis selected 15 significant variables in a radiomic model named malignant probability score which displayed an AUC=0.876 (Sensitivity (Se) =0.98, Specificity (Spe)= 0.52 Accuracy (Acc) =0.78). An Abbreviated protocol combing FAST analysis, TTE and the malignant probability score increases the diagnostic performance (AUC= 0.882, Se=0.95 , Sp=0.64, Acc=0.82) compared to the BI-RADS from FULL protocol (AUC=0.831, Se=0.98, Sp=0.17 , Acc=0.63) and from FAST protocol (0.800, Se=0.92, Sp=0.28, Acc=0.64).

CONCLUSION

A model based on radiomics parameters including kinetic texture parameters extracted from an ULTRAFAST sequence reach better diagnostic performance than BI-RADS on FAST or FULL standard protocol.

CLINICAL RELEVANCE/APPLICATION

Radiomic analysis on early MR enhancement improves BI-RADS classification on an abbreviated protocol (ULTRAFAST + FAST) and overtakes BI-RADS classification on conventional FULL protocol or FAST protocol..

SSQ01-03 To Develop a Radiomic Nomogram from Multi-Parametric MRI for the Prediction of Breast Cancer

Thursday, Dec. 5 10:50AM - 11:00AM Room: S406B

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PURPOSE

To develop a radiomic nomogram from multi-parametric MRI for the prediction of breast cancer..

METHOD AND MATERIALS

This study involved 200 patients with 211 lesions (145 malignant lesions and 66 benign lesions), who underwent multi-parametric MRI examine including non-enhanced and enhanced T1WI, T2WI, diffusion weighted imaging (DWI) and pharmacokinetic dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) before surgery or puncture. Apparent diffusion coefficient (ADC) map in DWI and quantitative parameter (Ktrans, Kep, Ve, and Vp) maps in pharmacokinetic DCE-MRI were used. Region of interests (ROIs) were sketched in enhanced T1WI map and mapped to other maps in every slice of lesions. A total of 1132 radiomic features were extracted from each MRI parameter map. The radiomic features were further selected and classified by support vector machine (SVM) and logistic regression. Radiomic models were constructed via 10 times 5-folds cross-validation and valuated with the receiver operating characteristic (ROC) curves. The optimal radiomic model was selected by comparing the area under ROC curve (AUC) values of each single and joint parameter. The nomogram based on the optimal radiomics model was built to assess risk of breast cancer in patients.

RESULTS

AUC values of radiomic models of non-enhanced T1WI, enhanced T1WI, T2WI, ADC, Ktrans, Kep, Ve, and Vp maps were 0.79, 0.81, 0.84, 0.83, 0.86, 0.80, 0.78 and 0.82 respectively in diagnosis of breast cancer. The radiomic model of combination of Ktrans, T2WI and ADC maps was considered as the optimal model with an AUC of 0.88. The radiomic nomogram was built from Ktrans, T2WI and ADC to predict malignant risk of breast lesions.

CONCLUSION

Radiomic nomogram based on multi-parametric MRI could be used to predict risk of breast cancer for every patient, and will be beneficial to improve the accuracy of breast cancer diagnosis preoperatively.

CLINICAL RELEVANCE/APPLICATION

The optimal model was constructed by combining radiomic features of Ktrans, T2WI and ADC maps. The nomogram of optimal radiomic model could help to predict malignant risk of breast lesions in clinical.

SSQ01-04 Assessment of Continuous Learning on Radiomic Analysis of Breast Lesions on a Large Clinical DCE-MRI Dataset

Thursday, Dec. 5 11:00AM - 11:10AM Room: S406B

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PURPOSE

To assess the robustness of AI (radiomics with machine learning) analysis methods on MRI examinations in the task of distinguishing malignant from benign breast lesions with continuous learning using augmented training datasets.

METHOD AND MATERIALS

Study included a total of 1979 breast MRI examinations performed within 2015, 2016, and 2017, retrospectively collected under a HIPAA-compliant, IRB approved protocol with1483 malignant and 496 benign lesions based on histopathological testing. The three years of data contained unique patients (no overlap between the years) with average clinical characteristics of 45.8, 46.5, 47.7 years in age, and 1.8, 1.8, 1.7 cm in size. AI radiomic analyses of each lesion included: automatic lesion segmentation, automated extraction of 38 radiomic features, and machine learning classification using support vector machine analysis. Independent training and testing was performed to assess the performance of multiple learning stages on breast lesion classification. Three classification tasks to mimic the clinical setting were performed to evaluate the robustness of continuous AI learning by examining various training:testing dataset arrangements: (1) 2015 cases: 2016 cases, (2) 2015 cases: 2017 cases, and (3) 2015+2016 cases: 2017 cases, respectively, with the latter two serving as an example of a yearly-based continuous learning scenario. Area under the ROC curve (AUC) was used as the figure of merit to assess the classifier performance for all lesions as well as only mass lesions and only non-mass lesions.

RESULTS

AUC values for the three training:testing datasets were 0.88, 0.88, and 0.89, respectively, showing initial high performance and slight improvement with additional training. For masses and non-mass lesions within the three training:testing datasets, AUCs of 0.87, 0.87, and 0.88 and of 0.90, 0.89, 0.90, were obtained, respectively.

CONCLUSION

Statistically improved classification performance was observed with continuous learning using the yearly-augmented datasets. Further study with a larger multi-institutional dataset and smaller learning increments are needed to validate the findings from this study.

CLINICAL RELEVANCE/APPLICATION

The continuous learning of machine learning in radiomic analysis for the classification performance using augmented datasets showed potential to yield improved performance and to be adopted in clinical setting.

SSQ01-05 MRI Background Parenchymal Enhancement (BPE) are Associated with Breast Cancer Recurrence Risk and Metastasis

Thursday, Dec. 5 11:10AM - 11:20AM Room: S406B

Awards
Trainee Research Prize - Fellow

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PURPOSE

Breast tumor-derived radiomic features in breast DCE-MRI have been shown associated with prognosis. DCE-MRI background parenchymal enhancement (BPE) has been reported as a risk marker for breast cancer mainly studied in screening populations. We investigated roles of BPE quantified in cancer-affected breasts in association with breast cancer distant recurrence risk (via Oncotype DX) and breast cancer axillary lymph node (ALN) metastasis.

METHOD AND MATERIALS

A retrospective IRB-approved study was conducted on two independent cohorts of totally 244 breast cancer patients (all unilateral and confirmed by pathology). Cohort I had 127 ER+ and Node- invasive breast cancer patients who had Oncotype DX scores available, while Cohort II had 117 invasive breast cancer patients who had ALN metastasis status available. Tumors were segmented in 3D space on the affected breasts using an interactive MRI segmentation software by an experienced radiologist, and DCE-MRI-based radiomic features (i.e., morphological, texture and contrast enhancement kinetics) were extracted from the segmented tumors. On the tumor-excluded whole breast region, previously validated automated computer algorithms were applied to quantify the absolute volume of BPE and its relative amount over the whole-breast volume, at three different enhancement ratio cut-offs (i.e., 20%, 30%, and 40%). A linear discriminant analysis model with typical feature selection was used to classify 1) High vs Low+Intermediate Oncotype risk categories on Cohort I and 2) ALN metastasis positive vs negative on Cohort II, on tumor-based radiomics alone, BPE measures alone, and their combination. AUC and accuracy were performance metrics.

RESULTS

Tumor-based radiomic model's AUC was 0.76 and 0.88 for Oncotype DX and ALN classification, respectively, while the corresponding AUC was 0.75 and 0.82 on using BPE alone. When combining radiomics and BPE, the corresponding AUC increased to 0.82 and 0.92, respectively, and accuracy increased to 0.80 from 0.76 (Oncotype) and to 0.92 from 0.83 (ALN).

CONCLUSION

Quantitative BPE is associated with breast cancer distant recurrence risk and ALN metastasis and it can enhance the classification when combined with tumor-derived radiomics.

CLINICAL RELEVANCE/APPLICATION

DCE-MRI BPE measures quantified in cancer-affected breasts may provide additional complementary information over tumor-derived radiomics to enhance breast cancer prognosis assessment.

SSQ01-06 Characterization of Breast Lesions by 4D Radiomics of Dynamic Contrast-Enhanced Breast MRI Data

Thursday, Dec. 5 11:20AM - 11:30AM Room: S406B

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PURPOSE

To evaluate a temporally and spatially-resolved (4D) radiomics approach on dynamic contrast enhanced (DCE) breast MRI images to

distinguish benign from malignant enhancing breast lesions.

METHOD AND MATERIALS

This retrospective study was approved by the local IRB and informed consent was waived. Consecutive patients with mammographic or US suspicious findings underwent 1.5T breast MRI according to international recommendations (EUSOMA, EUSOBI, ACR). Eligible for this study were lesions with a histologically proven diagnosis by image-guided biopsy. Two blinded readers, supervised by an experienced breast radiologist analyzed all DCE using a commercially available software. This software extracts BI-RADS derived and pharmacokinetic enhancement features (Tofts model) in a voxel-wise manner. The raw data were extracted and further analyzed by principal component analysis (PCA) and artificial neural networks (ANN, multilayer perceptron). The diagnostic accuracy of the extracted features was measured by the area under the receiver operating characteristics curve (AUC).

RESULTS

470 (295 malignant, 175 benign) lesions in 329 patients (mean age 55.3 years, range 15-83) were examined. 72 DCE features were extracted based on automated volumetric lesion analysis. Five independent component features were extracted using PCA; the AUC to differentiate benign from malignant lesions ranged between 0.579-0.799. ANN using a split sample approach (70% training and 30% validation sample) combined these features into a predictive model revealing an AUC of 0.836 (95%-CI 0.799-0.868).

CONCLUSION

The investigated automated 4D Radiomics approach revealed a high diagnostic ability to distinguish between benign and malignant lesions without requiring subjective reader interpretation.

CLINICAL RELEVANCE/APPLICATION

The application of computer aided interpretation of breast MRI images may reduce the workload of radiologists, thereby reducing the overhead associated with breast MRI acquisition and interpretation.

SSQ01-07 Quantitative MRI Radiomics in the Task of Predicting Molecular Classification of Invasive Breast Cancers in a Large Clinical Dataset from China

Thursday, Dec. 5 11:30AM - 11:40AM Room: S406B

Participants
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PURPOSE

To evaluate the potential of quantitative MRI radiomics in the task of predicting molecular classification of invasive breast cancers in a large clinical dataset from China.

METHOD AND MATERIALS

Our research involved a retrospectively acquired clinical DCE-MRI database of 998 invasive breast cancers. Immunohistochemistry molecular classification was performed including estrogen receptor, progesterone receptor, human epidermal growth factor receptor 2, and Ki-67, the molecular subtype (luminal A, luminal B, HER2-enriched, and triple-negative). The average age of the patients were 48.4 years with a standard deviation 9.6 years. Once each tumor was indicated to our radiomics workstation, the machine learning algorithm automatically segmented and extracted radiomic features on the primary tumor, including those from six categories: size, shape, morphology, enhancement texture, kinetics, and enhancement-variance kinetics. Within 5-fold cross validation, feature selection and classification with linear discriminant analyses was conducted. Performance of the classifier model for molecular subtyping was evaluated using receiver operating characteristic analysis.

RESULTS

The resulting radiomic tumor signatures from the radiomics classifier yielded AUC values of 0.75 (se = 0.08), 0.72 (se = 0.05), and 0.76 (se = 0.09) in the tasks of distinguishing between luminal A/luminal B vs. HER2-enriched, luminal A/luminal B vs. triple negative, and HER2-enriched vs. triple negative, respectively. Luminal A/luminal B tumors exhibited smaller sizes as compared to HER2-enriched tumors and higher irregularity compared to triple negative tumors. HER2-enriched tumors showed more irregularity than triple negative tumors.

CONCLUSION

Quantitative MRI radiomics demonstrated promising classification performance in predicting molecular classification of invasive breast cancers in a large clinical dataset from China.

CLINICAL RELEVANCE/APPLICATION

Our computerized radiomic analysis method has potential to yield a quantitative predictive signature for advancing precision medicine.

SSQ01-08 Radiomics of Triple-Negative Breast Cancer: Prediction of Systemic Recurrence

Thursday, Dec. 5 11:40AM - 11:50AM Room: S406B

Participants

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PURPOSE

To predict and validate the systemic recurrence free survival of triple-negative breast cancer (TNBC) with radiomics of preoperative breast MRI

METHOD AND MATERIALS

This IRB-approved retrospective study included 231 TNBCs. Radiomics analysis was performed for TNBCs on the preoperative subtracted constrast-enhanced breast MRI. Rad score was generated from the radiomic features. Patients were assigned as the training set (n=182, GE scanner) and the validation set (n=49, Philips scanner). Uni- and multivariate Cox proportional hazard regression was performed for the features to predict the systemic recurrence. External validation with the validation set was performed with the selected features chosen from the multivariate analysis, and C-index was calculated.

RESULTS

Systemic recurrence was observed in 22 (9.5%) cases (training set, n=19; validation set, n=3); among these, 9 died from the recurrence (training set, n=7; validation set, n=2). The rad score was generated with 32 radiomics features. In the training set, the Rad score was significantly higher in the group with systemic recurrence (median, -8.430; interquartile range (IQR), -8.800 to -8.259) than the group without recurrence (median, -9.873; IQR, -10.226 to -9.468, P<0.001). On univariate analysis, pathologic invasive cancer size, lymphovascular invasion status, surgery type, number of metastatic axillary lymph node, and Rad score were significantly associated with the systemic recurrence. Multivariate analysis was performed with the pathologic invasive cancer size, lymphovascular invasion status, surgery type, number of metastatic axillary lymph node, and Rad score, and lymphovascular invasion (P=0.015) and Rad score (P<0.001) remained statistically significant. The C-index predicting the systemic recurrence of the training set with selected five variables was 0.97. When the model was validated with the validation set, the C-index was 0.848.

CONCLUSION

Radiomics of preoperative breast MRI could be used to predict the systemic recurrence of TNBC and the validation showed the compatible result.

CLINICAL RELEVANCE/APPLICATION

Radiomics of preoperative breast MRI could be used to predict the systemic recurrence of TNBC and the validation showed the compatible result.

SSQ01-09 Radiomics of Breast MRI and 18F-FDG PET/CT as a Prognostic Criteria of Invasive Breast Cancer of No Special Type

Thursday, Dec. 5 11:50AM - 12:00PM Room: S406B

Participants
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PURPOSE

Breast cancer is a heterogeneous group of tumors with a different prognosis. Nottingham Prognostic Index (NPI) and molecular subtypes of primary tumors are used for predicting patient outcomes. The aims of this study were: - to explore the presence of correlation between apparent diffusion coefficient (ADC), perfusion enhancement integral (PEI) and standardized uptake value (SUV) values and pathological prognostic factors such as Ki-67 and molecular type; - to identify the associations between ADC, PEI and SUVmax values and NPI prognostic groups; - to consider the viability of using DWI and 18F-FDG PET/CT for risk stratification.

METHOD AND MATERIALS

64 patients (mean age 54.1) with invasive breast carcinoma (IBC) were recruited into a retrospective study. Breast MRIs including DWI with ADC maps, DCE perfusion PEI maps and 18F-FDG PET/CT were made with an interval between studies not exceeding 2 weeks. Mean and minimal ADC values, mean PEI and SUVmax of breast tumors were measured. All patients were divided into three risk groups according to NPI and four (luminal A, luminal B, HER2+ and triple-negative) molecular types groups. For assessment of possible association between ADC, SUVmax, PEI and Ki-67 Spearman's correlation coefficient was used. Kruskall-Wallis test was applied for comparison ADCmean, ADCmin, PEImean and SUVmax means in molecular types and NPI prognostic groups.

RESULTS

Negative intermediate correlation between ADCmin, ADCmean values and Ki-67 was revealed. There were statistically significant differences between mean SUVmax and PEImean in NPI prognostic groups and mean ADC values in molecular type groups. Mean ADC values for Luminal A tumors were statistically significant higher than for Luminal B (P=0.02) and triple negative (P=0.039) types. Also, there were significant differences between means SUVmax in tumors with different grade and means ADCmin and PEImean for different stages of regional lymph node metastatic disease.

CONCLUSION

SUVmax, PEI and ADC correlated with prognostic factors and may be used for predicting the prognosis of breast cancer. ADC value can be used as in vivo marker of invasive breast cancer molecular type.

CLINICAL RELEVANCE/APPLICATION

Although the use of SUVmax, ADC and PEI as potential in vivo markers of survival cannot yet replace biopsy, the perspective of a

dynamic assessment of changes in the molecular status of a tumor and metastasis during treatment is of interest.

Printed on: 10/29/20

SSQ02

Science Session with Keynote: Cardiac (Valvular Imaging and Intervention)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E353C

CA IR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSQ02-01 Cardiac Keynote Speaker: Imaging of Transcatheter Mitral Valve Repair

Thursday, Dec. 5 10:30AM - 10:50AM Room: E353C

Participants
Jonathon Leispic, Vancouver, BC (*Presenter*) Nothing to Disclose

SSQ02-03 Aortic Valve Area and Aortic Valve Calcium Score Calculation in Aortic Stenosis Using Computed Tomography: Comparison with Echocardiography

Thursday, Dec. 5 10:50AM - 11:00AM Room: E353C

Participants
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PURPOSE

To compare the aortic valve area (AVA) measured on CT and echocardiography and demonstrate the correlation between the aortic valve calcium score and AVA in patients with aortic stenosis.

METHOD AND MATERIALS

A total of 535 patients (66.8 ± 8.8 years of age, 56% men) with aortic stenosis who underwent preoperative cardiac CT and echocardiography for aortic valve replacement were included. The calculated AVA on echocardiography (AVAecho) and CT (AVACT) by obtaining left ventricular outflow tract (LVOT) diameter, AVA measured by planimetry (AVAplani), and the aortic root size by CT were obtained. AVACT was calculated with the mean LVOT diameter from the maximum and minimum diameters measured at 20-30% of the R-R interval. AVC was obtained on unenhanced images. Concordance between AVAecho and AVACT was evaluated. Logistic regression analysis was performed to find clinical and imaging parameters to predict discordance between AVAecho and AVACT.

RESULTS

AVACT and AVAecho showed high correlation (r=0.748, p<0.0001), whereas AVAplani and AVAecho showed moderate correlation (r=0.52, p<0.001). AVACT was larger than AVAecho (difference 0.24 ± 0.35 cm2, p<0.0001). AVC showed poor negative correlation with AVAecho (r=-0.34, p<0.001). After excluding patients with rheumatic valvular disease or bicuspid aortic valve, lnAVC showed mild correlation with AVAecho (r=-0.42, p<0.0001). Using cut-point values of AVACT (<1.2cm2) and AVAecho (<1.0cm2) for diagnosing severe aortic stenosis, patients'characteristics in concordance (AVAecho<1.0 cm2 and AVACT<1.2cm2) and discordance (AVAecho<1.0cm2 but AVACT>1.2cm2) groups were compared. Discordant group had larger body surface area (BSA) (1.6 vs. 1.7 m2, p=0.005), and AVAecho (0.61 vs. 0.80 cm2, p<0.001) and end-diastolic volume index (EDVI) (66.5 vs. 78.0 mL/m2, p=0.02) were larger than concordant group. Aortic annulus size (diameter, perimeter and area) normalized to BSA was larger in discordant group (p<0.05). BSA (odds ratio [OR]:11.83, 95% confidence interval [CI]:1.28-109.17; p=0.03), AVAecho (OR:1.13, 95%CI:1.09-1.17; p<0.001), EDVI (OR:1.02, 95%CI:1.002-1.03; p=0.03), and normalized annulus area (OR:3.68; 95%CI:1.84-7.36; p<0.0001) were significant predictors of discordance between AVAecho and AVACT.

CONCLUSION

AVAecho and AVACT showed high correlation, and AVC was poorly correlated with AVAecho. BSA, AVAecho, EDVI, and annuls size were factors to associate with the discordance between AVAecho and AVACT.

CLINICAL RELEVANCE/APPLICATION

AVACT is larger than AVAEcho, and discrepancies are expected between the two parameters when larger BSA, EDVI, and annulus sizes appear in patients with aortic stenosis.

SSQ02-04 Development of Deep Learning-Based Algorithm for Automatic Detection and Classification for Aortic Valve Calcium

Thursday, Dec. 5 11:00AM - 11:10AM Room: E353C

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PURPOSE

Quantitative aortic valve calcium (AVC) measured using CT is well correlated with the severity of AS on echocardiography, and has prognositc implications. We aimed to develop a deep learning-based algorithm for fully automated quantification of AVC from non-enhanced cardiac CT scan and to compare its performance to those of radiologist readers for classification of severe AVC.

METHOD AND MATERIALS

A deep learning-based algorithm (modified 3D U-net) was developed using single-center data of 589 CT exams from March 2010 to August 2017; datasets dividing into subsets for training (412 scans): validation (40 scans): test (137 scans). The deep learning algorithm was set to segment AVC volume and to classify severe AVC by quantifying AVC volume based on the segmentation result. Manually measured AVC volume was used as the ground truth. Visual grading system of AVC severity was developed by modification of Rosenhek scoring system, with four categories (mild, moderate, severe and very severe). The cutoff value of AVC volume for >=severe AVC grading was set by the ROC curve. To validate AVC segmentation performance, dice coefficient was evaluated between AVC volume derived by deep learning algorithm and the ground truth. Diagnostic performance of deep learning algorithm for classification of severe AVC was analyzed using accuracy and AUC. Four radiologist readers determined AVC grade in two reading rounds. The diagnostic performance of the deep learning for classifying severe AVC was compared with that of each reader's assessment.

RESULTS

The cutoff value for severe AVC was set as calcium volume >763.6mm3. After applying deep learning algorithm, the Dice coefficient score in test dataset was 0.816. In the test data sets, the deep learning had an accuracy of 93.3% and AUC of 0.983 (95% confidence interval 0.934-0.999) for diagnosis of severe AVC, which was better than any radiologist reader with or without grading system (accuracy 72.7-89.9% and AUC 0.775-0.903, P<0.05 without grading system; accuracy 79.8-92.9% and AUC 0.829-0.924, P<0.05 with grading system).

CONCLUSION

Deep learning-based automated AVC quantification was highly comparable with manual measurements. The diagnostic performance of deep learning algorithm for classification of severe AVC outperforms radiologist readers.

CLINICAL RELEVANCE/APPLICATION

Deep learning-based automated AVC quantification can accurately identify severe AVC and is recommended in the evaluation of AVC.

SSQ02-05 Combined Coronary CT-Angiography and TAVI-Planning: A Contrast-Neutral and Efficient Routine Approach to Exclude Significant Coronary Artery Disease

Thursday, Dec. 5 11:10AM - 11:20AM Room: E353C

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PURPOSE

To analyze the ability of CT coronary angiography (cCTA) to exclude significant coronary artery disease (CAD) during pre-TAVI-evaluation.

METHOD AND MATERIALS

208 consecutive patients undergoing pre-TAVI-evaluation (108 female; mean-age 79.5±7.2 years) were retrospectively included. Patients after CABG had been excluded. All patients were examined with a standard protocol consisting of a retrospectively gated CT scan of the heart, immediately followed by a high-pitch scan of the vascular access route utilizing a single bolus of 70 ml iodinated contrast-medium. No betta-blockers or nitrates were applied. Heart-rate and heart-rate-variability during the scan were 74.5±19.3 and 22.7±33.1 beats-per-minute; attenuation at the ascending was 462.7±138.8 HU. Images were evaluated per segment (18-AHA) for significant CAD (stenosis >=50%); examinations where stenoses could not be excluded were read as positive. Routinely all patients received invasive coronary angiography (ICA) 76.4% (159/208), which was omitted if renal function

was impaired significantly and no significant stenosis could be identified on cCTA. All stenoses visually identified on ICA were graded qualitatively (QCA) with the same cut-off.

RESULTS

cCTA was negative for significant CAD in 43.8% of patients (91/208). Sensitivity, specificity, PPV, NPV and accuracy were 96.5%, 49.0%, 51.4%, 96.2% and 66.0% per patient and 81.3%, 85.9%, 24.4%, 98.8% and 85.6% per segment, respectively. The significant stenoses additionally identified on ICA were most frequently located in side-branches (2/3) or the distal LAD.

CONCLUSION

cCTA and pre-TAVI evaluation can be performed jointly with no need for additional contrast medium or medication. cCTA is able to exclude significant CAD in a relatively high proportion of this high-risk collective.

CLINICAL RELEVANCE/APPLICATION

Severe aortic stenosis is a frequent disease in the elderly and often coincides with significant CAD. The latter is recommended to be excluded or treated before TAVI. Patients with severe aortic stenosis prior to TAVI-implantation are often frail and comorbid with a high incidence of nephropathy. cCTA can reduce the number of ICA and total amount of contrast-medium applied, thereby making pre-procedural-evaluation for TAVI-Planning safer for elderly patients with a high incidence of nephropathy.

SSQ02-06 Gender-Based Dynamic Evaluation Of Mitral Valve Geometry In Primary And Functional Mitral Regurgitation Using Multiphase Computed Tomography: Implications For Transcatheter Mitral Valve Repair

Thursday, Dec. 5 11:20AM - 11:30AM Room: E353C

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PURPOSE

There is lack of data regarding gender-based disparities in dynamic mitral geometry in patients with mitral valve disease. We aimed to compare 3-dimensional CT mitral measurements among male and female patients with primary- (PMR) and functional mitral regurgitation (FMR), and control patients, using prototype mitral evaluation tool.

METHOD AND MATERIALS

Patients were retrospectively identified who underwent multiphase ECG-gated cardiac CT. Data were loaded into prototype mitral evaluation tool. Anatomical parameters recorded throughout the cardiac cycle (0-95%, at 5% increments) included: circumference, planar surface area (PSA), anterior-posterior (A-P) diameter, and anterolateral-posteromedial (AL-PM) diameter. Male and female patients were compared among three groups, with $p<0.01$ considered statistically significant.

RESULTS

A total of 150 subjects (63.5±14.0 years, 64% males) were included: 50 with PMR, 50 with FMR, and 50 control. Mitral dimensions were significantly higher in males compared to females in PMR, FMR and control groups, with circumference (145±13 vs. 142±15, 135±12 vs. 123±14, and 121±10 vs. 112±8mm), and PSA (1550±247 vs. 1468±294, 1309±251 vs. 1083±227, and 1076±173 vs. 929±136mm2), respectively (all $p<0.001$). Additionally, different patterns in annular dimensions were observed among males and females across cardiac phases (Figure).

CONCLUSION

Multiphase ECG-gated cardiac CT showed larger annular dimensions in males compared to females with dramatic variability across the cardiac cycle in different mitral valve diseases.

CLINICAL RELEVANCE/APPLICATION

Our study findings advocate the significance of obtaining multiphase CT measurements for dynamic, pre-procedural evaluation of complex 3-dimensional mitral valve geometry for catheter-guided prostheses, which may vary between male and female patients with various types of mitral valve disease.

SSQ02-07 Assessment of Late Contrast Enhanced Dual-Energy CT Derived Myocardial Scar in Various Aortic Stenosis Groups

Thursday, Dec. 5 11:30AM - 11:40AM Room: E353C

Participants
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PURPOSE

To assess the relationship between myocardial scar (MS) derived from late contrast enhanced dual energy CT (LCE-DECT) and subtypes of aortic stenosis (AS), particularly the "classical (low flow)" and "paradoxical (normal flow)" low gradient subgroups which are challenging to manage clinically.

METHOD AND MATERIALS

Sixty patients with severe AS underwent echocardiography and multiphase CT (MDCT) that included research LCE-DECT sequences for pre-transcatheter aortic valve replacement (TAVR) evaluation. A weighted scar burden was calculated based on the per-segment extent of scar in the entire LV. Patients were grouped into those with and without 'significant' scar (>50% transmural LCE in at least one segment). LV volumes and function from MDCT were analyzed by a semiautomatic software. Patients with AS were grouped into 1)low flow (LF) and normal flow (NF), based upon MDCT derived stroke volume index (SVi) thresholds (LF<=39ml/m2; NF>39ml/m2) previously validated by our group to best correlate with SVi of <= 35 ml/m2 by right heart catheterization and 2) low gradient (LG) and high gradient (HG), based on echocardiographic mean aortic gradient (LG<40mmhg, HG>=40mmhg). Association of clinical and CT derived parameters with MS were assessed using the chi-square test and Wilcoxon rank sum test for categorical and continuous variables. P <0.05 was considered significant.

RESULTS

Twenty-six patients (43%) showed significant myocardial scar. The presence of significant scar was associated with lower LVEF (62% [61, 77] vs. 72% [51, 75]; p=0.02) and lower stroke volume (39 [40.2, 52.3] vs. 44 [36, 46.6] ml/m2, p=0.01). The proportion of patients with significant scar was higher among LF (67%) than NF groups (31%; p=0.007), as well as between AS subgroups (LF-LG, 80%; LF-HG, 54.5%; NF-LG, 37.5%; NF-HG, 26%; p=0.029). The weighted scar burden tended to be higher in the LF-LG group as compared to other AS groups (LF-LG, 7.5 vs. LF-HG, 2 vs. NF-LG 0.5 vs. NF-HG, 2[p=0.256]).

CONCLUSION

Patients with LF-LG AS are more likely to have >50% transmural myocardial scar detected on LCE-DECT than other AS patients, with a tendency toward higher quantitative scar burden.

CLINICAL RELEVANCE/APPLICATION

Patients with LF-LG AS have a worse prognosis than NF AS. More extensive myocardial scar in LF-LG AS patients may contribute to their poor prognosis. Further evaluation is needed to assess whether LCE-DECT scar assessment may help predict improvement after TAVR.

SSQ02-08 Statistical and Textural Analyses in CT Valve Imaging: A New Tool for Identifying Disease Severity in Calcific Degenerative Aortic Valve Stenosis

Thursday, Dec. 5 11:40AM - 11:50AM Room: E353C

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PURPOSE

To investigate the discriminatory capability of radiomic features, extracted using statistical and textural analyses, in patients with moderate and severe degenerative aortic stenosis (DAS) from CT valve images.

METHOD AND MATERIALS

This unicenter study prospectively enrolled 97 patients with DAS to perform a 320-multidetector CT using low-dose contrast (0.5ml/kg). Fifty-two (55%) and 43 (45%) of patients had severe or moderate DAS, respectively, according to current guidelines. A 10mm maximum intensity projection was created to cover the entire leaflet width. The valve circumference was manually approximated with a circle on each image by defining points at the circle center and radius (Figure 1A). From these points, two masks were defined: a quarter circle area at the valve center (mask 1) and entire valve circle area (mask 2). Using the package "radiomics" in the R programming environment, first order features (FOF), gray level co-occurrence matrix (GLCM), gray level run length matrix (GLRLM), and gray level size zone matrix (GLSZM) features were calculated for the two masks. Four different angles for pixel comparison were used for the second order statistics. Mean differences (expressed in percentage differences) in radiomics features between severe and moderate DAS were performed using Wilcoxson rank-sum test or Student t test accordingly. We also performed ROC analysis to evaluate diagnostic accuracy, with a DeLong confidence interval for Area Under Curve (AUC).

RESULTS

269 (88%) radiomic features were significantly different in patients with moderate and severe DAS. Fifty-four (18%) showed high discriminatory power (AUC>0.8), with the best AUC achieved by FOF followed by GLCM and GLRLM (Figure 1B). Among FOF, the best performers were the measures of shape - Kurtosis and Skewness, applied to the center of valve (mask 1). Patients with

severe disease had lower and broader peaks than those with moderate disease (Figure 1C).

CONCLUSION

The vast majority of radiomic features tested were significantly different in patients with moderate and severe DAS. These features, particularly FOF in the center of valve, can accurately identify hemodynamic severity of aortic stenosis.

CLINICAL RELEVANCE/APPLICATION

The relationship between calcium leaflet distribution and hemodynamic disease severity in calcific degenerative aortic valve stenosis is poorly understood.

SSQ02-09 Structural Mitral Valve Analysis Utilizing a New Fully Automated Analysis Software Package

Thursday, Dec. 5 11:50AM - 12:00PM Room: E353C

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PURPOSE

The aim of this study was to evaluate a novel fully automated mitral valve analysis software package (Mitral Analysis Prototype, Siemens Healthineers), designed for planning minimally invasive mitral valve procedures based on cardiac CT.

METHOD AND MATERIALS

The study included 53 patients (25 women: 66.8 ± 12.3 years) who had undergone cardiac computer tomography angiography (CCTA) prior to transcatheter mitral valve replacement (TMVR) or surgical mitral valve intervention (replacement or repair). Therapeutically relevant mitral valve annulus parameters (projected area, circumference, trigone-to-trigone (T-T) distance, anterior-posterior (AP) diameter and anterolateral-posteromedial (AL-PM) diameter) were measured. Results of the fully automated mitral valve analysis software package with and without manual adjustments were compared to the reference standard of a user-driven measurement program (3mensio, Pie Medical Imaging). Measurements were assessed for correlation between the fully automated software both with and without manual adjustment and the user driven program. A secondary analysis included the time to obtain all measurements.

RESULTS

Fully automated measurements showed a moderate to strong correlation (circumference, r=0.78; projected area, r=0.82; T-T distance, r=0.66; AP, r=0.69, and AL-PM diameter, r=0.66) compared to the user-driven analysis. There was a strong correlation between fully automated measurement with manual adjustments and user-driven analysis regarding circumference (r=0.91), projected area (r=0.93), T-T distance (r=0.71), AP (r=0.78) and AL-PM diameter (r=0.66). The time required for full mitral valve analysis was significantly lower using the fully automated software compared to the standard assessment (134.4±36.4 sec vs. 304.3±77.7 sec) (P<0.01).

CONCLUSION

The fully automated mitral valve analysis software, when combined with manual adjustments, demonstrated a strong correlation compared to the user-driven software, while maintaining superior time-efficiency for obtaining comprehensive procedure planning measurements.

CLINICAL RELEVANCE/APPLICATION

This novel fully automated mitral valve analysis software allows for a fast and accurate evaluation of mitral valve parameters for planning minimally invasive structural heart disease therapy.

SSQ03

Cardiac (Coronary Artery Disease: CT and MRI Techniques)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E450B

CA CT MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Evan J. Zucker, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Ming-Yen Ng, MBBS, Hong Kong, Hong Kong (*Moderator*) Nothing to Disclose

Sub-Events

SSQ03-01 Iterative Reconstruction in Coronary CT Angiography from Full Coverage Axial Data with Less than 180° of Rotation

Thursday, Dec. 5 10:30AM - 10:40AM Room: E450B

Participants
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PURPOSE

This abstract reports diagnostic image quality measurements of coronary CT angiography on a 16cm coverage system with high temporal resolution using model-based iterative reconstruction(MBIR).

METHOD AND MATERIALS

Even in the systems with 0.25s rotation time, it is not guaranteed that a quiet cardiac phase is possible to be captured within 240° of axial projections, which equals approximately 180° +2·γmax(γmax denotes the maximum fan angle) and is the amount of data that FBP requires before limited angle artifacts show up in the image. Using an analytic cardiac vessel phantom, mean square error and structural similarity metrics, we have determined that 135° degrees of axial rotation is a threshold for which MBIR still returns images without limited angle artifacts. Evaluated projection range was between 90° and 240°. Then, MBIR was applied to 48 scans from a clinical trial, using only 135° of data centered at the predetermined quiet cardiac phase. Data was acquired on a 320-row, 16cm CT scanner and MBIR images were compared to the standard protocol reconstruction that uses 240° of data. Average heart rate in the trial was 78.6±16.1 bpm and mean effective dose was 1.5±0.75mSv. Two experienced radiologists evaluated the image quality using a 4-point rating system focusing on motion artifacts. Scores above 3 were considered diagnostic, with 4 being the best.

RESULTS

MBIR cases were rated diagnostic 83.3% of the time, while standard protocol reconstruction was diagnostic only 58.3% of the time. Average rating for MBIR was 3.28 and 3.16 for the two observers and standard cases were rated 2.72 and 2.7 respectively. There was a significant difference in the scores between MBIR and standard cases by both radiologists ($p<0.001$).

CONCLUSION

MBIR improved the diagnostic image quality significantly by allowing stable reconstructions from a shorter scan, thereby increasing temporal resolution by at least 25%. Other improvements in image quality such as low noise and high resolution were also noted.

CLINICAL RELEVANCE/APPLICATION

Stable MBIR reconstruction with less than 180° of projection data can be used to reduce the motion artifacts in coronary CT angiography, improving the scan success rate of the single beat cardiac scans significantly and thereby reducing the need for repeated scanning.

SSQ03-03 Contrast Media Iodine Concentration in the Left Ventricle Affects the Level of Radiation-Induced DNA Damage during CCTA

Thursday, Dec. 5 10:50AM - 11:00AM Room: E450B

Participants
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PURPOSE

To investigate the relationship between iodine concentration in the left ventricle and radiation-induced DNA damage in blood lymphocytes during a coronary CT angiography (CCTA).

METHOD AND MATERIALS

This prospective patient study was approved by the institutional ethical committee and written informed consent was obtained. All scans were performed on a Revolution CT (GE Healthcare) using a one heartbeat scan and a patient-tailored contrast media injection protocol, administering Ultravist 370 mg I/mL (Bayer Healthcare) with a patient specific injection volume, depending on the sex, weight and height of the patient. Blood samples (5 mL) were collected, before and after the CCTA, and radiation-induced DNA double-strand breaks were assessed using γH2AX immunofluorescent staining of the blood lymphocytes. An average of 3000 lymphocytes was analyzed for each blood sample. The net amount of induced DNA damage was considered as the difference in the amount of γH2AX foci per cell before and after the CCTA scan, and was normalized to the CTDIvol (mGy). Iodine concentration in the left ventricle was determined by measuring the CT signal (HU) in a 477.5±208.9 mm² ROI and by applying a HU-iodine calibration curve obtained from phantom experiments. Correlation between the iodine concentration in the left ventricle and the CTDIvol normalized amount of DNA damage per cell was investigated using a Spearman's rank-order test.

RESULTS

We report results of the first 15 patients (median age 66 y, 9M/6F) included in the study. Patients were scanned with a median CTDIvol of 10.8 mGy (95% CI: 8.4-15.8 mGy). Due to differences in patient physiology, the left ventricle iodine concentrations ranged from 13,7 till 25,2 mg I/mL. The CCTA scans caused a net increase in DNA damage ranging from 0.00041 to 0.0074 foci/cell. We observed a significant exponential correlation (r=0.55 , p-value=0.035) between dose normalized DNA damage and left ventricle iodine concentration.

CONCLUSION

The amount of iodine contrast concentration in the left ventricle has an impact on the amount of radiation induced DNA double strand breaks.

CLINICAL RELEVANCE/APPLICATION

In CCTA, iodine contrast concentration has an impact on radiation safety. A reduction in iodine concentration reduces radiation induced DNA damage.

SSQ03-04 3D Multiparametric Image Fusion in Coronary Artery Disease

Thursday, Dec. 5 11:00AM - 11:10AM Room: E450B

Participants
Jochen Von Spiczak, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose
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Robert Manka, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Hatem Alkadhi, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To allow for comprehensive non-invasive diagnostics of coronary artery disease (CAD) by 3D image fusion of CT coronary angiography (CT-CA), CT derived fractional flow reserve (CT-FFR), whole-heart dynamic 3D cardiac MR perfusion (CMR-Perf), and 3D cardiac MR late gadolinium enhancement (CMR-LGE).

METHOD AND MATERIALS

17 patients (54±10 years, one female) who underwent both cardiac CT and CMR imaging due to suspected or known CAD were included. A software facilitating 3D fusion of multimodal, multiparametric cardiac image data was developed. Post processing of CT data included: a) segmentation of the coronary tree and heart contours; b) calculation of CT-FFR values; c) color-coding of the coronary tree according to CT-FFR. Post processing of CMR data included: a) segmentation of the left ventricle (LV) in CMR-Perf and CMR-LGE; b) co-registration of CMR to CT data; c) mathematical projection of CMR-Perf and CMR-LGE values onto the high-resolution LV from CT. Algorithms adopted from the animation movie industry were applied yielding photorealistic rendering. Results from 3D image fusion were compared to separate 2D readouts of CT and CMR.

RESULTS

Image quality of CT-CA, CMR-Perf, and CMR-LGE was rated good to excellent (scores 2.6, 2.6, and 2.5 on four-point Likert scale, 3 = excellent). CT-CA revealed significant stenoses (i.e., >50%) in 7/17 cases (41%). CT-FFR was possible in 16/17 cases (94%) and showed pathologic flow in 7/17 cases (41%). CMR-Perf identified 8/17 patients (47%) with hypoperfusion; average ischemic burden was 17±5%. CMR-LGE showed myocardial scar in 3/17 cases (18%); average scar burden was 7±4%. Conventional 2D readout of all imaging modalities resulted in 9/17 cases (53%) with inconsistent findings. Multimodal 3D image fusion was feasible in all patients. Perfusion deficits and myocardial scar could be correlated to culprit coronary lesions where applicable. Most (7/9=78%) of the problems with separate 2D readout could be solved by 3D image fusion, with two cases remaining controversial or incomplete, respectively.

CONCLUSION

Multimodal, multiparametric 3D cardiac image fusion of CT and CMR image data is feasible and helps for comprehensive non-invasive CAD diagnostics.

CLINICAL RELEVANCE/APPLICATION

Comprehensive, non-invasive diagnostic workup of coronary artery disease involves a multitude of pathologic aspects, which are all combined within one 3D visualization approach for the first time.

SSQ03-05 A Randomized Controlled Clinical Trial of Prolonged Stent Deployment Strategy in Primary Percutaneous Coronary Intervention for ST-Segment Elevation Myocardial Infarction

Thursday, Dec. 5 11:10AM - 11:20AM Room: E450B

Participants
Min Ma, Chengdu, China (*Presenter*) Nothing to Disclose
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PURPOSE

The aim of this study was to evaluate whether prolonged inflation would decrease the no-reflow phenomenon in primary percutaneous coronary intervention(PPCI) compared with the conventional strategy.

METHOD AND MATERIALS

This was a prospective, single-center, blinded, randomized controlled trial.The primary outcomes were the number of patients with Thrombolysis in myocardial infarction (TIMI) flow grade 3, the incidence of intraoperative no-reflow/slow flow, the corrected TIMI frame count, the myocardial blush grade(MBG), and the number of patients with ST-segment resolution>50%. The procedural time and radiation exposure time were also assessed. A subset of patients was included in a cardiac magnetic resonance (CMR) examination approximately 3 to 5 days after the index procedure to assess extent of microvascular obstruction (MVO).

RESULTS

Sixty patients were randomized into a prolonged inflation strategy group(A group, n=30) and a rapid inflation/deflation strategy group (B group, n=30). TIMI flow grade 3 was found in 96.7% (29/30) of the A group and 63.3% (19/30) of the B group (p=0.005). The A and B group respectively showed the following parameters: 0% (0/30) VS 30% (9/30) no-reflow or slow flow (p=0.002); 90% (29/30) vs 66.7% (20/30) ST-segment resolution >=50% (p=0.028); 35.6±14.5 frames vs 49.18±25.2 frames on corrected TIMI frame count (p=0.014); and 60% (16/30) vs 20% (6/30) MBG 3 (p=0.001). The major cardiovascular adverse event rate was 3.3% (1/30) in both groups (p=1.0) at one month and 3.3% (1/30) for the A group vs 6.7% (2/30) for the B at one year (p=1.0). There were no statistically significant differences in the procedural time,the radiation exposure time and major bleeding events between the two groups. In the CMR substudy, the presence of MVO was detected in 6.7% (1/15) of patients in the A group and in 50% (5/10) of patients in the B group(p=0.023).

CONCLUSION

The effect of the prolonged inflation strategy could prevent the no-reflow phenomenon and reducing the incidence of MVOs and improve myocardial microcirculation perfusion. In addition, long term follow-up and large-sample, randomized controlled clinical trials with a long-term follow-up period are needed to confirm this preliminary result.

CLINICAL RELEVANCE/APPLICATION

The effect of the prolonged inflation strategy may be an effective way to reduce microvascular obstruction.CMR modality is an effective technique to prove this phenomenon.

SSQ03-06 Implementation of Transdermal versus Sublingual Nitroglycerin Administration to Optimize Coronary CT Angiography Scanner Utilization

Thursday, Dec. 5 11:20AM - 11:30AM Room: E450B

Participants
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PURPOSE

Coronary CT angiography (CCTA) requires patient preparation including nitroglycerin (NTG) administration, which improves coronary artery assessment. We compared CCTA exam times when using sublingual vs. transdermal NTG administration.

METHOD AND MATERIALS

This retrospective, single center study included outpatients who underwent elective CCTA betweem 4/2016 and 3/2019 and received NTG. Until 5/2018, patients received sublingual NTG tablets (0.6 mg), administered by the supervising physician on the CT scanner table. After 6/2018, patients received transdermal NTG patches (0.8mg/h), placed at least 45 minutes prior to the exam outside the scanner room by a qualified nurse. CCTA time slots were 20 minutes. We compared number of exams exceeding allotted time slots and CCTA exam times subcategorized by room time (patient time inside the scanner suite), preparation time (time from registration to start of room time), and total appointment time (arrival in the radiology department to dismissal) between the two NTG delivery methods by Wilcoxon Rank Sum Test. Severity of coronary artery disease (CAD) burden was also recorded.

RESULTS

The study population included 3,180 patients of whom 2,341 (73.6%) received NTG by tablets and 839 (26.4%) by patches. Mean age was 59.8±13.1 years, 1,388 (43.6%) were females and average BMI was 29.0±6.0 kg/m2. Patient characteristics and CAD burden were not significantly different between NTG delivery methods (>50% luminal coronary stenosis: n=716 [22.5%], p=0.770). Room time was significantly shorter when using NTG patches compared to tablets (18 min [95% confidence interval (CI): 10-37 min], 27 [15-54] min, p<0.001). Preparation time was significantly longer in patients receiving NTG patches compared to tablets (88 [46-135] min, 58 [26-120] min, p<0.001). Total appointment time was significantly longer in patients receiving NTG patches compared to tablets (107 min [68-160] min, 87 [51-151] min, p<0.001). Only 36.6% (n=307) of the exams following patient preparation with NTG patches exceeded the 20-min exam time slot limit compared to 73.0% of exams (n=1,709) using NTG tablets.

CONCLUSION

A workflow using transdermal NTG patches reduce exam times inside the scanner suite and results in less exams exceeding the allotted exam time slot.

CLINICAL RELEVANCE/APPLICATION

Using transdermal NTG patches for patient preparation prior CCTA reduces times in the scanner room and allowed the use of 20-minutes time slots.

SSQ03-07 Automatic Coronary Artery Disease Reporting and Data System (CAD-RADSTM) in Cardiac CT Angiography Using Paired Convolutional Neural Networks

Thursday, Dec. 5 11:30AM - 11:40AM Room: E450B

Participants
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PURPOSE

The coronary artery disease reporting and data system (CAD-RADSTM) was recently introduced for standard reporting and decision making. We aimed to assess the utility of an automatic post-processing and reporting system based on CAD-RADSTM in suspected coronary artery disease patients.

METHOD AND MATERIALS

A machine learning model was designed for CAD-RADS assessment categories with automatic coronary lumen segmentation algorithm based on convolutional neural networks. The model was trained in a derivation cohort encompassing 2000 patients who underwent coronary computed tomography angiography (CCTA). Patients with bypass grafts, stents were excluded from the training. Then compared to radiologists for classification of CAD-RADS with commercially-available automated segmentation and manual post-processing in a prospective validation cohort.

RESULTS

346 patients were included in the study among 360 patients with three poor CCTA images. Compared with radiologists, the positive predictive value, negative predictive value, sensitivity and specificity of AI for diagnosis of coronary heart disease were 80%, 70%, 80% and 70% respectively. There was no significant difference between the CNN-based CAD-RADS grading and radiologists based CAD-RADS grading in CCTA (P=0.87). The consistency test showed that the Kappa value of the two groups was 0.694 (P<0.05), the consistency was good.

CONCLUSION

The standardized report of CNN-based CAD-RADS in CCTA images can accurately evaluate suspected patients with CAD, and has good consistency with the radiologists.

CLINICAL RELEVANCE/APPLICATION

Report of CNN-based CAD-RADS has good consistency with the radiologists.

SSQ03-08 Use of Salient Features to Optimize a Machine Learning Classifier of Coronary Artery Disease Severity

Thursday, Dec. 5 11:40AM - 11:50AM Room: E450B

Participants
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PURPOSE

Machine learning-based methods have been proposed as an alternative to the current gold standard of determining the hemodynamic significance of coronary artery lesions, invasive Fractional Flow Reserve (FFR) measurements. In this work, we look to optimize the performance of a machine learning classifier that used coronary CT angiography image data to determine coronary artery disease severity.

METHOD AND MATERIALS

50 coronary CT angiographies (CTAs) were collected (Aquilion ONE, Canon Medical Systems) at 70% of the R-R cardiac cycle. Straightened curved planar reformations (SCPRs) of different artery branches were generated (Vitrea, Vital Images) using a slice thickness of 5.0 mm considering four rotational views around the vessel centerline per CTA for a total dataset size of 200. The dataset was split into a training cohort numbering 125 and a testing cohort numbering 75. FFR values were measured to create a labeled dataset. A convolutional neural network was developed to classify input SCPRs by the severity of the coronary lesion. The network synthesized class activation maps (CAMs) such that the most salient features (lesion and aorta) in the SCPRs were visualized. SCPR image data were modified such that the aorta was removed, rendering the lesion as the only salient feature present, and the network was re-trained using the optimized data. Network performance on both original and optimized test data was assessed using area under the receiver operating characteristics curve (AUC), classification accuracy, and a Student's T-Test.

RESULTS

Mean AUC was 0.727 (95% confidence interval, 0.675-0.773) and 0.799 (0.761-0.837) using the original and optimized SCPR data respectively. Mean classification accuracy was 68.1% (63.8%-72.4%) and 79.1% (76.1%-82.1%) using the original and optimized SCPR data respectively. There was a statistically significant advantage to using the optimized SCPR data for classification of coronary disease severity in terms of both AUC ($p = 0.001$) and classification accuracy ($p = 0.0001$).

CONCLUSION

This work indicates the potential utility of CAMs for debugging and optimizing a machine learning algorithm to aid in clinical decision making.

CLINICAL RELEVANCE/APPLICATION

Machine learning provides a valuable alternative to invasive FFR measurements for the determination of coronary artery disease severity.

SSQ03-09 Comparison of Post-Surgical Wall Shear Stress Values in Arterial and Venous Coronary Grafts Using Computational Fluid Dynamics Guided by CCTA and 4D Flow MR Imaging

Thursday, Dec. 5 11:50AM - 12:00PM Room: E450B

Participants
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Laura Jimenez-Juan, MD, Toronto, ON (*Presenter*) Nothing to Disclose

PURPOSE

Graft failure is a major complication in coronary artery bypass graft (CABG) surgery, whose root causes are still unknown. In coronary arteries, growing evidence indicates that low and oscillatory values of wall shear stress (WSS) contribute to atherosclerosis plaque progression. The role of WSS in graft failure remains still unclear. In a pilot cohort of patients, we developed a computational fluid dynamics model to obtain WSS non-invasively from CCTA images, and compared WSS values in arterial and venous grafts. Differently from previous works, the study is prospective, with a uniform interval between CABG surgery and WSS analysis of one month. Furthermore, 4D flow MRI is used to incorporate patient-specific flow conditions into the computational model.

METHOD AND MATERIALS

Five participants were scanned using CCTA and 4D flow MRI 30±5 days after CABG surgery. Fluid dynamics simulations with appropriate coronaries and graft material properties were performed with Simvascular (Stanford University, Stanford, CA). WSS was spatially and temporally averaged (spatially-averaged TAWSS) for 5 arterial and 6 venous grafts. The oscillatory shear index (OSI) and the ratio between wall area exposed to adverse TAWSS (< 0.4 Pa) and total graft area were also analyzed.

RESULTS

No significant difference was found in spatially-averaged TAWSS between venous and arterial grafts (2.26±2.12 Pa in venous vs. 5.11±3.48 Pa in arterial grafts, p=0.079) and maximum OSI (0.27±0.20 in arterial and 0.25±0.20 in venous grafts, p=0.456). The relative area exposed to low TAWSS was significantly higher in venous grafts (22.4±20.0% in venous vs. 0.77±0.98% in arterial grafts, p=0.022).

CONCLUSION

One month after surgery, our study found larger areas of abnormal WSS in venous than in arterial grafts. This observation may be related to the higher failure rate of venous grafts.

CLINICAL RELEVANCE/APPLICATION

This work is a step forward towards understanding the root causes of graft failure in CABG patients, and identifying reliable biomarkers for the early prediction of graft failure.

SSQ04

Chest (Interventional/Systemic Vasculature)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E451A

CH IR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Daniel Ocazionez-Trujillo, MD, Houston, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSQ04-01 Imaging Findings Related to Lung Tract Sealant Use in Percutaneous CT-Guided Lung Biopsy

Thursday, Dec. 5 10:30AM - 10:40AM Room: E451A

Participants
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PURPOSE

The purpose of this study is to elucidate the short and long-term imaging findings associated with lung tract sealant use.

METHOD AND MATERIALS

Following IRB approval, patients were retrospectively identified who underwent percutaneous Computed Tomography (CT)-guided lung biopsy with a hydrogel-based lung tract sealant between January 2016 and January 2018 at a single institution. In order to elucidate imaging findings of lung tract sealant use, patients who underwent surgical resection within 3 months of the biopsy were excluded from review. CT or PET/CT images of patients who did not undergo resection with at least 3 month imaging follow-up were reviewed noting any parenchymal changes along the needle tract on CT images and any areas of FDG avidity along the needle tract.

RESULTS

A total of 1,010 consecutive CT-guided lung biopsies were performed between 01/01/2016 and 01/01/2018. A lung tract sealant was used in 324/1,010 (32%) of patients. Of the 324 patients, 154 underwent surgical resection following the biopsy and were excluded. 85 patients had no cross-sectional imaging follow-up >3 months post-biopsy and were excluded. 20 patients with pleural-based or subpleural nodules were excluded due to inability to visualize the lung tract sealant path. A total of 65/324 (20%) patients with benign (n=33) or malignant disease (n=32) were subsequently included in this analysis. 54/65 (83%) of patients had nodular-to-linear scarring along the path of lung tract sealant deployment during lung biopsy at the 3-6 months follow-up cross-sectional CT or PET/CT. These findings were found to persist to an average of 13.8 months (SD: 7.8 months, R: 30 - 4 months), even in the setting of primary nodule resolution. Follow-up PET/CT obtained more than 3 months (Mean: 13 months, SD: 5 months) post-biopsy was available in 25/65 (38%) patients with benign (n=9) and malignant (n=16) disease. Faint FDG-uptake located in the region corresponding to the scar associated with the tract sealant was found in 15/25 (60%) patients.

CONCLUSION

Lung tract sealants are used frequently due to their proven risk reduction of pneumothorax. However, they are associated with long-term imaging findings that have not been described before.

CLINICAL RELEVANCE/APPLICATION

The radiologist should be aware of to these changes to minimize the risk of misinterpreting the findings for residual or new disease. Larger studies are needed to establish the etiology of these findings.

SSQ04-02 Radiofrequency Ablation for Resectable Colorectal Lung Metastases: A Prospective Multicenter Phase 2 Study (MLCSG-0802)

Thursday, Dec. 5 10:40AM - 10:50AM Room: E451A

Participants
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Yasutaka Baba, MD, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To prospectively evaluate the efficacy of radiofrequency ablation (RFA) for resectable colorectal cancer (CRC) lung metastases.

METHOD AND MATERIALS

This study included CRC patients with 5 or fewer lung metastases measuring 3cm or smaller to treat by lung RFA. All tumors were judged to be technically resectable by surgeons. The primary endpoint was 3-year overall survival rate with an expectance rate of 55%. The cancer-specific survival rate, local tumor progression rate, and safety were evaluated as secondary endpoints. The survival rates were generated by using the Kaplan-Meier method. Prognostic factors of overall survival were evaluated by univariate analysis of log-rank tests and multivariate analysis of Cox proportional regression models. Adverse events (AEs) were evaluated according to the Common Terminology Criteria for Adverse Events version 3.0.

RESULTS

Seventy patients (49 men, 21 women; mean age, 66.3 ± 10.0 years; age range, 37-82 years) were enrolled from 14 institutions. Eighty-eight sessions of lung RFA were performed for 100 lung tumors with a mean maximum diameter of 1.0 ± 0.5 cm (range, 0.4 - 2.8 cm). RFA was chosen because of refusal of surgery in 62 patients (89%) or relatively high risk of general anesthesia due to high age in 5 patients (7%) and comorbid disease in 3 patients (4%). The 3-year overall survival rate was 84% (95% confidence interval [CI], 76 - 93). Rectal cancer (p=0.001), positive carcinoembryonic antigen (p=0.002), and absence of previous chemotherapy (p=0.02) were found to be significant negative prognostic factors on univariate analysis. All these 3 factors retained its significance on multivariate analysis. The 3-year cancer specific survival rate was 90% (95% CI, 82 - 97). Local tumor progression was found in 6 patients (9%, 6/70) 6 - 19 months after initial RFA. One patient died of hemothorax (Grade 5 AE rate; 1% [1/88]) on the following day after RFA. There was no grade 3 or 4 AE. Grade 2 AE of pneumothorax occurred in 18 sessions (20%, 18/88).

CONCLUSION

Although lung RFA has a potential risk to induce life-threating complication, it can provide a favorable prognosis for patients with resectable CRC lung metastases.

CLINICAL RELEVANCE/APPLICATION

This study showed that lung radiofrequency ablation could offer favorable outcomes for patients with colorectal lung metastases measuring 3 cm or less even though they were surgically resectable.

SSQ04-03 Can Thoracic MR Imaging Improve Diagnostic Accuracies of Transthoracic Needle Aspiration and Core Biopsies and Decrease Complications in Patients with Mediastinal Tumor?

Thursday, Dec. 5 10:50AM - 11:00AM Room: E451A

Participants
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PURPOSE

To determine the utility of thoracic MR imaging for improving diagnostic accuracies and decreasing complications on transthoracic needle aspiration and core biopsies in patients with mediastinal tumor.

METHOD AND MATERIALS

210 gender, age, size and location matched mediastinal tumor patients (112 malignant and 98 benign tumors) underwent transthoracic needle aspiration biopsy (TNAB) and core biopsy (TNCB) with and without thoracic MR imaging including diffusion-weighted imaging (DWI) and unenhanced and contract-enhanced in- and opposed-phase T1-weighted gradient echo imaging (with MR imaging: n=105, without MR imaging: n=105) and pathological examinations. Then, diagnostic accuracy and complication rates such as bleeding and pneumothorax. To determine the utility of thoracic MR imaging for TNAB and TNCB, diagnostic accuracy and complication rates as bleeding and pneumothorax rates were compared between two methods by McNemar's test. Then, multivariate logistic regression analyses were performed to determine significant factors for improving diagnostic accuracy and decreasing each complication rate among radiological methods, needle gage of each biopsy method, number of puncture, needle path length, needle/ pleural angle, needle approach and lesion size.

RESULTS

Diagnostic accuracies of TNAB and TNCB by CE-CT and thoracic MR imaging (TNAB: 96.2 [101/105] %, TNCB: 98.0 [103/105] %) were significantly higher than that without MR imaging (TNAB: 81.9 [86/105] %, p<0.0001; TNCB: 87.6 [92/105] %, p<0.0001). There were no significant differences of bleeding rate and pneumothorax rate between two methods (p>0.05). On multivariate logistic regression analysis, thoracic MR imaging was the significant factor for improving diagnostic accuracy of TNAB (Odds ratio [OR]: 5.5, p=0.003) and TNCB (OR: 7.5, p=0.01). Moreover, aspiration biopsy needle gage (OR: 0.51, p=0.04), needle/ pleural angle (OR: 1.1, p=0.04) and lesion size (OR: 0.95, p=0.04) were significant factors for decreasing pneumothorax rate. However, there were no significant factors for decreasing bleeding rate (p>0.05).

CONCLUSION

Thoracic MR imaging has a potential to improve diagnostic accuracies of TNAB and TNCB and decrease pneumothorax rate in patients with mediastinal tumor.

CLINICAL RELEVANCE/APPLICATION

Thoracic MR imaging has a potential to improve diagnostic accuracies of TNAB and TNCB and decrease pneumothorax rate in patients with mediastinal tumor.

SSQ04-04 Lung Navigation Using Micro-Electro-Mechanical (MEM) Tracked Virtual Bronchoscopy

Thursday, Dec. 5 11:00AM - 11:10AM Room: E451A

Participants
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PURPOSE

Develop a fully integrated micro-electro-mechanical (MEM) tracking system for virtual bronchoscopy (VB) navigation that assists endobronchial diagnostic and therapeutic interventions.

METHOD AND MATERIALS

Preliminary work used a 3D printed airway phantom in which all five branches selected as targets were correctly reached under the guidance of VB navigation. A swine study was conducted under a protocol approved by the Institutional Animal Care and Use Committee. Chest CT images were processed using custom software and computer to provide 2D multi-planar reconstructions and a 3D endoluminal rendering, tumor segmentation, and navigation path planning and display for real-time image guidance. Navigation routes were planned for six different target bronchi as identified virtual targets. The inexpensive wireless gyroscope MEM unit was clipped to the operator handle of the bronchoscope to track the rotation of the scope. The software rotated the VB display in real time to match the view of the bronchoscope at each branch point, displaying the correct bronchus to intubate along the course. The translation of VB was manually adjusted along the planned path to match the insertion depth of the bronchoscope. The bronchoscope's own camera captured and separately displayed real bronchoscopy images of the airways.

RESULTS

All 6 peripheral targets were quickly and accurately reached without radiation, in under a minute, with the hardware and software integration. Accuracy of targeting were verified by cone beam CT for 3 targets. The bronchoscope was successfully tracked and navigated through branch points leading to 2, 3 or 4 daughter bronchi, using combined real and virtual feedback during all navigation tasks.

CONCLUSION

The system successfully displayed consistent real and corresponding virtual bronchoscope navigation and navigation paths throughout the procedures. The wireless navigation system facilitated rapid and accurate passage through complex branching to peripheral targets. Future development will automate VB translation by tracking insertion depth.

CLINICAL RELEVANCE/APPLICATION

This innovation may result in more effective and efficient endobronchial navigation with no need for disposable tracking devices inside the patient airway. The feasibility work provides the framework for definitive validation studies of an integrated VB system.

SSQ04-05 Automated Segmentation of the Thoracic Aorta in a Large Epidemiological Study

Thursday, Dec. 5 11:10AM - 11:20AM Room: E451A

Participants
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PURPOSE

The purpose of this study was to develop and evaluate a fully automated algorithm for segmentation and shape analysis of the thoracic aorta in non contrast-enhanced MR-angiography (NE-MRA) images from a large, multi-centric cohort, such as the German National Cohort (GNC).

METHOD AND MATERIALS

100 Patients of the GNC, underwent a NE-MRA of the thorax based on a 3D SPACE STIR sequence in coronal orientation on a 3T scanner. First, the entire thoracic aorta was manually segmented by two experienced radiologists using the Medical Imaging Interaction Toolkit (MITK) to generate a training dataset for 100 patients. The second part of the study was to design a suitable algorithm based on a deep neural segmentation network implemented with the TensorFlow framework, trained on 75 datasets. The segmentation results of the automated algorithm applied to 25 separate datasets were analyzed in order to evaluate the performance and accuracy of the alogrithm. Qualitative analysis was performed using a Likert scale to assess segmentation accuracy: 0=correct vessel detection; 1=non-significant errors of shape; 2=significant errors affecting morphology; 3=Insufficient vessel recognition. Accuracy and dice coefficients were computed as quantitative measures of the accuracy of automated segmentation results compared to manual segmentatiaon. Based on the automatically generated masks, a shape analysis of the vessel is performed to obtain a profile of the vessel-diameter for each patient.

RESULTS

The evaluation of the algorithm revealed a voxel-wise prediction accuracy of 99.8% for the correct label and mean dice coefficient of 92%[83.4%-99.9%]. The qualitative evaluation,based on the Likert scale described above, showed predominantly accurate segmentation results: [0]:9 patients, [1]:12 patients. Only in four patients significant segmentation errors [2] were detected.

CONCLUSION

A fully automated algorithm for segmentation and shape analysis of the thoracic aorta in NE-MRA images was developed with accurate results regarding quality of segmentation. This algorithm can be applied to large epidemiological imaging studies, such as the GNC for automated analysis of thousands of data sets.

CLINICAL RELEVANCE/APPLICATION

Aneurysms of the thoracic aorta are often only detected in acute stages with a poor prognosis. Therefore, it is important to explore possibilities of early detection and prognostic assessment of pathologic changes of the thoracic aorta.

SSQ04-06 Can Presurgical Three-Dimensional (3D) Fusion Image Predict the Valve Deformation at Transcatheter Aortic Valve Implantation (TAVI) for Aortic Stenosis Patients?

Thursday, Dec. 5 11:20AM - 11:30AM Room: E451A

Participants
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PURPOSE

Transcatheter aortic valve implantation (TAVI) is a treatment of choice for symptomatic aortic stenosis (AS). Three-dimensional (3D) fusion image using scanned product valve (ex vivo valve) has been occasionally utilized for the planning before TAVI (Fig. 1 and 2a). However, it should be taken into account for deformity after the valve placement. We hypothesized that the in vivo valve image obtained from post-TAVI CT in a different AS patient (Fig. 2b) may be more suitable for fusion image. The purpose of this study is to evaluate whether or not the fusion images created from in vivo valve more closely simulate the actual post-TAVI than those from ex vivo valve.

METHOD AND MATERIALS

The study group consisted of 35 patients who had undergone TAVI using SAPIEN 3 (Edwards, California) valve device with an original diameter of 23 mm. The 3D fusion CT images were created using ex vivo (method A) and in vivo (method B) valves. The height and the diameter of ex vivo and in vivo valves on the pre-TAVI fusion images were measured. Each measurement was subtracted from that of placed valve on post-TAVI CT to evaluate the difference. The differences in the height and diameter between pre- and post- TAVI CT images were compared between methods A and B, using a paired t- test.

RESULTS

In method A, the differences in the height and the diameter of ex vivo valve ranged from 0.1 mm to 2.0 mm (mean ± standard deviation [SD]: 1.2 ± 0.5 mm) and from 1.7 mm to 5.5 mm (mean ± SD: 3.1 ± 0.9 mm), respectively. In method B, the differences in the height and the diameter of in vivo valve ranged from 0.0 mm to 1.3 mm (mean ± SD: 0.4 ± 0.3 mm) and from 0.0 mm to 2.2 mm (mean ± SD:0.7 ± 0.5 mm), respectively. The differences were significantly smaller in method B (p values < 0.001) (Fig. 3).

CONCLUSION

The 3D fusion CT images created from in vivo valve more closely simulate the actual post-TAVI than those from ex vivo valve.

CLINICAL RELEVANCE/APPLICATION

The 3D fusion CT image using in vivo valve may be more appropriate for the simulation before TAVI, which may lead to better treatment outcome after TAVI.

SSQ04-07 The New Indicators of TEVAR in Patients with Complicated Type B Aortic Dissection

Thursday, Dec. 5 11:30AM - 11:40AM Room: E451A

Participants
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PURPOSE

To determine the morphological predictors for prognosing complicated type B aortic dissection (cTBAD) in dynamic CT angiography (CTA), and to investigate the influence of timing after thoracic endovascular aortic repair (TEVAR).

METHOD AND MATERIALS

Seventy-nine patients with cTBAD who underwent TEVAR between July 2013 and March 2018 were retrospectively enrolled. Patients were classified into three groups by the timing of intervention from presentation of symptoms to TEVAR (hyperacute: <2 days; acute: 2-14 days; subacute: 14-90 days). Baseline, operative characteristics and morphological parameters were reviewed. Endpoints comprised early (< 30 days) and late (> 30 days) adverse events after the intervention. Logistic regression analysis was performed to identify independent predictors for early mortality. Receiver operating characteristic (ROC) analysis was used to determine the best cut-off value of each predictor for predicting early death. Cumulative survival and freedom from adverse events were estimated using the Kaplan-Meier method and log-rank test.

RESULTS

The highest mortality (13.9%, 11 of 79) and adverse event rates (24.1%, 19 of 79) were discovered within 30 days after the procedure in the total cohort. Patients received TEVAR in hyperacute phase had significantly worse survival and lower event-free rates compared with those in acute and subacute groups (all $p < 0.05$) (Fig. 1, 2). Relative true luminal area (rTLA, defined as the ratio of true lumen area to aorta area in cross section) less than 25% (rTLA < 25%) in one cardiac cycle ($p = 0.049$) as well as the differences between the maximum and the minimum rTLA (D-TLA, $p < 0.001$) were both associated with increased early death. In addition, D-TLA ($p = 0.006$) and performing TEVAR in hyperacute phase ($p = 0.006$) were both independent predictors for early mortality. The area under the curve (AUC) of D-TLA was 0.849 with the cut-off value of 21.5% (sensitivity: 72.7%; specificity: 86.8%) (Fig. 3A). Patients with D-TLA > 21.5% had worse survivals in the long-term follow-up in comparison to those with D-TLA <= 21.5% ($p < 0.001$) (Fig. 3B).

CONCLUSION

D-TLA obtained in dynamic CTA is associated with worse survival postoperatively. Performing TEVAR in hyperacute phase may result in worse outcomes.

CLINICAL RELEVANCE/APPLICATION

Dynamic CTA is useful to identify the risk of adverse events in patients with cTBAD after TEVAR intervention.

SSQ04-08 Incidental Detection of Aortic Aneurysms in Contrast and Non-Contrast CT Using Deep Learning

Thursday, Dec. 5 11:40AM - 11:50AM Room: E451A

Participants
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PURPOSE

A large portion of aortic aneurysms (AAs) are undetected for years and can be missed by CT especially when done without contrast. A fully-automated method is developed and tested on a large population of patients to detect AAs in CT scans containing at least partial aorta, with intention to be used as an incidental detector of AAs in clinical environment.

METHOD AND MATERIALS

To achieve our objective, we used deep learning (DL) models and trained and evaluated it using close to 3300 CT volumes from both public and private datasets. Eight hundred CT scans were manually annotated. Multi-stage DL networks were trained to segment the aorta. Once segmented it was divided into thoracic and abdominal sections (if present) and the diameters were measured by the algorithm independently for each section. AA likelihood was determined by comparing the automatically obtained diameter to established clinical guidelines. A private multi-institutional dataset (not used in training) was utilized to validate algorithm performance. It had 2513 studies with 346 volumes with positive findings including 87, 76, 206 for ascending, descending, and abdominal aneurysms, respectively. The validation dataset consisted of thoracic CT (55.2%), abdominal/pelvis CT (19.3%), and their combinations (25.5%). It consisted of contrast (44.8%) and non-contrast (55.2%) scans, with a slice thickness ranging from 0.5 to 5mm. The scanner manufacturers included GE (51.8%), Siemens (25.4%), Toshiba (11.6%), Philips (10.7%), and others (<1%). The associated radiology reports (RRs) were analyzed to establish ground truth for AAs. The automatic probabilities were

compared to the aneurysm status from the RRs and the AUCs were computed.

RESULTS

The AUCs for thoracic and abdominal aneurysm detections were 0.95 and 0.94, respectively. The 95% confidence regions were [0.93, 0.97] for thoracic and [0.92, 0.95] for abdominal aneurysm detections.

CONCLUSION

A fully automated multi-stage DL based method was developed for AAs detection on contrast and non-contrast CT containing at least partial aorta. Solid robustness and good accuracy were obtained on a multi-institutional and multi-acquisition dataset of 2513 studies indicating the method can potentially be used to detect AAs in scans for which AAs are not expected (incidental setting) reducing chances of misses.

CLINICAL RELEVANCE/APPLICATION

Automatic aortic aneurysm (AA) detection from contrast and non-contrast CTs may reduce chance of missing AAs in clinics as well as for consistent measurements of longitudinal aorta diameter interval.

SSQ04-09 Deep Learning Algorithm for Surveillance of Pneumothorax after Percutaneous Transthoracic Lung Biopsy: Validation in Multi-Center, Consecutive Cohorts

Thursday, Dec. 5 11:50AM - 12:00PM Room: E451A

Participants
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PURPOSE

To evaluate the performance of a deep learning algorithm (DLA) for detection of pneumothorax (PTX) after percutaneous transthoracic needle biopsy (PTNB) on chest radiograph (CR), in consecutive cohorts from multiple institutions.

METHOD AND MATERIALS

We consecutively included 1757 patients (60.0% male; median age 66 years) who underwent PTNB in 3 different institutions (Institution A:B:C=1055:388:314). We utilized a commercially-available DLA for identification of CRs with PTX. For each CR, DLA provided a probability score for the presence of PTX, along with a localization heat map. Reference standards were defined by attending thoracic radiologists of each institution. The amounts of PTX were stratified based on guidelines from the British Thoracic Society and the American College of Chest Physicians (ACCP), and percentage amount. Performance of the DLA was evaluated with area under the receiver operating characteristic curve (AUROC), sensitivities and specificities at pre-defined operating cutoff. Performance of DLA was indirectly compared with that of radiologists, by retrospective evaluation of radiology reports by radiologists in each institution.

RESULTS

PTX occurred in 17.5% (308/1757; 10.5-21.9% across institutions) of cases, among which 16.6% (51/308; 12.1-17.3% across institutions) required catheter drainage. The DLA showed AUROC of 0.937 (0.931-0.947 across institutions) for identification of PTX. Sensitivity and specificity of the DLA was 70.5% (66.8-79.1% across institutions) and 97.7% (96.3-98.5% across institutions), respectively. Radiologists showed significantly lower sensitivity (55.5%, $P<.001$) and higher specificity (99.8%, $P<.001$) than the DLA, with median turnaround time of 70.7 hours. The DLA showed 94.1% sensitivity for PTX requiring catheter drainage, and 100% sensitivities for large PTX by both guidelines and PTX with percentage amount >=20%. Radiologists showed significantly lower sensitivities for large PTX by ACCP guideline (84.6%, $P=.046$) and PTX with percentage amount >=20% (87.3%, $P<.001$) than the DLA.

CONCLUSION

The DLA appropriately identified CRs with post-PTNB PTX in multi-center, consecutive cohort, with higher sensitivity than radiologists in the actual practice.

CLINICAL RELEVANCE/APPLICATION

The nice performance of DLA in cohort simulating the actual clinical situation suggests potential for utilization in the practice, to help sensitive detection and timely management of post-PTNB PTX.

SSQ05

Science Session with Keynote: Chest (Thoracic MRI)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E350

CH MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Andrew J. Plodkowski, MD, Brookside, NJ (*Moderator*) Nothing to Disclose

Sub-Events

SSQ05-01 Chest Keynote Speaker: MRI of the Thorax - Concepts and Challenges

Thursday, Dec. 5 10:30AM - 10:40AM Room: E350

Participants
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SSQ05-02 Distinguishing Cystic Fibrosis Severity Using Dynamic 19F Lung MR Imaging

Thursday, Dec. 5 10:40AM - 10:50AM Room: E350

Participants
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PURPOSE

To investigate dynamic 19F lung MRI gas dynamics to distinguish disease severity in Cystic Fibrosis (CF) patients

METHOD AND MATERIALS

Coronal images of 14 healthy controls and 18 subjects with CF were acquired using a multinuclear capable 3.0 T MRI scanner (PRISMA, Siemens) with a custom 8-channel 19F-tuned chest coil (ScanMed). Subjects inhaled 19F labelled perfluoropropane (PFP) gas mixed with 21% O2 (operating under investigational new drug IND 122,215) during the wash-in phase of the scan. Fifteen second 19F GRE vibe breath hold images were obtained following three breaths of PFP for five cycles of wash in. Gas was then switched to room air for wash-out phase and images were similarly acquired every 3 breaths until wash-out was complete. Semi-automated segmentation was used to identify ventilated voxels and custom software then implemented a previously described bi-exponential model fit with parameters including wash-in and wash-out time constants, peak signal, delay from origin, and delay to steady state. Upper and lower limits for wash-in and wash-out time constants were then defined to derive fractional lung volumes (FLV) comprising a percent of fitted time constants above upper limit ("slow") or below lower limit ("fast").

RESULTS

For fitted wash-out time constant, one-way ANOVA revealed differences between normal, mild, and moderate CF groups for "fast" FLV ($p<0.001$), "slow" FLV ($p=0.0012$), and standard deviation of all fitted wash-out time constant ($p<0.001$). For fitted wash-in time constant, one-way ANOVA revealed no differences for "fast" FLV ($p=0.51$), "slow" FLV ($p=0.34$), or standard deviation of all fitted wash-in time constants ($p=0.12$). Tukey's HSD revealed differences between mild and moderate CF using wash-out time constant for "fast" FLV ($p=0.011$) and standard deviation ($p=0.015$).

CONCLUSION

Dynamic 19F ventilation MRI is able to distinguish cystic fibrosis severity using parameters based on bi-exponential fit model. Wash-out time constant showed the most differentiating power corresponding to progressive air trapping physiology seen in cystic fibrosis.

CLINICAL RELEVANCE/APPLICATION

This novel imaging technique has advantages over xenon ventilation MRI including cheaper contrast material and inert compound allowing functional imaging with multiple image sets. We anticipate applications for many other lung diseases including pediatric lung malformations, lung resection, COPD monitoring, and bronchiectasis.

SSQ05-03 Automated Quantification of T2 High-Signal-Intensity Volume for Monitoring Lung Inflammation and Response to Treatment in Cystic Fibrosis

Thursday, Dec. 5 10:50AM - 11:00AM Room: E350

Participants
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PURPOSE

We aim at quantifying the relative high-signal-intensity volume (T2-HSV) using a T2 radial turbo spin echo sequence (T2-RTSE) with black blood contrast, in both healthy volunteers and CF. Secondary objectives were to correlate T2-HSV to pulmonary function test (PFT) in CF, to evaluate T2-HSV changes after treatment, and to evaluate the quantification provided by a composite volume-intensity product (T2-VIP) .

METHOD AND MATERIALS

Ten healthy volunteers and twelve CF patients were prospectively enrolled between January 2017 and November 2017. All participants underwent a lung MR protocol including T2-RTSE. CF participants also underwent PFTs the same day. Six CF were under respiratory exacerbation and repeated MRI after treatment. Automated quantification of T2-HSV and T2-VIP were done by two observers. Comparison of means was performed using Mann-Whitney test, correlations were done by using Pearson test, comparison of paired means using paired t-test and reproducibility evaluated using intraclass correlation coefficient.

RESULTS

In healthy volunteers and CF, T2-HSV was equal to 0% ± 0 and 5.9% ± 5.0, respectively and T2-VIP was equal to 0ms ± 0 and 464ms ± 340, respectively ($p<0.001$). In CF, correlations were found between T2-HSV or T2-VIP with forced expiratory volume in 1 second (r -0.81 and r -0.90, respectively; $p<0.001$). A significant decrease in both T2-HSV and T2-VIP was observed after treatment ($p=0.005$ and $p<0.001$, respectively). The reproducibility of MR metrics were very good.

CONCLUSION

Automated quantification of high-signal-intensity volume is feasible in vivo in CF using MRI. The reproducible method may be a promising MR tool to monitor inflammatory modifications and response to treatment, without radiation nor contrast-product exposure.

CLINICAL RELEVANCE/APPLICATION

Automated quantification of high-signal-intensity volume is feasible in vivo in CF using MRI. The reproducible method may be a promising MR tool to monitor inflammatory modifications and response to treatment, without radiation nor contrast-product exposure.

SSQ05-04 Opportunities for Functional Lung Imaging at Low-Field MRI

Thursday, Dec. 5 11:00AM - 11:10AM Room: E350

Participants
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PURPOSE

Lung imaging is notoriously difficult with MRI. We show that a high-performance low field MRI system may offer two advantages for lung imaging: 1. Improved field homogeneity resulting in prolonged T2* and improved imaging of the lung parenchyma and 2. Increased oxygen relaxivity for functional assessment of ventilation.

METHOD AND MATERIALS

Lung MRI was performed on a prototype 0.55T system (ramped down MAGNETOM Aera, Siemens Healthcare, Erlangen, Germany). This system is unique because it uses modern magnet design, fast gradient design, modern RF system, custom phased array coils and advanced imaging methods. Images were compared to a commercial 1.5T (MAGNETOM Aera, Siemens Healthcare, Erlangen, Germany). Anatomical lung imaging (T2w turbo spin echo) and 3D oxygen-enhanced ultrashort TE imaging was performed on healthy volunteers and patients with disease (eg. lymphangioleiomyomatosis (LAM) and bronchiectasis) with 100% oxygen (15L/min through, non-rebreather face mask). Room-air and oxygen images were registered and subtracted to estimate regional ventilation.

RESULTS

Images at 0.55T provided superior visualization of the lung parenchyma compared to 1.5T and useful insight into lung pathology, including the assessment of cysts and bronchial wall thickening. This can be attributed to the improved B0 homogeneity, minimized susceptibility gradients at air/tissue interfaces, and the longer T2* of lung tissue. The relaxivity of molecular oxygen was 4.7e-4

mmHg-1s-1 at 0.55T (vs 3.1e-4 mmHg-1s-1 at 1.5T). In healthy volunteers, lung signal increased by 18.2 ±6.3% (n = 5) with oxygen inhalation, compared with only 8.6±2.9% at 1.5T in the same subjects. Patients with LAM (n = 8) had only 6.5 ± 5.1% signal increase with oxygen inhalation and showed increased heterogeneity in the signal enhancement.

CONCLUSION

This system pairs modern system design with low magnetic field. By comparison, most low field systems are not designed to be high performance and, thus, compromise image quality. We demonstrate the potential of a state-of-the-art low field MRI to enable lung imaging. Moreover, we demonstrate the potential of oxygen as a contrast that performs better at lower field for the assessment of regional lung function.

CLINICAL RELEVANCE/APPLICATION

Low field MRI with modern magnet design may provide a unique opportunity for functional assessment of the lung by virtue of the improved field uniformity and improved oxygen contrast performance.

SSQ05-05 Ferumoxytol-Enhanced MR Venography of the Central Veins of the Thorax to Evaluate Stenoses and Occlusions in Patients with Renal Failure

Thursday, Dec. 5 11:10AM - 11:20AM Room: E350

Participants
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PURPOSE

Hemodialysis patients have a high prevalence of central venous stenosis and frequently need imaging for access planning; however, these individuals cannot receive gadolinium due to concern for NSF. The purpose of this study was to assess the diagnostic performance of ferumoxytol-enhanced MR venography (MRV) for detection of stenoses and occlusions of the central veins of the thorax, with conventional venography as the reference standard.

METHOD AND MATERIALS

This retrospective study was approved by the IRB; a waiver of informed consent was obtained. Analysis was performed on 35 consecutive patients (mean age 48.6 years, 17 male, 18 female) who underwent ferumoxytol-enhanced MRV of the central veins and concurrent conventional venography. The central veins were divided into 7 segments for evaluation. Two radiologists interpreted MRVs in consensus for stenoses and occlusions. Confidence levels were scored on a scale of 1-4, with 4 being completely confident. Quantitative analysis consisted of measurement and calculation of the signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and intraluminal signal heterogeneity for all venous segments.

RESULTS

Of the 126 total venous segments with corresponding conventional venography, 80 were stenotic or occluded. The sensitivity and specificity for detection of stenosis or occlusion was 0.98 and 1.0, respectively, whereas the sensitivity and specificity for detecting occlusions alone was 0.98 and 0.99. Mean reader confidence was 3.5. The calculated mean intraluminal SNR, CNR, and heterogeneity was 219.7, 169.2, and 0.07, respectively. There were no adverse events related to contrast administration.

CONCLUSION

Ferumoxytol-enhanced MR venography demonstrated excellent sensitivity and specificity for detection of central venous stenoses and occlusions of the thorax. Given that ferumoxytol is an FDA-approved parenteral iron supplement for hemodialysis patients that does not carry a risk of NSF, this contrast agent is particularly well-suited for noninvasive vascular imaging in this population.

CLINICAL RELEVANCE/APPLICATION

Since gadolinium is contraindicated for hemodialysis patients, ferumoxytol-enhanced MRV is an excellent modality for evaluation of the central veins and avoids the risk of Gd-associated NSF.

SSQ05-06 Quantitative Assessment of Diaphragm Dysfunction Using MRI in COPD

Thursday, Dec. 5 11:20AM - 11:30AM Room: E350

Participants
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PURPOSE

It is believed that diaphragm dysfunction is related to the airflow limitation resulting in lung hyperinflation in patients with chronic obstructive pulmonary disease (COPD). We applied dynamic MRI to quantitatively evaluate diaphragm dysfunction in COPD.

METHOD AND MATERIALS

The study comprised 80 stable COPD patients with different disease severities (GOLD stages 1-4) and 21 healthy volunteers. Chest

MRI was performed in a 3T scanner with end-inspiratory/expiratory 3D-SPGR sequence and 2D dynamic diaphragmatic sequence. Images were automatically segmented. We measured the area under the diaphragm (ds), the height of the diaphragm (dh), cranial-caudal length (cc), anterior-posterior length (ap) and lung area (ls) at the start and end of inspiration. The anterior and posterior diaphragm angles and the paradoxical diaphragmatic movement ratio were analyzed. These parameters were investigated in correlation with pulmonary function test and emphysema index.

RESULTS

In the severe COPD patients with GOLD 3-4, we observed that insp-exp-ratio of ds and dh decreased significantly, and insp-exp-ratio of the ls, cc and ap reduced, which reflected the change of diaphragmatic position. The anterior and posterior diaphragm angles reduced in patients with GOLD3-4 at the start and end of inspiration, which reflected the change of the diaphragmatic shape.

CONCLUSION

Chest dynamic MRI can provide new imaging biomarkers to assess diaphragm dysfunction in COPD without specialized equipment.

CLINICAL RELEVANCE/APPLICATION

Figure 1: Sagittal dynamic cine-MRI image of the right hemidiaphragm at the end of inspiration (left) and expiration (right), showing the shape of diaphragm in COPD patient get flat and the excursion diaphragm in COPD patient reduced.

SSQ05-07 Non-Invasive MR-Based Characterization of Pleural Effusions and Ascites in Patients with Suspected Lymphatic Leakage Using a 6-Point mDIXON Fat Quantification Method

Thursday, Dec. 5 11:30AM - 11:40AM Room: E350

Participants
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PURPOSE

To assess whether MR-based 6-point mDixon fat quantification (mDIXONquant) allows for non-invasive differentiation of chylous (i.e. rich in triglycerides [TG]; e.g. chylothorax) and non-chylous effusions.

METHOD AND MATERIALS

In-vitro, ex-vivo and in-vivo MR-examinations were performed using the commercially available mDIXONquant on a clinical 1.5T MR-scanner. Proton density fat fraction (PDFF) was measured by a ROI-based approach on parameter maps. For in-vitro experiments eight fatty fluid solutions with known TG content (145 to 19000 mg/dl) were examined. For ex-vivo evaluation 14 chylous and 6 non-chylous clinical fluid samples were examined. In-vivo testing was performed in 29 patients with chylous (n=16) and non-chylous (n=13) effusions. All clinical samples underwent laboratory testing for TG, total protein, leucocytes, sodium, potassium, calcium and chloride levels. Laboratory values were correlated with PDFF and receiver operating characteristic analysis was used to determine the optimal PDFF threshold to differentiate chylous and non-chylous fluids.

RESULTS

In-vitro analysis showed that PDFF-values highly correlated with TG-content (r=0.998). Ex-vivo analysis revealed significant differences between PDFF for chylous (2.5% ±1.2) and non-chylous fluids (0.8% ±0.2)(p=0.0013). Ex-vivo PDFF highly correlated with TG-content (p<0.0001; r=0.88). In-vivo PDFF also significantly differed between chylous (6.2% ±4.3) and non-chylous fluids (0.6% ±0.6)(p<0.0001). In-vivo PDFF correlated strongly with TG-content (p<0.0001; r=0.96), and moderately with protein levels (p =0.0054; r=-0.66). Using PDFF cut-off values of either > 1.2% or > 1.8% yielded a sensitivity of 86% or 79% and specificity of 91% or 100%, respectively, for in-vivo differentiation of chylous and non-chylous effusions.

CONCLUSION

Non-invasive differentiation of chylous and non-chylous effusions is feasible using a commercially available MR-based fat quantification method. This can be helpful for pre-interventional work-up of complex cases (e.g combined pleural/pericardial effusions and ascites) in which diagnostic paracentesis may lead to an increased risk of complications

CLINICAL RELEVANCE/APPLICATION

This noninvasive MR technique can be seen as an alternative and reliable diagnostic approach allowing for the differentiation between chylous and non-chylous effusions in cases where paracentesis is not possible.

SSQ05-08 Imaging and Quantitative Evaluation of Pulmonary Blood Flow Using Pseudo-Continuous Arterial Spin Labeling (PCASL) with True-FISP Imaging at 1.5 Tesla: Free-Breathing and Timed Breath-Hold Examinations

Thursday, Dec. 5 11:40AM - 11:50AM Room: E350

Participants
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PURPOSE

To evaluate PCASL imaging with True-FISP data acquisition to assess lung perfusion at 1.5 Tesla and to evaluate a free-breathing examination scheme.

METHOD AND MATERIALS

Ten volunteers (31±7 y/o, 2f) were examined in a 1.5 Tesla MRI with ECG-triggered PCASL True-FISP imaging of the lung under free-breathing (FB) and timed breath-hold (TBH) by labeling the pulmonary trunk during systole. Four coronal slices were acquired with a post labeling delay of 1000 ms and non-rigidly registered in several steps by a cubic B-spline-based multi-resolution non-rigid registration with mutual information as similarity metric and Quasi-Newton optimization algorithm. To assess the quality of image registration, the mean structural similarity index (MSSIM) and the normalized mean squared error (NMSE) were calculated using TBH data as reference. MSSIM and NMSE were compared using a paired sample t-test. A p-value <0.05 was considered significant. To quantify lung perfusion, parenchyma was segmented using Gaussian mixture model clustering and compared with Bland-Altman plots. In two patients with pulmonary embolism, FB examinations were performed.

RESULTS

High perfusion signal could be assessed in all volunteers and patients. Image registration lead to high image quality even under free breathing. Mean average over cardiac cycle pulmonary perfusion values acquired under FB (slice 1-4, ml/min/ml: 1.34±0.39, 0.98±0.36, 0.97±0.38, 0.94±0.43) were in good accordance to those from TBH (slice 1-4, ml/min/ml: 1.30±0.40, 0.97±0.35, 0.95±0.37, 0.87±.38). In patients, perfusion deficits were in accordance with embolism visible in CT.

CONCLUSION

ECG-triggered PCASL True-FISP imaging of the lung at 1.5 Tesla can provide perfusion images of high image quality by labeling the pulmonary trunk. Using non-rigid image registration, reliable quantitative perfusion maps and good image quality can be assessed, even when acquired under free breathing.

CLINICAL RELEVANCE/APPLICATION

PCASL imaging with True-FISP data acquisition enables perfusion images of the lung of high image quality even under free breathing without contrast agent which can be of clinical singificance for different types of lung diseases.

SSQ05-09 Pulmonary Thin-Section MR Imaging with Ultra-Short Echo Time (UTE) versus Low-Dose CT versus Standard-Dose CT: Capability for Nodule Detection and Lung-RADS Classification

Thursday, Dec. 5 11:50AM - 12:00PM Room: E350

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PURPOSE

To compare the capability of pulmonary MR imaging with ultra-short echo time (UTE-MRI) for lung nodule detection and Lung-RADS classification with thin-section low- and standard-dose CTs.

METHOD AND MATERIALS

110 consecutive patients (64 males and 46 females: mean age, 65 years) with suspected pulmonary nodules at near-by hospital were examined with standard- and low-dose CTs (270 mA [SDCT] and 60 mA [LDCT]) and UTE-MRI. According to SDCT findings, all nodules were divided into solid, part-solid and ground glass nodules. In each patient, probability of presence at each pulmonary nodule was assessed on all three methods by means of 5-point visual scoring system by two board certified chest radiologists. In addition, all nodules were classified based on Lung-RADS on each method by same radiologists. To compare nodule detection capability, Jackknife alternative free-response receiver operating characteristic (JAFROC) analysis were performed among all methods. In addition, we assessed the differences among the three methods in terms of figure of merit (FOM) values, sensitivity and false-positive rate by means of one-way ANOVA. To evaluate Lung-RADS classification capability, inter-observer agreement of each method was evaluated by kappa statistics with $\chi 2$ test. In addition, inter-method agreements were also assessed by kappa statistics with $\chi 2$ test were performed.

RESULTS

FOMs of all methods (UTE-MRI: FOM=0.89, LDCT: FOM=0.86, SDCT: FOM=0.89) had no significant difference ($p>0.05$). Sensitivity (SE) and false-positive rate per case (FP) of UTE-MRI (SE: 92.5[508/549] %, FP: 0.62/case) had no significant difference with those of LDCT (SE: 93.2 [512/549] %, $p>0.05$; FP: 0.68/case, $p>0.05$) and SDCT (SE: 93.4 [513/549] %, $p>0.05$; FP: 0.55/case, $p>0.05$). Inter-observer agreement of each method for Lung-RADS classification was shown as almost perfect (UTE-MRI: $\kappa=0.92$, $p<0.0001$; LDCT: $\kappa=0.93$, $p<0.0001$; SDCT: $\kappa=0.95$, $p<0.0001$). Inter-method agreements for Lung-RADS classification were also assessed as almost perfect (UTE-MRI vs. LDCT: $\kappa=0.87$, $p<0.0001$; UTE-MRI vs. SDCT: $\kappa=0.89$, $p<0.0001$; LDCT vs. SDCT: $\kappa=0.95$, $p<0.0001$).

CONCLUSION

Pulmonary MR imaging with UTE is considered at least as valuable as low- and standard-dose CTs for lung nodule detection and Lung-RADS classification.

CLINICAL RELEVANCE/APPLICATION

MR imaging with UTE is considered at least as valuable as low- and standard-dose CTs for lung nodule detection and Lung-RADS classification.

Printed on: 10/29/20

SSQ06

Gastrointestinal (Oncology)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S103AB

GI OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Carolyn L. Wang, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company
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Sub-Events

SSQ06-01 CT Resectability According to NCCN Criteria After Neoadjuvant FOLFIRINOX Chemotherapy for Borderline and Unresectable Pancreatic Ductal Adenocarcinoma

Thursday, Dec. 5 10:30AM - 10:40AM Room: S103AB

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PURPOSE

To assess CT resectability according to NCCN criteria and associated CT findings for predicting R0 resection after neoadjuvant FOLFIRINOX chemotherapy in patients with pancreatic ductal adenocarcinoma (PDAC)

METHOD AND MATERIALS

Among 204 consecutive patients with PDAC who underwent neoadjuvant FOLFIRINOX therapy from 2013 to 2017, eligible patients fulfilled the following criteria were identified: 1) patients underwent both pre- and post-chemotherapy multiphase CT, 2) available pathologic result of resection margin, and 3) borderline or unresectable PDAC assessed on pre-chemotherapy CT according to NCCN criteria. We finally analyzed 64 patients (36 men; mean age, 58.8 years). For CT resectability after chemotherapy, two abdominal radiologists independently evaluated following CT findings: a) contact angle of artery or vein, b) involved depth of artery or vein, 3) degree of perivascular tumor enhancement of artery or vein in portal venous phase, and 4) tumor size and enhancement. Change in CT resectability before and after therapy was classified as regression, stable or progression. Inter-reader agreement was evaluated using intraclass correlation coefficient (ICC). Uni- and multi-variate logistic analyses were used to identify R0 resection-associated CT findings.

RESULTS

ICC for CT findings ranged from 0.64 to 0.94. R0 resection was achieved in 67% (6/9), 72% (23/32) and 68% (15/22) patients with resectable, borderline and unresectable PDAC, respectively. Sensitivity and specificity of CT resectability (resectable & borderline vs. unresectable) for R0 resection were 66% and 37%, respectively. R0 resection was made in 58% (11/19), 74% (24/31) and 69% (9/13) patients with regression, stable and progression, respectively. Sensitivity and specificity of change in CT resectability (regression & stable vs. progression) for R0 resection were 80% and 21%, respectively. On univariate analysis, low perivascular tumor enhancement of artery or vein was significant. Low perivascular enhancement of vein (<=42.5 HU; odds ratio, 6.50; P<.02) was independently associated with R0 resection on multivariate analysis.

CONCLUSION

CT resectability according to NCCN criteria after neoadjuvant chemotherapy was sensitive but not specific for assessing R0 resection. The degree of perivascular tumor enhancement may have added values to predict R0 resection.

CLINICAL RELEVANCE/APPLICATION

Efficacy of CT resectability after neoadjuvant FOLFIRINOX chemotherapy

SSQ06-02 MDCT-Based Radiomic Signature as A Predictor of Disease-Free Survival: Bringing Promotion to Preoperative Clinical Model of Gastric Cancer

Thursday, Dec. 5 10:40AM - 10:50AM Room: S103AB

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PURPOSE

To establish a contrast-enhanced multiple-row detector computed tomography (MDCT)-based radiomic signature for disease-free survival (DFS) prediction in gastric cancer and validate its incremental value to the preoperative clinical risk model.

METHOD AND MATERIALS

A total of 249 gastric cancer patients in this retrospective study were randomly divided into a training cohort (n=166) and a validation cohort (n=83) at a ratio of 2:1. Two-dimensional radiomic feature extraction was conducted based on tumor volumes of interest from portal venous phase MDCT images. The least absolute shrinkage and selection operator penalized Cox proportional hazards regression was used to select radiomic features and establish a radiomic signature. A radiomic nomogram in combination with the radiomic signature and significant clinical factors was developed by multivariate Cox regression. Model 1 (radiomic signature), model 2 (clinical model), and model 3 (radiomic nomogram) were evaluated in terms of discrimination, calibration, and clinical usefulness.

RESULTS

A four-feature radiomic signature showed good stratification ability in gastric cancer patients with high-risk and low-risk of DFS in both cohorts (training cohort: hazard ratio [HR] = 2.718, $P < 0.001$; validation cohort: HR = 1.825, $P < 0.05$). Univariate radiomic feature indicated good predictive performance with Harrell's concordance indices (shape feature, 0.664; first-order feature, 0.625; two texture features, 0.543 and 0.487). The radiomic nomogram (model 3) combining the radiomic signature and two significant clinical factors (AFP and EMVI defined on MDCT) demonstrated the best performance over model 1 and model 2 with a concordance index of 0.721 (95% confidence interval [CI], 0.648-0.793) as well as good fitness by calibration curves and great clinical usefulness by decision curves.

CONCLUSION

MDCT-based radiomic signature was established and validated as a preoperative predictor of DFS in gastric cancer patients, offering assistance to prognostic prediction and treatment decisions.

CLINICAL RELEVANCE/APPLICATION

For individualized treatment decision, prognosis of gastric cancer can be analyzed by radiomic approach based on high-throughput mining of quantitative image features from preoperative medical imaging.

SSQ06-03 Development of Prognostic Prediction Model of TACE for Hepatocellular Carcinoma Based on Radiomics Analysis of Preoperative DCE-MRI

Thursday, Dec. 5 10:50AM - 11:00AM Room: S103AB

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PURPOSE

Transcatheter arterial chemoembolization (TACE) is the first-line treatment for hepatocellular carcinoma (HCC), but its efficacy often has individualized differences. The purpose of this study was to develop a precise prognostic model for TACE treatment of hepatocellular carcinoma based on dynamic contrast;enhanced magnetic resonance imaging (DCE-MRI).

METHOD AND MATERIALS

Retrospective collection of 107 pathologically confirmed liver cancer patients who underwent TACE in our hospital from January 2013 to June 2018 in present study. All patients underwent DCE-MRI before treatment and followed up for 3 months after TACE, who were further divided into effective group (n=70) and ineffective group (n=37) according to the reaction of the tumor based on

mRECIST criteria. The enrolled patients in the above two groups were randomly divided into a training set (n=74) and a validation set (n=33). Analysis Kit software was used to delineate the volume of interest (VOI) of lesions based on the contrast-enhanced T1-weighted images and extract a total of 396 quantitative texture parameters, which were further dimension reduction by Kruskal-Wallis (K- W) one-way ANOVA test, univariate logistic regression and LASSO algorithm, and selected the most useful features. The selected imaging features were then combined into a Rad score, which was further assessed by ROC curve analysis in the training and validation sets.

RESULTS

Six radiomic feature were finally selected to form the Rad score. The AUC for differentiating between effective group and ineffective group in the training set was 0.868 (95% CI: 0.802, 0.901), and the sensitivity and specificity were 73.5% and 88.2%, respectively. In the validation group, the AUC was 0.853 (95% CI: 0.782, 0.891), and the sensitivity and specificity were 81% and 82.6%, respectively.

CONCLUSION

A reliable TACE prognostic prediction model was developed based on the radiomics analysis of contrast-enhanced T1-weighted images, which is of great value for prognosis management of HCC patients undergoing TACE.

CLINICAL RELEVANCE/APPLICATION

A good and stable TACE short-term prognostic prediction model was constructed by using DCE-MRI based texture analysis, which is of great value for the management of HCC patients undergoing TACE.

SSQ06-04 Prognostic Value of Extracellular Volume Fraction Determined by Equilibrium Contrast-Enhanced CT in Patients with Pancreatic Adenocarcinoma Who are Scheduled for Chemoradiotherapy

Thursday, Dec. 5 11:00AM - 11:10AM Room: S103AB

Participants
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PURPOSE

Several recent studies indicated that extracellular volume fraction (ECV) of the malignant tumors may be useful in evaluating tumor aggressiveness and response to therapy. The purpose of this study was to determine the prognostic value of ECV quantified by equilibrium contrast-enhanced CT obtained prior to chemoradiotherapy (CRT) in patients with pancreatic adenocarcinoma.

METHOD AND MATERIALS

Thirty-five patients with histologically-proven pancreatic adenocarcinoma who had no distant metastasis and underwent dynamic CT before treatment were retrospectively studied. Absolute enhancement in Hounsfield unit was determined for the tumor (Etumor) and aorta (Eblood) by placing regions-of-interest on pre-contrast and equilibrium-phase CT images. The tumor ECV was calculated as the following equation: ECV(%) = Etumor x (100 - hematocrit(%)) / Eblood. Univariate and multivariate analyses were performed to evaluate the value of the tumor ECV as well as age, sex, primary tumor site, tumor diameter, surgical indication, and CA19-9 for the prediction of progression-free survival (PFS) and overall survival (OS).

RESULTS

The median and interquartile range of ECV in pancreatic adenocarcinoma was 35.8% and 25.0 - 43.6% in all patients. During the median observation period of 23 months, 29 (83%) of 35 patients experienced disease recurrence (n=25) or death (n=19). Kaplan-Meier curves for PFS and OS according to the ECV are shown in Figure 1. In univariate analysis, the tumor ECV of > median (35.8%) was significantly associated with better prognosis for both PFS (p=0.017) and OS (p=0.003). Multivariate analysis revealed that tumor ECV was an independent prognostic factor for PFS (Hazard ratio [95% CI], 0.383 [0.165-0.889]; p=0.025) and OS (Hazard ratio [95% CI], 0.213 [0.069-0.660]; p=0.003).

CONCLUSION

Higher tumor ECV determined by pre-contrast and equilibrium-phase CT prior to CRT is significantly associated with better outcome in patients with pancreatic adenocarcinoma. The tumor ECV can be quantified by routine dynamic CT and has excellent prognostic value in patients with pancreatic adenocarcinoma.

CLINICAL RELEVANCE/APPLICATION

Tumor ECV quantified by equilibrium contrast-enhanced CT is a novel imaging biomarker that permits prediction of the prognosis in patients who are scheduled for CRT.

SSQ06-05 Baseline Clinical and Imaging Predictors of Treatment Response and Overall Survival of Patients with Metastatic Melanoma Undergoing Immunotherapy

Thursday, Dec. 5 11:10AM - 11:20AM Room: S103AB

Participants
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PURPOSE

We aimed to identify predictive clinical and CT imaging biomarkers and assess their predictive capacity regarding overall survival (OS) and treatment response in patients with metastatic melanoma undergoing immunotherapy.

METHOD AND MATERIALS

The local institutional ethics committee approved this retrospective study and waived informed patient consent. 103 patients with immunotherapy for metastatic melanoma were randomly divided into training (n= 69) or validation cohort (n=34). Baseline tumor markers (LDH, S100B), baseline CT imaging biomarkers (tumor burden, Choi density) and CT texture parameters (Entropy, Kurtosis, Skewness, uniformity, MPP, UPP) of the largest target lesion were extracted. To identify treatment response predictors, binary logistic regression analysis was performed in the training cohort and tested in the validation cohort. For OS, Cox regression and Kaplan Maier analyses were performed in the training cohort. Bivariate and multivariate models were established. Goodness of fit was assessed with Harrell's C-index. Potential predictors were tested in the validation cohort also using Cox-regression and Kaplan-Meier analyses.

RESULTS

Baseline S100B (Hazard ratio(HR)= 2.543, p0.018), tumor burden (HR=1.657, p=0.002) and Kurtosis (HR=2.484, p<0.001) were independent predictors of OS and were confirmed in the validation cohort (p<0.048). Tumor burden and Kurtosis showed incremental predictive capacity allowing a good predictive model when combined with baseline S100B levels (C-index=0.720). Only S100B was predictive of treatment response (OR<=0.630, p<=0.022). Imaging biomarkers didn't predict treatment response.

CONCLUSION

We identified easily obtainable baseline clinical (S100B) and CT predictors (tumor burden and Kurtosis) of OS in patients with metastatic melanoma undergoing immunotherapy. However, imaging predictors didn't predict treatment response.

CLINICAL RELEVANCE/APPLICATION

Baseline S100B levels, baseline tumor burden and Kurtosis of the largest target lesions are independent survival predictors in patients with metastatic melanoma undergoing immunotherapy. Baseline S100B level are also predictive of response to immunotherapy.

SSQ06-06 Evaluating for Primary Malignancy in Patients with Solitary and Multiple Brain Lesions: the Diagnostic Value of CT Chest, Abdomen, and Pelvis

Thursday, Dec. 5 11:20AM - 11:30AM Room: S103AB

Participants
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PURPOSE

Patients with newly discovered brain lesions on CT or MRI often undergo CT of the chest, abdomen, and pelvis in an effort to identify a primary cancer that may have metastasized to the brain. The aim of this study was to determine the frequency of finding a primary cancer on CT of the chest, abdomen, and/or pelvis in these patients.

METHOD AND MATERIALS

We evaluated how often a primary malignancy was diagnosed in the chest versus abdomen and pelvis portions of CT scans in patients with newly identified brain lesions. Multiple brain lesion characteristics were recorded, such as size, the presence of enhancement and hemorrhage as well as whether lesions were single or multiple.

RESULTS

Out of 287 consecutive cases over five years, the final diagnoses were 136 primary brain malignancies (47%), 91 metastatic malignancies (32%), and 60 benign entities (21%). Of the 91 metastatic malignancies, 68 were of lung primary (75%). Chest CT identified a primary malignancy in 65 of 287 total cases (23%), 62 of which were lung cancers. The abdomen and pelvis portion of the CT scans identified a primary malignancy in only 3 cases (1%). In 26 cases, where the brain lesion(s) did not enhance, only 1 was a metastasis.

CONCLUSION

In patients with newly discovered brain lesions on imaging, CT of the chest to identify a primary lung cancer is warranted in patients with enhancing brain lesions. Without signs/symptoms of abdominopelvic malignancy, CT of the abdomen/pelvis will rarely reveal a primary cancer that metastasized to the brain.

CLINICAL RELEVANCE/APPLICATION

Utilizing CTC in place of CTCAP would reduce healthcare costs and patient radiation dose in patients with new brain lesions found on imaging and without sign/symptoms of an abdominopelvic malignancy.

SSQ06-07 Prediction of Outcome in Anal Squamous Cell Carcinoma Using Radiomic Feature Analysis of Pre-

Treatment FDG PET-CT

Thursday, Dec. 5 11:30AM - 11:40AM Room: S103AB

Participants
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PURPOSE

Incidence of anal squamous cell carcinoma (ASCC) is increasing, with curative chemoradiotherapy (CRT) as the primary treatment of non-metastatic disease. A significant proportion of patients have loco-regional treatment failure (LRF), but rarely distant relapse. Accurate prognostication of progression free survival (PFS) would help personalisation of CRT regimens. The study aim was to evaluate novel imaging pre-treatment features, to prognosticate for PFS in ASCC.

METHOD AND MATERIALS

Consecutive patients with ASCC treated with curative intent at a large tertiary referral centre who underwent pre-treatment FDG-PET/CT were included. Radiomic feature extraction was performed using LIFEx software on baseline FDG-PET/CT. Outcome data (PFS) was collated from electronic patient records. Elastic net regularisation and feature selection was used for logistic regression model generation on a randomly selected training cohort and applied to a validation cohort using TRIPOD guidelines. ROC-AUC analysis was used to compare radiomic feature model performance with a regression model combining standard prognostic factors (age, sex, tumour and nodal stage).

RESULTS

189 patients were included in the study, with 102/145 in the training cohort and 30/44 in the validation cohort. PFS and median follow-up were 70.3% / 35.1 months and 68.2% / 37.9 months, respectively. GLCM Entropy (a measure of randomness of distribution of co-occurring pixel grey-levels), NGLDM Busyness (a measure of spatial frequency of changes in intensity between nearby voxels of different grey-level), minimum CT value (lowest HU within the lesion) and SMTV (a standardized version of MTV) were selected for inclusion in the prognostic model. AUC for elastic net model prediction in the validation cohort was 0.738, the AUC for standard prognostic factors was 0.602.

CONCLUSION

Radiomic features extracted from pre-treatment FDG-PET/CT in patients with ASCC may provide better PFS prognosis than conventional staging parameters. With external validation this might be useful to help personalise CRT regimens in the future.

CLINICAL RELEVANCE/APPLICATION

Radiomic feature analysis with FDG-PET/CT can be used in anal squamous cell carcinoma to predict outcomes, which could potentially be used to help personalise future chemoradiotherapy regimens.

SSQ06-08 Radiomics Analysis of Advanced Gastric Cancer: A More Accurate Method for Real-Time Assessment of Treatment Response to Neoadjuvant Chemotherapy

Thursday, Dec. 5 11:40AM - 11:50AM Room: S103AB

Participants
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PURPOSE

To develop a computed tomography (CT) based radiomics method for diagnosis of pathological downstaging after each cycle of neoadjuvant chemotherapy (NAC) in advanced gastric cancer (AGC), evaluate its performance and compare with the clinical conventional RECIST assessment at CT imaging.

METHOD AND MATERIALS

This retrospective study include 247 AGC patients who received 1-4 cycles of NAC and followed by surgery. Ninety-two of them (37.2%) achieved pathological downstaging. We extracted 1231 features from post-NAC portal venous-phase CT scans for each patient, then made up 28 cross-combination radiomic models with 7 feature selection methods and 4 classifiers within a nested cross-validation (CV) structure. The optimal model was selected. Its performance was assessed with respect to its discrimination and compared with that of RECIST at CT imaging in two external validation cohorts, which included patients who received 1-2 cycles and 3-4 cycles of NAC, respectively.

RESULTS

The optimal radiomics model consisting of the feature selection method of wilcoxon and classifier of linearSVC achieved a mean AUC of 0.919 (the highest among the 28 machine-learning models). It used 92 features, including wavelet-LHL_glszm_GrayLevelNonUniformity, wavelet-LLL_glrlm_RunLengthNonUniformity, and wavelet-LHL_firstorder_TotalEnergy, the

weight of which ranked in the top 3. This model had a good diagnostic ability in both two external validation cohorts (AUC 0.927±0.093; AUC 0.884±0.102, respectively), which outperformed the RECIST method (NRI 39.5%, p<0.05; NRI 35.4%, p<0.05, respectively).

CONCLUSION

Contrast-enhanced CT based radiomics has an excellent ability of preoperative diagnosis and early detection of pathological downstaging, more sensitive and accurate than routine method, which may have significant clinical implications on real-time assessment of downstaging for AGC patients who were experiencing NAC.

CLINICAL RELEVANCE/APPLICATION

The effective radiomics model combining 85 radiomic features might turn into a noninvasive and convenient potential imaging biomarker of chemotherapy response, providing more accurate and timely evaluation to optimize and individualize the treatment.

SSQ06-09 Agreement between Prospective Local Evaluation and Retrospective Central Evaluation of Metastatic Colorectal Cancer by RECIST

Thursday, Dec. 5 11:50AM - 12:00PM Room: S103AB

Participants
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PURPOSE

Response evaluation criteria in solid tumors (RECIST) measurements are commonly performed prospectively at the cancer centers in order to assess disease progression. However, data from clinical trial are also commonly assessed by a central review in retrospective fashion at the conclusion of trial. The purpose of our study was to assess concordance level between prospective and retrospective RECIST reporting performed by trained radiologists.

METHOD AND MATERIALS

The study was IRB approved. One hundred five CT studies in 39 patients with metastatic colorectal cancer were included. Radiologists reviewed all scans using RECIST guideline both prospectively and retrospectively. Prospective and retrospective studies were evaluated six weeks apart. The agreement in RECIST between prospective and retrospective assessment were evaluated.

RESULTS

In 34 of 39 (87.2%) patients and in 59 of 66 (89.4%) follow-up assessments, prospective and retrospective evaluation with different radiologists agreed on RECIST classification. In all patients with discordance, the radiologists selected at least 1 different target lesion in every patient. In patients with the same target lesion selected (n=7), prospective and retrospective RECIST agreement reached to 100%. When prospective and retrospective RECIST evaluation were performed by the same radiologist, agreement rate was slightly higher when compared to performance of two different radiologists (89.7% vs 87.2% of patients and 93.9% vs 89.4% of follow-up assessments (p>0.05). In the prospective and retrospective evaluation by the same radiologist, measurement variabilities resulted in RECIST discordance in 2 patients (5.1%).

CONCLUSION

If RECIST is strictly applied by blinded and trained radiologists, a strong agreement between prospective and retrospective evaluation can be observed. However, differences in target lesion selection and measurement variations may lead to differences in response assessment.

CLINICAL RELEVANCE/APPLICATION

If RECIST is strictly applied by blinded and trained radiologists, a strong agreement between prospective and retrospective evaluation can be observed. Therefore, prospective evaluation of response rate during the trial using RECIST may be a valid reflection of future evaluation by a central imaging core.

SSQ07

Gastrointestinal (Advanced MRI Techniques)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S103CD

GI MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Hersh Chandarana, MD, New York, NY (*Moderator*) Equipment support, Siemens AG; Software support, Siemens AG; ;
Kelly L. Cox, DO, Jacksonville, FL (*Moderator*) Nothing to Disclose
Michael A. Ohliger, MD,PhD, Burlingame, CA (*Moderator*) Travel support, General Electric Company; Speaker, General Electric Company

Sub-Events

SSQ07-01 Impact of Temporal Resolution and Motion Correction for Dynamic Contrast-Enhanced MR Imaging of the Liver Using an Accelerated Golden-Angle Radial Sequence

Thursday, Dec. 5 10:30AM - 10:40AM Room: S103CD

Participants
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Samuel Kadoury, Montreal, QC (*Presenter*) Nothing to Disclose

PURPOSE

To evaluate the impact on image quality and quantitative dynamic contrast-enhanced (DCE)-MRI perfusion parameters when varying the number of respiratory motion states on DCE-MRI perfusion parameters using eXtraDimensional Golden-Angle Radial Sparse Parallel (XD-GRASP).

METHOD AND MATERIALS

This prospective study was approved by the institutional review board and consent was obtained from patients. Eleven patients, 6 men and 5 women (70 years ± 11 [standard deviation]), underwent DCE-MRI examinations on a 3.0 T MRI (Achieva TX, Philips Healthcare). T1 mapping was performed using the variable flip-angle method with fat-saturated cartesian 3D gradient-echo acquisitions in breath-hold. DCE acquisition was performed in free-breathing using a 3D stack-of-stars gradient-echo golden-angle radial acquisition. Contrast injection was performed 30 s after initiating the DCE acquisition. Nonparametric analysis was conducted on the time-intensity curves. Parametric analysis was performed using a dual-input single-compartment model. Comparison of signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR) and perfusion parameters was made for XD-GRASP with different number of respiratory motion states.

RESULTS

A total of 22 HCCs (size: 11 - 52 mm) were evaluated. XD-GRASP reconstructed with increased motion states improves the SNR ($P < 0.05$) but reduces temporal resolution (0.04 volume/s vs 0.17 volume/s for one motion state) ($P < 0.05$). The peak enhancement ratio and normalized maximum intensity time ratio increased with decreasing number of motion states ($P < 0.001$) while the transfer constant from the portal venous plasma to the surrounding tissue significantly decreased ($P < 0.05$).

CONCLUSION

Peak enhancement ratio, normalized maximum intensity time ratio and transfer constant from the portal venous plasma to the surrounding tissue were sensitive to the number of motion states and to the temporal resolution. While a higher number of motion states improves SNR, the resulting lower temporal resolution can influence quantitative parameters that capture rapid signal changes.

CLINICAL RELEVANCE/APPLICATION

XD-GRASP can be used to perform quantitative perfusion measures for HCC response assessment, but the number of motion states may significantly alter some quantitative parameters.

SSQ07-02 Clinical Application of Amide Proton Transfer Imaging in the Liver: The Feasibility Study

Thursday, Dec. 5 10:40AM - 10:50AM Room: S103CD

Participants
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PURPOSE

To investigate the feasibility of amide proton transfer (APT) magnetic resonance imaging (MRI) in the liver and to evaluate its ability to characterize focal liver lesions (FLL)

METHOD AND MATERIALS

A total of 85 patients with suspected FLLs who underwent APT imaging at 3T were included. APT imaging was obtained at single slice to include FLL through five breath holds with interleaved APT and B0 field map scans. APT signals in the background liver and FLL were analyzed with the asymmetric magnetization transfer ratio (MTRasym). Technical success rate of APT imaging was calculated. MTRasym values were compared between the background liver and FLL, and between different FLLs using paired sample t-test or Wilcoxon signed rank test.

RESULTS

Technical success rate of APT imaging in the liver was 69.4% (59/85), and the reason of failure was too large B0 inhomogeneity. The acquisition time of APT imaging was approximately 1 minute. Among 59 FLLs with analyzable APT images, MTRasym values of 27 patients with liver metastases and 23 patients with hepatocellular carcinomas (HCCs) were compared. MTRasym values of metastases and background liver were significantly different (0.13 ± 2.15% vs. -1.62 ± 2.12%, P = 0.001), while those values of HCCs and background liver were similar (-1.41 ± 3.68% vs. -1.18 ± 1.60%, P = 0.767). MTRasym values of metastases were significantly higher than those of liver metastases (P = 0.027).

CONCLUSION

APT imaging could have a role to differentiate metastasis from HCC, although approximately 30% of cases were failed to obtain acceptable APT images of the liver.

CLINICAL RELEVANCE/APPLICATION

APT imaging might be useful to characterize focal liver lesions, but further technical improvement is required to apply APT imaging in the human liver.

SSQ07-03 Evaluation of Liver MRE Analyzability Criteria Using a Simulation Method Based on Successively and Concentrically Decreasing the Size of Selected Regions-of-Interest: A Proof-of-Concept Study

Thursday, Dec. 5 10:50AM - 11:00AM Room: S103CD

Participants
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PURPOSE

An objective method to determine the adequacy of liver magnetic resonance elastography (MRE) exams is to use a cutoff for total region-of-interest (ROI) size, usually either 500 or 700 pixels (Px) over four slices. However, little objective evidence supports either of these cutoffs. We performed a simulation study to evaluate how the mean, and the range of calculated liver stiffness values varies for these, and two higher cutoff values as we concentrically shrink total ROI size, for data from a multi-center drug development clinical trial of adults with nonalcoholic steatohepatitis (NCT02854605).

METHOD AND MATERIALS

Two-hundred and six MR exams were selected from the aforementioned clinical trial, based on availability of elastograms, and ROI size >= 4000 Px over four slices placed at clinical trial sites during the study. For each exam, stiffness values for all pixels were recorded. Stiffness values were calculated by randomly removing ten concentric Px at a time from the ROI edges, and repeating 100 times. For each simulation of 100 iterations, the stiffness ranges, at 500, 700, 2000, and 4000 Px were captured, and the medians were calculated. An absolute stiffness value difference was recorded for each of the four cutoffs, compared to the stiffness value reported using all pixels, and the means were calculated.

RESULTS

Average absolute differences in mean stiffness values across all simulations at the four cutoff values, compared to those obtained using all pixels, increased as cutoff values decreased (0.073, 0.148, 0.256, and 0.292 kPa for 4000, 2000, 700, and 500 Px, respectively). The median values of the the stiffness ranges across all simulations at the four cutoffs similarly increased as cutoff value decreased (0.014, 0.021, 0.038, 0.043 kPa at 4000, 2000, 700, and 500 Px, respectively).

CONCLUSION

At a proof-of-concept level, and subject to validation in other independent cohorts, this data supports that MRE liver stiffness analyzability cutoffs down to 500 Px over four slices are reasonable. For all four pixel cutoffs, the median values of the stiffness ranges, and the average absolute differences in mean liver stiffness compared to values obtained using all pixels, were small.

CLINICAL RELEVANCE/APPLICATION

These results suggest that MRE analyzability using a cutoff as low as 500 Px is likely to be acceptable for drug development clinical trials, and also for clinical care after further validation.

SSQ07-04 T1 Relaxation Times of the Liver and Spleen to Predict Significant Liver Fibrosis: Is There an Additional Value of Normalization to Blood Pool?

Thursday, Dec. 5 11:00AM - 11:10AM Room: S103CD

Participants
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PURPOSE

To analyze liver and spleen native T1 relaxometry values to predict significant fibrosis and their additional value when normalized to the blood pool.

METHOD AND MATERIALS

156 patients without solid liver lesions, prior liver surgery or portal vein thrombosis on routine liver multidetector CT scans underwent liver MRI with gradient-echo based MR elastography (MRE) and Shortened Modified Look-Locker Inversion recovery (shMOLLI) based T1 relaxometry. T1 relaxation times were measured in the right liver lobe and in the spleen, as well as in the aorta and in the vena cava. MRE liver stiffness were compared with T1 relaxation times alone, as well as T1 relaxation times normalized to the blood pool in the vena cava and in the aorta. Pearson correlation, students t-test and receiver operation characteristics (ROC) analysis were used to investigate the usefulness of different T1 relaxometry values to predict significant liver fibrosis, using a cutoff value of 3.5kPa in MRE (corresponding to F2 or higher in histology).

RESULTS

Correlation between T1 relaxometry values and MRE liver stiffness was r=0.49-0.59 ($p<0.001$) for T1 of the liver and for T1 of the liver normalized to blood pool, while T1 of the spleen was less useful (r=0.11-0.17). Both normalized and not normalized T1 values of the liver allowed to significantly separate patients with significant liver fibrosis from those without significant liver fibrosis ($p<0.001$). In ROC-analysis, T1 relaxometry values normalized to the blood pool did not perform better than T1 values alone (Figure).

CONCLUSION

Native T1 relaxation times of the liver allowed to predict clinically significant liver fibrosis, while T1 relaxation times of the spleen were less useful. There was no additional value of liver and spleen native T1 relaxometry values to predict significant fibrosis when normalized to the blood pool.

CLINICAL RELEVANCE/APPLICATION

T1 relaxometry is acquired in 9 seconds per slice and may be installed on any MR scanner without the need for additional hardware. It allows to predict significant liver fibrosis without time-consuming image post-processing

SSQ07-05 New Radial Technique for the Calculation of T2 Relaxation Time in Liver MRI

Thursday, Dec. 5 11:10AM - 11:20AM Room: S103CD

Participants
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Imaging

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PURPOSE

The purpose is to investigate the clinical application of 2D radial TSE (2DRTSE) sequencing by evaluating the quantitative T2 relaxation time (msec) of liver lesions and the background liver parenchyma. We also evaluated image quality.

METHOD AND MATERIALS

MRI was performed at 3.0 T in this IRB-approved prospective study. The prototype 2D radial TSE sequence (2DRTSE) generated 22 echo axial images corresponding to 22 different TEs (ranging from 8.6 ms to 188.8 ms) with prospective acquisition correction for free-breathing patient scans. By placing an ROI on the automatically generated T2 map, 2 radiologists obtained relaxation times for various liver lesions and background liver. Radiologists scored image quality. Weighted linear kappa statistics and the Lin concordance correlation coefficient (CCC) were used to assess inter-reader agreement. The differences in paired T2RTs of the two readers were plotted against their mean values using Bland-Altman plots. Multiple lesions within the same patient were considered independently.The Kruskal-Wallis test was used to compare T2RTs among different lesion types.

RESULTS

19 patients were included in the study. There were 36 liver lesions: 2 cysts, 9 hemangiomas, 21 solid lesions, and 4 necrotic metastatic lesions. The solid lesions were 12 metastases, 8 HCC, and 1 FNH.The mean calculated T2RT value for solid lesions (81.5 ms) was significantly lower than that for hemangiomas (153.9 ms; P = 0.0024).The Wilcoxon rank-sum test revealed that the mean calculated T2RT for liver cysts (285.7 ms) was significantly higher than solid lesions (81.5 ms; P = 0.025). For the 2 radiologists, the CCC was 0.996 (95% confidence interval 0.9914-0.9978) for the calculated T2 of each liver lesion, indicating substantial agreement. The mean calculated T2RT for the background liver was 42.2 ms. The Bland-Altman plot of the liver T2RT data showed 95% agreement between readers, allowing for a range of +10 to -13.3 ms. . Qualitative analysis of liver margins revealed good liver margin visibility in 100% of the evaluated slices

CONCLUSION

2D radial TSE sequencing is capable of providing good T2W images and a quantitative T2RT map. The quantitative T2 map was useful for the characterization of liver lesions.

CLINICAL RELEVANCE/APPLICATION

2D radial TSE sequence may supplant current T2WI acquisition. The value of lesion detection for T2-weighted imaging will be enhanced by the addition of quantitative T2RTs.

SSQ07-06 Respiratory Motion Artifacts in Gadoterate- and Gadoxetate-Enhanced Dynamic Phase Liver MRI After Intensified and Standard Pre-Scan Preparation: A Bi-Institutional Analysis

Thursday, Dec. 5 11:20AM - 11:30AM Room: S103CD

Participants
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PURPOSE

Gadoxetate disodium induced transient severe arterial phase respiratory motion (TSM) substantially degrades image quality in liver dynamic contrast-enhanced MRI (DCE-MRI). Extent of liver DCE-MRI procedural information and explanation and/or training of breath-hold commands in standard pre-scan patient preparation (SPPP) might vary between institutions due to missing standardization, contributing to the occurence of gadoxetate-related TSM. This bi-institutional study investigates the effect of intensified pre-scan patient preparation (IPPP; SPPP + custom-made educational material about liver DCE-MRI + standardized breath-hold training) on gadoxetate-related TSM.

METHOD AND MATERIALS

At site A and B, 50 (site A) and 58 (site B) patients received IPPP and 50 (site A) and 52 (site B) patients received SPPP prior to gadoxetate-enhanced liver DCE-MRI. As control, the effect of IPPP and SPPP was crosschecked in each 101 patients who received gadoterate-enhanced liver DCE-MRI (site B). Respiratory motion (RM) was scored in dynamic phase images using a Likert-scale (1 [none] - 5 [non-diagnostic]) independently by 5 (site A) and 2 (site B) blinded readers.

RESULTS

In the gadoxetate group, IPPP neither significantly mitigated TSM which was observed in 19% of patients (p=0.366) nor RM in any dynamic phase of patients without TSM (all p>0.072). In the gadoterate group, however, IPPP significantly mitigated RM in all dynamic phases (all p<0.031) compared to SPPP. The inter-reader agreement for grading of RM artifacts was excellent in pre-contrast and all dynamic phase images with all intra-class correlation coefficients (ICCs) >0.92.

CONCLUSION

IPPP failed to reduce gadoxetate-related TSM supporting the hypothesis that gadoxetate disodium acts as a chemo-toxic trigger that evokes breath-hold difficulty which cannot be willingly suppressed or attenuated by education and training. Interestingly, IPPP also did not significantly mitigate RM in any dynamic phase in the non-TSM subgroup of patients who received gadoxetate disodium whereas IPPP very effectively reduced RM in all dynamic phases in the non-TSM subgroup of patients who received gadoterate meglumine. This implies that gadoxetate-related breath-hold difficulty does not only affect the TSM subgroup of patients or exclusively the arterial phase as previously proposed but rather all dynamic phases, albeit to a much lesser extent.

CLINICAL RELEVANCE/APPLICATION

Intensified pre-scan patient preparation seems to be a very effective and cost-neutral strategy to reduce respiratory motion in liver DCE-MRI employing extracellular contrast agents.

SSQ07-07 Clinical Evaluation of Diffusion-Weighted MRI based Virtual Elastography for the Assessment of Liver Fibrosis

Thursday, Dec. 5 11:30AM - 11:40AM Room: S103CD

Participants
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PURPOSE

To compare diffusion-weighted MRI (dMRI) based elastography and standard MR elastography (MRE) for the assessment of liver fibrosis in a clinical setting.

METHOD AND MATERIALS

In an IRB approved retrospective study 99 patients underwent 2D MRE and dMRI on a 3T scanner. 25 patients had to be excluded due to insufficient image quality resulting in a final study population of 74 patients (45 men, mean age 68.1±8.7 years). Shear modulus measured by MRE (µMRE) was obtained in each subject by placing liver ROIs on the stiffness maps by two independent readers. Shifted apparent diffusion coefficient (sADC) was calculated from dMRI acquired without mechanical vibration with b=200 and 1500 s/mm2. dMRI-based virtual shear modulus (µDiff) was then derived from sADC as previously shown. MRI-based liver fibrosis stages were estimated from µMRE and µDiff values using optimal cutoff values according to METAVIR score (F0-F4). Statistical analysis was undertaken using Bland-Altman plots and Bayesian prediction analysis.

RESULTS

Inter-reader agreement was very high (mean difference: 0.04±0.43 kPa; -0.03±0.60 kPa for µDiff and µMRE, respectively, not significant). Correlation between sADC and µDiff was highly significant (r2=0.81, p=6 10-24) with µMRE and µDiff values showing agreement for each patient (mean difference: -0.02±0.88 kPa, not significant). Complete agreement in fibrosis staging was obtained in 55% of the patients and good agreement (ΔF=±1) in 36%. Categorizing fibrosis into "insignificant" (F0/F1) and "significant" (F2-F4) agreement between the two methods reached 85% (63/74, Kappa=0.85).

CONCLUSION

dMRI-based virtual shear modulus values and resulting fibrosis stages showed high agreement with those by MRE. dMRI holds great potential for the evaluation of liver fibrosis non-invasively without the need for any mechanical vibration setup as an alternative to MRE and biopsy.

CLINICAL RELEVANCE/APPLICATION

Diffusion MRI based virtual elastography holds great potential as an alternative to MRE to evaluate liver fibrosis non-invasively without the need for any mechanical vibration setup.

SSQ07-08 Diagnostic Accuracy of Liver Imaging Reporting and Data System (LI-RADS) for HCC in Non-Cirrhotic Patients with Chronic Hepatitis

Thursday, Dec. 5 11:40AM - 11:50AM Room: S103CD

Participants
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PURPOSE

The use of the Liver Imaging Reporting and Data System (LI-RADS) has not been validated in non-cirrhotic patients with chronic hepatitis. This study examines the accuracy of LI-RADS v2018 for hepatocellular carcinoma (HCC) using contrast-enhanced MR imaging in non-cirrhotic patients with chronic hepatitis.

METHOD AND MATERIALS

This retrospective single-center study was approved by our IRB with waived informed consent requirement. Between 2016 and 2018, 160 patients with chronic hepatitis and histology-proven absence of cirrhosis underwent contrast-enhanced MR imaging. In consensus, two radiologists retrospectively assigned LI-RADS v2018 categories to each of a total of 161 observations. The reference standard was histology for malignant lesions and clinical and radiological follow-up for at least one year for benign lesions. Sensitivity, specificity, accuracy, positive predictive value (PPV), negative predictive value (NPV), and false positive rate (FPR) of LR-5 for the diagnosis of HCC were estimated.

RESULTS

The final diagnoses and LI-RADS categories of each observation are summarized in Table. Overall, 71 (44.1%) lesions were HCCs, 23 (14.3%) were non-HCC malignancies, and 67 (41.6%) were benign. LI-RADS categories of LR-1, LR-2, LR-3, LR-4, LR-5, and LR-M were assigned in 6 (3.7%), 43 (26.7%), 15 (9.3%), 12 (7.5%), 70 (43.5%), and 15 (9.3%) observations, respectively. Among LR-5s, 64 (91.4%) were HCCs and 69 (98.6%) were malignant. The sensitivity, specificity, accuracy, PPV, NPV, and FPR of LR-5 for HCC were 90.1%, 93.3%, 91.2%, 91.4%, 92.3%, and 6.7%, respectively. Among LR-Ms, 4 (27%) were HCCs and 15 (100%) were malignant.

CONCLUSION

This single-center, retrospective study suggests that LIRADS v2018 using contrast-enhanced MR imaging has high accuracy for HCC in non-cirrhotic HCC patients with chronic hepatitis. Multicentric, prospective studies are needed to validate this preliminary finding.

CLINICAL RELEVANCE/APPLICATION

This single-center, retrospective study suggests that LI-RADS v2018 using contrast-enhanced MRI may be valid in non-cirrhotic patients with chronic hepatitis. Further studies are warranted.

Printed on: 10/29/20

SSQ08

Gastrointestinal (Advanced CT Technique)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S102CD

CT GI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Meghan G. Lubner, MD, Madison, WI (*Moderator*) Grant, Koninklijke Philips NV; Grant, Johnson & Johnson;
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Sub-Events

SSQ08-01 Adaptive Statistical Iterative Reconstruction Technique (ASIR-V) with Different Weights on Spectral CT Using Conventional 120kVp Scan: A Phantom Study

Thursday, Dec. 5 10:30AM - 10:40AM Room: S102CD

Participants
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PURPOSE

To explore image quality of spectral CT using conventional 120kVp scan under the different weight of ASIR-V by using abdominal model.

METHOD AND MATERIALS

The abdominal model (Body rings)was scanned by GE Revolution CT using conventional 120kVp scan. Images were reconstructed using 20% weight to 80% weight (10%-step) of ASIR-V. The CT value, SD and CNR of different tissues(liver and erector spinae)were measured. Anova test and regression analysis were used to compare the different tissues of noise values (SD) and CNR weights of ASIR-V. The post-processing images were evaluated by two radiologists on a 4-point scale using a double-blinded method

RESULTS

With increasing of ASIR-V weight, the noise values of 7 groups generally exhibited a decreasing trend. By regression analysis, the linear regression equation of ASIR-V weight and image noise was y = -0.84x +11.321(x=ASIR-V weight y =noise),),R2 =0.977 F =832.187 P=0.000.With increasing of ASIR-V, the CNR of 7 groups generally exhibited an increasing trend. By regression analysis, the linear regression equation of ASIR-V weight and CNR was y = 0.98x + 3.425 (x = ASIR-V weight y = contrast noise ratio),R2=0.891 F =163.690, P =0.000. There was no significant difference in 30% and 40% weight of ASIR-V between the seven groups(P>0.01), but 30% and 40% weight of ASIR-V were the best in the subjective scores. There was a significant difference in the subjective scores between the other groups (P<0.01).

CONCLUSION

Image noise reduces and image quality improves as ASIR-V weight increases ina linear relationship. At 60% weight of ASIR-V,the image noise was substantially reduced and the subject score was the best. At 70% and 80% weight of ASIR-V,the image noise was substantially reduced and the subject score was poor.

CLINICAL RELEVANCE/APPLICATION

When using spectral CT using conventional 120kVp scan for liver scanning, the image quality can be improved by increasing the weight of ASIR-V to an appropriate value for better display of anatomies

SSQ08-02 Correlation between Hepatic Fatty Infiltration Degree and CT Number Measurement at Different Tube Voltages Using Animal Model

Thursday, Dec. 5 10:40AM - 10:50AM Room: S102CD

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PURPOSE

To investigate the correlation between the hepatic fatty infiltration degree and CT number measurement at different tube voltages (kVp).

METHOD AND MATERIALS

28 healthy SD rats weighing 200g-300g were used for the study. After 2 weeks of adaptive feeding, rats were divided into two groups: normal control group (n=5 with normal diet); experimental group (n=23 with high fat diet). After 4, 6 and 8 weeks, 8, 8 and 7 rats in the experimental group and 1, 1 and 3 rats from the control group, respectively underwent CT scans with 80kVp, 100kVp, 120kVp and 140kVp tube voltage. Rats were sacrificed after the CT scans to obtain liver specimens. CT number was measured on the conventional CT images of all tube voltages. Correlation between CT number measurement and pathologic findings was obtained.

RESULTS

There were 8, 11 and 9 normal, mild, moderate fatty liver rats based on pathology. The CT numbers for these 3 groups of rats were 69.48±1.12HU, 68.12±1.23HU and 66.57±1.08HU at 80kVp; 69.81±0.82HU, 68.56±1.72HU and 66.64±1.31HU at 100kVp; 69.24±1.42HU, 67.78±1.68HU and 65.92±1.50HU at 120kVp; and 68.58±1.63HU, 66.90±1.69HU and 64.82±1.47HU at 140kVp. The CT numbers at all tube voltages and pathology results were all negatively correlated with r values of -0.73, -0.71 -0.71 and -0.71.

CONCLUSION

CT number measurements at all 4 tube voltages (80, 100, 120 and 140kVp) all have good and similar correlation with pathologic findings for fatty infiltration degree, and changing tube voltage settings may not change the ability to differentiate normal and fatty liver tissues.

CLINICAL RELEVANCE/APPLICATION

CT number measurements at all 4 tube voltages (80, 100, 120 and 140kVp) all have good and similar correlation with pathologic findings for fatty infiltration degree, and changing tube voltage settings may not change the ability to differentiate normal and fatty liver tissues,it has a certain value in clinic fatty liver patients.

SSQ08-04 Automated Organ Segmentation Using Deep Learning with Window Setting Optimization

Thursday, Dec. 5 11:00AM - 11:10AM Room: S102CD

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PURPOSE

Window display settings is a key feature of clinical CT interpretation. A Window setting optimization (WSO) module can be combined with any deep convolutional neural network to automatically find the optimal window range in CT images. In this study, we aim to find the optimal window setting values for segmentation of four different organs and to improve the performance of the segmentation models.

METHOD AND MATERIALS

We collected whole-body CT scans (both contrast & non-contrast axial series) of 21 patients. We randomly selected 33 CT series for training and 6 for testing. Manual segmentation was done for four organs (lungs, liver, spleen, and kidneys) on the CT scans by a board-certified radiologist. We only included the CT slices that had at least one pixel of each organ for experiments. For this segmentation, we developed a deep convolutional neural network model with a WSO module, comprised of a 1x1 convolutional layer and an activation function. We trained the model with a WSO module and obtained an optimal windowing level and width through learning. To explore the effect of WSO module, we trained segmentation models with two types of WSO using ReLU and sigmoid activation functions and compared against model without a WSO module.

RESULTS

For a model without a WSO module, the mean dice scores of kidneys, spleen, liver, and lungs were 0.737, 0.926, 0.947, and 0.971, respectively. For a model with a sigmoid type of WSO module, the mean dice scores of kidneys, spleen, liver, and lungs were 0.758, 0.926, 0.944, and 0.969, respectively, and for a model with a ReLu type of WSO module, the mean dice scores were 0.778, 0.953, 0.974, and 0.947, respectively. Optimized window values (level, width) of kidneys, spleen, liver, and lungs with the sigmoid activation function were (-45, 454), (-37, 371), (-35, 359), and (-188, 2177), respectively. In case of using the ReLU activation function, values were (39, 388), (39, 388), (38, 375), and (43, 429) for kidneys, spleen, liver, and lungs, respectively.

CONCLUSION

We developed deep learning models for segmentation of 4 organs (lungs, liver, spleen, and kidneys) and improved performance with a WSO module.

CLINICAL RELEVANCE/APPLICATION

WSO modules can improve AI applications, which are convolutional neural networks, and can give readers an optimized window setting for target organs.

SSQ08-05 Quantitative and Qualitative Evaluation of Imaging Quality of Hepatic Multiphase CT with Four Different Image Reconstruction Techniques including FBP, Hybrid IR, MBIR, and DLR

Thursday, Dec. 5 11:10AM - 11:20AM Room: S102CD

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PURPOSE

The purpose of this study was to evaluate the imaging quality of multiphasic hepatic CT images with four image reconstruction techniques.

METHOD AND MATERIALS

Multiphasic hepatic CT imaging in 30 patients were performed with a state-of-the-art ultra-high resolution CT scanner (Aquilion Precision; Canon Medical Systems, Otawara, Fukushima, Japan). High resolution mode (1024x1024 matrix, 0.25-mm section thickness) was employed for the CT imaging. All images were reconstructed with a combination of 512x512 matrix and 5-mm section thickness using the four image reconstruction techniques (filtered back projection (FBP), Hybrid Iterative Reconstruction (IR) (AIDR 3D), Model based IR(MBIR)(FIRST) and deep learning reconstruction(DLR)(AiCE). CT measurements were performed in the aorta (Ao) on hepatic arterial-dominant phase (HAP), in the portal vein (PV) and hepatic parenchyma (HP) on portal venous phase (PVP), and in the inferior vena cava (IVC) and HP on delayed phase (DP) images. The standard deviation (SD) of the psoas muscle as image noise was also measured on the images. All images were qualitatively assessed in terms of sharpness, granularity, and overall quality of the images in 4 -point grading scale (1-4; none, poor, good, excellent).

RESULTS

There were no significant differences in the mean CT values of the all organs on all phase images among the four different image reconstruction techniques. The mean SD on each phase images were same with each image reconstruction technique and they were 15.6 with FBP, 9.4 with Hybrid IR, 8.0 with MBIR, and 8.1 with DLR. The mean SD of all organs on the all phase images with FBP were higher than those of Hybrid IR, MBIR, and DLR. The all values with MBIR and DLR were lower than those with Hybrid IR. There were no significant differences in the all values between MBIR and DLR. The mean scores of sharpness, granularity, and overall quality of the images with DLR (3.9, 3.9, 3.9) were better than those with FBP (3.6, 3.5, 3.5), Hybrid IR (3.6, 3.6, 3.7), and MBIR (3.5, 3.5, 3.6). All these scores with MBIR were worse than those with Hybrid IR and DLR.

CONCLUSION

Based on the quantitative and the qualitative analyses, DLR was the most appropriate image reconstruction technique for multiphasic hepatic CT images obtained with the high resolution acquisition.

CLINICAL RELEVANCE/APPLICATION

It is possible to reduce further imaging noise in MBIR and DLR in comparison to FBP and Hybrid IR.

SSQ08-06 Evaluation of Malignant Liver Lesions Post Conventional Transarterial Chemoembolization: Intraprocedural Robotic Cone Beam CT (IP-CBCT) versus Multidetector CT (MDCT)

Thursday, Dec. 5 11:20AM - 11:30AM Room: S102CD

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PURPOSE

To assess the latest technology intraprocedural robotic cone beam CT (IP-CBCT) versus postprocedural most recent multi-detector CT (MDCT) for volume imaging after conventional transarterial chemoembolization (cTACE) regarding diagnostic image quality in patients with liver lesions and tumor enhancement by ethiodized oil (Lipiodol).

METHOD AND MATERIALS

114 patients (63 females / 51 males) treated with 126 cTACE procedures underwent postinterventional Lipiodol-enhanced robotic IP-CBCT (4s, 220°, 366 images, scan length 17.5 cm) and 4 to 6 hours later native MDCT (120 kV, 76 mAs, 273 images, scan length 22.6 cm). 18 patients were treated for HCC, 96 patients for hepatic metastases of different primaries. Retrospectively, number and size of lesions and Lipiodol enhancement were evaluated and compared with the pre-interventional MRI. Image qualilty (IQ) was qualitatively evaluated in consensus with two experienced radiologists using a Likert scale (0-4).

RESULTS

For IP-CBCT significantly superior qualitative IQ scores of 3.1±0.7 were received for lesion delineation vs. 2.4±0.9 for MDCT ($p<0.05$). For general IQ IP-CBCT was evaluated with 3.0±0.6 vs. 3.1±0.4 for MDCT ($p>0.05$). Lipiodol-enhanced lesion volume correlated in 95.5% with the MRI in IP-CBCT vs. 78.33% in MDCT ($p<0.05$) due to a washout phenomenon. Complete washout was observed after a mean of 3.2h for 14% of patients (n=16). The MDCT provided no additional diagnostic information on non-target Lipiodol accumulation or other new damage.

CONCLUSION

Post-Lipiodol CBCT allows sufficient diagnostic image quality and precise information on target and non-target embolization, while enabling the radiologist to immediately adjust the therapy or react to complications. A prospective randomized trial is recommended

and planned.

CLINICAL RELEVANCE/APPLICATION

Post Lipiodol CBCT results in improved diagnostic and therapeutic information in TACE patients with malignant liver lesions.

SSQ08-07 Delayed Bolus Trigger Timing at CT Correlates with Reduced Ejection Fraction and Suboptimal Early Portovenous Contrast Phase

Thursday, Dec. 5 11:30AM - 11:40AM Room: S102CD

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PURPOSE

To assess whether the delayed time to Hounsfield unit trigger during bolus-tracking for CT correlates with reduced heart function on echocardiography and suboptimal portovenous contrast timing in the abdomen.

METHOD AND MATERIALS

The health record was searched for patients who underwent portovenous CT evaluation of the abdomen using bolus-tracking and who were also evaluated by echocardiography within 2 weeks of CT. Patients were excluded if there was an abnormal contrast injection curve related to poor IV access. The time of bolus trigger at 100 Hounsfield unit in the abdominal aorta at the celiac axis, patient age, and the ejection fraction from echocardiography were recorded. Two radiologists carried out consensus scoring of the liver contrast phase in each examination with a 5 point Likert score, 5 representing an optimal portovenous phase with proper contrast in the hepatic veins. Simple linear regression (univariate) was used to test for linear associations with bolus trigger time.

RESULTS

116 patients with a mean age of 60 ± 14 years fulfilled study criteria. The mean bolus trigger time was 18 ± 6 seconds (Range: 6-36 seconds) and the mean ejection fraction was 52 ± 12% (Range: 20-69%). A longer time to bolus trigger had a significant linear association with lower ejection fraction (P=0.020), lower hepatic contrast score (P=0.007) and older age (P=0.009).

CONCLUSION

Delayed time to Hounsfield unit trigger during routine bolus-tracking for CT can indicate reduced heart function and bolus-tracking often does not adequately adjust to provide an optimal portovenous contrast phase in the abdomen in the setting of reduced heart function.

CLINICAL RELEVANCE/APPLICATION

Bolus-tracking can provide data to aid in the diagnosis of reduced heart function; tailored protocols should be made for patients with suspected cardiac dysfunction to ensure that proper contrast phases are obtained in the abdomen.

SSQ08-08 Pancreatic CT Imaging With an Ultra-High Resolution CT Scanner and a New Denoising Reconstruction Algorism Using Deep Learning Technology: Intraindividual Comparative Study with Conventional CT Imaging

Thursday, Dec. 5 11:40AM - 11:50AM Room: S102CD

Participants
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PURPOSE

To evaluate the image quality of pancreatic CT imaging with an ultra-high resolution (UHR) CT scanner and a new denoising reconstruction algorism using deep learning technology compared with conventional CT imaging.

METHOD AND MATERIALS

Twenty consecutive patients with cystic pancreatic lesions, who underwent follow-up CT examinations with both a UHR CT scanner and a conventional CT scanner, constituted the study population. High resolution CT images with a matrix of 1024 x 1024 and a thickness of 0.25 mm were reconstructed with deep learning reconstruction algorism at the UHR CT scanner. Conventional CT images were reconstructed with a matrix of 512 x 512 and a thickness of 0.5 mm using a hybrid iterative reconstruction algorism. Image noise (standard deviation of CT values) and contrast-to-noise ratio (CNR) were measured and compared between the two CT image sets by using the paired t-test. Subjective image noise, sharpness of structural contour, delineation of the main

pancreatic ducts and cystic lesions, and overall image quality were assessed using a 5-point scale and compared by using the Wilcoxon signed rank test.

RESULTS

Image noise at UHR CT (9.4 ± 1.6) was significantly lower than that at conventional CT (13.0 ± 4.7, P < .01). CNR at UHR CT (12.7 ± 3.7) was significantly higher than that at conventional CT (8.8 ± 3.0, P < .01). Subjective image noise at UHR CT was lower than that at conventional CT images (P < .01). Sharpness, delineation of the main pancreatic duct, and overall image quality at UHR CT were significantly superior to those at conventional CT (P < .01, P < .05, P < .01, respectively). Delineation of the cystic lesions at UHR CT were also superior to those at conventional CT, although the difference did not reach statistical significance (P = .1).

CONCLUSION

Combination of a UHR CT scanner and a denoising reconstruction algorism using deep learning technology can provide high quality pancreatic CT images with less image noise and higher spatial resolution and improve the delineation of anatomical structures compared with conventional CT imaging technique.

CLINICAL RELEVANCE/APPLICATION

Ultra-high resolution CT enhanced by deep learning-based denoising reconstruction algorism may contribute to a precise evaluation of the pancreatic neoplasms due to its excellent image quality.

SSQ08-09 Determining the Use of Water Oral Contrast Based on Visceral Fat Index and Body Mass Index for CT Abdomen Pelvis Exams in the Outpatient Oncology Setting

Thursday, Dec. 5 11:50AM - 12:00PM Room: S102CD

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PURPOSE

Assess effect of visceral fat in the CT evaluation of bowel and peritoneum with oral water versus positive density oral contrast in the outpatient oncology setting.

METHOD AND MATERIALS

100 consecutive subjects (54 males median age 64±14 years) had outpatient oncologic follow up CT abdomen pelvis exams with water used as oral contrast and available prior CT with gastrografin/barium. 500ml oral water was given 30 minutes prior to each outpatient CT scan as part of a department patient quality improvement initiative. CT exams were retrospectively evaluated and visceral fat area was segmented and thresholded (-274 to -49HU), at axial L2-3 level using a custom MATLAB (The Mathworks, Natick, MA) script, and divided by body surface area to provide visceral fat index (VFI). Bowel visualization adequacy was scored on a Likert scale (1-4) based on prior research. Confidence in ruling out peritoneal metastases and abscess were each scored on a Likert scale (1-3). Patient satisfaction surveys were obtained rating exam and wait time satisfaction on a Likert scale (1-10). Univariate receiver operating curve analysis was performed on VFI and body mass index (BMI) to predict excellent bowel visualization (Likert 1) and definitive confidence in ruling out peritoneal metastases and abscess (Likert 1). Mann Whitney U test was used to compare continuous variables, and Pearson correlation coefficient was used for correlation.

RESULTS

CT water oral contrast bowel visualization scores:1 (n=83), 2 (n=14), 3 (n=3), 4(n=0). CTs scored 1 had higher VFI 68±36 cm/m2 than CTs scored >=2; 17±16 cm/m2, p<.00001 and higher BMI 30±7 vs. 23±2 respectively p<.00001. Higher VFI was predictive of (Likert 1) excellent bowel visualization with AUC 0.91 (95%CI 0.84-0.98) p<0.001, while higher BMI had AUC 0.89 (95%CI 0.83-0.96) p<0.001. VFI threshold >= 23.76 cm/m2 sensitivity 0.92 and specificity 0.77 while BMI threshold >= 24 sensitivity 0.89 and specificity 0.82. BMI had only moderate correlation with visceral fat, R=0.62, p<.00001. Patient satisfaction was significantly higher with water compared to positive density oral contrast p<0.00001.

CONCLUSION

Our results suggest VFI >23.76 cm/m2 and BMI >24.37 are predictive of adequate CT bowel and peritoneal evaluation with oral water contrast. VFI had better diagnostic accuracy than BMI in predicting optimal CT evaluation, yet these are only moderately correlated.

CLINICAL RELEVANCE/APPLICATION

There is benefit to including VFI in addition to BMI when determining which CTs will benefit most from receiving positive density oral contrast versus water. Additionally, oral water significantly improves patients' experience compared to positive density contrast.

SSQ09

Genitourinary (Imaging of Pregnancy)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E351

GU MR OB

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSQ09-01 The Placenta Accreta Spectrum (PAS) and MRI: Preliminary Findings in High-Risk Pregnancies and Associated Need for Cesarean Hysterectomy

Thursday, Dec. 5 10:30AM - 10:40AM Room: E351

Participants
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PURPOSE

To evaluate MR findings described in PAS and identify those significantly associated with PAS severe enough to result in cesarean hysterectomy. Interobserver agreement was also assessed.

METHOD AND MATERIALS

We performed an IRB approved retrospective review of 56 pregnancies, from our 2006-2019 MR database referred for clinically suspected PAS. After randomization, single shot fast spin echo, balanced steady state free precession and T1-weighted sequences were independently evaluated by two reviewers, one expert and one with 4 years MR experience, after review of 10 test training cases. Evaluation of 11 variables was performed, including bladder-serosal interface interruption, bridging vessels, placental texture near the scar, presence of complete or low-lying previa, radiology impression of presence or absence of invasion and degree, bulge characteristics, dark linear bands or lacunae, and cervical varices. To assess readers agreement, simple kappa and prevalence adjusted bias adjusted kappa(PABAK) were used. Univariate logistic regressions were used to assess the association with cesarean hysterectomy.

RESULTS

From the study, 6 of 11 characteristics assessed by the expert were significantly associated($p<0.05$) with the outcome of hysterectomy:interrupted bladder-serosal interface(0.007), serosal bridging vessels(0.005), radiologist prediction of invasion degree(0.002) and presence(0.02), inhomogeneous texture near scar(0.003) and low-lying or placenta previa(0.0005). Dark linear band quantification, cervical varices size, lacunae and bulge presence or size were not significant. The reader agreement was fair to moderate according to PABAK. Simple Kappa was constantly underestimated due to unbalance in the dataset.

CONCLUSION

An expert reader was significantly predictive of presence and degree of invasion with MRI in women whose placental invasion was severe enough to result in cesarean hysterectomy. Other significant findings included bridging vessels, bladder serosal interruption, low-lying or complete previa, and inhomogeneous texture near scar. However, in this small series, interobserver agreement was only fair to moderate, suggesting the need for better-defined variables assessed with more MRI cases and larger training datasets.

CLINICAL RELEVANCE/APPLICATION

Several MR findings were associated with PAS severe enough to result in cesarean hysterectomy, but interobserver agreement between radiologists remains less than optimal.

SSQ09-02 MRI Diagnosis of Placenta Accreta Spectrum Disorder

Thursday, Dec. 5 10:40AM - 10:50AM Room: E351

Participants
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PURPOSE

To evaluate the accuracy of magnetic resonance imaging in diagnosing abnormal placentation.

METHOD AND MATERIALS

A retrospective review of placental MRI exams from December 2004 to January 2019 was performed. MRI reports were reviewed for suspicion of abnormal placentation. Criteria suggesting pathology included the presence of dark intraplacental bands, heterogeneous signal intensity, thick nodular contour along the urinary bladder surface, uterine bulging into the bladder, and loss of the myometrial margin with attention paid to parametrial regions. MRI was considered positive even if only one of these criteria were present. Comparison was made with findings at either delivery, operation, and pathology reports.

RESULTS

478 MRI exams were reviewed. 279 exams were negative both on MRI and delivery/pathology. 13 exams interpreted as normal on MRI underwent hysterectomy with pathology demonstrating placenta accreta. 148 exams were interpreted as positive for abnormal placentation, and were diagnosed as accreta, increta, or percreta on delivery/pathology. 38 cases interpreted as positive on MRI had normal placental delivery and pathology. MR diagnosis of abnormal placentation had a sensitivity of 92%, specificity of 88%, PPV of 80%, NPV of 96%, and an accuracy of 89%.

CONCLUSION

Placental adhesive spectrum disorder is a significant cause of maternal morbidity and mortality. Detailed imaging provides important information critical for the management of patients with this disorder. Prenatal MRI has a high degree of accuracy for the diagnosis of placenta adhesive spectrum disorder, specifically the myoinvasive forms. MRI provides detailed topographic information and is a critical component in the workup of patients at high risk for this condition.

CLINICAL RELEVANCE/APPLICATION

Advance knowledge of the diagnosis of abnormal placentation allows for predelivery operative planning and management. With this information, a multidisciplinary approach to this potentially catastrophic condition can be put into place to prevent significant morbidity and mortality.

SSQ09-03 Abnormal Fetal Placental Vasculature on MRI of Patients at High Risk for Placenta Accreta Spectrum Disorders: Analysis of 130 Cases

Thursday, Dec. 5 10:50AM - 11:00AM Room: E351

Participants
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PURPOSE

To investigate the association of abnormal intraplacental (fetal) vessels on MRI of patients with placenta accreta spectrum (PAS) disorders with extent of invasiveness and poor clinical outcome

METHOD AND MATERIALS

Between 3/2016-2/2019, 130 high-risk gravid patients for abnormal placentation were referred for dedicated prenatal MRI (mean age:34.7 years, mean gestational age: 32.5 weeks); all patients underwent C-section within 6 weeks from MRI. Intraoperative/pathological findings confirmed the presence of PAS in 101/130 patients (percreta: n=58, creta/increta: n=43). 48/101 patients with PAS underwent hysterectomy, whereas in 44/101 patients, bladder repair was performed. All MRIs were reviewed by consensus by two expert radiologists after completion of the study for the presence of at least one long (>2cm), intraplacental flow void structure originating from the chorionic plate, crossing the placental parenchyma and reaching the basal plate, with paucity of branching along its course (stripped fetal vessel). Presence of stripped fetal vessels and their caliper were statistically tested for any association with degree of invasiveness and peripartum events including intraoperative blood loss, operation time, and need for hysterectomy or bladder repair.

RESULTS

There was a significant association ($p<0.001$) between presence of stripped fetal vessels with number of prior C-sections, presence of placenta percreta, hysterectomy and bladder repair treatment. Subjects with stripped fetal vessels on MRI, had significantly greater blood loss (1514.2.8vs382.8ml, $p<0.001$) and increased delivery times (145.2vs60.3min, $p<0.001$). The diameter of stripped fetal vessels was greater in patients with >=2 prior C-sections (5.2vs4.3mm,$p<0.001$), placenta percreta (5.3vs3.6mm,$p<0.001$), major bladder repair (6.4vs3.6mm,$p<0.001$) and caesarian hysterectomy (5.5vs3.5mm,$p<0.001$); additionally, stripped fetal vessel diameter was positively and significantly associated with intraoperative blood loss and duration of delivery.

CONCLUSION

The presence and extent of abnormal fetal intraplacental vasculature seems to be related with PAS invasiveness and adverse

The presence and extent of abnormal fetal intraplacental vasculature seems to be related with PAS invasiveness and adverse peripartum events.

CLINICAL RELEVANCE/APPLICATION

Accurate prenatal identification of aggressive forms of PAS may optimize treatment planning, improving patients' clinical outcome.

SSQ09-04 Apparent Diffusion Coefficient Differences in Twins of Monochorionic Diamniotic Pregnancy Complicated by Twin-To-Twin Transfusion Syndrome

Thursday, Dec. 5 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

To evaluate the difference in apparent diffusion coefficient (ADC) of the placental parenchyma between donor and receptor of monochorionic diamniotic (MCDA) pregnancies complicated by twin-to-twin transfusion syndrome (TTTS) and compare those values with a control group of uncomplicated MCDA pairs.

METHOD AND MATERIALS

Prospective monocentric cohort study. Magnetic resonance (MR) was performed prior to surgery in TTTS and electively planned around 20 weeks (w) of gestation age (GA) for the uncomplicated MCDA cohort. Regions of interest (ROIs) for ADC calculations were placed at the cord insertion of each twin or as close as possible in velamentous insertion. Another ROI was drawn at the border of the placenta away from the presumed vascular equator. Intrapair ADC differences for the different ROIs (central (c) and peripheral (p), resp.) were compared between donor and recipient (Wilcoxon-signed rank test). GA at time of MR and intertwin ADC differences were compared between TTTS and MCDA twins (Mann-Whitney test).

RESULTS

71 pregnancies were included in the analysis. Median GA at the time of MRI was 21 w (range 18-27) in the uncomplicated (N=47) and 21 w (range 18 - 29) in the TTTS cohort (N=24) (p=.9). Intrapair ADC differences for the different placental regions and the difference in mean ADC (=(cADC + pADC)/2) of both regions in TTTS are summarized in the table. Between TTTS and MCDA cohorts, central ADC measurements in the donor (168 x10^-5 mm^2/s; 159 - 182 x10^-5 mm^2/s) and smallest twin (179 x10^-5 mm^2/s; 166-197 x10^-5 mm^2/s), respectively, differed significantly (p=.02), whereas no differences were observed between the receptor and larger twin (p=.6). cADC difference between the donor and receptor in TTTS were also larger than those in uncomplicated MCDA pregnancies (p=0.04).

CONCLUSION

In TTTS, central ADC measurements are helpful to differentiate receptor and donor insertion compared to peripheral ADC calculations. Furthermore, from an ADC point of view, the receptor seems to exhibit normal values, with the donor behaving significantly different.

CLINICAL RELEVANCE/APPLICATION

Diffusion weighted imaging has demonstrated differences in pregnancies with abnormal placental function. We want to analyze the added value of ADC measurements in TTTS twins prior to surgery.

SSQ09-05 The Value of MRI in Predicting Intraoperative Massive Hemorrhage during Hysteroscopic Treatment of Cesarean Scar Pregnancy

Thursday, Dec. 5 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

To explore the value of MRI in predicting intraoperative massive hemorrhage during hysteroscopic treatment for cesarean scar pregnancy

METHOD AND MATERIALS

A retrospective analysis of 77 first trimester CSP patients who were diagnosed by MRI and confirmed by operation and pathology from January 20 to December 2018. According to the intraoperative blood loss, CSP patients were divided into two groups. The Inclusion criteria of intraoperative massive bleeding group: intraoperative blood loss >=200ml, by hysteroscopic treatment with or without preoperative bilateral uterine artery embolization or medication; The Inclusion criteria of non-massive bleeding group: intraoperative blood loss <200ml, by single hysteroscopic treatment without preoperative bilateral uterine artery embolization or medication. The clinical data and MRI features were compared between the two groups. The multivariate logistic regression analysis was used to analyze the risk factors of CSP intraoperative massive hemorrhage. The ROC curve was used to evaluate the efficacy and optimal threshold

RESULTS

Between the intraoperative massive hemorrhage group (11 cases) and non- massive hemorrhage group (66 cases), the gestational

between the intraoperative massive hemorrhage group (11 cases) and non-massive hemorrhage group (30 cases), the gestational age, the maximum diameter of the gestational sac, the depth of the gestational sac, and LUST were significantly different($p < 0.05$). There were no significant differences in age, number of cesarean delivery, interval between current CSP and last cesarean, number of abortions, preoperative ß-HCG, CSP types, gestational sac or uterine hemorrhage between the two groups ($P>0.05$). Multivariate logistic regression analysis showed that only the lower uterus scar thickness was significantly different ($P=0.034$,OR=2.757, 95% CI=1.082-7.028). The ROC curve analysis showed that the AUC of the gestational age, the maximum diameter of the gestational sac, the depth of the gestational sag and LUST were 75.0%, 82.1%, 85.9%, and 91.5%, respectively. The best predictor is the LUST and the optimal cutoff value is 2.2mm, the diagnostic sensitivity, specificity, and the Youden index are 90.9%, 74.2%, and 65.2%, respectively.

CONCLUSION

Preoperative MRI can accurately predict the risk of major bleeding during cesarean section scar pregnancy and guide treatment

CLINICAL RELEVANCE/APPLICATION

To inverstigate risk factors of intraoperative excessive haemorrhage during during hysteroscopic treatment of cesarean scar pregnancy, and to guide treatment.

SSQ09-06 Role of Placental Elastography for Prediction of Preeclampsia in Early Second Trimester

Thursday, Dec. 5 11:20AM - 11:30AM Room: E351

Participants
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PURPOSE

To evaluate the role of shear wave placental elastography (SWE) in pre-clampsia (PE) and to give a cut off value of elasticity that would help in prediction of pre-eclampsia in early second trimester (14-20 weeks of period of gestation).

METHOD AND MATERIALS

A total of 230 patients who presented in obstetric OPD between 14-20 weeks of gestation and were willing to have delivery in our instituition were enrolled in the study. After taking detailed obstetric history, gray scale obstetric ultrasound with doppler scan SWE was performed. Mean value of elasticity was taken in every patient; and data were analysed to give the best cut-off value that would determine the diagnosis of PE. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy for prediction of PE were calculated based on SWE measurements. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0. A p value of <0.05 was considered statistically significant.

RESULTS

There was a statically significant difference in the value of elasticity in normal patients and in those who developed PE. The study concluded cut-off value of 2.9667 kPa for prediction of pre-eclampsia, with a sensitivity of 92%, specificity of 91.71%, PPV of 57.5% and NPV of 98.9% in a statistically significant manner with p-value of <0.05.

CONCLUSION

Placental stiffness is higher in patients who develop pre-eclampsia during pregnancy. It can be quantitatively measured by shear wave elastography values for prediction of pre-eclampsia in early second trimester.

CLINICAL RELEVANCE/APPLICATION

Placental elastographic values were statistically significant and higher in the patients developing preeclampsia in later pregnancy. Shear wave elastography can help us to diagnose this life threatening condition in early second trimester before the clinical appearance of preeclampsia, and act to provide early treatment and antenatal care to reduce the devastating maternal as well as fetal outcomes.

SSQ09-07 Differences in Brain Development between Fetuses with Intrauterine Growth Restriction and Normally-Grown Group Assessed by Fetal MRI

Thursday, Dec. 5 11:30AM - 11:40AM Room: E351

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PURPOSE

To evaluate different features of brain development by Magnetic Resonance Imaging (MRI) in intrauterine growth restricted (IUGR) fetuses compared to normally-grown fetuses.

METHOD AND MATERIALS

3T MRI was performed in 42 IUGR and 28 nearly age-matched normally-grown fetuses using T2-weighted half Fourier acquisition single-shot turbo spin echo (HASTE). Cortical thickness was assessed in 4 brain regions (insula, frontal, occipital and temporal) and corrected by biparietal diameter/2. Also whole brain area (WBA) at the level of cavum septum pellucidum and area of 6 brain regions (frontal, temporal, occipital, cerebellum, midbrain and pons) were evaluated and corrected by WBA and compared between the two groups. Any cases with brain structural anomaly were excluded. All fetuses were followed until birth.

RESULTS

No significant differences were found about maternal characteristic and fetal gestational age between two groups. IUGR fetuses had significantly lower birth weight (2377 g vs 2965 g in control group). Brain signal was normal in all cases. The corrected thickness of cortex was significantly thinner in insula and temporal lobes in IUGR fetuses compared to control group (0.034 vs 0.043 and 0.036 vs 0.047 respectively, P value of < 0.05), but there was no significant different in frontal and occipital lobes. IUGR fetuses has significantly smaller WBA. The assessed corrected area of brain regions was not significantly different between groups except the corrected area of cerebellum which was smaller in normally-grown fetuses (0.147 vs 0.130, P value of < 0.05). During follow up, there was only one still birth in IUGR group.

CONCLUSION

IUGR fetuses had a significantly thinner Insular and temporal lobe cortex and smaller WBA. Among different brain regions, cerebellum was less affected by growth restriction.

CLINICAL RELEVANCE/APPLICATION

Growth restriction significantly affects brain development and the fetal MRI has a potential value to assess the various aspects of this effect.

SSQ09-08 Fetal Anterior Abdominal Wall Thickness (FAAWT): A Promising Parameter to Predict Fetal Macrosomia in Pregnancies with Gestational Diabetes

Thursday, Dec. 5 11:40AM - 11:50AM Room: E351

Participants
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PURPOSE

To evaluate the correlation of fetal anterior abdominal wall thickness and other standard fetal biometric parameters between 36-39 weeks of gestation with neonatal birth weight in pregnancies with gestational diabetes.

METHOD AND MATERIALS

This is a prospective cohort study conducted in a tertiary care Centre with institutional ethics approval. One hundred singleton pregnancies with gestational diabetes mellitus (GDM) between 36-39 weeks of gestation were included after informed written consent. Exclusion criteria comprised of women with diseases known to affect fetal growth, uncertain gestational age, fetuses with congenital anomalies and intrauterine growth restriction. Standard fetal biometry parameters including Biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) and estimated fetal weight (EFW) were measured. Fetal anterior abdominal wall thickness (FAAWT) was measured ultrasonographically in AC view. Actual neonatal birth weights were recorded. Birth weight >90th centile (INTERGROWTH-21st charts) was considered as a cut-off for macrosomia. Statistical analysis was done and 95% confidence level was considered significant for all tests.

RESULTS

16 out of 100 neonates were found to be macrosomic (16%). Third trimester mean FAAWT was significantly higher in macrosomic babies (6.36±0.5 mm) as compared to non-macrosomic babies (5.54±0.61 mm) (p-value <0.0001). A FAAWT >6 mm (ROC curve derived) provided sensitivity of 87.5% (95% CI 61.7-98.4), specificity of 75% (95% CI 64.4-83.8), PPV of 40% (95% CI 23.9-57.9) and NPV of 96.9% (95% CI 89.3-99.6) for prediction of macrosomia. While other standard fetal biometric parameters (BPD, HC, AC, FL and EFW) did not correlate well with actual birth weight in neonates with macrosomia in GDM patients, only FAAWT was found to have statistically significant correlation (correlation coefficient of 0.626, p-value 0.009).

CONCLUSION

The FAAWT was the only fetal sonographic parameter to have significant correlation with neonatal birth weight in macrosomic neonates of GDM mothers. We found a high sensitivity (87.5%), specificity (75%) and NPV (96.9%) which suggests that FAAWT <6 mm can quite confidently rule out macrosomia in pregnancies with GDM.

CLINICAL RELEVANCE/APPLICATION

FAAWT is a promising and easily measurable parameter to rule out fetal macrosomia in late third trimester in pregnancies with GDM, thus, allowing proper obstetric management .

SSQ09-09 Three-Dimensional Fetal MRI Visualization of Cerebellar White Matter Tracts

Thursday, Dec. 5 11:50AM - 12:00PM Room: E351

Participants
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PURPOSE

Cerebellar white matter connectivity plays a crucial role in affective, cognitive and motor processing. Prenatal diffusion tensor imaging (DTI) can non-invasively visualize major white-matter tracts of the fetal forebrain. We retrospectively assessed the success rate of visualizing the superior, middle and inferior cerebellar peduncle (SCP, MCP and ICP) as well as transverse pontine fibers (TPF) in the third trimester.

METHOD AND MATERIALS

Cases with DTI sequences (b-value of 700 s/mm², 16 gradient encoding directions) covering the cerebellum were retrospectively assessed. Deterministic tractography was performed using the Philips IntelliSpace software based on at least two regions of interest. A visibility score was calculated as the fraction of visible tracts divided by the amount of potentially visible tracts.

RESULTS

14 Fetal MRI were assessed (9 with 1.5T and 5 with 3T MRI) with 38.51±1.00 GW (mean±standard deviation) at 1.5 T and 35.80±1.20 at 3T. There was no significant difference (p=.66) between the scores of 1.5T (0.69±0.27) and 3T (0.74±0.17). SCP could be depicted in 71% of cases, MCP in 71%, ICP in 55% and TPF in 93%.

CONCLUSION

Prenatal tractography of cerebellar white matter tracts is feasible in the third trimester and shows excellent correlation with the respective anatomy. Fetal MR based DTI thus may improve the characterization of infratentorial malformations during the third trimester, when ultrasound is limited by acoustic shadowing at the skull base.

CLINICAL RELEVANCE/APPLICATION

Fetal MR tractography with diffusion tensor imaging can demonstrate cerebellar white matter tracts in the third trimester of pregnancy. This could improve the characterization of infratentorial malformations prenatally.

Printed on: 10/29/20

SSQ10

Genitourinary (Renal Masses: Artificial Intelligence, Machine Learning, and Texture)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E352

AI GU

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSQ10-01 Radiomics Panels of CT-Based Shape and Texture Metrics Robustly Discriminate Benign from Malignant Renal Masses

Thursday, Dec. 5 10:30AM - 10:40AM Room: E352

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PURPOSE

Differentiating benign from malignant renal masses using enhancement alone can be difficult. Additional imaging metrics (e.g. tumor shape and texture) have been shown to improve discrimination. Using a radiomics framework utilizing machine learning to quantitatively analyze shape and texture features of renal tumors in three dimensions, we tested its ability to objectively and robustly distinguish between benign and malignant renal masses on imaging. We also assessed the necessity of shape metrics in the prediction model.

METHOD AND MATERIALS

Routine standard-of-care computed tomography (CT) images of 485 patients with 291 (60%) malignant and 194 (40%) benign masses diagnosed between 2010 and 2015 were segmented. Point coordinates of tumor contours in all axial slices were input into a MATLAB (MathWorks) algorithm. 33 shape metrics and 760 texture metrics were calculated per tumor. We used Random Forest (SAS HPFOREST) for algorithm development, and 10-fold cross validation to obtain robust classification accuracy. Area under the curve (AUC) was used to assess robust discrimination power based on predicted probability from each fold of testing data. Sensitivity analysis was conducted by eliminating data with different missing patterns. SAS 9.4 was used for all data analysis.

RESULTS

In the cohort of 4-phase studies (n = 283), an AUC of 0.65 in the independent testing subset was achieved by 33 shape metrics alone, whereas an AUC of 0.69 was achieved when adding 760 texture metrics. Sensitivity analysis conducted in different phases with complete data also demonstrated similar results. Shape metrics appeared in top 3% variable of importance (VOI), featuring most prominently in the corticomedullary phase, with the sagittal convex hull perimeter ratio (CHP) consistently being a high-performing shape metric across all phases.

CONCLUSION

Robust prediction accuracy by shape alone and high ranking of VOI from shape in the combined model signify that shape analysis should not be ignored or underestimated in distinguishing benign from malignant tumors. A future radiomics platform powered by machine learning should therefore combine both shape and texture metrics rather than utilize them in isolation from each other.

CLINICAL RELEVANCE/APPLICATION

Combining both shape and texture metrics on a radiomics platform utilizing machine learning facilitates the differentiation of benign from malignant renal tumors on routine standard-of-care imaging.

SSQ10-02 Machine Learning of Multi-Phase CT Texture Features to Differentiate Clear Cell Renal Cell Carcinoma from Oncocytic Renal Neoplasms

Thursday, Dec. 5 10:40AM - 10:50AM Room: E352

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PURPOSE

Among common subtypes of renal masses, differentiation of clear cell renal cell carcinoma (cc-RCC) from oncocytic neoplasms is limited at CT and MRI. This study evaluates the diagnostic accuracy of machine learning (ML) of multi-phase CT texture analysis (TA) features to differentiate cc-RCC from oncocytic tumors.

METHOD AND MATERIALS

With IRB approval, we compared 81 consecutive cc-RCC and 66 consecutive oncocytic tumors (25 chromophobe RCC and 41 oncocytomas) with multi-phase CT performed from 2012-2018. A radiologist manually segmented tumors and second order TA features were extracted from non-contrast enhanced CT(NECT), corticomedullary (CM) and nephrographic (NG) contrast-enhanced CT(CECT). TA features were inputted into a ML Bayesian optimization algorithm and tested using 10-fold randomly stratified cross-validation. The ML system uses Gaussian processes with a heuristic technique to propose models evaluated by a fitness score to achieve the highest accuracy.

RESULTS

There was no difference in age, gender or size of tumors ($p>0.05$). Comparing the three CT phases, NG phase CECT TA achieved the highest discriminatory ability. The optimized ML algorithm which achieved the highest accuracy of classification at NG phase CECT incorporated various texture features most importantly: skewness, mean and RNLU. The area under the ROC curve (standard error) with optimal sensitivity/specificity for diangosis of cc-RCC was: 0.822 (0.087) and 71.3/81.4%. Statistically significant texture features compared between groups differed from NECT to CM and NG phase CECT; however, combining the most important features between phases did not improve accuracy of classification compared to NG phase analysis alone.

CONCLUSION

Machine learning of nephrographic phase CECT second order texture features achieved moderate accuracy to differentiate between clear cell RCC and oncocytic (chromophobe RCC + renal oncocytoma) neoplasms and outperformed assessment at unenhanced CT, corticomedullary phase CECT and combined three phase assessment.

CLINICAL RELEVANCE/APPLICATION

Machine learning of nephrographic phase enhanced CT texture features may improve classification of solid renal masses, in particular, moderate accuracy was achieved for the difficult comparison of clear cell RCC to oncocytic tumors where conventional CT/MRI evaluation is limited.

SSQ10-03 Machine Learning Derived Decision Tree to Identify Renal Mass Histological Type Based on CT Texture Analysis

Thursday, Dec. 5 10:50AM - 11:00AM Room: E352

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PURPOSE

Many renal masses share overlapping imaging features on contrast enhanced CT. In addition, subjective assessment of imaging features suffer from not insignificant interoberver variability. We created a machine learning derived decision tree matrix to differentiate subtypes of renal masses based on extracted quantitative texture features from CT images.

METHOD AND MATERIALS

Multi-phase contrast enhanced CT (CECT) including Non contrast (NC), Corticomedullary (CM), nephrographic (N) and excretory (E) of 268 patients. 93 had papillary RCC (prcc), 105 clear cell RCC (crcc), 43 Oncocytoma (oc) and 27 lipid poor AML(AML) . The CT images were subject to filtration-histogram based CT Texture analysis (CTTA) using a commercially available research software (TexRAD Ltd, www.texrad.com, part of Feedback Plc, Cambridge, UK). Using the DICOM images, filtration step extracted texture features using different spatial scale filters corresponding to fine, medium and coarse texture scales followed by histogram quantification: Mean gray-level pixel intensity, Entropy, Standard-Deviation (SD), Mean of positive pixels (MPP), Kurtosis and Skewness were derived. CTTA data obtained from excretory phase images (n=208) were used to build a decision tree for

classification of subtypes using a recursive partitioning and regression tree algorithm in R, employing a 10-fold cross validation technique and a cost matrix favoring detection of crcc due to its relative poor prognosis.

RESULTS

The decision tree is shown in the attached figure various texture features assessed using various filters. The sensitivity for detecting AML, crcc, oc and prcc was 0.3, 0.76, 0.68 and 0.71; specificity 0.94, 0.81, 0.93 and 0.87 and Accuracy was 0.75, 0.70, 0.58 and 0.76

CONCLUSION

A machine learning derived decision tree classification algorithm can be applied on CT derived texture features to identify different histological subtypes of renal masses

CLINICAL RELEVANCE/APPLICATION

A machine learning derived decision tree classification of renal masses based on quantitatively derived textural features may be clinically relevant in triaging patients for conservative versus aggressive management.

SSQ10-04 CT Texture Predicts Metastatic RCC Response to Anti-Angiogenic Therapy

Thursday, Dec. 5 11:00AM - 11:10AM Room: E352

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PURPOSE

The objective of this study was to quantify initial changes in CT texture to predict progression-free survival (PFS) in patients with metastatic renal cell carcinoma (RCC) treated with anti-angiogenic therapy.

METHOD AND MATERIALS

For this retrospective post-hoc secondary analysis of a prospective phase III trial, adult patients with metastatic RCC treated with sunitinib were included (N=275). Up to 5 target lesions were segmented using freeform regions-of-interest on 2D axial images on the baseline and initial post-therapy CT studies using eMASS software (eMASS LLC, Hoover, AL), to derive change in tumor length and vascular tumor burden (VTB). The segmentations were then processed using TexRAD software (Feedback Medical Ltd., Cambridge, UK) which used a CT texture filtration-histogram technique. A total of 6 texture parameters were measured at 6 filtration levels for a total of 36 texture/filtration parameters. Initial changes in CT texture were associated with PFS using univariate Kaplan Meier survival analysis (log-rank test). Multivariate Cox-proportional analysis was used to assess the independence of CT texture from other imaging biomarkers.

RESULTS

Median PFS of the cohort was 1.1 years. An increase in CT texture at the fine to medium texture scales were associated with shorter PFS (fine: SD, p=0.001; Entropy, p<0.001; medium: Entropy, p=0.001). A multivariate Cox model indicated that a change in fine texture (SD: HR=1.4, 95%CI: 1.0-1.9, p=0.033), tumor length (HR=1.8, 95%CI: 1.1-2.7, p=0.010) and VTB (HR=3.1, 95%CI: 2.0-4.7, p<0.001) were independent predictors of PFS.

CONCLUSION

Quantitative changes in CT texture on initial post-therapy CT images are predictive of PFS and independent of changes in tumor length and vascular tumor burden in patients with metastatic RCC treated with anti-angiogenic therapy.

CLINICAL RELEVANCE/APPLICATION

Change in tumor texture on CT can be quantified with no additional radiation or patient cost and has the potential to serve as a predictive biomarker of response to targeted therapy in patients with metastatic RCC.

SSQ10-05 Automated Detection of Renal Ultrasound Abnormalities Using Deep Learning

Thursday, Dec. 5 11:10AM - 11:20AM Room: E352

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PURPOSE

To develop a deep learning model that detects abnormalities on renal ultrasound examinations, as well as the presence of cystic lesions.

METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant single center retrospective study involved 2,240 renal ultrasound examinations comprising 108,257 images. Scans were performed on Siemens Acuson Sequoia, GE Logiq E9, Siemens Acuson S2000, and ATL HDI 5000. Each examination was labeled by a board-certified radiologist for normal vs. abnormal and for the presence of cystic lesions. 10% of examinations were held out as a separate test set, whose ground truth labels were by consensus of two out of three board-certified radiologists. Scanner types were equally distributed across training and test sets, as well as normal and abnormal classes. The number of images per exam was balanced between abnormal and normal classes. After image pre-processing and data augmentation, a basic DenseNet-121 was investigated as well as four models with refinements over the DenseNet base, including an instance-aggregation model, an embedding-aggregation model, an attention model, and an ensemble of the best three attention models. Next, the well-performing attention models were applied to the detection of renal cystic lesions. All models were optimized using Adam with default parameters, with tuning of learning rate and regularization performed on the validation set.

RESULTS

For binary classification of normal vs. abnormal, the basic Densenet-121 had an AUC of 0.61. Instance- and embedded-aggregation improved performance to AUC=0.69 and 0.81, respectively. The attention model (AUC=0.82) and the ensemble of attention models (AUC=0.84) performed best. For cystic lesion detection, high diagnostic accuracy was achieved using the attention model (AUC=0.91) and the ensemble of attention models (AUC=0.95).

CONCLUSION

Diagnostic performance of baseline models for classification tasks can be increased using aggregation and attention techniques. Attention models had the highest diagnostic performance for normal vs. abnormal renal ultrasound characterization and the detection of renal cystic lesions.

CLINICAL RELEVANCE/APPLICATION

Our model could potentially serve as a triage tool for patients undergoing renal ultrasound examinations. It could improve operational efficiency for radiologists by optimizing workflow, improving patient throughput, and providing a quicker time to diagnosis and treatment for the referring physician.

SSQ10-06 Deep Learning to Distinguish Benign from Malignant Renal Lesions Based on Routine MR Imaging

Thursday, Dec. 5 11:20AM - 11:30AM Room: E352

Awards
Trainee Research Prize - Fellow

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PURPOSE

With increasing incidence of renal mass, it is important to make a pre-treatment differentiation between benign renal mass and malignant tumor. We aimed to propose a deep learning model to distinguish benign renal tumors from renal cell carcinoma (RCC) using routine MR imaging by applying a residual convolutional neural network (ResNet).

METHOD AND MATERIALS

Preoperative MR images (T2-weighted and T1-post contrast sequences) of 467 renal lesions in a multicenter cohort with definitive pathology were divided into training, validation, and test sets (70:20:10 split). An ensemble model based on ResNet was created combining clinical variable, T1C and T2WI MR images using a bagging classifier to predict renal tumor pathology. Final model performance was compared with expert interpretation.

RESULTS

Among the 467 renal lesions, 367 were malignant and 100 were benign. The final ensemble model achieved a test accuracy of 87.2%, F1 score of 0.925, and precision recall AUC of 0.939. In comparison, expert 1 achieved an accuracy of 85.1% and F1 score of 0.914, and expert 2 achieved an accuracy of 87.5% and F1 score of 0.875.

CONCLUSION

Deep learning can non-invasively distinguish benign renal tumors from RCC using conventional MR imaging in a multi-institutional dataset with high accuracy compared to experts.

CLINICAL RELEVANCE/APPLICATION

With the wide use of imaging modalities, the detection of incidental renal tumors increases rapidly. There is a substantial number of patients with benign renal tumors who undergo unnecessary surgery with its concurrent risk and morbidity. Our deep learning model has the potential to noninvasively and accurately distinguish benign from malignant renal lesions and help guide clinical management.

SSQ10-07 T2WI Texture Analysis of Fat-Poor Angiomyolipoma and Other Renal Tumors: Histologic Subtype Classification

Thursday, Dec. 5 11:30AM - 11:40AM Room: E352

Participants
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PURPOSE

The purpose of this study was to explore the value of T2WI texture analysis in differentiation between fat-poor angiomyolipoma and renal cell carcinoma.

METHOD AND MATERIALS

T2WI Texture analysis was applied to analyze renal tumors, including 32 clear cell renal cell carcinomas (ccRCCs), 25 papillary RCCs(pRCCs), 27 chromophobe RCCs(cRCCs) and 20 fat-poor angiomyolipomas(fat-poor AMLs). All the tumors were removed by surgery and pathologically confirmed. These renal masses were divided into four groups: group A (fat-poor AMLs and RCCs), group B (fat-poor AMLs and ccRCCs), group C (fat-poor AMLs and pRCCs) and group D (fat-poor AMLs and cRCCs). Lesions were delineated on software named Radiomics Cloud Platform by two radiologists to extract the corresponding volume of interest (VOI) and then 93 features based on feature classes were generated. The average values of two radiologists were obtained and used as the final data. The difference features between fat-poor AMLs and RCCs were screened by Mann-Whitney U test in each group. Receiver operating characteristic (ROC) analysis was performed and area under the ROC curve (AUC) was calculated for features that were significantly different ($P < 0.01$). The corresponding optimal thresholds were determined and diagnostic effect was assessed.

RESULTS

Among the significantly different ($P < 0.01$) features(n=19, 22, 6 and 13 in group A, B, C and D respectively), minimum generated the largest AUC of 0.889±0.044(95% CI 0.812 - 0.942),0.881±0.049(95% CI 0.761 - 0.954),0.893±0.049(95% CI 0.765 - 0.965)and 0.894±0.048(95% CI 0.770 to 0.965) in group A, B, C and D respectively. The corresponding cut-off value of minimum was 189, 189, 176 and 138, which permitted the diagnosis of RCC, ccRCC, pRCC and cRCC with sensitivity of 90.48%, 90.62%, 92.00% and 88.89%, specificity of 80%, 80%, 80% and 80%, positive predictive value of 95.00%, 87.88%, 85.19% and 85.71%, negative predictive value of 66.67%, 84.21%, 88.89% and 84.21% and accuracy of 88.46%, 86.54%, 86,67% and 85.11% respectively.

CONCLUSION

T2WI texture analysis can effectively distinguish between fat-poor angiomyolipoma and common renal cell carcinoma. Minimum had the optimal diagnostic performance.

CLINICAL RELEVANCE/APPLICATION

Fat-poor AML, not showing visible fat, can mimic RCC, leading to unnecessary surgical resection. T2WI texture analysis can effectively differentiate between these two tumors, so patients may benefit.

SSQ10-08 Renal Cysts: Role of MRI-Based 3D Texture Features to Classify Renal Cystic Lesions According to the Bosniak Classification

Thursday, Dec. 5 11:40AM - 11:50AM Room: E352

Participants
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PURPOSE

Purpose: To determine the role of MRI texture features to differentiate Bosniak 2F from Bosniak 3-4 renal cysts given the known interobserver variation for Bosniak cyst classification in the clinic.

METHOD AND MATERIALS

This retrospective study was performed from January 2005 to September 2016. Patients with a complex renal cyst (Bosniak category 2F, 3 and 4) on MRI were selected. 176 patients were identified; only the highest category cyst was included per patient. Cysts were divided into two groups: 107 patients had Bosniak 2F cysts, and 69 had Bosniak 3 or 4 cysts. The standard of reference for group assignment was agreement on Bosniak classification between at least 2 of 3 independent expert reviewers; findings at histology or 4-year follow up. Each cyst was delineated 2x on the venous phase of the post contrast MRI in 3D using the inner core (Inner), and outer region that included both the lesion's inner core and its periphery (Total). The difference between these two regions defined the cyst's periphery (Border). Six histogram-derived texture features were computed for each of the three ROIs on the native and transformed images, resulting in 18 features per cyst. Univariate t-tests were computed on the two groups Accounting for Bonferroni correction for multiple comparisons, features with $p<(0.05/18)=0.0028$ were selected and univariate diagnostic models were built separately for each selected feature. 95% confidence intervals were estimated using 1000 bootstrap iterations.

RESULTS

11 features with $p<0.0028$ were found. Among them, the top three univariate diagnostic performances were variance, entropy, and uniformity. (95% confidence interval indicated in brackets) (please refer to the table included in the figure)

CONCLUSION

Texture analysis can differentiate Bosniak 2F from Bosniak 3-4 renal cysts with good accuracy, sensitivity, and specificity.

CLINICAL RELEVANCE/APPLICATION

The radiomics techniques are helpful to differentiate Bosniak 2F and Bosniak 3-4 status of the cyst given the known interobserver variation for Bosniak cyst classification.

SSQ10-09 Development and External Validation of Prediction Models for the Fuhrman Nuclear Grade of Clear Cell Renal Cell Carcinoma: A Comparison between CT- and MR-Based High-Dimensional Machine Learning Models

Thursday, Dec. 5 11:50AM - 12:00PM Room: E352

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PURPOSE

To compare the diagnostic performance between CT- and MR-based machine learning models in predicting the Fuhrman nuclear grade of clear cell renal cell carcinoma (ccRCC).

METHOD AND MATERIALS

Patients with pathologically proven ccRCC from 1 February 2009 to 31 December 2018 were included by this retrospective study for development dataset. Additional dataset from another institution and the Cancer Imaging Archive (TCIA) dataset, including both CT and MR imaging prior to surgery, were collected for external validation dataset. The features were extracted from precontrast phase (PCP), corticomedullary phase (CMP), nephrographic phase (NP) on CT, as well as fat-suppressed T2WI, T1WI, CMP and NP on MRI. The CatBoost was utilized to investigate machine learning models for the differentiation of low- from high-grade ccRCC. The performance of machine learning classifiers based on CT and MRI were compared.

RESULTS

A total of 416 patients with 419 pathologically proven ccRCCs were included for development dataset and ten pairs of dataset with both CT and MRI from another hospital and TCIA database were used for external validation. Thirty-nine, 41, 35 and 17 features were extracted from ctPCP, ctCMP, ctNP and ctALL images, and 34, 38, 37, 38 and 12 features derived from fat-suppressed T2WI, T1WI, mrCMP, mrNP and mrALL images, respectively. The classifier based on all-phase CT and all-sequence MR images achieved the best performance in differentiating low- from high-grade ccRCC with area under the ROC curve (AUC) of 0.82 and 0.73, respectively. In the external validation set, the classifier based on all-phase CT and all-sequence MR images also obtained the best performance in differentiating low- from high-grade ccRCC with AUC of 0.76 and 0.77, respectively. The comparison of the AUC for all-phase T-based vs all-sequence MR-based machine learning classifier showed no significantly different performance.

CONCLUSION

Both CT- and MR-based machine learning model are valuable noninvasive techniques in differentiating low- and high-Fuhrman nuclear grade ccRCC. MR-based machine learning model had comparable but no better performance than CT-based model.

CLINICAL RELEVANCE/APPLICATION

(dealing with preoperative ccRCC grading)'Both CT- and MR-based machine learning model can be used to preoperatively predict

(dealing with preoperative ccRCC grading) Both CT- and MR-based machine learning model can be used to preoperatively predict the Fuhrman nuclear grade of ccRCC and MR-based model had comparable but no better performance than CT-base model.'

Printed on: 10/29/20

SSQ11

Informatics (Education, Analytics, Quantitative)

Thursday, Dec. 5 10:30AM - 12:00PM Room: N229

AI BQ ED IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SSQ11-01 Redesigning Radiology Training for The Innovation Age: Two-Year Results of the First Core Residency Curriculum in Invention, Design Thinking, and Artificial Intelligence - The MESH Incubator

Thursday, Dec. 5 10:30AM - 10:40AM Room: N229

Participants
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CONCLUSION

The MESH CRDC is the first core curriculum in technological innovation integrated into a residency program, and results in significant increases in the technological innovation skill- and knowledge-set of residents.

Background

Radiology training lacks structured processes to help staff develop patient-centered technologies as well as curricula to train healthcare professionals in the fundamentals of informatics, artificial intelligence, idea generation, intellectual property, device and software prototyping, and entrepreneurship. To expand our previously created first-in-kind innovation incubator in a radiology department, the Medically Engineered Solutions in Healthcare (MESH) Incubator™, we created and tested a novel residency innovation curriculum, the MESH Core Residency Design Curriculum (CRDC™).

Evaluation

We conducted a Likert-type survey of current radiology residents regarding aspects of medical innovation to inform the design of the MESH CRDC, a one-week innovation rotation. The MESH CRDC took place in the MESH Incubator, a physical invention workspace in an academic hospital. Residents were enrolled from an ACGME-accredited radiology residency program. Residents who completed the MESH CRDC were assessed using a 21 question pre- and post-course exam, created by experts in various aspects of innovation. A pre- and post-course Likert-type method was employed to assess resident comfortability with 5 fundamental aspects of medical technologies. Anonymous sessions ratings and comments were also collected. Wilcoxon matched-pairs signed-rank test was used to analyze differences in pre- and post-course data.

Discussion

11 residents completed the MESH CRDC. There was a significant increase in exam scores after completion of the CRDC rotation, with a median pre- and post-course score of 52.38% and 90.48%, respectively ($p = .001$, 95% confidence interval = 38.10% to 57.14% and 76.19% to 100.00%, respectively). Pre- and post-course Likert methods (1-5, 1 = very uncomfortable, 5 = very comfortable) were employed to assess resident comfortability in 5 key tenants of innovation in medicine, demonstrating significant post-course increases in multifaceted aspects of a technological innovation skillset.

SSQ11-02 A Web-Based MRI Simulator for Radiographer Education: Quantitative Evaluation of an Actual Classroom Experience

Thursday, Dec. 5 10:40AM - 10:50AM Room: N229

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PURPOSE

The present study gives a quantitative answer to the following question: Does an MRI simulator built on specific functional and non-functional requirements help radiographers learn MRI theoretical and practical concepts better than a traditional educational method based on lectures?

METHOD AND MATERIALS

We designed and implemented a web-based MRI simulator for educational purposes. The simulator mimics an actual MRI console, and allows trainees to select and execute MRI sequences, with the capacity to perform geometrical planning, to modify acquisition parameters and to obtain simulated images accordingly. Using this MRI simulator, the study was carried out during a one-day classroom experience by a total of 60 students from the School of Radiographers at the Hospital XXXXX. The experiment followed a randomized pre-test post-test design with a control group and an experimental group. Both groups attended the same introductory lecture on MRI; then the control group attended a practical lecture while students in the experimental group carried out guided exercises with the simulator, covering the same contents. We designed a 10-item instrument to assess knowledge level before (pre-test) and after (post-test) our intervention. The instrument was split into two halves, corresponding to each of the two sessions attended. We hypothesized that the use of the simulator would reflect on increased learning outcomes in the practical part of the instrument. The instrument had an acceptable reliability value.

RESULTS

No differences were found in the pre-test; statistical differences (p-value < 0.05) were found in favor of the experimental group in the second half of the post-test, both in terms of the test score ($p=0.018$) as well as the gain (defined as the difference between post-test and pre-test scores, $p=0.036$); its associated effect size turned out to be significant as well (Cohen's $d > 0.6$).

CONCLUSION

We have designed an experiment aimed at comparing differences in learning outcomes between a method that makes use of an MRI simulator and a traditional educational approach. We have shown that a simulator built on specific design requirements is a valuable complement to traditional education procedures; our departing hypothesis is now backed up with statistical differences in learning results

CLINICAL RELEVANCE/APPLICATION

Despite the large number of MRI simulators that have been proposed, we have no evidence that any of them has been evaluated in terms of educational power. Our design requirements (capability of spatial planning, sequence parameter tuning and artifact reduction) have given rise to measurable differences in an actual classroom experience. This encourages using our technology for radiographer education.

SSQ11-03 Stop Repeating the Same Old Mistakes: Improving Residents' Reporting through a Report Comparison Tool

Thursday, Dec. 5 10:50AM - 11:00AM Room: N229

Participants
Jan Vosshenrich, MD, Basel, Switzerland (*Presenter*) Nothing to Disclose
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PURPOSE

To create a web-based report comparison tool for fast and objective feedback helping residents to improve the quality of their radiologic reports and to let them conveniently track their progress over time.

METHOD AND MATERIALS

Different states of each radiologic report are queried from the RIS-database automatically every 15 minutes. States are tracked according to the RIS-data and include the resident's first draft, the revised report after review with an attending and the finalized report. Changes in content between the different states of a report are visualized as a color-coded side-by-side comparison. A search engine lets the user select a time period or a number of reports (e.g. last 10 reports), subspecialties (e.g. neuroimaging) and modalities (e.g. MRI). Furthermore, only cases reviewed and finalized by a specific attending may be selected. A dashboard view visualizes calculated metrics for the queried reports, including similarity index (intersection of initial and final version divided by union of initial and final version), add index (ratio of added words) and delete index (ratio of deleted words). Indices are displayed for each report as well as a personal median for all reports queried which is displayed side-by-side to the overall median of all residents.

RESULTS

Since its introduction in late 2017, our report comparison tool assisted residents in tracking changes in more than 150,000 reports. Visualized data in side-by-side comparison offers residents an easy and fast way to comprehend changes in each report as well as to identify recurring errors. The dashboard provides residents with a macroscopic view on progress over time and may assist in identifying sections where reports needs more emphasis.

CONCLUSION

One of the key skills to acquire during residency is a clear style of reporting and to be able to explicitly communicate findings and recommendations. Our tool offers residents additional objective feedback concerning the quality of their reports. It is independent of subjective evaluation by an attending and illustrates development over time.

CLINICAL RELEVANCE/APPLICATION

Report state comparison is a useful tool to provide personalized feedback and to better understand learning patterns of residents. Data may be extracted and analyzed to maintain effective teaching.

SSQ11-04 Algorithmic Prediction of Delays in On-Call Radiology Scans and Interpretations: A Quality Improvement Study

Thursday, Dec. 5 11:00AM - 11:10AM Room: N229

Participants
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CONCLUSION

A machine learning algorithm was trained to predict delays in scanning and interpreting cross-sectional radiology studies while on call, which may serve as a step towards quality improvement.

Background

The time taken for radiology scans to be performed, interpreted, and communicated back to the clinicians during on-call settings is an important quality measure that carries patient safety and hospital finance implications. Reasons for delays in radiology are multifactorial; thus identifying the cohort of cases expected to be delayed would represent a step towards quality improvement. The aim of this study is to leverage the big data approach in radiology to predict cases that are likely to result in delay.

Evaluation

We collected 12,525 cross-sectional studies from May 2018 to March 2019 at a single academic hospital that were performed during off-hours (evenings, nights, weekends, and holidays) and interpreted by on-call residents. More than 30 metadata for each study were extracted, including order time, scan time, phone call time to clinician, time of preliminary interpretation, clinical history, scanner, body part, ED vs inpatient, contrast, resident, technologist, and ordering physician. After splitting data into training and test sets (75:25 ratio), a random forest algorithm was trained to predict above median delay in exam order to preliminary reporting (or phone communication). Randomized parameter search was conducted in Scikit-Learn to dynamically derive the optimal tree numbers (n=100), depths, and useful features (ED vs inpatient, body part, order time, scan time). Confusion matrix and ROC curve were generated.

Discussion

The average time from order to preliminary reporting (or phone call) was 320.4 +/- 463.7 (median 194.5) minutes, with scan completion to reporting time averaging 89.01 +/- 198.2 minutes (median 69.0). The random forest model achieved AUC of ROC curve on the test set (n=3,132) at 0.76. 1,168 cases were correctly classified as below median and 1126 cases were correctly classified as above median. 414 cases were incorrectly classified as below median and 424 cases were incorrectly classified as above median. Error analysis confirmed no systematic error.

SSQ11-05 Staying on Time: Data-Driven Algorithm for Optimizing Patient Scheduling

Thursday, Dec. 5 11:10AM - 11:20AM Room: N229

Participants
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CONCLUSION

Optimal scheduling uses real exam duration distributions to rearrange the order of exams to produce the most stable (least delayed) schedule. The algorithm is not MRI-specific and can be applied to any other modality or workflow.

Background

Modern healthcare workflow presents a complex combination of different resources and priorities, yet exam scheduling still relies on very outdated, static, manual techniques.. Despite the variability of exam length even within the same exam types, exams are typically scheduled into same-size blocks., The order of exams is also rarely taken into account to design a stable schedule. Our goal was to devise an algorithm to take into account the probabilistic nature of exam lengths in the formulation of an optimal schedule.

Evaluation

We used a full year of MRI scheduling data available from our Radiology Information System (3700 exams per MRI scanner). Two

data-driven algorithms were developed: one to learn the real distribution of exam durations from the RIS data, and one to discover the most optimal sequencing of exams during a day. The optimal sequencing was formulated as the order of real exams most likely to stay on time. Exam batching to speed up processing was considered as well. With many millions of possible sequences, a highly-efficient branch-and-bound algorithm was designed to find the best solution in a few minutes of computational time.

Discussion

The analysis of the current, manually-designed schedules has revealed that they are far from optimal, with significant amounts of delay accumulating as the day progresses. It has also demonstrated that scheduling sequences change frequently, randomly deviating from the initial design. These problems can be solved or significantly reduced by replacing random and suboptimal schedules by optimal schedules, resulting in 30-45-minute reduction of delay time depending on the probabilistic exam composition.

SSQ11-06 How Not To Do Radiomics - Observations from a Double Baseline Study in Glioblastoma

Thursday, Dec. 5 11:20AM - 11:30AM Room: N229

Participants
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PURPOSE

Radiomics, the extraction of predefined quantitative features from a region of interest in medical imaging, is a popular tool for disease classification and predicting outcomes. Intensity and texture features are highly sensitive to variations in acquisition parameters. Here, we focus on the effect of normalization on the repeatability of intensity and texture features in a unique double-baseline magnetic resonance imaging (MRI) dataset of patients with glioblastoma. We find that preprocessing is a key, yet under reported driver of repeatability and reproducibility.

METHOD AND MATERIALS

We evaluated imaging from 48 patients from two IRB approved clinical trials. Patients underwent two baseline scans 2-5 days apart using identical imaging protocols on a 3.0T MRI system. Radiomics features were extracted from skull-stripped T2w-FLAIR using the pyradiomics package based on manual segmentations by expert raters. We extracted features under four different conditions: fixed bin width (of 10) or fixed bin count when quantizing voxel intensities, and with or without normalization. We determined intraclass correlation coefficient (ICC) between feature values on the first and second visit as a measure of repeatability and Spearman's correlation coefficient to look for associations between features.

RESULTS

Under each condition, we extracted 16 intensity and 22 texture features. ICC values ranged between 0.5 to 0.9 for different preprocessing schemes. Normalization leads to higher ICCs values for intensity features, but has a mixed effect on the repeatability of texture features depending on the binning technique. Correlation between different texture features is substantially higher using fixed bin width compared to fixed bin count.

CONCLUSION

Normalization has a positive effect on intensity and texture feature repeatability on MRI. Users need to be careful in the choice of histogram bins to ensure the extraction of meaningful features and preprocessing and parameters need to be reported to enable reproduction of radiomics research. More research on the influence of image acquisition and feature extraction on the repeatability of radiomic features has to be undertaken to make radiomics a robust image-analysis tool.

CLINICAL RELEVANCE/APPLICATION

We examine the effect of normalization and histogram binning on the repeatability of radiomic features to make radiomics a widely adoptable tools for clinical application.

SSQ11-07 Differentiation between Pancreatic Cancer and Nontumorous Pancreas on Computed Tomography by Radiomics and Machine Learning

Thursday, Dec. 5 11:30AM - 11:40AM Room: N229

Participants
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PURPOSE

Pancreatic cancer (PC) is the most lethal cancer and the fourth leading cause of cancer death in the United States. Radiomics is a methodology that extracts quantitative statistics and features from medical images. The purpose of this study is to develop a machine learning model to differentiate PC from nontumorous pancreas (NP) on contrast-enhanced computed tomography (CT) using radiomic features.

METHOD AND MATERIALS

Contrast-enhanced venous phase CT images of 100 cases with PC and 100 controls were reviewed by an expert radiologist, and tumors and pancreases were manually labeled for PC. Most of NP labels were segmented by a pre-trained deep learning model. Data were split into training set (60 NP cases, 60 PC cases), validation set (20 NP cases, 19 PC cases), and test set (20 NP cases, 19 PC cases). Pancreas and tumor were cut into patches of 20 pixels by 20 pixels for subsequent extraction of radomic features. A total of 91 radiomic features were extracted and subject to eXtreme Gradient Boosting (XGBoost) model to perform classification.

RESULTS

A total of 3596 patches of PC and 19446 patches of NP were generated and used for training, and the testing set included 691 patches of PC and 3889 patches of NP. For differentiation between PC and NP, the accuracy of the XGBoost by patch-based analysis was 93.43%, with an area under the receiver operating characteristic (ROC) curve (AUC) of 0.94712. In patient-based analysis, the accuracy, sensitivity, specificity and AUC were 95.12%, 0.90476, 1, and 0.95238, respectively. Top 10 features with highest feature importance score were median, 10 percentile, energy, skewness, 90 percentile, maximum, minimum, and kurtosis in first order statistics, dependence nonuniformity in gray level dependence matrix (GLDM), and cluster shade in gray level cooccurrence matrix (GLCM).

CONCLUSION

We developed a machine learning model that could differentiate between CTs of pancreas with PC and without PC with a 95.12% accuracy in patient-based analysis and 93.43% accuracy in patch-based analysis. Among the important features which our model selects, features in first order statistics have the highest importance score followed by features in higher order statistics related to nonuniformity.

CLINICAL RELEVANCE/APPLICATION

This model can accurately differentiate between cancerous and nontumorous pancreas and is a potential computer-aided diagnosis tool.

SSQ11-08 Use of DICOM Header Analysis for Practice Quality Improvement and Equipment Utilization in Digital Radiography

Thursday, Dec. 5 11:40AM - 11:50AM Room: N229

Participants
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CONCLUSION

Clinical DICOM header analysis is a feasible and valuable tool to provide insight into unintended practice variation and provides metrics that can be used to optimize and better standardize clinical image quality.

Background

DICOM headers contain a wealth of information about image acquisition and processing parameters that could be used for practice quality improvement and equipment utilization in digital radiography (DR).

Evaluation

Infrastructure was architected and tools were developed to receive and extract DICOM header information from clinical DR images. Image information from public and private header elements from 18 systems were mined, aggregated and analyzed. Data extracted included study and image times, study description, station name, software version, kV, SID, exposure mode, AEC chamber selection, mAs, exposure time, grid use, detector serial number, exposure index (EI), EI target and deviation index, as well as processing-related tags such as processing name, window width/level, parameters such as contrast and edge enhancement when available. This data was used for efforts towards practice standardization, image optimization and equipment utilization. In one case, we found grids were not used as anticipated for several exams with a gridded technique. In another example, many exam views showed variation in image processing selection; this identified where system defaults were not set up as expected, or where technologists were struggling to consistently achieve good image quality with default processing. Data extracted from headers also made it more efficient to ascertain median EI values and ranges of EI. EI data combined with image quality analysis, helped to identify where we needed to improve our EI targets, techniques, etc. Data was also used to help determine the frequency of use and estimated need for purchase of 10"×12" detectors.

Discussion

Data analyzed from clinical DICOM headers provided us with valuable information on equipment usage, image acquisition and processing. These data have been successfully used for quality improvement, technologist education, and equipment purchase decisions.

SSQ11-09 Liver Surface Nodularity as a Quantitative CT Imaging Biomarker for Staging Liver Fibrosis

Thursday, Dec. 5 11:50AM - 12:00PM Room: N229

Participants
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CONCLUSION

The LSN score, a quantitative CT imaging biomarker, has developed into a clinically applicable method for accurately staging of liver fibrosis.

Background

Chronic liver disease (CLD) is a major cause of morbidity and mortality in the United States (U.S.) and worldwide. The progression of liver fibrosis is common with HCV, HBV, AH, and NASH forms of CLD and is initially a slow and gradual development of fibrotic bands and numerous regenerative nodules that progressively increase in number and size. We developed software to quantify liver surface nodularity on CT images and generate a Liver Surface Nodularity (LSN) score that can be used to noninvasively and stage liver fibrosis and cirrohosis.

Evaluation

In retrospective studies comparing the LSN score to the stage of HCV hepatic fibrosis on biopsy, the range of accuracy (AUC) for differentiating early fibrosis (>F2), advanced fibrosis (>F3) and cirrhosis (F4) were: 0.88-0.90, 0.89-0.93, and 0.90-0.96, respectively. The accuracy for staging hepatic fibrosis was further improved when mathematically combined with the FIB-4 index, which includes patient age, basic serum liver function tests, and platelet count. The LSN score has also been used to substage cirrhosis and was highly predictive of hepatic decompensation and death in a large cohort (N=830) with a variety of forms of cirrhosis. Furthermore, the LSN score demonstrated high diagnostic accuracy (AUC: 0.87) for detecting clinically significant portal hypertension and outperformed liver and splenic volumes and multiple serum indices.

Discussion

The advantages of the CT LSN score for staging hepatic fibrosis are high accuracy and precision with HCV CLD, high accuracy for staging cirrhosis and predicting clinically significant portal hypertension and future liver-related events, vendor neutral method, rapid image acquisition and processing, no need for patient fasting, no need for additional hardware, very low technical failure rate, and applicability to routine noncontrast CT images.

Printed on: 10/29/20

SSQ12

Science Session with Keynote: Molecular Imaging (Image Analysis and Quantification)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S501ABC

BQ MI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Ciprian Catana, MD, PhD, Charlestown, MA (*Moderator*) Nothing to Disclose
Dima A. Hammoud, MD, Bethesda, MD (*Moderator*) Nothing to Disclose

Sub-Events

SSQ12-01 Molecular Imaging Keynote Speaker: Recent Efforts for the Use of Machine Learning for PET/MRI

Thursday, Dec. 5 10:30AM - 10:50AM Room: S501ABC

Participants
Ciprian Catana, MD, PhD, Charlestown, MA (*Presenter*) Nothing to Disclose

SSQ12-03 Addressing Long-Term Fate of Iron Oxide Nanoparticles(ION) and Specific MRI Cell Tracking by Combining MRI and Mass Spectrometry with 57Fe-ION

Thursday, Dec. 5 10:50AM - 11:00AM Room: S501ABC

Participants
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PURPOSE

Iron oxide nanoparticles (ION) are common contrast agents for (pre-)clinical MRI, but signal is always influenced by endogenous iron hampering quantification of administered ION. We combine non-radioactive 57Fe-ION MRI with laser-ablation-mass-spectrometry (LA-ICP-MS) for differentiation between endogenous iron (56Fe) and applied ION. We aim to assess distribution and long-term fate of ION, to correlate ION concentration to T2-relaxivity and to apply 57Fe-ION for cell tracking.

METHOD AND MATERIALS

Healthy C57BL/6 mice were injected with custom engineered 57Fe-ION (NanoPET, Berlin). For ION distribution T2-mapping of liver, spleen, kidney and brain was performed on a 9.4T small-animal MRI after 2h, 1d, 3d, 7d, 30d and 90d (n=5 each). For iron amount/T2 correlation mice were injected with increasing ION dosage. Mice were sacrificed and organs extracted for LA-ICP-MS to quantify 57Fe and the 56Fe/57Fe isotope ratio. To evaluate 57Fe-ION for cell tracking mice were injected s.c. with a polyacrylamide-gel (pellet) to induce local inflammation. After 24h first baseline MRI with T2-mapping of the pellet was performed, followed by i.v. injection of either 57Fe-ION or PBS as control (n=3 each). 24h later MRI was repeated followed by histology and LA-ICP-MS.

RESULTS

57Fe-ION MRI with LA-ICP-MS enabled to specifically assess and resolve local distribution and long-term fate of ION. 57Fe of ION was first found in cells of the reticulo-endothelial-system (RES), but relocated to endogenous iron stores especially in spleen, blood and brain parenchyma after 90d. A non-linear dependence of T2-relaxivity on increasing ION dosage was observed in the liver, likely resulting from ION packing and state during metabolic processing. T2-relaxivity in the cell tracking model was mainly influenced by applied 57Fe-ION, which were located in adjacent inflammatory tissue representing invaded labelled cells, and not by endogenous iron sources.

CONCLUSION

Combining 57Fe-ION MRI and LA-ICP-MS enables to study ION distribution and long-term fate, MRI iron quantification and validation of ION-based cell tracking in a specific, non-radioactive and quantitative manner.

CLINICAL RELEVANCE/APPLICATION

57Fe-ION MRI supports research to study ION contrast agent biodistribution and long-term fate, to facilitate iron quantification and to validate MRI cell tracking studies.

SSQ12-04 Evaluation of Low Dose PET Simulation Using Time-, Space-, and Order-Based Approaches on a SiPM Digital Photon Counting Time-of-Flight PET/CT

Thursday, Dec. 5 11:00AM - 11:10AM Room: S501ABC

Participants
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PURPOSE

To introduce and evaluate low dose PET simulation using different approaches on the new generation solid state (SiPM) digital photon counting (DPC) Time-Of-Flight (TOF) PET/CT.

METHOD AND MATERIALS

FDG PET/CT of uniformity phantom (~37MBq), NEMA Body phantom with 6 hot spheres (46MBq) and 82 tumors of oncology patients (460±47 MBq, 53±4 min p.i, 10-30 BMI) were imaged 90s/bed on a DPC TOF system (Vereos). Low dose PET (50% counts reduction) was generated based on listmode data using 3 simulation approaches: 1) Time-based (T): 45s/bed, 2) Space-based: Sparse-ring configurations with every other detector disabled in tangential (ST) and axial (SA), and 3) Order-based (O): every other prompt event in order was extracted. Images were reconstructed in 3D-OSEM (low dose: 3i7s, full dose: 3i15s). Image quality was evaluated via blinded image review and quantitative assessment (lesion SUVmax, liver SUVmean, p value, Bland Altman Plots).

RESULTS

Visually, all lesions remained visible and clearly identifiable on all simulated half dose PET without compromised image quality. Image noise appeared visible at BMI >24, more on the half dose PET simulated by O approach than those by T and ST/SA approaches. Quantitatively, no significant SUVmax differences (-1±3%, -6±7%, -6±6% and -3±8%) were found (p=0.46, 0.33, 0.30 and 0.33) between any simulated half dose PET (T, ST, SA and O) and the full dose PET. Liver SUV was robust (-1±1% variances). BAP analysis indicated good SUV correlation between half dose PET and full dose PET ([-0.07, -0.72, 0.58], [-0.36, -1.46, 0.73], [-0.43, -1.32, 0.46] and [-0.35, -1.81, 1.10] in [Bias, Lower LOA, Upper LOA] for T, ST, SA and O PET. Phantom PET showed more consistent results with less SUV variances compared to the clinical PET. More details on sensitivity, advantages and disadvantages of the approaches will be presented.

CONCLUSION

The study demonstrated 3 approaches based on Time, Space and Order for low dose PET simulation. It indicated that these approaches are practicable to provide equivalent low dose PET simulation, and it is feasible to reduce PET dose by at least a factor of two from current standard of care (SOC) using the solid-state DPC PET.

CLINICAL RELEVANCE/APPLICATION

It is challenging and also unethical to test low dose PET imaging in patients especially pediatric via sequential imaging protocols for comparison, which necessitates simulation approaches to enable such.

SSQ12-05 CT Radiomic Features Predicting Epidermal Growth Factor Receptor Mutation Status In Lung Adenocarcinoma

Thursday, Dec. 5 11:10AM - 11:20AM Room: S501ABC

Participants
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PURPOSE

To evaluate the ability of CT radiomic features for predicting the epidermal growth factor receptor (EGFR) mutation status in Asian lung adenocarcinoma patients so as to choose the best targeted therapies.

METHOD AND MATERIALS

The study was approved by the Institutional Review Committee and gave up informed consent. A total of 237 adenocarcinoma patients (115 males and 122 females; mean age of 62.30 ±9.57 years) who confirmed by pathological examination from July 2017 to December 2018 were involved in this study and undergone a chest CT (contrast-enhanced CT, Thickness 0.63mm) examination before the operation. The data of EGFR gene expression, mutation sites, clinical features and CT imaging were collected and analyzed retrospectively. Radiomics features were post-processed and extracted by Radiomics software, implemented in a client server application of the manufacturer (syngoVia, Research Frontier, Siemens Healthcare, Germany). A total of 849 CT features were extracted from the volume of each tumor. After the feature selection by univariate analysis, multivariate logistic regression analysis was used to build the classifiers to predict the mutation status of EGFR.

RESULTS

Univariate analysis showed a statistically significant correlation between patient gender and EGFR mutation with p = 0.003. 72 of 849 imaging radiomic features were proved that had statistically associated with EGFR mutation (p<0.05). The top 10 most relevant features were involved to establish the logistic regression models. In model selection, two and eight features were applied to build classifier by the min-BIC and min-AIC criteria respectively. The performances of logistic regression classifiers with radiomic features obtained the AUC of 0.81 and 0.75 with min-AIC and min-BIC selected respectively. Their AUCs were improved to 0.83 and 0.75 by adding patient gender into the model establishment. The sensitivity and specificity were 77% and 81% at the best diagnostic decision point.

CONCLUSION

CT imaging radiomic features of lung adenocarcinoma combined with clinical variables showed better performance on predicting the mutation status of EGRF. CT imaging radiomic features might have the potential to be the biomarker for identifying EGRF mutations.

CLINICAL RELEVANCE/APPLICATION

Radiomics could not only investigate the genetic mutations among tumors but also show the diagnostic value and have the potential to be a diagnostic tool in the future.

SSQ12-06 Non-Invasive, Macrophage-Specific Spectral Photon Counting CT K-Edge Imaging in Atherosclerosis Using PEGylated Gold Nanoparticles

Thursday, Dec. 5 11:20AM - 11:30AM Room: S501ABC

Participants
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PURPOSE

To detect and quantify the macrophages component within the atherosclerotic plaques using a pegylated gold nanoparticles and a spectral photon-counting computed tomography (SPCCT) via K-edge imaging, in comparison to histological, transmission electron microscopy analysis and quantitative ICP mass spectrometry.

METHOD AND MATERIALS

In vivo imaging was performed on 7 atherosclerotic and 4 non-atherosclerotic NZW rabbits (control) using thiol-pegylated gold nanoparticles. Imaging was performed with a prototype SPCCT system over two days. Quantitative analysis was based on the attenuation (HU) and concentrations of gold measured on gold K-edge images within the aortic parietal wall. Transmission electron microscopy (TEM) on 8 following slices to the ones used for histology on atherosclerotic rabbits was performed to confirm the macrophage uptake of gold nanoparticles.

RESULTS

SPCCT images depicted a thickened aorta with few calcifications before injection. Conventional and K-edge images depicted enhancement within the arterial lumen after injection corresponding to arterial peak and blood pool imaging effect. Atherosclerotic plaque enhancement was observable at day 1 and 2, appearing as a well delimited enhanced plaque, supported by a thickened parietal wall and some calcifications.Only the K-edge images allow of the distinction of plaque enhancement within calcifications. TEM images of rabbit aorta sections confirmed the localization in high number of gold nanoparticles in macrophages.

CONCLUSION

We show the feasibility of noninvasive specific detection and quantification of macrophages in atherosclerotic plaques of rabbits using the K-edge capability of SPCCT and intravenous injection of pegylated gold nanoparticles.

CLINICAL RELEVANCE/APPLICATION

Noninvasive specific detection and quantification of macrophages in atherosclerotic plaques using spectral photon-counting CT and intravenous injection of pegylated gold nanoparticles may be helpful for diagnosis and prognosis in atherosclerosis, in particular for coronary imaging.

SSQ12-07 Prognostic Value of Radiomic Features from 18F-FDG PET/CT in Patients with Oral Cavity Squamous Cell Carcinoma

Thursday, Dec. 5 11:30AM - 11:40AM Room: S501ABC

Participants
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PURPOSE

To evaluate the prognostic value of radiomic features extracted from pre-operative 18F-FDG PET/CT in patients with advanced stage oral cavity squamous cell carcinoma (OCSCC)

METHOD AND MATERIALS

The study retrospectively included 113 patients with advanced stage OCSCC (pathologic TNM stage III=28, IV=85; 107 males, 6 females; median age 49 years, range: 29-89). All patients had biopsy-proven SCC of oral cavity, locally- or loco-regionally advanced disease with no distant metastasis (M0), and staging 18F-FDG PET/CT scan. Patients were treated with surgical resection of the primary tumor followed by adjuvant chemo(radio)therapy. The maximum pathologic axial tumor size was 33.5±16.8 mm. Primary tumor from PET images was segmented using absolute isocontour threshold of 40% of the maximum standard uptake value (SUV). Using TextIriX, a texture analysis plugin developed for OsiriX by our group, a total of 78 radiomic features (including shape, first order and texture features) were extracted. SUVs within the segmented volume were normalized between the minimum and maximum values, then discretized into 64-bins to construct the grey-level matrices. No spatial resampling was used. ROC curves of the extracted features were plotted against disease-specific survival (DSS) status. All patients had a follow-up of 5-years or till death.

RESULTS

Fifty-two patients died of cancer (5-year DSS=51.6%). The following radiomic features were associated with DSS (run entropy, zone entropy, entropy, dependence entropy, dependence non-uniformity, size zone non-uniformity, run-length non-uniformity), with AUC ranging from 0.637-0.661 ($p < 0.01$). Using backward Cox hazard model with 1000-samples bootstrapping, only run entropy (randomness in the distribution of run lengths and gray levels) was independently associated with DSS (hazards ratio=2.71, 95% confidence interval=1.5-5, p=0.001). When dichotomizing all patients by median value of run entropy (value=5.2), patients with entropy <= median had 5-year-DSS of 64.5% with mean survival time of 72.6 months compared to 5-year DSS of 38.5% and mean survival time of 42.4 months for patients with high entropy (p=0.003).

CONCLUSION

Tumor run entropy from 18F-FDG PET/CT was significantly and independently associated with disease-specific survival in patients with OCSCC.

CLINICAL RELEVANCE/APPLICATION

Radiomic features extracted from 18F-FDG-PET/CT are associated with prognosis in patients with oral cavity cancer.

SSQ12-08 High Definition Image Reconstruction: Enhancing PET Quantification as Enabled by Digital Photon Counting PET/CT

Thursday, Dec. 5 11:40AM - 11:50AM Room: S501ABC

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PURPOSE

Digital photon counting PET/CT enables more sensitive event detection and localization, leading to an increase in count density in the image data allowing image reconstruction with a larger matrix size resulting in smaller voxel volumes. We evaluated the quantitative impact of higher definition reconstruction on clinical data acquired on a next-generation digital photon counting PET/CT system.

METHOD AND MATERIALS

80 clinical patients were imaged for 90 seconds per bed position on a solid state digital photon counting PET/CT system (Philips Vereos, dPET) following injection of 13 mCi 18F-FDG. Standard definition (SD) reconstruction used a 4x4x4 mm3 isometric voxel volume, 144x144 matrix. Secondary reconstructions were completed using a 2x2x2 mm3 voxel volume, 288x288 matrix (high definition, HD) protocol, and a 1x1x1 mm3 voxel volume, 576x576 matrix (ultra-high definition, UHD) protocol. Using the SD images as reference, target tumor lesions and physiologic uptake were assessed by SUVmax and SUVmean, respectively. The percent difference from SD reconstruction measurements was calculated.

RESULTS

Quantification was significantly ($p<0.05$) improved by the use of larger reconstruction matrices. In background tissues, the average SUVmean increased 2.7% from SD values for the HD images and 4.3% for the UHD images. In target lesions the SUVmax increased an average of 24.9% and 57.9% for HD and UHD reconstructions. These improvements are consistent with the improved recovery coefficients seen in phantom data. The change in SUVmax of target tumor lesions was related to the tumor volume, with lesions less than 5cm3 having greater increases in SUVmax than lesions which were larger or more homogeneous.

CONCLUSION

High definition image reconstruction improves quantification of PET radiotracer activity. The reduction in partial volume effects created by utilizing smaller voxel sizes is enabled by the improved count senstivity and substantially faster time of flight timing resolution of the digital photon counting PET/CT platform.

CLINICAL RELEVANCE/APPLICATION

Next-generation digital photon counting PET/CT technology enables the use of larger reconstruction matrices due to improvements in spatial resolution and annihilation event localization.

SSQ12-09 Improving 18F-FMISO Hypoxia Target Map with EPRI and DCE-MRI

Thursday, Dec. 5 11:50AM - 12:00PM Room: S501ABC

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PURPOSE

Electron Paramagnetic Resonance (EPR) pO2 images provide a radiobiologically validated standard to accurately identify hypoxia within tumors. Using EPR pO2 images as ground truth, we show the modification of PET-18F-MISO images using dynamic contrast enhanced (DCE)-MRI to better predict true hypoxia as defined by EPR in preclinical models for the eventual translation of this application to clinical human imaging.

METHOD AND MATERIALS

We used 6 MCa4 and SCC7 tumor mouse models grown in the leg in the range of 250-400 mm^3. Under minimal anesthesia, each mouse leg was set in a soft vinylpolysiloxane cast and imaged in EPR using trityl as the oxygen spin probe, followed by a T2 and DCE-MRI using gadolinium as the contrast agent, then a PET/CT scan using FMISO as the radiotracer to target hypoxia. Based on the Tofts model, ktrans and kep maps were obtained from DCE-MRI, as well as the Relative Signal Increase (RSI) of contrast. Data from all modalities were registered. We modeled radiotracer retention as the logistic function of pO2 to map the quantitative EPR pO2 image to PET-FMISO Tumor:Muscle ratio (TMR) images, so that its sigmoidal point of inflection was at the threshold of retention. Then a linear combination of the PET and DCE-MRI data was mapped to the logistic[pO2] data using the least squares method, and that combination of PET-DCE-MRI data was finally mapped back to EPR pO2 torr units by applying an inverted logistic function as a check. The Dice coefficient between EPR pO2 < 15 torr and PET or modified PET > 1.4 TMR was used as a metric of the effectiveness of mapping.

RESULTS

On average, the Dice coefficient before and after implementing our mapping method increased by 32% to define hypoxic regions within the tumor. We anticipate that a more sophisticated combination including a nonlinear combination of PET and MRI will improve Dice coefficient overlap of PET-FMISO and EPR pO2 image-defined hypoxia.

CONCLUSION

The improvement of overlap between our reference standard of hypoxia definition by EPR with mapped PET-DCE-MRI when compared to PET-FMISO alone shows that using solely PET-FMISO to define hypoxia is insufficient.

CLINICAL RELEVANCE/APPLICATION

Our mapping method to improve the accuracy of hypoxia definition using clinically accepted imaging methods can improve radiotherapy outcomes for tumor cure, and show another clinical advantage of PET-MRI imaging.

SSQ13

Musculoskeletal (Hardware and Orthopedic Implants)

Thursday, Dec. 5 10:30AM - 12:00PM Room: N226

MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSQ13-01 Diagnosis of Hip Arthroplasty Infection is Highly Accurate with State-of-the-Art MR Imaging

Thursday, Dec. 5 10:30AM - 10:40AM Room: N226

Participants
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PURPOSE

To evaluate MRI findings of hip arthroplasty infection and determine their diagnostic accuracy

METHOD AND MATERIALS

This retrospective case control study was approved by the local ethical committee. Dedicated Compressed-Sensing Slice Encoding for Metal Artifact Correction (CS SEMAC) MR exams from 40 patients with proven hip arthroplasty infection and 100 patients with non-infected arthroplasty were evaluated by two musculoskeletal radiologists for bone (peri-implant osteolysis, edema, periosteal reaction), articular (effusion, capsule appearance and thickness) and periprosthetic soft tissue findings (collection, intramuscular edema, bursitis, adenopathy). Chi square test was used to compare the groups. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were evaluated for each finding. Interobserver reliability was assessed with κ statistics.

RESULTS

Differences between infection and control group was highly significant ($P<0.001$) for the three following findings. Periosteal reaction was found in 31 of 40 patients with infection and in 10 of 100 in the control group, with a sensitivity of 77.5%, a specificity of 90.0%, a PPV of 75.6% and a NPV of 90.9%. Capsule edema was found in 33/40 (infection group) and in 5/100 (control group), with a sensitivity of 82.5%, specificity of 95.0%, PPV of 86.8% and NPV of 93.1%. Intramuscular edema was found in 38/40 (infection group) and in 14/100 (control group) with a sensitivity of 95.0%, a specificity of 86%, a 73.1% PPV and a NPV of 97.7%. The interobserver agreement was almost perfect with κ values between 0.88 and 0.92.

CONCLUSION

The presence of periosteal reaction, capsule edema and intramuscular edema at MRI of hip arthroplasty has a high sensitivity, specificity and negative predictive value for diagnosing infection.

CLINICAL RELEVANCE/APPLICATION

State-of-the-art MRI allows excluding hip arthroplasty infection and could avoid unnecessary joint aspiration.

SSQ13-02 Radiographic Evidence of Soft Tissue Gas Fifteen Days after Total Knee Arthroplasty is Predictive of Early Prosthetic Joint Infection

Thursday, Dec. 5 10:40AM - 10:50AM Room: N226

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PURPOSE

The diagnosis of early prosthetic joint infection (PJI), defined as within six weeks after total knee arthroplasties (TKA), can be difficult due to expected post-surgical changes and elevated inflammatory markers. The role of radiographic evaluation in this situation carries unclear clinical significance. This study had two primary aims: 1) To determine when soft tissue gas is no longer an expected post-operative radiographic finding; and 2) To determine whether soft tissue gas is predictive of early PJI. The secondary aim was to determine if soft tissue gas correlated with microbiological culture results. To the best of our knowledge, this is the first study to address these questions in the literature.

METHOD AND MATERIALS

IRB approved retrospective study of patients who underwent TKA from 2008-2018, with available imaging between 5 days and 6 weeks post-operatively, and no interval intervention prior to imaging. All confirmed early PJI cases were included (n=25; 15 patients). For comparison, TKA patients without PJI (n=180; 150 patients) were selected randomly. Radiographs were reviewed by two musculoskeletal radiologists for presence of soft tissue gas. Comparative analysis was performed using Fisher's exact, binomial and nonparametric t-tests. A two-tailed $p<0.05$ was considered significant.

RESULTS

Soft tissue gas was identified in 13/25 (52.0%, 28.3±2.3 days post-op) cases with early post-operative PJI and 4/180 (2.2%, 15.3±7.3 days post-op) cases without PJI ($p<0.0001$, odds ratio 47.67 (95% Confidence Interval (CI): 13.79-143)). Presence of soft tissue gas had a sensitivity of 0.52 (95% CI: 0.36-0.70) and specificity of 0.98 (95% CI: 0.94-0.99). Staphylococcus species were the dominant organisms in cases with gas (45.0%) and in the absence of gas (50.0%), $p = 0.66$; but cases with gas demonstrated a wider variety of microbiology species ($p = 0.01$). 100% of cases with soft tissue gas prior to a suggested cut-off of 15 days post-op had no evidence of early knee PJI while 92.9% of cases with soft tissue gas after this cut-off had confirmed early knee PJI.

CONCLUSION

Post-operative soft tissue gas present on imaging performed fifteen days or more after TKA is predictive of early PJI and associated with a wider spectrum of cultured organisms.

CLINICAL RELEVANCE/APPLICATION

Soft tissue gas on post-operative radiographs fifteen days or more after TKA is predictive of early knee PJI as opposed to an expected post-operative finding.

SSQ13-03 Evaluation of a New Adaptive Iterative Metal Artifact Reduction Method in Clinical Whole-Body Low-Dose CT Skeletal Survey Examinations

Thursday, Dec. 5 10:50AM - 11:00AM Room: N226

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PURPOSE

Whole-body low-dose CT (WBLDCT) skeletal surveys contain many images and are being increasingly performed. Current iterative metal artifact reduction (iMAR) methods require parameters that are tailored to metal type and body region, requiring creation of many image sets in patients with multiple metallic implants. This study aims to evaluate an adaptive iMAR (AiMAR) algorithm, which automatically selects best parameters to allow a single image set to be used across all body regions, for use in WBLDCT.

METHOD AND MATERIALS

Projection data were collected from 25 patients, each with two types of metal implants, who underwent clinical WBLDCT on Siemens SOMATOM Definition Edge or Force scanners (120kV; CAREDose4D on with quality reference mAs of 110 or 70, respectively). Implants included dental, shoulder, spine, hip and knee prostheses, as well as pacemakers. Three AiMAR strength settings (2, 4, and 5) were considered, in addition to the original images without metal artifact reduction. For each setting, soft tissue and bone kernel images were reconstructed with a 3 mm image thickness and increment, resulting in eight image series. All series were anonymized and randomized for a reader study. Two musculoskeletal radiologists scored the images for artifact degree, anatomy visualization, and diagnostic quality, as well as ranked overall performance.

RESULTS

K-related sample Friedman test revealed statistically significant differences among the four settings in artifact degree, anatomy visualization, and diagnostic quality (all $p<0.01$). AiMAR strength 5 showed best artifact reduction but was noted to cause tissue/bone cortex blurring or loss in 10/25 patients. AiMAR strength 4 was ranked highest in overall performance.

CONCLUSION

AiMAR was evaluated in patients with multiple implants for WBLDCT skeletal surveys. Strength 4 provided excellent metal artifact reduction in a single reconstruction to address multiple implants in the same patient, overcoming current workflow limitations from body-part-specific iMAR techniques.

CLINICAL RELEVANCE/APPLICATION

WBLDCT skeletal survey exams often suffer from metal artifacts. The evaluated adaptive iterative metal artifact reduction algorithm with strength 4 provided significant metal artifact reduction for multiple implants while improving clinical workflow.

SSQ13-04 Effect of Radiofrequency Pulse Transmission Polarization on Metal Related Artifacts at 3T Magnetic Resonance Imaging: Circular versus Elliptical Polarization

Thursday, Dec. 5 11:00AM - 11:10AM Room: N226

Participants
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PURPOSE

To investigate the effect of circular and elliptical polarization of the radiofrequency (RF) pulse on the metal related artifacts of total hip arthroplasty implants during Metal Artifact Reduction Sequence (MARS) MRI at 3T.

METHOD AND MATERIALS

For this in-vitro study, we used a clinical cobalt-chromium total hip arthroplasty system with polyethylene liner immersed in a standard ASTM gel phantom. Clinical MARS MR sequences including high-bandwidth turbo spin echo (HBW-TSE), Slice Encoding for Metal Artifact Correction (SEMAC), and compressed sensing (CS) SEMAC were acquired in axial, coronal, and sagittal planes using proton density weighting. Each scan was acquired twice with circular (CP) and elliptical (EP) RF polarization, while keeping other sequence parameters identical. After anonymization and randomization, metal artifacts were volumetrically quantified for CP and EP images using manual segmentation. Additionally, observers compared the two modes for overall image quality through side-by-side display of each image pair and selcetion of the prefered polarization mode (tied selections allowed). A p-value of less than 0.05 was considered significant for all statistical analyses.

RESULTS

On quantitative analysis, metal artifact degraded regions were significantly smaller on EP images compared to the corresponding CP images of the same location and pulse sequence (paired t-test: $p < 0.02$ for all pulse sequences). The overall artifact volume (including implant itself) calculated using axial HBW-TSE images was 19% lower for EP (510 cm3) compared to CP (608 cm3). Readers chose image quality of EP in 56% (95% CI: 51%-61%) and CP in 7% (95% CI: 4%-9%) of the cases with significantly superior image quality of EP (signed test: p-value < 0.001 for all pulse sequences).

CONCLUSION

MRI at 3T with elliptical RF pulse polarization results in stronger metal artifact reduction and overall superior image quality than circular polarization. Switching to elliptical polarization for 3T MARS imaging of metal containing body parts may eventually hold promise for in vivo clinical imaging.

CLINICAL RELEVANCE/APPLICATION

MARS MRI performed with elliptical polarization of the RF pulse has the potential to provide images with lower artifact and higher image quality instead of circular polarization.

SSQ13-05 Impact of Stem Design and Cementation on Postoperative Femoral Antetorsion in 227 Patients with Total Hip Arthroplasty (THA)

Thursday, Dec. 5 11:10AM - 11:20AM Room: N226

Participants
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PURPOSE

In total hip arthroplasty (THA), surgeons try to achieve a physiological antetorsion with a combined cup and stem approach. Still, postoperative antetorsion of the femoral stem is known to show large variabilities. The purpose of this study was to assess if postoperative femoral antetorsion is influenced by stem design or cementation.

METHOD AND MATERIALS

Following ethics approval, we analyzed the postoperative femoral antetorsion in metal suppressed MR examinations of 227 patients with THA and five stem (S) designs (S1-5). S1 was cementless and short curved (n=32), S2 and S3 were cementless and standard straight (n=53 and n=51, respectively), S4 was collared cementless standard straight (n=48) and S5 cemented straight (n=43). Prostheses with suspected stem loosening were excluded. Two fellowship-trained musculoskeletal radiologists independently

evaluated femoral antetorsion by measuring the angle between the axis along the proximal neck of the femoral component and a tangent aligned to the posterior femoral condyles. Statistical analysis included general descriptive statistics, univariate analysis and inter-reader reliability.

RESULTS

Inter-reader reliability was very good with an ICC of 0.98. The cementless collared S4 showed the highest antetorsion with 18.1° (SD ±10.5°; range -10° to 45°), which was significantly higher than the antetorsion of the collarless S3 with 13.3° (±8.4°; -4° to 29°) and the cemented S5 with 12.7° (±7.7°; -3° to 27°) with p=0.012 and p=0.007, respectively. S1 and S2 showed an antetorsion of 14.8° (±10.0°; 1° to 37°) and 14.1° (±12.2°; -20° to 41°), which did not differ significantly from S3-5 (all p>0.165). The combined standard deviation of the cementless stems (S1-4) was significantly higher compared to the cemented S5 with 10.5° and 7.7°, respectively (p=0.019).

CONCLUSION

Different patterns of femoral antetorsion exist for different stem types of THA, with some statistical differences between cemented and cementless stems as well as between cementless types with and without collar. The cemented stems demonstrated the lowest variability, suggesting the lowest rate of inadvertent malrotation during implant placement.

CLINICAL RELEVANCE/APPLICATION

This is the first study reporting the postoperative range of femoral antetorsion in patients with THA for different stem designs, and can be used as a reference dataset for clinical evaluation.

SSQ13-06 Loss of Reduction is Common After Coracoclavicular Ligament Reconstruction

Thursday, Dec. 5 11:20AM - 11:30AM Room: N226

Participants
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PURPOSE

Coracoclavicular ligament reconstruction is an increasingly common treatment for significant acromioclavicular joint injury. We have anecdotally noted loss of acromioclavicular joint reduction, coracoclavicular interval widening, distal clavicular osteolysis, and osseous tunnel widening on follow-up imaging. Our purpose is to report radiographic features and complications following coracoclavicular ligament reconstruction.

METHOD AND MATERIALS

Retrospective query of our imaging database identified 55 cases of coracoclavicular ligament reconstruction. Cases with at least one month of follow-up and available operative report were reviewed with attention to acromioclavicualar joint alignment, coracoclavicular interval widening, distal clavicular osteolysis, widening of the osseous tunnel, and hardware complication. Two additional blinded radiologists reviewed the cases to assess for inter-reader agreement.

RESULTS

32 patients with post-operative imaging following coracoclavicular ligament reconstruction (23 male, 9 female; age range 24-64, imaged 1-34 months following surgery) were included. Loss of acromioclavicular joint reduction was the most common imaging finding at follow-up (n = 25), with 88% of cases seen within 6 months of surgery. 19 patients with loss of acromioclavicular reduction progressed to coracoclavicular interval widening. Distal clavicular osteolysis was seen in 21 patients, with 90% of cases seen within 6 months of surgery. Reconstruction tunnels widened on average 2 mm (range 0 - 4 mm). Hardware complication, including perihardware fractures, was seen in 6 patients. Loss of acromioclavicular joint reduction was found to have a statistically significant association with distal clavicular osteolysis (p = 0.032). Inter-reader agreement was substantial for coracoclavicular interval widening (k = 0.63), moderate for tunnel widening (k = 0.48) and hardware complication (k = 0.56), and fair for distal clavicular osteolysis (k = 0.40) and loss of acromioclavicular reduction (k = 0.39).

CONCLUSION

Loss of acromioclavicular joint reduction, distal clavicular osteolysis, and tunnel widening are frequently demonstrated after coracoclavicular ligament reconstruction.

CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware of the common imaging findings following coracoclavicular reconstruction. Attention to early loss of reduction or distal clavicular osteolysis may guide treatment approach and impact patient outcomes.

SSQ13-07 Fast Magnetic Imaging with Metallic Artifact Reduction Using Spectral Bin Modulation of Multiacquisition Variable Resonance Image Combination Selective Imaging

Thursday, Dec. 5 11:30AM - 11:40AM Room: N226

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PURPOSE

To assess the clinical utility of a prototype metal artifact reduction sequence (MAVRIC-SL) at 3T. This sequence allows a surgical prosthesis-dependent spectral bin reduction. We compared the prototype MAVRIC-SL with conventional 2D FSE sequences and further compared MAVRIC-SL images acquired with all the spectral bins, and those with the optimized spectral bins.

METHOD AND MATERIALS

MAVRIC SL images were acquired in a total 25 subjects. For each subject, the optimized number of spectral bins were determined using a short spectral calibration scan. The MR image sets used for analysis consisted of MAVRIC-SL PD-weighted or MAVRIC-SL STIR or MAVRIC-SL PD-weighted acquired with all 24 spectral bins, the corresponding images with the optimized spectral bins, conventional image of PD-weighted FSE or STIR images. The images were reviewed by a musculoskeletal radiologist and were scored using a five-point scale for artifact reduction around the prosthesis, visualization of the prosthesis, and visualization of peri-prosthetic tissues. Quantitative evaluation of peri-prosthetic tissues was also done. For statistical analyses, Paired Sample t-test was used to test for significance.

RESULTS

The MAVRIC SL images enabled significantly improved metallic artifact reduction as compared with conventional 2D FSE sequences. The optimized spectral bin numbers calculated by the spectral calibration scan ranged from 6 to 20, and this depended on the prosthesis susceptibility, size, and the orientation to the B0 field. The scan times were significantly different ($p<0.05$, 20% reduced scan time). Compared to the MAVRIC SL images acquired with all 24 bins, artifact reduction, visualization of prosthesis and visualization of peri-prosthetic tissues was not significantly different.

CONCLUSION

Compared to the MAVRIC SL images acquired with all 24 spectral bins, MAVRIC SL acquired with an optimized number of spectral bins can reduce metallic implant induced susceptibility artifacts with no significant image quality degradation, while still providing a decrease in scan time. With fewer spectral bins, the patient convenience can be increased by reducing the scan time, or the reduced time can be used to increase the spatial resolution to obtain a higher resolution image.

CLINICAL RELEVANCE/APPLICATION

MAVRIC-SL with spectral bin modulation improved image quality and decreased metallic artifacts with similar scan times to conventional images.

SSQ13-08 Comparison of Metal Artifact Reduction (MAR) Algorithms: Which is Better MAR for Hip Prostheses Evaluation

Thursday, Dec. 5 11:40AM - 11:50AM Room: N226

Participants
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PURPOSE

To compare the effect of various metal artifact reduction (MAR) algorithms in CT imaging of patients with hip prostheses

METHOD AND MATERIALS

Total 47 patients with hip prostheses were enrolled who underwent dual-layer detector spectral CT (28 men and 19 women, mean age of 63.2±10.7 years). Conventional images (CI) with iterative reconstruction algorithm (iDose 2), CI with orthopedic metal artifact reduction algorithm (O-MAR), and a variable energy range of virtual monoenergetic image (VMI, 50~200 keV) were obtained from the dual energy CT data. The image quality was quantitatively assessed by comparing CT numbers, standard deviations (SDs), corrected image noise (CIN), contrast-to-noise ratios (CNRs) and artifact index (AIs) in the seven region-of-interests (ROIs) placed around the hip prostheses among three datasets. The structural similarity (SSIM) was used to quantitatively evaluate the performance of metal artifact correction in O-MAR and VMI using CI as a reference images. Qualitative evaluation included degree of metal artifact, conspicuity of bone trabeculation, and presence of pseudolesions.

RESULTS

The lowest image noise, AI, CNR were found in O-MAR, followed by high-keV VMI in most of the regions. VMI and O-MAR showed the similar SSIM values in periprosthetic region, but VMI showed significantly higher SSIM values than O-MAR in other soft tissue region, indicating lesser metal artifact reduction of VMI. On qualitative evaluation, O-MAR provided lesser metal artifact but induced new artifacts including lesser conspicuity of bone trabeculation, artefactual cortical thinning and pseudocemented appearance in the adjacent bone.

CONCLUSION

For evaluation of hip prostheses, O-MAR presented quantitatively and qualitatively favorable image quality than VMI and iDose 2, but it can generate new artifacts.

CLINICAL RELEVANCE/APPLICATION

As MAR algorithms are popularized in many institutions by technical advance, we need to know what the most favorable MAR algorithm is and to be aware of the new artifacts generated by MAR algorithm.

SSQ13-09 Metal-Artifacts in Orthopaedic Implants: How Can We Improve our CT-Scans and What About Tin-Filter Technology?

Thursday, Dec. 5 11:50AM - 12:00PM Room: N226

Participants
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PURPOSE

The purpose of the study was to assess, how to improve CT image quality in the presence of different orthopaedic implants while using various CT modalities, especially DECT and tin- filter technology vs conventional CT. Furthermore, we wanted to explore, if scanning at reduced dose can still provide good image quality in the presence of metal implants.

METHOD AND MATERIALS

4 cadavers (pelvis und lower L- spine) with different orthopaedic implants were tested, using 9 various scan-protocols, consisting of Full-dose (FD, CDTI 10 mGy) and low dose (LD, CDTI 3,3 mGy) scans. That included scans with tin-filter technique, DECT and conventional CT on a 3rd generation DECT scanner. Additionally, besides standard 3rd generation iterative reconstruction software (ADMIRE), a novel metal artefact reduction software (iMAR) was used. Evaluation was done by using a 6-part Likert scale for objective and subjective parameters.

RESULTS

In all 4 cadavers FD tin filter scans with 150 kV Sn showed the best overall results, which was improved by using MARS-software. Looking only at metal artefact reduction, the best results were obtained, using DECT technique (FD as well as LD), but these images suffered from high imaging noise, leading to a blurring of fine osseous structures as trabecular bone, which reduced their overall rating. Even low dose scans at 150 kV Sn, showed a good overall rating.

CONCLUSION

Tin filter technology did effectively reduce metal artefacts while providing good image quality of the adjacent bony structures near orthopaedic implants. While DECT showed the best metal artefact reduction it suffered from image noise, that obscured fine bony structures. Using a LD 150 kV tin filter program can significantly reduce dose (1/3 of normal dose) and still provide good image quality and good metal artefact reduction at the same time.

CLINICAL RELEVANCE/APPLICATION

Metal- artefact reduction is an important task in CT scanning. To explore the best possible way how to obtain this (by means of hardware-tools, software-tools or a combination of both) is important.

Printed on: 10/29/20

SSQ14

Nuclear Medicine (Breast/General Oncology Nuclear Medicine and PET)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S402AB

BR MR NM OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
Amy M. Fowler, MD,PhD, Madison, WI (*Moderator*) Institutional research support, General Electric Company; Author with royalties, Reed Elsevier
Bital Savir-Baruch, MD, Atlanta, GA (*Moderator*) Research Grant, Blue Earth Diagnostics Ltd; Consultant, Blue Earth Diagnostics Ltd

Sub-Events

SSQ14-01 Can We Replace Sentinel Lymph Node Resection in Breast Cancer Patients by Breast MRI, Axillary MRI, Axillary 18F-FDG PET/MRI or Axillary Sonography?

Thursday, Dec. 5 10:30AM - 10:40AM Room: S402AB

Participants
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Lino Sawicki, MD, Dusseldorf, Germany (*Presenter*) Nothing to Disclose

PURPOSE

To compare the diagnostic performance of Mamma-MRI, axillary MRI, axillary 18F-FDG PET/MRI and axillary sonography in the detection of lymph node metastases in patients suffering from breast cancer.

METHOD AND MATERIALS

56 female patients with breast cancer (mean age 53.5±12.2 years) with newly diagnosed, histopathologically proven breast cancer were prospectively enrolled in this two-center trial. All patients underwent dedicated prone 18F-FDG breast PET/MRI and supine whole-body 18F-FDG PET/MRI as well as axillary sonography. Sentinel lymph node biopsy (SLNB) and/or axillary lymph node dissection were performed in all patients and histopathology served as reference standard. Sensitivity, specificity, PPV, NPV and accuracy regarding axillary lymph node assessment were calculated for dedicated breast MRI, axillary MRI, axillary 18F-FDG PET/MRI and axillary sonography.

RESULTS

According to the reference standard, lymph node metastases were present in 25 patients with a total of 78 metastases. On a patient based analysis, dedicated breast MRI identified 14/25 (56%), axillary MRI 15/25 (60%), axillary PET/MRI 19/25 (76%) and axillary sonography 18/25 (72%) of the patients with a positive nodal status. On a lesion-based analysis, sensitivity, specificity, PPV, NPV and accuracy were 54.5%, 88.9%, 88.9%, 54.5% and 67.6% for breast MRI; 55.1%, 90%, 89.3%, 53.2% and 57,5% for axillary MRI; 71.4%, 92.1%, 65.0%, 89.7% and 78.2% for axillary PET/MRI and 60.0%, 86.2%, 84.0%, 61.1% and 71.9% for axillary sonography.

CONCLUSION

18F-FDG PET/MRI and sonography serve equally acceptable diagnostic accuracy for nodal staging in breast cancer patients and are both superior to dedicated breast MRI or supine whole-body MRI. Although PET/MRI provides important information for staging workup breast cancer patients, neither PET/MRI nor axillary sonography do reliably differentiate N-positive from N-negative breast cancer patients.

CLINICAL RELEVANCE/APPLICATION

Sentinel lymph node biopsy cannot be replaced by imaging procedures alone and is still mandatory for staging breast cancer patients.

SSQ14-02 Simultaneous PET/MRI in the Early Prediction of Response to Neoadjuvant Chemotherapy in Patients with Locally-Advanced Breast Cancer

Thursday, Dec. 5 10:40AM - 10:50AM Room: S402AB

Participants
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PURPOSE

Aim of the study was to assess whether simultaneous PET/MRI could be helpful in the early prediction of the response to neoadjuvant chemotherapy (NAC) in patients with locally advanced breast cancer (LABC).

METHOD AND MATERIALS

Between January 2017 and July 2018, 20 consecutive patients (mean age 45 yrs) with LABC who underwent anthracycline- and taxane-based neoadjuvant chemotherapy (NAC) followed by surgical resection were prospectively enrolled. Simultaneous breast PET/MRI examination was performed twice in each patient, one week before NAC and early after the second anthracycline cycle. PET/MRI images were analyzed to extract quantitative diffusion (ADCmin, ADCmean), perfusion (Ktrans, Kep, Ve, IAUC) and metabolic (SUV2d, SUV3d, MTV) parameters. The variation of each parameter (delta, D) after the second anthracycline cycle was then calculated. The normality of the data was tested using the Shapiro-Wilk test. Differences in terms of pre-treatment and D parameters between patients histologically classified as complete response (CR) and partial response (PR) were compared using of the nonparametric Mann-Whitney U test. Logistic regression analysis was performed to identify imaging parameters predictive of the response.

RESULTS

D-Size, D-Ktrans, Kep, D-Kep, MTV and D-MTV resulted significantly different ($p<0.03$) between patients who showed CR and PR. In detail, pre-treatment Kep and MTV were significantly lower in patients with CR while the variation of each parameter was significantly higher in patients with CR as compared to patients with PR. A cut-off value of 5.09 D-MTV perfectly predicted the response to treatment (Figure 1). MRI parameters significantly associated to the response to treatment were D-Ktrans ($p=0.05$), Kep (0.04), and D-Kep (0.05).

CONCLUSION

Simultaneous breast PET/MRI could be useful to early predict the response to NAC in patients with LABC. Our preliminary observations show that functional (i.e. perfusion and metabolic) rather than morphological parameters may identify patients who will respond completely, particularly using both pre-treatment and the variation of quantitative parameters early after the second cycle of NAC.

CLINICAL RELEVANCE/APPLICATION

Simultaneous breast PET/MRI may be useful for early identification of LABC patients who would benefit from continuing NAC or for whom surgical excision could be optionally considered.

SSQ14-03 Quantitative 18F-FDG Uptake of Invasive Breast Cancer Using Harmonized Prone PET/CT and Simultaneous Breast PET/MRI with 10 Minute PET Acquisition Time

Thursday, Dec. 5 10:50AM - 11:00AM Room: S402AB

Participants
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PURPOSE

To compare tumor 18F-FDG uptake measured with 10 min PET acquisition using breast PET/MRI harmonized with prone PET/CT in patients with newly diagnosed invasive breast cancer.

METHOD AND MATERIALS

This HIPAA-compliant, IRB-approved single-institution, prospective study was performed from 2016 to 2018. Patients with biopsy-proven invasive breast cancer undergoing preoperative breast MRI were included. Patients who were pregnant, lactating, had implants, or underwent neoadjuvant therapy were not eligible. Fasting subjects underwent PET/CT (Discovery 710) of the breasts 60 min after injection of 10 mCi 18F-FDG. Patients were scanned at one bed position for 10 min in the prone position using the breast MRI coil housing with metal components removed. A low dose CT scan was obtained for attenuation correction. Subjects then underwent simultaneous breast PET/MRI (Signa 3.0T PET/MR) using an 8-channel breast coil 85 min after 18F-FDG injection. Standard clinical breast MRI sequences and Dixon-based sequences for attenuation correction were obtained simultaneously with the PET acquisition for 30 min. PET reconstruction was harmonized between scanners based on phantom scans. For analysis, the first 10 min of PET/MRI acquisition was compared to PET/CT. Standardized uptake value (SUV) measurements were performed for the tumor and contralateral normal (nl) fibroglandular tissue. Bland-Altman analysis was performed to determine measurement bias and 95% limits of agreement.

RESULTS

23 women (mean 49.6 yrs; 33-70) with 24 biopsy-proven sites of invasive breast carcinoma participated. Mean lesion size was 3.8 cm (1.1-8.8 cm) on MRI. Mean±SEM for tumor SUVmax, tumor SUVmean, and nl breast SUVmean for PET/MRI vs PET/CT, respectively, were 8.6±1.3 vs 7.3±1.1, 4.9±0.76 vs 3.7±0.57, and 1.4±0.083 vs 1.3±0.090. Measurement bias for PET/MRI vs PET/CT was 15.6% [-15.1,46.2] for tumor SUVmax, 28.7% [-7.21,64.6] for tumor SUVmean, 3.74% [-29.3,36.7] for tumor SUVmax/nl breast SUVmean, and 17.1% [-18.2,52.5] for tumor SUVmean/nl breast SUVmean.

CONCLUSION

Quantitative assessment of 18F-FDG uptake of invasive breast cancer is feasible using simultaneous breast PET/MRI with acceptable agreement between PET/MRI and PET/CT.

CLINICAL RELEVANCE/APPLICATION

Establishing the agreement between PET/CT and simultaneous breast PET/MRI for tumor 18F-FDG uptake is important for potential clinical applications such as neoadjuvant therapy response assessment.

SSQ14-04 Comparison of Whole-Body 18F-FDG-PET/MRI and PET/CT in Terms of Lesion Detection in Asymptomatic Subjects: A Retrospective Study

Thursday, Dec. 5 11:00AM - 11:10AM Room: S402AB

Participants
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PURPOSE

To compare fluorine fluorodeoxyglucose (18F-FDG) combined positron emission tomography and magnetic resonance imaging (PET/MRI) with 18F-FDG combined positron emission tomography and computed tomography (PET/CT) in terms of organ-specific lesion detection in asymptomatic subjects for cancer screening.

METHOD AND MATERIALS

2794 individuals undergoing PET/MRI (Biograph mMR, Siemens Healthcare, Erlangen, Germany) and 4283 individuals undergoing PET/CT examinations (Biograph mCT, Siemens Healthcare, Knoxville, USA), from January 2016 to December 2017 in our center, were enrolled for this retrospective study. The local ethics committee approved this study. Written, informed consent was obtained from all subjects. Besides PET/MRI and PET/CT examinations, the screening methods included ultrasound, CT (for PET/MRI), MRI (for PET/CT) and tumor marker tests of CEA, CA19-9, PSA (for male) and CA125 (for female), dependent on the cancer type. Subjects who had no positive findings in the following 12 months were considered as 'cancer negative'.

RESULTS

In the 2794 subjects, PET/MRI detected 66 suspicious lesions, 54 of them were diagnosed as malignant tumors (true positive) and 12 of them were benign (false positive). 12 malignant tumors were missed but detected by other modalities (false negative). The detection rate, sensitivity, specificity, PPV and NPV of PET/MRI screening were 1.93% (54/2794), 81.8% (54/66), 99.5% (2715/2728), 81.8% (54/66) and 99.5% (2715/2728) respectively. In the 4283 subjects, PET/CT detected 55 suspicious lesions and 48 of them were malignant tumors (true positive) and 7 of them were benign (false positive). 7 malignant tumors were missed but detected by other modalities (false negative). The detection rate, sensitivity, specificity, PPV and NPV of PET/CT screening were 1.12% (48/4283), 87.3% (48/55), 99.8% (4228/4283), 87.3% (48/55) and 99.8% (4228/4283) respectively. The detailed distribution of cancer types is shown in Figure.

CONCLUSION

To our best knowledge, this is the first work to compare the diagnostic values of PET/MRI and PET/CT for cancer screening in asymptomatic subjects. Both methods can detect a wide variety of cancer at early stage.

CLINICAL RELEVANCE/APPLICATION

Compared to PET/CT, PET/MRI has a higher detection rate and a higher sensitivity in solid organs except lung. Considering also the reduced radiation dose, PET/MRI is recommended as part of a cancer screening program for asymptomatic subjects.

SSQ14-05 Whole-Body MRI and 18F-FDG PET/MRI for N and M Staging in Primary Breast Cancer: A Multicenter Trial

Thursday, Dec. 5 11:10AM - 11:20AM Room: S402AB

Participants
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PURPOSE

To evaluate and compare the diagnostic potential of whole-body MRI and 18F-FDG PET/MRI for N and M staging in newly diagnosed, histopathological proven breast cancer.

METHOD AND MATERIALS

A total of 77 patients with newly diagnosed, histopathological proven breast cancer were enrolled in this study prospectively. All patient underwent a whole-body 18F-FDG PET/MRI in supine position. The MRI protocol included a transverse T2-weighted, a T1-weighted and a DWI sequence of the whole body from head to the thigh. The N and M staging was assessed according to the eighth edition of the American Joint Committee on Cancer staging manual in MRI datasets alone and in 18F-FDG PET/MRI datasets, respectively. Histopathology or follow up examination as reference standard were available in all 77 patients for N and M staging. A McNemar chi2 test was performed to investigate whether differences in the evaluation of the correct N and M stage between 18F-FDG PET/MRI and MRI were statistically significant.

RESULTS

MRI and PET/MRI were concordant for N and M staging in 74 of 77 (96.1%) patients. Compared to the reference standard, PET/MRI as well as MRI determined a correct N and M stage in 57/77 (74%) of the patients, respectively. A positive nodal status was present in 33/77 patients (43%). PET/MRI determined the N stage correctly in 62 of 77 (80.5%) patients with a sensitivity of 78.8% and a specificity of 93.2%. MRI determined the N stage correctly in 61 of 77 (79%) with a sensitivity of 75.8% and a specificity of 93.2%. Distant metastases were present in 4/77 patients (5%). PET/MRI detected all of the histopathological proven metastases (100% identification), while one metastasis was missed in MRI (75% identification). Additionally, PET/MRI leads to false-positive findings in 6 patients (8%) and MRI in 5 patients (7%). No statistically significant differences between the modalities were seen.

CONCLUSION

18F-FDG PET/MRI was shown to be slightly superior to MRI in the N and M staging in primary breast cancer patients. However, both modalities bear the risk to overestimate the M-stage.

CLINICAL RELEVANCE/APPLICATION

A whole-body 18F-FDG PET/MRI and MRI are highly accurate for evaluating the M stage in breast cancer patients and therefore could be considered in combination with a dedicated breast 18F-FDG PET/MRI as staging method of choice at time of diagnosis.

SSQ14-06 Correlation of 18F-FDG PET/MRI Imaging Information with Relevant Immunohistochemical Markers in Breast Cancer Patients: Could PET/MRI Identify High-Risk Patients?

Thursday, Dec. 5 11:20AM - 11:30AM Room: S402AB

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PURPOSE

To correlate prognostically relevant immunohistochemical parameters of breast cancer with simultaneously acquired standardized uptake values (SUV) and apparent diffusion coefficient (ADC) derived from hybrid PET/MRI.

METHOD AND MATERIALS

56 female patients with therapy naive, histologically proven breast cancer (mean age 54.1±12.0 years) underwent dedicated prone 18F-FDG breast PET/MRI and supine whole-body 18F-FDG PET/MRI. As part of the diagnostic imaging protocol, diffusion-weighted imaging (DWI, b values: 0, 500, 1000 s/mm²) was performed simultaneously with PET acquisition. A region of interest (ROI) encompassing the entire primary tumor was drawn into each patient's breast and prone PET/MR images to determine the glucose metabolism represented by maximum and mean SUV and into ADC maps to assess tumor cellularity represented by mean and minimum ADC values. Histopathological tumor grading as well as additional prognostically relevant immunohistochemical markers, i.e. Ki-67, progesterone, estrogen receptor, and human epidermal growth factor receptor 2 (HER2/neu) were determined.

RESULTS

We found a significant inverse correlation between both SUV- and ADC-values derived from breast PET/MRI ($r=-0.49$ for SUVmean vs. ADCmean and $r=-0.43$ for SUVmax vs. ADCmin, both $p<0.001$). Tumor grading as well as Ki67 showed a significant positive correlation with SUVmean from both whole-body PET/MRI ($r=0.42$ and $r=0.37$, $p<0.001$) and breast PET/MRI ($r=0.37$ and $r=0.32$, $p<0.01$). For immunohistochemical markers, HER2/neu significantly correlates inverse with ADC-values from breast PET/MRI ($r=-0.35$, $p<0.01$). In addition, estrogen receptor expression showed significant inverse correlation with SUV-values from whole-body PET/MRI ($r=-0.47$, $p<0.001$) and breast PET/MRI ($r=-0.45$, $p<0.001$).

CONCLUSION

The present data show a correlation between increased glucose-metabolism, cellularity, degree of differentiation as well as Ki67 and HER2/neu expression of breast cancer primaries. 18F-FDG-PET and DWI from hybrid PET/MRI may offer complementary information for evaluation of breast cancer aggressiveness in initial staging and treatment response.

CLINICAL RELEVANCE/APPLICATION

Easily applicable information from PET/MRI leads to complementary knowledge in breast cancer staging workup. This could help to identify high-risk patients efficiently.

SSQ14-07 Impact of 18FDG PET/MRI on Therapeutic Management in Breast Cancer Patients - A Prospective Multicenter Comparison Trial to the Guideline Staging Algorithm

Thursday, Dec. 5 11:30AM - 11:40AM Room: S402AB

Participants
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PURPOSE

To investigate whether the differences between the traditional staging imaging algorithm and 18F-FDG PET/MR lead to different therapeutic decisions in patients with breast carcinoma

METHOD AND MATERIALS

A total of 57 female patients with newly diagnosed breast cancer and elevated pre-test probability for distant metastases (initial tumor stage, immunohistochemical receptor expression) from two centers were prospectively included in this study. The traditional staging imaging algorithm was performed in clinical routine at the home institution of the patient. Additionally, each patient underwent a PET/MRI including dedicated diagnostic breast imaging and a whole-body MRI. Tumor stage was determined according to AJCC Staging Manual separately for both, 18F-FDG PET/MR and traditional staging algorithm. To determine the different treatment strategies each patient was discussed two times in separate DMT sessions. In one, the determination of the treatment strategy was based exclusively on the results of the traditional algorithm and in the other on the PET/MR. The primary endpoint was the incidence of differences between the therapy recommendations. The secondary endpoint was the comparison of diagnostic accuracy between the traditional staging algorithm and PET/MR for the TNM classification.

RESULTS

PET/MR and the traditional staging algorithm agreed on TNM-stages in 45 of 57 (78.9%) patients. All deviations between were due to a higher stage in PET/MR. Compared with the reference standard, PET/MR determined correct stage in 53/57 (93.0%) and the traditional staging algorithm in 43/57 (75.4%), respectively and resulting in a significant higher diagnostic accuracy in PET/MR. Different therapeutic decisions between PET/MR and the traditional staging algorithm occurred in 7/57 (12.3%) of the patients.

CONCLUSION

For breast cancer patients with elevated pre-test probability for distant metastases a change of the therapy regime occurs in 12.3% compared to the traditional staging algorithm when staged by 18F-FDG PET/MR. Furthermore the study revealed the diagnostic superiority for determining the exact TNM stage of 18F-FDG PET/MR over the traditional staging algorithm

CLINICAL RELEVANCE/APPLICATION

Current guidelines should consider systemic staging with 18F-FDG-PET/MRI in breast cancer patients with elevated pre-test probability for distant metastases at the time of initial diagnosis.

SSQ14-08 CT-Less Direct Correction of Attenuation and Scatter in Image Space Using Deep Learning for Total-Body PET: A Feasibility Study

Thursday, Dec. 5 11:40AM - 11:50AM Room: S402AB

Participants
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PURPOSE

A total-body PET scanner like EXPLORER provides a substantial sensitivity gain of a factor of approximately 40 over current clinical PET scanners. The 40-fold increase in the effective sensitivity can reduce total radiation dose by 1/40th; however, the extra radiation dose of CT for PET attenuation and scatter correction (ASC) will mitigate the merit of the ultralow-dose PET. Therefore, we propose CT-less direct ASC without any intermediate step using deep learning (DL) potentially for total-body PET.

METHOD AND MATERIALS

In an IRB-approved study, we obtained images from 59 whole-body 18F-FDG PET/CT studies that were acquired from March 2016 through August 2017. A deep convolutional neural network (DCNN) was implemented with the 59 pairs of uncorrected PET (without ASC; PETUC) and corrected PET (with ASC; PETASC) as inputs to predict attenuation-scatter corrected PET (PETDCNN) directly from uncorrected PET (50/9 split for training and test data). Quality of the predicted images (PETDCNN) was evaluated using standardized uptake values (SUV) by the normalized root mean square error (NRMSE), peak signal to noise ratio (PSNR), and structural similarity index (SSIM). Statistical analyses were performed using joint and error histograms.

RESULTS

The overall performance of PETDCNN is quantitatively comparable to CT-based ASC (PETASC). Across the test set of 9 subjects, the NRMSE was 0.26 ± 0.05; the average PSNR was 14.75 ± 3.22; the average SSIM was 0.94 ± 0.03, demonstrating high image similarity between PETDCNN and reference PETASC. The joint histogram shows the voxel-wise similarity between PETDCNN and

reference PETASC with the slope of 1.05 and R2 of 0.90 which was consistent with the result of the error histogram where most of errors (~ 90%) stay within ±0.5 SUV differences.

CONCLUSION

We demonstrated the feasibility of CT-less direct ASC using deep learning potentially for total-body PET. The clinical translation of our approach will remove the need of CT scans for PET ASC, which results in significant reduction of radiation dose particularly for pediatric patients or treatment follow-ups.

CLINICAL RELEVANCE/APPLICATION

Our proposed DL method can remove the need of CT for PET ASC, which reduces the radiation dose from a whole-body CT scan, preserving the merit of ultra-low dose imaging in total-body PET.

SSQ14-09 Quantitative Standardized Uptake Value Evaluation of 4x Faster PET Scans Enhanced Using Deep Learning

Thursday, Dec. 5 11:50AM - 12:00PM Room: S402AB

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PURPOSE

The goal of this study was to evaluate the accuracy of quantitative standardized uptake values (SUV) for noisy PET scans acquired 4x faster and subsequently enhanced using deep learning.

METHOD AND MATERIALS

15 subjects (7 male, 8 female; mean age: 67 years, range: 45;85 yrs, average BMI: 30, range: 19-48) referred for clinical whole-body PET/CT exams underwent two separate PET scans - one with the standard acquisition duration followed by one acquired 4 times faster, following IRB approval and informed consent. The 4x faster PET images were enhanced using a deep learning (DL) software (SubtlePET, Subtle Medical, Menlo Park, CA). One nuclear medicine physician reviewed the standard acquisition PET images, identified possible lesions and some normal regions, and drew regions of interest (ROIs) in OsiriX. The same lesions were reviewed on the DL-enhanced 4x faster scan images and the ROIs from the standard acquisition were propagated to the DL-enhanced 4x faster scan. Quantitative mean and maximum SUV values per ROI between the standard and DL-enhanced 4x faster acquisitions were visualized using Bland-Altman tests and compared using concordance correlation coefficients (CCC), linear regressions, and Mann-Whitney U-Tests.

RESULTS

A total of 63 ROIs were identified in the standard acquisition PET images. The Bland-Altman plot in Fig.1a-b (dotted line indicating mean, and dashed line indicating 95% limits of agreement) showed minimal differences between SUVs obtained from the two sets of scans, with almost all values contained within the 95% limits of agreement interval. CCC and linear Pearson coefficient values of 0.99 for both SUV-max and SUV-mean indicated very strong agreement between the SUV values from standard acquisition and DL-enhanced scan (Fig.1c-d, where the dotted line indicates the unity line). This was further indicated by the lack of statistical significance of p=0.68 for SUV-max and p=0.77 for SUV-mean values using the Mann-Whitney U-Test. Sample images can also be seen in Fig.1.

CONCLUSION

Deep learning can enhance 4x faster PET acquisitions without compromising quantitative SUV values compared a standard duration acquisition.

CLINICAL RELEVANCE/APPLICATION

Deep learning can enhance image quality of noisy 4x faster PET acquisitions thereby enabling higher comfort for patients, higher throughput of PET scans for hospitals, or reduced radiotracer dosages.

SSQ15

Neuroradiology/Head and Neck (Artificial Intelligence)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S404AB

AI HN NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSQ15-01 Deep Learning for Brain Tissue Segmentation

Thursday, Dec. 5 10:30AM - 10:40AM Room: S404AB

Participants
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PURPOSE

Brain segmentation, the identification of white matter, grey matter, deep grey matter, and the ventricles is typically one of the first imaging preprocessing steps of neuroimaging analysis. Currently, the reference standards for this involve either laborious manual segmentation or computationally taxing applications such as FreeSurfer that typically require hours. Deep learning has recently emerged as a promising tool for image analysis, and we hypothesize that a trained neural network that has established its weights can be optimized for inference to automatically recognize prior features. This would enable segmentation of brain structures to be completed in a matter of seconds as opposed to hours, freeing computational resources for other tasks.

METHOD AND MATERIALS

MRIs of the brain were collected from the University of California, Irvine Imaging Archive. All MRIs were passed through FreeSurfer for brain extraction and segmentation, which served as the gold standard. A customized version of U-net was developed for this study. Specifically, we designed a 3D/2D architecture capable of utilizing contextual information from adjacent MRI slices while also providing a memory-efficient method for brain segmentation. To assess algorithm generalization, we used a 5-fold cross-validation approach. Performance of masks was assessed by comparing the Dice score coefficient.

RESULTS

A total of 873 brain MRIs were included for this study. Brain extraction using the 3D/2D neural network approach resulted in a Dice scores of .862 for ventricle segmentation, 0.938 for white matter segmentation, 0.896 for grey matter, and 0.908 for deep grey matter segmentation. The processing time for our brain extraction program averaged under 5 seconds per patient, which was significantly lower compared to FreeSurfer (average time in 73 minutes, $p < 0.001$) on single CPU.

CONCLUSION

The modified U-Net produced competitive white matter, grey matter, deep grey matter, and ventricle segmentation results compared to FreeSurfer while reducing CPU load.

CLINICAL RELEVANCE/APPLICATION

Deep learning enabled brain segmentation can be accurately completed in seconds as opposed to hours, which can free computational resources for other tasks. This has important implications for neuroimaging research reliant on segmentation.

SSQ15-02 Clinical Context Improves the Performance of AI Models for Cranial Fracture Detection

Thursday, Dec. 5 10:40AM - 10:50AM Room: S404AB

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PURPOSE

Clinical history plays a vital role in a physician's or radiologist's diagnosis. However, when training AI models, clinical history or presence of an abnormality which correlates to the target abnormality were not generally considered. In this study, we use scalp hematoma as an additional clinical context in training the models and study the accuracy (AUC and average precision) of a fracture detection AI model before and after adding this clinical context.

METHOD AND MATERIALS

Using 141,105 studies, we trained a convolutional neural network (CNN) to detect cranial fractures on non-contrast head CT scans. Scalp hematoma is considered a good indicator by physicians for diagnosing fractures. We confirmed this by automated natural language processing (NLP) analysis of large number of reports. Therefore, scalp hematoma is a good candidate for improving AI algorithms for detecting fractures. A logistic regression model was trained to detect a cranial fracture, using the presence of a scalp hematoma and the output probability of the CNN as inputs. The original CNN by itself (Model 1) and the combined CNN-logistic regression algorithm (Model 2) were tested using an independent set containing 18200 scans. We used area under the ROC curve (AUC) and average precision (AP), a probability based metric that is inversely proportional to false positive rate, as evaluation metrics.

RESULTS

Analysis of 141,105 reports confirmed that scalp hematoma was present in 49.8% of scans with fractures and conversely fractures were present in 29.8% of scans with scalp hematoma. The CNN with images as sole inputs reached an AUC and AP of 0.9599 and 0.7952 respectively. Adding scalp hematoma as a feature increased AUC to 0.9666. AP however, increased significantly to 0.8190.

CONCLUSION

Using a simple probabilistic algorithm to add clinical context to a CNN resulted in a significant improvement in AP. As AUC is saturated, there is no significant difference in AUC. Results show significant decrease in false positive rate without impacting sensitivity.

CLINICAL RELEVANCE/APPLICATION

Like radiologists, deep learning models can be more accurate when they incorporate clinical context in addition to image analysis.

SSQ15-03 Pathology Localization of MCI Progression via Attention Neural Networks

Thursday, Dec. 5 10:50AM - 11:00AM Room: S404AB

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PURPOSE

In recent studies, the intrinsic relationship between pathological region localization and respective feature extraction was usually neglected. To address this issue, we proposed a novel strategy for joint pathological region localization and identification of progressive MCI (pMCI) from stable MCI (sMCI).

METHOD AND MATERIALS

We propose iterative attention focusing (IAF) attention neural networks for yielding disease-relevant attention map and predicting diagnosis result. There are two major components in IAF: 1) the full-size diagnosis network (FDN), and 2) the attention map generator (AMG). The reason of such design is that the attention maps generated previously can provide guidance for separation task, and the improvement of FDN separation performance can be helpful for precise localization of disease-related regions. We used the 1.5T T1 MR images from ADNI-1 dataset for training and 3.0T T1 images from ADNI-2 dataset for testing. In particular, the training set includes 226 sMCI and 167 pMCI subjects, and the testing set contains 239 sMCI and 38 pMCI subjects. It is worth noting that we followed previous studies to use the exact same sMCI and pMCI data for easier comparison of results.

RESULTS

For pMCI vs. sMCI separation task, results show our method achieved accuracy of 81.6%, which outperform other state-of-the-art methods such as VBM-based method of 64.3% and patch-based deep learning method (LDMIL) of 76.9%. Note that we also achieved higher sensitivity, as 60.5% against VBM of 36.8% and LDMIL of 42.1%, which indicates our method is more capable to identify possible MCI converters. Besides, our method can provide a focused attention map on specific pathological locations related to MCI progression, with detailed anatomical patterns. Results show the regions most relevant to MCI progression are mainly located at the left brain, including temporal lobe, entorhinal cortex, and hippocampus. Note that these discriminative regions differ among individuals.

CONCLUSION

We proposed novel attention neural networks for joint pathological region localization and identification of pMCI from sMCI. Besides diagnosis results, the focused attention maps provide specific pathological locations related to MCI progression.

CLINICAL RELEVANCE/APPLICATION

Our purposed attention neural networks can serve as a novel computer-aided dementia diagnosis method and allow for more insights and better understanding of the progression of MCI to AD.

SSQ15-04 Deep Learning-Based Automated Detection and Localization of Cerebral Aneurysms on MR Angiography

Thursday, Dec. 5 11:00AM - 11:10AM Room: S404AB

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PURPOSE

To develop a deep learning algorithm for automated detection of cerebral aneurysms on time-of-flight MR angiography and evaluate its diagnostic performance.

METHOD AND MATERIALS

MR images with aneurysms based on the radiological reports were extracted from January 2014 through December 2016 in our hospital. The examinations were randomly divided into two: training data set, which provided training and validation data, and test data sets (468 and 120 examinations, respectively). Additionally, 50 examinations without aneurysm were randomly selected in the same study period and added in the test set. Manual ground truth annotation of aneurysms by two radiologists and pre-processing including resampling and 3D patching around vessels and the aneurysms using vessel segmentation were performed. Next, the deep learning algorithm based on 3D ResNet architecture was established with the training data set for patch-wise classification followed by pixel voting algorithm. Its sensitivity, positive predictive value, and specificity were evaluated in the independent test data sets.

RESULTS

The training data set included 551 aneurysms (mean size, 4.13 ± 2.41 mm). Test data set included 147 aneurysms (mean size, 3.98 ± 2.11 mm). The sensitivity, the positive predictive value, and the specificity for the test data set was 87.1% (128/ 147), 95.5% (128/ 134), and 92.0% (46/ 50), respectively. One aneurysm was newly diagnosed by the algorithm in the test data set. The detection sensitivity was greatest for aneurysms larger than 5mm (23/25, 92.0%) and lowest for aneurysms 3mm or smaller (59/70, 84.3%). Fourteen out of the 19 missed aneurysms and 9 out of the 10 false positive detections in the test data set were located in the internal carotid artery.

CONCLUSION

A deep learning algorithm detected cerebral aneurysms with high sensitivity, positive predictive value, and specificity.

CLINICAL RELEVANCE/APPLICATION

A deep learning-based algorithm detects cerebral aneurysms with high diagnostic performance on MR angiography and might be useful for a more accurate and efficient evaluation of cerebral aneurysm.

SSQ15-05 Deep Learning based Detection and Localization of intracranial Aneurysms in Digital Subtraction Angiography

Thursday, Dec. 5 11:10AM - 11:20AM Room: S404AB

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PURPOSE

To detect and localize intracranial aneurysms on digital subtraction angiography images using deep learning.

METHOD AND MATERIALS

In this IRB-approved analysis, 706 digital subtraction angiography (DSA) images were derived after image augmentation of a cohort of 234 patients (150 female, mean age 59 years, range 20-92; 84 male patients, mean age 55, range 19-83) from a tertiary neurointerventional center. 389 (55% of total) single frame anterior-posterior and lateral images of a DSA series of 184 aneurysms (41 ruptured and 143 unruptured; average size 7mm, standard deviation ± 5.3mm, range 1mm to 25mm) and 317 (45% of total) aneurysm negative study images were retrospectively analyzed regarding the presence and localization of intracranial aneurysms. The presence and location of aneurysms was determined on 3D rotational DSA images by two experienced interventional neuroradiologists. The data was split into testing and training sets in a ratio of 4:1 to avoid overfitting. Deep learning was performed by use of commercial-grade machine learning software (Cognex, ViDi Suite 2.0) based on the open source Tensorflow framework in supervised mode. Computation was performed on a desktop personal computer with a dedicated graphical processing unit (Nvidia GeForce GTX 1080). Classification results were based solely on unseen test data. Sensitivity, specificity, precision, F1 score, and the area-under-the-curve (AUC) from receiver operating characteristics (ROC) analysis thereof were calculated.

RESULTS

Of the 184 aneurysms, 139 (76 %) were correctly detected and localized on both views. No size difference was found between detected and undetected aneurysms (5.7 ± 3.3mm vs. 7.1 ± 5.5mm; p= 0.19). Intracranial aneurysms were detected and correctly localized with a sensitivity of 79 %, a specificity of 79 %, a precision of 0.75, a F1 score of 0.77, and an AUC of 0.85.

CONCLUSION

Deep learning allows for detection and localization of intracranial aneurysms on DSA images.

CLINICAL RELEVANCE/APPLICATION

This proof-of-principle study demonstrates the feasibility of applying deep learning to DSA images. This algorithm has the potential to assist in the detection and localization of intracranial aneurysms on DSA images.

SSQ15-06 Deep Learning-Based Synthetic Post-Contrast T1-Weighted MR Imaging of Glioblastomas

Thursday, Dec. 5 11:20AM - 11:30AM Room: S404AB

Awards
Trainee Research Prize - Resident

Participants
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Soonmee Cha, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Post-contrast MRI is essential for characterizing brain tumors, especially glioblastomas. Despite its widespread use, there are costs and drawbacks associated with gadolinium contrast including additional scan time, side effects, and the theoretical risks associated with deposition. The purpose of our study was to evaluate the feasibility and accuracy of a deep learning algorithm designed to generate synthetic post-contrast images from pre-contrast MR images of glioblastomas.

METHOD AND MATERIALS

We analyzed preoperative MR images from 131 patients with glioblastoma. The imaging protocol included pre and post-contrast T1, T2, T2 FLAIR, arterial spin labeling, susceptibility (SWI), and diffusion (DWI) weighted sequences. 105 (80%) of the preprocessed datasets were used to train a deep convolutional neural network based on a modified U-net architecture with decomposed 3D convolutions and residual learning. The network was trained with all available pre-contrast image data, and separately with each iteration of a "leave-one-out" approach to determine the contribution of each series. Synthetic post-contrast T1-weighted images were generated from the remaining 26 (20%) of the datasets and compared directly to real post-contrast images using mean absolute percentage error.

RESULTS

Our deep-learning network was able to generate synthetic post-contrast T1-weighted images that were qualitatively and quantitatively similar to real post-contrast images. The average percent absolute error for synthetic post-contrast images was 8.3% for the whole brain and 13.0% for the tumor region only. The largest contribution to the synthetic post-contrast images across the whole brain was from T1 pre-contrast images followed by SWI. The largest contribution to the tumor region only was from DWI followed by SWI.

CONCLUSION

We used a deep learning algorithm to generate synthetic post-contrast T1-weighted images of brain glioblastomas. Synthetic post-contrast images were qualitatively and quantitatively similar to real post-contrast images. This relatively small retrospective study suggests that there may be a role for deep learning to help reduce the need for administration of gadolinium-based contrast agents in some cases.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates a deep learning algorithm that can generate accurate synthetic post-contrast T1-weighted images from pre-contrast images in patients with glioblastoma.

SSQ15-07 Classification of IDH Mutation Status in Brain Tumors Using Deep Learning

Thursday, Dec. 5 11:30AM - 11:40AM Room: S404AB

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PURPOSE

Isocitrate dehydrogenase (IDH) mutation status is a widely recognized biomarker in diagnosing and treating primary brain tumors. Currently, it is determined using immunohistochemistry or gene sequencing on tissue specimens, acquired through biopsy or surgery. In this work, we developed a fully automated deep-learning network for non-invasive prediction of IDH mutation status using MRI.

METHOD AND MATERIALS

87 preoperative multi-parametric brain MRI using the Penn curated dataset from the cancer imaging archive (TCIA)[1] database and genomic information from the cancer genome atlas(TCGA) database were used[2,3,4]. An additional 127 cases from the TCIA database were also identified. The final dataset consisted of 214 cases with 89 IDH mutated and 125 IDH wild type cases. Whole tumor masks for 87 cases were acquired from Penn segmentation resource for TCIA cases and were used as the ground truth for segmentation in the training dataset. The testing dataset did not require whole tumor masks. Data preprocessing steps included (a)co-registering to an anatomical template, skull-stripping, (b)N4BiasCorrection[5] to remove RF inhomogeneity & (c)intensity normalization to zero-mean and unit variance. Two separate networks were designed, developed and trained for a voxel-wise dual-class segmentation of whole tumor with two classes representing IDH mutated and wild type. T2-net was trained using only T2w images, and TS-net (three-sequence-net) was trained using multi-contrast MR data (T2w, FLAIR, and post-contrast T1). A 32x32x32 patch-based training and testing approach was implemented. Majority voting was used to classify the IDH status on a voxel-wise basis followed by logistic regression and ROC analysis.

RESULTS

Using majority voting T2-net achieved an accuracy of 96.1% with AUC of 0.972, and TS-net achieved accuracy of 96.9% with AUC of 0.981.

CONCLUSION

We developed an automated 3D deep learning voxel-wise network for IDH mutation classification in brain tumors. The network trained using only T2w images achieved comparable results to a network trained using multi contrast images, making it a promising tool for clinical implementation. Acknowledgement-NIH/NCI U01CA207091

CLINICAL RELEVANCE/APPLICATION

Classifying of IDH status has important implications regarding brain tumor diagnosis, treatment, and prognosis. Artificial intelligence can provide accurate noninvasive identification of IDH status using conventional MRI sequences.

SSQ15-08 Denoising MR Images of the Cervical Spine: Multi-Reader Assessment of a Deep Learning Approach

Thursday, Dec. 5 11:40AM - 11:50AM Room: S404AB

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PURPOSE

To assess quality in MR images of the cervical spine after applying a deep learning reconstruction (DLRecon) algorithm for noise reduction.

METHOD AND MATERIALS

The DLRecon algorithm was constructed using a deep convolutional residual encoder network trained with a database of >10,000 images, designed to reduce thermal noise and ringing artifact while improving spatial resolution. DLRecon provides a tunable noise reduction factor (0-100%) to accommodate user preference (50% was used). The algorithm was integrated into the system vendor's reconstruction pipeline such that two sets of images were generated from a single set of raw K-space data with reconstruction time of <2 seconds per image.Three neuroradiologists reviewed 2D FSE T2 sagittal and axial MR images of the cervical spine acquired from 20 patients on 3T GE scanners. The original and DLRecon images were presented in a randomized order. The readers were asked to rate both pairs based on 1) Apparent signal-to-noise ratio (SNR); 2) Ability to discern anatomical structures; 3) Diagnostic confidence; 4) Overall image quality; and 5) Artifacts. The first 4 metrics were rated on a scale of 1 to 5 (5=excellent) while the last metric was rated on a scale of 1 to 4 (4=no artifacts). For each metric, the effect of DLRecon on the score was measured with the paired sample t-test for each reader.

RESULTS

All three readers rated a significantly higher score on apparent SNR, ability to discern anatomical structures, and overall image quality ($p<0.01$). There was no significant effect of DLRecon on artifacts ($p=0.16/0.16/0.33$). Two readers rated significantly higher diagnostic confidence ($p<0.01$) with the third reader reporting a higher trend that did not meet statistical significance ($p=0.083$). Fig 1 shows MR images before and after DLRecon in a patient with multiple sclerosis.

CONCLUSION

In this multi-reader study, the proposed DLrecon method at a 50% noise reduction factor demonstrated improvement in SNR and overall image quality on clinical MR images of the cervical spine. There was no loss of diagnostic confidence in the examined cases with pathology including degenerative disc disease, cord infarct, and multiple sclerosis.

CLINICAL RELEVANCE/APPLICATION

DLRecon is an automated image reconstruction process with minimal processing time that integrates into routine MR examinations and provides enhancement in overall image quality and SNR without compromising diagnostic confidence.

SSQ15-09 Tumor Texture Features of Head and Neck Squamous Cell Carcinoma from Different Primary Sites Differ Significantly and Impact on the Performance of Machine Learning Prediction Models

Thursday, Dec. 5 11:50AM - 12:00PM Room: S404AB

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PURPOSE

Radiomic studies for prediction of clinical and molecular endpoints of head and neck squamous cell carcinoma (HNSCC) frequently combine tumors from different primary sites, with the assumption that the tumor texture features are not site dependent. We studied here whether texture features from different sites vary significantly and whether these variations affect the performance of machine learning models.

METHOD AND MATERIALS

603 contrast enhanced pre-treatment neck CT scans were evaluated from patients diagnosed with HNSCC, with tumors arising in the larynx or hypopharynx (LHP), lip & oral cavity (OC), and oropharynx (OP), further stratified based on HPV status to avoid its confounding effects. First order texture features with additional filtrations were extracted from each tumor and used in conjunction with patient age, smoking status, drinking status, and tumor T-stage to construct models for predicting nodal status and the presence of lymphovascular invasion (LVI) and perineural invasion (PNI). Statistical analysis was performed using Wilks test and Roy's largest root test to evaluate for variations in texture features based on tumor primary site. Two machine learning approaches (Random Forests (RF) and support vector machine (SVM)) were used to construct prediction models , using separate training (70%) and independent testing (30%) sets.

RESULTS

There were statistically significant differences ($P < 0.05$) between texture features of tumors arising in the OC, LHP, and OP. To evaluate whether the differences in texture features could affect prediction model performance, the models were constructed using texture data from the entire population or texture data stratified based on primary tumor site. Sub-stratification of texture data based on primary tumor site resulted in up to 14 % improvement in accuracy of prediction model compared to models using the combined datasets.

CONCLUSION

Significant differences in texture features exist for HNSCC arising from different primary sites below the hard palate, which can impact the performance of prediction models. For optimal performance and reliability, radiomic studies may have to stratify patients based on primary tumor site.

CLINICAL RELEVANCE/APPLICATION

Radiomic analysis can be used to predict various clinical endpoints of interest but the features can vary based on HNSCC primary site, which should be taken into account in clinical investigations using radiomic analysis of HNSCC.

SSQ16

Neuroradiology (White Matter)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S404CD

MR NR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSQ16-01 High-Resolution Myelin Imaging Using Synthetic MRI in 3D

Thursday, Dec. 5 10:30AM - 10:40AM Room: S404CD

Participants
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PURPOSE

Intact myelin is crucial for efficient signal transfer in the central nervous system. Neurodegenerative diseases such as MS and dementia result in myelin damage and the associated impairment of motor and cognitive function. Quantitative assessment of myelination is an important clinical biomarker in the treatment and follow-up of patients. Myelin can be measured using synthetic MRI; the measurement of the R1 and R2 relaxation and proton density PD in conjunction with a myelin model can provide myelin partial volume maps for the entire brain. Recently, a 3D acquisition method was developed for high-resolution, isotropic synthetic MRI. The purpose of this work was to compare myelin detection based on the 3D method with the more established 2D method.

METHOD AND MATERIALS

The 3D QALAS sequence is a segmented spoiled gradient echo sequence with 5 parallel acquisitions, interleaved with a T2 preparation and inversion pulse. The 2D MDME sequence (MAGiC) is a saturation recovery multi-slice TSE sequence with multi-echo read-out. Both sequences had a scan time of 6:10 minutes. The scanner was a patched Philips Ingenia 3T. Post-processing was performed by a prototype version based on SyMRI 11.1 (SyntheticMR, Sweden). A group of 12 volunteers was acquired two times with 3D QALAS and 2 times MDME in SAG orientation, both at 1.5T and 3T, to correlate automatically segmented myelin volume and myelin fraction of the brain.

RESULTS

The mean myelin volume for the entire group was 183 mL and the mean brain volume was 1300 mL (14.1%). A high correlation was found between volumes determined by QALAS and MDME. The Pearson correlation coefficient was 0.94, the mean difference was 0±13 mL. The difference between measurement 1 and 2 was -2±10 mL at 1.5T and 1±13 mL at 3T for QALAS whereas it was 0±4 mL at 1.5T and -3±4 mL at 3T for MDME. In Fig.1 representative images are shown for myelin mapping using MDME SAG, MDME AX and 3D QALAS. The color scale range is 0-40% partial volume.

CONCLUSION

Myelin measurements using 3D QALAS provides very similar values myelin and brain volumes in comparison to 2D MDME. The advantage of 3D QALAS is the ability to view the data in all orientations.

CLINICAL RELEVANCE/APPLICATION

High-resolution 3D myelin imaging can be done in a short scan time using synthetic MRI. The same data also provides conventional T1W, T2W and FLAIR images.

SSQ16-02 Quantitative Susceptibility Weighted Imaging (SWI): A Novel Imaging Biomarker to Predict Disease Activity in Multiple Sclerosis

Thursday, Dec. 5 10:40AM - 10:50AM Room: S404CD

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PURPOSE

Gadolinium(Gd) enhancement of multiple sclerosis (MS) lesions in T1W imaging (T1W+Gd) is the currently practiced method to differentiate active from inactive lesions. Our primary aim is to study the evaluation of Quantitative SWI in differentiating active from inactive lesions of MS using SWI phase values , there by assessing the variations in the iron content.

METHOD AND MATERIALS

In this prospective study, clinical data and images from patients who underwent MRI from September 2017 to January 2019 were reviewed. Lesions were divided into two groups; active (Group 1) and inactive (Group 2) lesions based on contrast enhancement. Phase values of the lesions (PL) and the contralateral normal white matter (PNWM) were calculated using SPIN software by drawing ROI. Subtracted phase values (PS=PL - PNWM) and iron content (PS /3) of the lesions were calculated in both groups. The means were compared by student T test and statistical significance was determined as p value < 0.05. Using ROC curve , a optimum cut off value with sensitivity and specificity were calculated

RESULTS

48 active lesions from 25 patients (Group 1) and 52 inactive lesions from 27patients (Group 2) were analysed. Mean subtracted phase values in group 1 and 2 were 3.64 and 15.84 respectively. The iron content (Mean±SD) of the inactive lesions was found to be higher (5.39 ±1.72 µg/g) than the active lesions (1.21±0.52 µg/g), which was statistically significant (P value <0.001). A cut off value of >2.5 µg/g will provide a sensitivity and specificity of 96.5% and 96.4% respectively to detect inactive lesion

CONCLUSION

Quantification of iron content using SWI phase values will differentiate active from inactive lesions, which can be a novel imaging biomarker in assessing disease activity.

CLINICAL RELEVANCE/APPLICATION

1.Various studies have concluded that repetitive use of Gd leads to deposition in brain accelerating secondary progression and atrophy inspite of normal renal function 2. Thus it can be a novel imaging biomarker to identify disease activity in patients who undergo routine neuroimaging for MS.

SSQ16-03 White Matter Hyperintensities on Magnetic Resonance Imaging and Aging: Comparison of Three Visual Rating Scales Using Convolutional Neural Networks

Thursday, Dec. 5 10:50AM - 11:00AM Room: S404CD

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PURPOSE

White matter hyperintensities (WMH) on magnetic resonance imaging (MRI) increase with age and are associated with stroke, cognitive decline, and dementia. Although consistent assessment of WMH burden is crucial for epidemiological and clinical studies, little evidence is available about the performance of proposed visual rating scales. We used deep-learning-based models to compare three visual WMH rating scales.

METHOD AND MATERIALS

We studied 418 healthy participants (mean, 66.67±7.96 years [range, 50-96 years]) consecutively recruited in a population-based aging study. All imaging studies were obtained on a 1.5 T MRI system (Vantage Elan, Canon Medical Systems, Japan). WMHs were rated according to Fazekas' scale (FZ), Age-Related White Matter Change (ARWMC) scale, and van Swieten's (VS) scale. For each scale, WMH burden was categorized as none or slight, moderate, or severe. Artifacts, lacunae, and chronic territorial infarcts were excluded. We used convolutional neural networks to assess WMH-metrics, including volume, dissemination, number of lesions, and mean entropy. We used t-tests to compare group means.

RESULTS

The different scales classified WMH burden as none or slight (FZ=331 subjects [mean WMH volume 0.487±0.639 mL]; ARWMC=327 subjects [0.477±0.625 mL]; VS=186 subjects [0.231±0.361 mL]), moderate (FZ=69 subjects [3.529±2.652 mL], ARWMC=70 subjects [3.404±2.604 mL], VS=177 [1.192±1.561 mL]), and severe (FZ=18 subjects [9.568±4.795 mL], ARWMC=21 subjects [8.707±5.068 mL], VS=57 subjects [5.675±4.326 mL]). On FZ and ARWMC, WMH volumes in each category were similar. However, on SV, WMH volumes in all categories were smaller than on FZ and ARWMC (P<0.001). Additionally, on FZ and ARWMC, WMH dissemination, number of lesions and mean entropy in moderate and severe category were also similar.

CONCLUSION

Our results indicate that FZ and ARWMC ratings of WMH CNN-based quantification are similar; SV tends to underrate WMH burden. Therefore, FZ and ARWMC could be applied equally to assess WMH characterization.

CLINICAL RELEVANCE/APPLICATION

FZ and ARWMC scales and volumes provide near-equivalent estimates of WMH burden; therefore, either can be used.

SSQ16-04 Unsupervised Learning Approach for Multiple Sclerosis Lesion Segmentation in Brain MRI: Application of Minimum Distance Estimation with a Cramer-von Mises Type Statistic

Thursday, Dec. 5 11:00AM - 11:10AM Room: S404CD

Participants
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PURPOSE

While recent advances in machine learning could enable automatic segmentation of multiple sclerosis (MS) lesions in brain MRI, many algorithms were based on the supervised learning. One caveat to this approach is its demand for large volume of labeled data with high quality. Considering difficulty of labeling, an approach of the unsupervised scheme can be an alternative solution to this self-contradictory problem. Here, we developed an algorithm based on the unsupervised learning to segment MS lesions on FLAIR MR image and validated its feasibility through open, clinical datasets.

METHOD AND MATERIALS

To segment MS lesions with using unlabeled data, we estimated their locations in the MR image. To obtain non-parametric and data-driven estimates, we used minimum distance estimation (MDE) with a Cramer-von Mises (CvM) type statistic which is known to be robust against anomalies. Briefly, starting from two randomly-generated regions of the MR image, our algorithm provided two segmented regions - MS lesions and another area - in a fast and stable manner. From pre-processed (brain extracted and bias-corrected) 3D FLAIR images, MS lesions were estimated for each axial image, using small-sized patches for sliding window scheme. After applying the median filtering to combined patches, final lesion maps were acquired. We applied a developed method for two different datasets: our hospital dataset (N=10, confirmed MS) and open dataset (MSSEG challenge, N=10). We calculated a dice coefficient for open dataset which has reference standard lesion segmentation results. Also we assessed visual appropriateness for two datasets.

RESULTS

A developed model was applied successfully to 3D FLAIR images, both in open and our hospital datasets. In general, there was good agreement for segmentation results with visual inspection of MS lesions and reference standard. Median DICE index for reference standards of open dataset was 0.39 (range 0.20-0.58), which was comparable with results of previous challenge winners. Even though some false negative lesions were found, they were small and subtle. Majoirty of false positive were cerebral cortices.

CONCLUSION

We demonstrated that MDE with a CvM type statistic could be a useful unsupervised method to segment MS lesions in FLAIR images.

CLINICAL RELEVANCE/APPLICATION

Unsupervised method for MS lesion segmentation could have clinical potential over supervised learning, when manual labeling data is limited.

SSQ16-05 New Multiple Sclerosis Clinical MR Protocol to Limit the Use of Intravenous Contrast Using CAD Software

Thursday, Dec. 5 11:10AM - 11:20AM Room: S404CD

Participants
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PURPOSE

The growing concern about deposition of free gadolinium in the brain of patients that undergo serial contrast-enhanced MRI studies demands careful use of IV contrast. We have implemented a new, CAD-assisted clinical MR protocol for the purpose of limiting gadolinium-based contrast injections in our patients with multiple sclerosis (MS).

METHOD AND MATERIALS

Following the results of our recent publication that demonstrated that all MS patients with enhancing lesions on their followup brain MR scan also have new lesions on pregad imaging, the new protocol uses a CAD software to determine in real time which patients

have new brain lesions, and only those patients who do get IV contrast. There are two major components in this clinical decision support system: 1) The CAD program, which detects new brain lesions by comparing 3D T2/FLAIR images from current and prior studies. 2) Our department clinical 3D lab, staffed with technologists, who not only run the program, but also assess the CAD results for new brain lesions. The workflow goes like this: The patient (without IV) gets the 3D FLAIR sequence first. As soon as this is done, the 3D lab runs the CAD program. Then the 3D lab calls the MR tech with the results: If there is no new lesion, only non-contrast imaging gets performed. If there is at least one new lesion, the MR tech places a butterfly in the patient's arm, and proceed with a complete contrast-enhanced scan.

RESULTS

The new clinical protocol has been used for about 2 months, on 360 followup scans, and resulted in 60% reduction in the rate of gadolinium injection. The accuracy of 3D lab assessment of CAD results versus final radiologist interpretation was more than 95%. Our preliminary study predicted a rate of 75% reduction, and the main reason for not achieving this figure in the clinical implementation is the unavailability of the 3D lab after hours. In that case, patients get contrast automatically. There is still room for improvement in CAD sensitivity, and assessment of CAD results by 3D lab techs.

CONCLUSION

We have implemented a new MR clinical protocol to avoid unnecessary gadolinium injections in patients with MS with a real-time decision support system. We believe that this will address the growing concern of our patients, as well as save time and resources.

CLINICAL RELEVANCE/APPLICATION

This protocol is now being used on every MS followup case, and is poised to improve patient experience, and save resources.

SSQ16-07 Comparing Selective Inversion Recovery Quantitative Magnetization Transfer and Diffusion Tensor Imaging to Assess Myelin Integrity in Multiple Sclerosis

Thursday, Dec. 5 11:30AM - 11:40AM Room: S404CD

Participants
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PURPOSE

We propose to validate Quantitative Magnetization Transfer (qMT) protocol and its derived myelin-sensitive pool-size-ratio (PSR) by comparing it with conventional radial diffusivity (RD) derived from diffusion tensor imaging (DTI). We hypothesize that i) Both PSR and RD discriminate pathological versus healthy tissue in brain of persons with multiple MS, ii) PSR shows comparatively stronger associations with clinical measures due to its superior specificity to myelin integrity.

METHOD AND MATERIALS

In this prospective case-control study 18 persons with MS and nine age-and-sex-matched healthy controls(HC) underwent conventional scans, DTI and qMT protocol scan on 3T. Disability was measured using Expanded Disability Status Scale (EDSS) and Timed 25-Foot Walk Test (T25-FW). Generalized linear mixed models for binary outcome were used to assess differences in PSR and RD between white-matter-lesions(WMLs), chronic-black-holes(cBHs), normal-appearing-white matter(NAWM), and normal-white-matter(NWM) of HCs. Association between variables were measured using non-parametric Spearman's Rank correlation analyses.

RESULTS

PSR and RD differed ($p<0.001$) between cBH and WML, WML and NAWM, but not between NAWM and NWM. PSR derived from cBHs ($r=-0.83, p<0.001$) and WML ($r=-0.76, p<0.001$) correlated with volume of cBH. No correlation was observed between RD and lesion burden or between both PSR and RD with brain atrophy. PSR derived from cBHs and WML correlated with EDSS ($r=-0.44, p=0.005$; $r=-0.63, p=0.005$), T25-FW ($r=-0.62, p<0.05$; $r=-0.63$, $p=0.005$) and disease duration ($r=-0.61, p=0.05$; $r=-0.71$, $p=0.002$) respectively.(Figure 1) On the contrary, no significant associations were seen between RD values and clinical measures.

CONCLUSION

Both PSR and RD can discriminate tissues with different types of pathology, but only PSR is sensitive to clinical measures. The differences can be attributed to the fact that qMT provides an indirect measure of macromolecular content through its communication with surrounding water, whereas DTI only offers information related to the presence or absence of barriers, which in damaged tissue, is complex. Additionally, qMT is not sensitive to fiber orientation as DTI and thus may also have a pivotal role in explaining our results.

CLINICAL RELEVANCE/APPLICATION

SIR-qMT derived metrics add specificity to the assessment of myelin integrity in persons with MS, suggesting a role as biomarker of neurodegeneration and repair.

SSQ16-08 Imaging of Acute Optic Neuritis: Is It Possible to Diagnose Demyelinating Disorders based on Optic Nerve Enhancement Patterns?

Thursday, Dec. 5 11:40AM - 11:50AM Room: S404CD

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PURPOSE

MRI patterns of optic nerve involvement have been described and correlated with underlying optic neuritis (ON) etiologies. Optic nerve enhancement is an accurate biomarker of acute ON. Our purpose is to analyze if there is any difference between patterns of optic nerve enhancement and acute ON etiologies.

METHOD AND MATERIALS

We retrospectively analyzed enhancement patterns on fat-suppressed T1-weighted images of 50 optic nerves (43 patients) with clinical and radiological acute ON, who presented at our institution over a 4-year period. We evaluated location and extension of enhancing optic nerve segments and the presence of perineural enhancement (PE). Images were analyzed in consensus by a third-year radiology resident and a neuroradiologist. The relation between optic nerve enhancement patterns and underlying etiology was evaluated. Fisher's exact test and chi2 were calculated.

RESULTS

Patients mean age was 30.7 years-old (range 6-79) and 28 were females (65.1%). Twenty-three (53.4%) were diagnosed with Multiple Sclerosis (MS), 8 (18.6%) Neuromyelitis Optica (NMO) and 12 (27.9%) anti-MOG. Seven patients had bilateral involvement [14.29% MS, 14.3% NMO, 71.3% anti-MOG (p=0.029)]. Nine nerves had PE (33.3% MS, 33.3% NMO and 33.3% anti-MOG). Thirty-five had intraorbital involvement [34.2% MS, 22.8% NMO, 42.8% anti-MOG (p=0.012)]. Canalicular involvement was seen in 28 patients (46.4% MS, 10.6% NMO, 42.9% anti-MOG), intracranial in 20 (45% MS, 15% NMO, 40% anti-MOG) and chiasmatic in 3 patients (33% MS, 33% NMO, 33% anti-MOG). Twenty-six patients had only 1 involved segment (61.54% MS, 19.23% NMO, 19.23% anti-MOG), 13 patients had 2 segments (38.5% MS, 15.4% NMO, 46.2% anti-MOG), 10 patients had 3 segments (30% MS, 20% NMO, 50% anti-MOG) and only one patient had 4 segments affected (anti-MOG). The median time from symptom onset to MRI was 8.7 days (range 0-33).

CONCLUSION

In acute ON, bilaterality and intraorbital involvement of optic nerves were more frequent in anti-MOG patients compared to MS and NMO groups. There was no statistically significant difference in the presence of PE or number of involved segments between groups.

CLINICAL RELEVANCE/APPLICATION

Despite acute ON treatment is similar in all demyelinating entities, prognosis and further management differs considerably. Patterns of nerve enhancement could differentiate between etiologies.

SSQ16-09 Neuromyelitis Optica Spectrum Disorders (NMOSD) - Is that Possible to Characterize Different Phenotypes by Magnetic Resonance Imaging?

Thursday, Dec. 5 11:50AM - 12:00PM Room: S404CD

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PURPOSE

Patients with neuromyelitis optica spectrum disorders (NMOSD) can be positive for antibodies against aquaporin-4 (anti-AQP4), against myelin oligodendrocyte glycoprotein (anti-MOG) or even double negative. Our goal in this study is to compare MRI findings between anti-AQP4 positive, anti-MOG positive and double negative patients.

METHOD AND MATERIALS

Two neuroradiologist blind for the antibody measures results retrospectively analyzed MRI scans from 72 NMOSD patients (29 patients positive for anti-MOG; 26 patients positive for anti-AQP4, and 17 patients negative for both antibodies). We compared the frequency and characteristics of optic neuritis, myelitis and brain lesions, including presence of medullary and area postrema lesions; the number of abnormal optic nerve and medullary segments, and the encephalic regions involved in each condition. We performed chi-square and person test for categorical variables and analysis of median with Mann-Whitney test for continuous variables.

RESULTS

When comparing anti-MOG versus anti-AQP4 patients, we observed significant differences in: presence of medullary lesions, MOG 44% AQP4 88% (p=0.001); presence of area postrema lesions MOG 3.7% AQP4 38% (p=0.002), normal brain MRI MOG 69% AQP4 23% (p=<0.001), optic chiasm lesions MOG 13,3% AQP4 61,1% (p=0.005); longitudinally extensive transverse myelitis (LETM) MOG 7% AQP4 80% (p<0.001); medullary bright spot lesions MOG 0% AQP4 50% (p<0.001). When comparing anti-MOG versus double negative (DN) we observed significant differences in: normal brain MRI MOG 69% DN 29% (p= 0.009); optic chiasm lesions MOG 13% DN 53% (p=0.042); median number of medullary segments involved MOG 4 DN 13 (p=0.01); corticospinal tract involvement MOG 3% DN 35% (p=0,048).

CONCLUSION

Anti-MoG related myelitis is less frequent and less extensive, compared to anti-AQP4 and double negative patients, and the bright spotty lesions are absent in anti-MoG patients. The anti-MOG related optic neuritis frequently spares the optic chiasm. These MRI findings might provide surrogate markers to differentiate NMOSD phenotypes.

CLINICAL RELEVANCE/APPLICATION

NMOSD patients showed different MRI patterns depending on the serological evaluation. To recognize specific MRI patterns for each autoantibody-related presentation might help understanding different pathological mechanisms and to guide personalized diagnostic and therapeutic interventions.

Printed on: 10/29/20

SSQ17

Pediatrics (Ultrasound)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S105AB

PD US

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SSQ17-01 Contrast-Enhanced Ultrasound (CEUS) in Pediatric Swine as a Pediatric Preclinical Model for Brain Imaging

Thursday, Dec. 5 10:30AM - 10:40AM Room: S105AB

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PURPOSE

Brain injury (direct and indirect) remains a leading cause of morbidity and mortality in children. We evaluate the feasibility of using a pediatric swine model to develop CEUS-based measures of brain perfusion to be applied in the setting of various types of brain injury.

METHOD AND MATERIALS

One-month old, 10kg pediatric swine (n=4) were anesthetized for the duration of the study. A 6 cm burr hole, dura intact, based on a template of the ultrasound transducer (Philips 10-3v), was created in the right frontal cranium to provide an acoustic window for visualization of an oblique coronal plane and bilateral thalami. All animals were pre-medicated with diphenhydramine to prevent any allergic reaction to the contrast. In this dataset, 3 sham animals were imaged, and 1 animal underwent asphyxial cardiac arrest. Ultrasound contrast agent (UCA) Lumason (Bracco Diagnostics) was administered as a a) weight-based (0.03 ml/kg) venous bolus or b) non-dilute steady infusion (0.4-1 ml/min) using an infusion pump. After localization of the imaging plane, CEUS cine clips were acquired for a) 90 seconds for bolus and b) 180 seconds including 2 or more flash-replenishment sequences for infusion while maintaining the mechanical index between 0.1-0.15.

RESULTS

In total, 13 bolus injections (average dose of 0.3 ml) and 17 flash-replenishment sequences were performed across all animals. The bolus provided global visualization of the perfusion while the infusion highlighted the microvasculature in the brain. CEUS provided adequate visualization of the vascular structures in the brain using both bolus and infusion in the sham and cardiac arrest model. Preliminary evaluation of bolus kinetics in the sham pigs showed a central gray nuclei to cortex ratio (GNC) similar to human neonates with a steep wash-in that crossed the 1.0 threshold and remaining above 1.0 for most of the enhancement period. This will be evaluated for the cardiac arrest model in future studies to identify any differences.

CONCLUSION

We demonstrated the similarity in brain perfusion between porcine and human neonates, specifically with respect to GNC and thus showing preliminary feasibility of its use as a neonatal model of brain pathology.

CLINICAL RELEVANCE/APPLICATION

CEUS can be performed in the bedside as a minimally invasive procedure and quantitative CEUS may provide critical information regarding changes in brain perfusion as a result of injury or as a response to therapy.

SSQ17-02 Transcranial Shear Wave Elastography (SWE) of Neonatal and Infant Brain for Quantitative Evaluation of Increased Intracranial Pressure

Thursday, Dec. 5 10:40AM - 10:50AM Room: S105AB

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PURPOSE

Increased intracranial pressure (ICP) is a severe disease state in infants that needs adequate diagnosis and a rapid therapy. Basic non-invasive diagnostic of increased ICP is based on clinical evaluation, B-mode ultrasound (B-US)as well as (Power-) Doppler ultrasound (D-US). Purpose of this prospective study was two-fold: first to analyse the technical possibility to perform SWE-measurements in infant brain and second to compare values between healthy neonates and those with hydrocephalus and suspected and/or invasively proven increased ICP.

METHOD AND MATERIALS

Prospective IRB-approved study in 166 neonates and infants (mean age 12 weeks, range 1 day up to 12 month), 110 of them healthy asymptomatic infants and 56 of them with diagnosed hydrocephalus, 38 with clinically increased ICP and 18 without clinically increased ICP. Invasive ICP-measurements were available in 37 children. All infants were examined with B-US, D-US and SWE with a high-res. linear 15 MHz probe (Aixplorer, Supersonic). Semi-quantitative and quantitative SWE-measurements were performed. SWE-values were compared to clinical symptoms and to results of invasive intracranial pressure measurements (37 participants). Correlations were calculated by Pearson and Spearman's correlations coefficients. Mean SWE-values in healthy children and those with increased ICP were compared by using student's t-test.

RESULTS

Brain-SWE was technically feasible in 110/124 (88.7%) healthy children and in 56/60 (93.3%) of children with hydrocephalus. SWE-values, thus rigidity of the brain parenchyma, were significantly higher in children with hydrocephalus compared to healthy children (mean 28.9 kPa vs. 18.2 kPa; p=0.0012). A correlation of invasive ICP measurements and SWE-values in a subgroup of patients with hydrocephalus revealed a direct correlation between increased ICP and increased SWE-values. Mean SWE-values were 30.3 kPa (range 26.0 - 45.2 kPa) in patients with proven increased ICP and 19.4 kPa (range 10.2 - 24.5 kPa) in patients with non-increased ICP (p<0.001).

CONCLUSION

SWE is feasible in neonates with increased ICP and might be a useful method for additional diagnostic imaging and monitoring of children with proven or suspected increased ICP. However, more evidence is necessary to further evaluate the usefulness of SWE measurements in neonates with hydrocephalus.

CLINICAL RELEVANCE/APPLICATION

SWE can be used as a surrogate marker for ICP in neonates and infants.

SSQ17-03 Incremental Role of Shear Wave Elastography and Sonographic Scoring Systems in the Imaging Diagnosis of Biliary Atresia

Thursday, Dec. 5 10:50AM - 11:00AM Room: S105AB

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PURPOSE

Infants with biliary atresia (BA) have a higher hepatic stiffness as compared to other causes of neonatal cholestasis (non-BA) because of early onset biliary cirrhosis, which has been evaluated in our study. To make greyscale and elastographic evaluation of BA more *objective* by means of scoring systems.

METHOD AND MATERIALS

Sixty-four infants with cholestatic jaundice were included in this prospectively conducted observational study. Hepatic SWE stiffness and other parameters were measured using Supersonic Aixplorer ultrasound system. The final diagnosis of BA was established based on intra-op cholangiogram and by liver biopsy wherever surgery was not feasible whereas BA was ruled out when there was gut excretion on HIDA scan or resolution of jaundice on follow-up. As liver stiffness in non-BA also slowly increases with age, we have grouped the patients into two age groups of <=60 days and >60 days for better validity.

RESULTS

1. Greyscale: Gall bladder wall irregularity was the most accurate (93.8%) greyscale feature in diagnosing BA; followed by fasting gall bladder length (89.1%) and triangular cord sign (84.4%). 2. SWE: SWE stiffness was significantly higher in BA as compared to non-BA in age-matched groups <=60 days: BA = 14.4kPa; Non-BA = 7.9kPa (p=0.003) >60 days: BA = 38.3kPa; Non-BA = 18.1kPa (p=0.0005) 3. Scoring systems *(Please refer to the image attached)*: *Grey Scale (GS) scoring system*, with a cut-off of >=7, developed solely on the basis of known greyscale parameters was most accurate (96.9%) in diagnosing BA in <=60 days infants. *Grey Scale + Elastography (GSE) scoring system*, with a cut-off of >=9, was most accurate (97.8%) in diagnosing BA in infants aged >60 days. *GSE scoring system*, with a cut-off of >=9, when implemented in <=60 days is more accurate (94.4%) than

conventional sonographic diagnosis (93.8%), but it is lower than that of GS scoring system (96.9%). Hence, it needs further validation with a larger sample size in infants <=60 days.

CONCLUSION

1. Scoring systems defined in our study are a simple yet effective way for accurate sonographic diagnosis of BA. 2. Recommendations for diagnosing BA GS score >=7 in <=60 days GSE score >=9 in >60 days when SWE is available GS score >=7 in all age groups when SWE is not available

CLINICAL RELEVANCE/APPLICATION

Our scoring systems are a significant step towards solving the decades of quandary persisting in the confident and early differentiation of biliary atresia from other causes of neonatal cholestasis.

SSQ17-04 Diagnostic Performance of Ultrasonography for Midgut Volvulus: A Pilot Study

Thursday, Dec. 5 11:00AM - 11:10AM Room: S105AB

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PURPOSE

Ultrasound (US) has been suggested as an alternative to upper gastrointestinal series (UGI) to diagnose midgut volvulus, but diagnostic performance characteristics of US for midgut volvulus are currently not well-defined. This pilot study aims to evaluate the interrater reliability, sensitivity, and specificity of US for midgut volvulus.

METHOD AND MATERIALS

Following IRB approval, a case-control study was performed on US exams which were performed for the indication of vomiting in children. Inclusion criteria were US exams with cine clips through the entire SMA/SMV pedicle and the expected region of the third portion of the duodenum (D3). 13 consecutive surgically-proven midgut volvulus (MV) cases with US exams meeting inclusion criteria were identified. For controls, US exams in 23 children without MV (confirmed by UGI, other imaging, or resolution of symptomatology on clinical follow up) were selected. Deidentified imaging sets with a still SMA/SMV image at the pancreatic head, a SMA/SMV pedicle cine clip, and a D3 region cine clip were created. 2 MV and 2 normal exams were removed to create a training set. Blinded to all patient information, 3 pediatric radiologists (1-10 years experience) independently reviewed the randomly ordered unknowns and assessed 4 findings (SMA/SMV relationship, whirlpool sign, D3 location, duodenal dilatation) and an impression (+ or - for midgut volvulus). Inter-observer agreement was determined using intraclass correlation (ICC), and sensitivity and specificity for MV were calculated.

RESULTS

Sensitivity and specificity for midgut volvulus were 100% and 95-100%, respectively (Table 1). Agreement between radiologists was excellent (ICC 0.90, range 0.83-0.95). For findings, the best agreement was presence of a whirlpool sign (ICC 0.88, range 0.79-0.93), with ICC's for other findings between 0.73 and 0.84.

CONCLUSION

This pilot study shows US can be sensitive and specific for midgut volvulus with excellent interrater reliability. Larger studies are needed determine whether US can substitute for UGI as the first line imaging modality.

CLINICAL RELEVANCE/APPLICATION

Midgut volvulus is a surgical emergency with longer time intervals between symptom onset and surgical correction increasing morbidity and mortality. Since many hospitals have 24/7 in-house ultrasound but rely on radiologist call-back for UGI after hours, time to surgical correction could be decreased if ultrasound could replace UGI.

SSQ17-05 Volume Changes in Testicular Torsion: Utility of a Volume Ratio on Ultrasound to Help Predict Torsion

Thursday, Dec. 5 11:10AM - 11:20AM Room: S105AB

Participants
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PURPOSE

Scrotal ultrasound (US) for testicular torsion may be challenging, particularly if there is preserved flow or early findings. We sought to determine if there is significant enlargement of the affected testis in pediatric patients with testicular torsion, in order to identify an additional criterion that may be helpful.

METHOD AND MATERIALS

A retrospective analysis of pediatric patients between the ages of 2-18 with testicular torsion and surgical confirmation from 2014-2018 was performed. The volumes of the torsed testes and unaffected sides were recorded, and a ratio of the abnormal to normal sides was calculated. Age matched controls with normal scrotal US were identified to determine typical testicular symmetry, and volume ratios were calculated by comparing the larger to smaller side. Finally, volumes in patients with testicular appendage torsion were recorded in order to determine whether any testicular volume changes were specific to torsion. Patients with preexisting conditions such as varicoceles or undescended testes were excluded from all groups. A comparison of the symptomatic testes and the volume ratios was performed using ANOVA statistical analysis. A ROC curve was used to evaluate a cut point ratio to maximize sensitivity and specificity for torsion.

RESULTS

34 patients with testicular torsion (mean age 13.2 yrs), 34 age matched controls (mean age 13.2 yrs), and 45 patients with testicular appendage torsion (mean age 9.5 yrs) were included. Mean testicular volume and ratio in the torsion group was 14.1 mL and 1.64, in the normal group was 7.8 mL and 1.15, and in the appendage torsion group was 1.83 mL and 1.06. Volume ratios in the testicular torsion group were significantly higher than in the controls ($p<0.05$), and were also higher than in the appendage torsion group ($p<0.05$). Volume ratios in the appendage torsion group were not statistically higher than the normal group. A volume ratio of 1.27 was determined to maximize sensitivity (72.97%) and specificity (90.79%) for torsion, yielding a PPV of 79.4% and a NPV of 87.3%.

CONCLUSION

Comparing the volume of the affected testis to the unaffected side may help in diagnosis of testicular torsion, particularly with a volume ratio > 1.27.

CLINICAL RELEVANCE/APPLICATION

The affected testicle in testicular torsion enlarges significantly compared to the normal side, and a volume ratio of 1.27 may be helpful as an additional criterion of torsion.

SSQ17-06 Contrast-Enhanced Ultrasound of Fetal Lung Perfusion in the Extra-Uterine Environment for Neonatal Development (EXTEND) System: Initial Experience in Congenital Diaphragmatic Hernia

Thursday, Dec. 5 11:20AM - 11:30AM Room: S105AB

Participants
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PURPOSE

The purpose of this study was to determine whether contrast-enhanced ultrasound (CEUS) could evaluate fetal lung perfusion and if quantification methods could detect differences in a pre-clinical animal model of congenital diaphragmatic hernia (CDH).

METHOD AND MATERIALS

Two fetal lambs underwent surgical left-sided CDH creation at 72-74 days gestational age (GA) and were delivered at GA 118-121 days (term=145 days) to the EXTra-uterine Environment for Neonatal Development (EXTEND) system, per published protocols.1 Two normal fetal lambs served as controls. Bilateral pulmonary artery Doppler waveforms were obtained and resistive and pulsatility indices (RIs and PIs) were calculated. 0.9-1.3mL activated Definity® contrast was mixed with 50mL saline and administered into the umbilical vein at an infusion rate of 100-120mL/hr, depending on estimated weight. CEUS was performed at multiple timepoints in each animal over 14 days and flash-replenishment cine acquisitions were obtained. Perfusion metrics were quantified in each lung using MATLAB. 1Partridge EA et al. An extra-uterine system to physiologically support the extreme premature lamb. Nat Commun. 2017;8:15112.

RESULTS

When compared to controls, CDH animals had increased right and left pulmonary artery RIs (0.85 vs. 0.76 and 0.87 vs. 0.76, respectively; $p<0.05$) and PIs (2.85 vs. 2.03 and 2.91 vs. 1.66, respectively; $p<0.05$). Fetal lung parenchymal perfusion was visualized in all 29 CEUS examinations and a total of 107 flash-replenishment cine acquisitions were adequate for quantification. In both lungs, CDH animals had increased flash-replenishment rate (0.86 vs. 0.54 arbitrary units/sec; $p<0.01$) and decreased mean transit time (mTT) (1.97 vs. 3.24 sec; $p<0.01$) when compared to controls.

CONCLUSION

CEUS can be performed to assess aberrations in pulmonary artery Doppler measurements and differences in fetal lung perfusion can be quantified. Increased pulmonary artery RI/PI, increased flash-replenishment rate, and decreased mTT in CDH animals are consistent with pulmonary hypertension and decreased pulmonary capillary surface area.

CLINICAL RELEVANCE/APPLICATION

CEUS can be used to evaluate fetal lung perfusion with applications in future studies assessing efficacy of surgical and pharmacologic interventions for CDH with anticipated direct human translation.

SSQ17-07 Contrast-Enhanced Voiding Urosonography, Technique and Comparison with Voiding

Cystourethrogram

Thursday, Dec. 5 11:30AM - 11:40AM Room: S105AB

Participants
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PURPOSE

To evaluate the feasibility and effectiveness of contrast enhanced voiding uronosography, compared to traditional voiding cystography (VCUG) in a tertiary hospital in Brazil

METHOD AND MATERIALS

This is an ongoing study that begun January 2016. Pediatric patients referred for VCUG were included in our study. Any patient with contraindication for the realization VCUG or who did not consent with the study was excluded. Equipment: GE precision 8000 Fluoroscopy and Toshiba Applio 500 Ultrasound Protocol: Written consent was obtained. Initial B mode ultrasound scan of the bladder and the kidneys was obtained. Afterwards bladder catheterization and emptying was performed, which was then slowly filled with the contrast solution (Sonovue 1,5 mL diluted in 500 mL of saline). During filling the kidneys and ureters were constantly checked for vesicoureteral reflux (VUR), characterized by the visualization of microbubbles in the ureter or renal pelvis. Filling was halted whenever bladder filling was complete, patient experienced symptoms of discomfort or urethral extravasation began. Patient were then asked to begin voiding (when possible) as to diagnose active vesicoureteral reflux. A second filling-voiding cycle was made afterwards. With the vesical catheter still in place, patients were submitted to a complete voiding cystography exam immediately afterwards. Two different radiologists interpreted each exam (one radiologist for ultrasound and a second radiologist for the voiding cystogram).

RESULTS

So far 34 patients (71 kidney ureter units(KUU)) were examined, with excellent agreement between both methods for VUR. Of the 71 KUU analyzed 20 were diagnosed with VUR in both urossonography and VCUG. 48 yielded negative results in both studies. There were 3 discordant results (2 moietys yielded positve results only in VCUG and 1 positive only in urossonography). No adverse reactions have been recorded

CONCLUSION

Voiding urossonography has showed excellent agreement with traditional voiding cystourethrogram for the diagnosis of vesicoureteral reflux. Advantages over traditional voiding cystourethrogram are absence of ionizing radiation and allowing a one-stop-shop approach to certain urologic conditions.

CLINICAL RELEVANCE/APPLICATION

Voiding urossonography is a viable and cost-effective alternative for VCUG in the diagnosis of VUR.

SSQ17-08 The Use of Contrast-Enhanced Ultrasound (CEUS) for Evaluation of Renal Perfusion Post-Angiography: A Preliminary Feasibility Study in Pediatrics

Thursday, Dec. 5 11:40AM - 11:50AM Room: S105AB

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PURPOSE

Renal artery angioplasty endpoint determination and follow up currently can be challenging. Pressure gradient measurements can determine immediate endpoints, however cannot be used as a follow-up tool. To determine if the use of CEUS imaging can qualitatively and quantitatively provide objective assessment of renal arterial and parenchymal perfusion pre and post renal artery angioplasty in children and potentially be used as a follow up imaging tool.

METHOD AND MATERIALS

The more recent practice in our institution of performing pre and post angioplasty CEUS was reviewed for the ability to generate time intensity curves (TIC). Inclusion criteria were visibility of all three renal poles, minimal motion of the kidney/imaging plane and parenchymal wash-out. Pre and post angioplasty regions-of-interest (ROI) were identified in renal parenchyma and main renal artery, and average contrast intensity over the total duration was used to generate a TIC and time-to-peak (TTP) enhancement.

RESULTS

Two of 8 cases were identified as meeting inclusion criteria, both cases involving the use of the cutting balloon, a novel technique for resistant renal artery angioplasty. In the first case, a faster/steeper gradient on the wash-in leading to a shorter parenchymal TTP from 9.6 pre to 8.7 sec post angioplasty, which is comparable to main renal artery stenosis reduction from 70% to 25% and

gradient reduction from 13 mmHg to 6 mmHg. In the second case, post-angioplasty imaging did not show significant improvement of main renal artery stenosis (50% pre to 31% post angioplasty). However, TTP showed significant improvement in the flow (11 sec down to 6 sec in parenchyma and 8 sec down to 3 sec in renal artery), comparable to intra-procedural gradient measurement (12 mmHg down to 3 mmHg).

CONCLUSION

This feasibility study suggests that standardized CEUS imaging may be able to evaluate pre and post angioplasty renal perfusion and may be used as a follow-up imaging tool to monitor RAS. Currently instituted standardized imaging and contrast dose will enable the generation of additional quantitative measure of perfusion assessment, in the entire, or selected parenchymal regions.

CLINICAL RELEVANCE/APPLICATION

CEUS provides a real-time method of assessing renal perfusion during intervention and follow-up. It may also provide objective end point determination for renal artery angioplasty.

SSQ17-09 Application of Contrast-Enhanced Ultrasound in Pediatric Hepatoblastoma

Thursday, Dec. 5 11:50AM - 12:00PM Room: S105AB

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CONCLUSION

CEUS has better spatial resolution than B-mode sonography in hemorrhage and/or necrosis of hepatoblastoma and the similar perfusion pattern is in the CT and CEUS. The CEUS is used for improves guide needle biopsy.

Background

Hepatoblastoma is a malignant tumor arising fro embryonic liver tissue. It is a common malignant tumor in childhood, among about 79% of children's liver tumors, mostly occurs under 3 years old. Two-dimensional ultrasound has limitations in the diagnosis of hepatoblastoma, and the Contrast-enhanced Ultrasound (CEUS) is still inexperienced in the pediatric diagnosis. It is worth discussing how to use for image diagnose in the hepatoblastoma.

Evaluation

Materials and Methods: Our study included 8 patients (6 males, 2 females) with age range 1~3 years old of the surgically or pathology confirmed hepatoblastoma and available baseline abdominal imaging by CEUS and CT. Those CEUS abdominal images were retrospectively analyzed and compared with the Contrast-enhanced Computed Tomography (CT). According to the PRETreatment EXTent of disease (PRETEXT) system, there were one case for low risk, 5 cases of intermediate risk and 2 cases of high risk. A case with intermediate risk hepatoblastoma complicated with tumor rupture.

Discussion

Result: All 8 cases of giant type liver tumor showed solid mass by B-mode ultrasonography. Contrast agent SonoVue® (Sulphur hexafluoride microbubbles) was given intravenously, the 2 cases tumor appeared hyper-enhancing in arterial and portal venous phase, hypo-enhancing in venous phase; 5 cases appeared hyper-enhancing in arterial phase, hypo-enhancing in portal venous and venous phase, and one case showed hypo-enhancing in third phase by the CEUS. There were 7 cases appeared central non-enhancing area by the CEUS same as CT. One CEUS showed surround non-enhancing area of the tumor, and CT image suggested hematoma enclosure. In addition, the CT showed 2 cases of capsule and 2 cases of calcification, but CEUS had no characteristic features. One case of portal vein thrombus showed both by CEUS and CT, and 8 cases showed intrahepatic vascular compression. The 7 of 8 cases tumor were successfully performed needle biopsy by the CEUS guided.

SSQ18

Physics (Dual Energy/Spectral CT)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E353A

CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSQ18-01 Noise Suppression in Image-Domain Multi-Material Decomposition for Dual-Energy CT by Noise Propagation Analysis

Thursday, Dec. 5 10:30AM - 10:40AM Room: E353A

Participants
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PURPOSE

Dual-energy CT (DECT) strengthens the material characterization and quantification due to its capability of material discrimination. The image-domain multi-material decomposition (MMD) via matrix inversion suffers from serious degradation of the signal-to-noise ratios (SNRs) of the decomposed images and thus the clinical application of DECT is limited. In this work, we propose a noise suppression algorithm based on the noise propagation for image-domain MMD.

METHOD AND MATERIALS

The noise in the decomposed images only distributes in two perpendicular directions. The noise perturbation is minimal along the principal axis and is thus suppressed along the principal axis by estimating the center of mass of the same-material pixel group. The proposed method is evaluated using the line-pair and contrast-rod slices of the Catphan©600 phantom and one patient data. We compared the proposed method with the direct inversion and the block-matching and three-dimensional (BM3D) filtration methods.

RESULTS

The results of Catphan©600 phantom and the patient show that the proposed method successfully suppresses the noise of the basis material images by one order of magnitude and preserves the spatial resolution of the decomposed images. Compared with the BM3D filtration method, the proposed method maintains the texture distribution of the decomposed images at the same SNR and the accuracy of the electron density measurement.

CONCLUSION

The algorithm achieves effective noise suppression compared with the BM3D filtration while maintaining the spatial distribution of the decomposed material images. It is thus attractive for advanced clinical applications using DECT.

CLINICAL RELEVANCE/APPLICATION

Improve the accuracy of dual-energy CT material decomposition and can be used for iodine removal in CTPA.

SSQ18-02 Implementation of Multi-Energy CT with Triple-Beam Dual-Source CT

Thursday, Dec. 5 10:40AM - 10:50AM Room: E353A

Awards
Trainee Research Prize - Fellow

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PURPOSE

To implement triple-beam energy-integrating-detector multi-energy CT (EID-MECT) on a dual-source (DS) CT scanner and compare its material decomposition (MD) performance with EID dual-energy CT (EID-DECT) and photon-counting-detector CT (PCD-CT) for two potential multi-contrast clinical tasks: biphasic liver imaging with iodine (I) and gadolinium (Gd), and small bowel imaging with iodine (I) and bismuth (Bi).

METHOD AND MATERIALS

The EID-MECT was implemented on a DSCT platform by mounting a z-axis split filter (0.05 mm Au, 0.6 mm Sn) on Tube A, which was operated at 120 or 140 kV. With Tube B operated at 70 or 80 kV, four triple-beam configurations were calibrated for MECT measurements: 70/Au120/Sn120, 70/Au140/Sn140, 80/Au120/Sn120, and 80/Au140/Sn140 kV. Mixed I/Gd samples were prepared, where the I/Gd enhancement values corresponded to late arterial/portal-venous phases, respectively, for biphasic liver imaging. Mixed I/Bi samples were prepared, where the I/Bi enhancement values corresponded to arterial/enteric enhancement, respectively, for small bowel imaging. Samples were placed in a 25-cm wide water phantom and scanned using the four configurations. The same phantom was scanned using twin-beam DECT (TB-DECT) (Au120/Sn120 kV), DS-DECT (80/Sn140 kV), and PCD-CT (80 kV: 25/35/50/55 keV for I/Gd; 140 kV: 25/50/75/90 keV for I/Bi), all at equivalent CTDIvol. Image-based MD was performed and mean (± std dev) material concentrations measured.

RESULTS

The optimal triple-beam configuration was 70/Au120/Sn120 and 70/Au140/Sn140 kV for I/Gd and I/Bi quantification, respectively. At equivalent radiation dose, noise in material concentration measurements was reduced for the triple-beam by 93%, 46%, and -2% for I/Gd quantification, and 62%, 24%, and 40% for I/Bi quantification, compared to TB-DECT, DS-DECT, and PCD-CT, respectively.

CONCLUSION

For the first time, the use of EIDs to perform MECT was experimentally demonstrated. Implemented with use of a Au/Sn split filter, three unique energy spectra were simultaneously measured using a DS system. Noise measured in material concentration was decreased relative to EID-DECT and comparable to or better than PCD-CT for two potential multi-contrast clinical tasks.

CLINICAL RELEVANCE/APPLICATION

With the triple-beam technique, the wide availability of DS-DECT in academic radiology departments can facilitate investigations of multi-contrast clinical tasks.

SSQ18-03 Multi-Contrast Imaging with Dual-Source (DS) Photon Counting Detector (PCD) CT and a Material Decomposition Technique Using Prior Knowledge Aware Iterative Denoising (MD-PKAID)

Thursday, Dec. 5 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

Multi-energy data acquired on photon counting detector (PCD) suffer from considerable energy overlap due to imperfect detector response. This work aims to use dual source (DS)-PCD-CT to improve energy separation of multi-energy data, and a recently developed material decomposition method (MD-PKAID) to enable high fidelity simultaneous multi-contrast imaging of iodine (I), gadolinium (Gd), and bismuth (Bi).

METHOD AND MATERIALS

Head/body phantoms including solution vials containing I/Gd/Bi contrast agents of different concentrations were scanned on a single-source (SS) whole-body PCD-CT (chess mode with 4 thresholds = 25/50/75/90keV) and two times of clinical doses. The energy thresholds were chosen to capture the K edges of Gd/Bi. Energy bin images were reconstructed using a quantitative kernel (D30). An image-domain least-square material decomposition (MD-LS) was used to generate I/Gd/Bi specific images. Next, the same phantoms were scanned on DS-PCD-CT which was emulated by two consecutive scans with 80 kV / Sn140 kV for low/high energy tubes (Sn=tin filter). Total radiation dose of DS-PCD was 52.8/14.0 mGy for the head/body scans, similar to clinical exams. The energy thresholds were set as 25/50 keV for 80kV scan, and 25/90 keV for Sn140 kV scan. A recently developed material decomposition method (MD-PKAID) was applied, which used the energy threshold-low images as a prior image to denoise individual material-specific images. The root-mean-square-errors (RMSE) of material concentration relative to the true concentrations were measured for each material.

RESULTS

The improved energy separation offered by DS-PCD-CT, combined with MD-PKAID, was able to achieve excellent performance of multi-contrast imaging of I/Gd/Bi contrasts. The material concentration RMSEs for I/Gd/Bi were 0.26/0.11/0.21 mg/mL for head phantom, and 0.50/0.31/0.29 mg/mL for body phantom, in comparison to the RMSEs of 1.82/1.44/0.63 mg/mL (head) and 10.88/7.54/1.76 mg/mL (body) using SS-PCD with MD-LS.

CONCLUSION

The combination of DS approach and PCD technology, coupled with an iterative material decomposition algorithm, allowed simultaneous multi-contrast imaging using I/Gd/Bi with low (<0.50mg/mL) quantification error.

CLINICAL RELEVANCE/APPLICATION

DS-PCD-CT and a novel material decomposition algorithm may allow successful multi-contrast imaging, which may enable novel molecular imaging with nanoparticles and extend the frontier of clinical CT.

SSQ18-04 Evaluation of a Novel Multi-Energy CT Phantom with High-Precision Low Iodine and Calcium Concentration Inserts Using a Third Generation Dual-Source CT System

Thursday, Dec. 5 11:00AM - 11:10AM Room: E353A

Participants
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PURPOSE

To evaluate a novel multi-energy CT (MECT) phantom with multiple radiologically relevant inserts representing blood and water with contrast elements at low concentrations.

METHOD AND MATERIALS

A prototype of MECT phantom Model 662 (CIRS Inc, Norfolk, VA), with dimensions 33 x 27 x 25 cm was designed based on CIRS standard Electron Density Phantom Model 062 and comprised of the 5 cm thick target section in between two scatter 10 cm sections. It can be used in the "head" configuration Ø18 cm or full-size "body" configuration. The phantom is manufactured from Plastic Water-LR® and includes numerous material targets encapsulated inside the Ø1cm inserts made of PW-LR. Solid iodine inserts in water and blood included 0, 0.2, 0.5, 1.0, and 2.0, 5, 10 and 15mg/cc. Calcium inserts included 10, 20, 40, 60, 120 and 240 mg/cc concentrations. The phantom was scanned using dual-source CT (SOMATOM Force, Siemens) in the conventional SECT mode to assess linearity with kV ranging 70-150 (plus 100Sn and 150Sn). The iodine inserts were also evaluated with the MECT technique using kV pair combinations: 80/Sn150, 90/Sn150, and 100/Sn150 kV.

RESULTS

The HU values of all materials (including background 'water') in the phantom behaved as expected in the investigated kV range. The HU vs. concentration curves measured in the 'head' phantom showed excellent linearity with R2 values of 0.9990 (iodine in water), 0.9995 (iodine in blood) and 0.9998 (calcium in water). Iodine accuracy in the 'body' phantom varied from -0.5 to +0.2 mg/cc under all conditions except the highest iodine concentration (15 mg/cc) measured with 90/150Sn and 80/150Sn kV pairs where the absolute error increased to -0.8 and -1.1 mg/cc, respectively. With exception of the lowest concentrations <=0.5 mg/cc, percent errors were consistently below 10%. At lower concentrations, the 100/Sn150 kV had the highest accuracy. Iodine DE ratio values in the 'body' phantom were in excellent agreement with the previously published results (Krauss et al, Invest Radiol 2015).

CONCLUSION

The evaluated MECT phantom showed excellent characteristics in terms of concentration linearity, expected kV dependence of all clinically relevant materials, appropriate iodine DE ratio values, and enabled evaluation of low concentrations of materials.

CLINICAL RELEVANCE/APPLICATION

With MECT gaining more clinical attention, carefully designed phantoms are desired for assessing performance of state-of-the-art MECT systems.

SSQ18-05 K-Edge Subtraction Imaging with a Mono-Energetic Compact Synchrotron X-Ray Source

Thursday, Dec. 5 11:10AM - 11:20AM Room: E353A

Participants
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PURPOSE

X-ray computed tomography (CT) is one of the most important diagnostic techniques in clinics. Yet, this method lacks the ability to differentiate similarly absorbing substances like commonly used iodine contrast agent and calcium, which is contained in calcifications, kidney stones and bones. K-edge subtraction (KES) imaging overcomes this limitation by subtracting two CT scans recorded at X-ray energies above and below the K-edge of the element in question. Thereby, reliable discrimination of contrast agent and calcium is achieved.

METHOD AND MATERIALS

KES benefits from monochromatic X-rays. Therefore, it has been mainly applied at synchrotron facilities. Here, we present the first proof-of-principle experiment of a filter-based KES CT performed at a compact synchrotron X-ray source based on inverse-Compton scattering, which provides a quasi-monochromatic X-ray beam of tunable energy in a laboratory setup. Two CT scans of an excised porcine kidney containing a kidney stone were performed. One scan was done with an iodine filter in the beam shifting the mean X-ray energy below the iodine K-edge energy, while the other one was performed with the full spectrum of the X-ray source.

RESULTS

KES CT allows for iodine contrast agent and calcium to be clearly separated, c.f. Figure 1. While both materials show almost the

same absorption values in the unfiltered CT scans (Figure 1a), KES and inverse KES allow to discriminate the two materials (Figure 1c, d) due to the step increase in absorption of iodine between the X-ray energies employed for the two CTs.

CONCLUSION

The results show that KES CT is feasible at a compact inverse-Compton scattering X-ray source, which is going to provide benefits for contrast enhanced 3D imaging in a pre-clinical setting. KES CT allows for a discrimination of iodine and calcium, which will be of special interest in various clinical situations like kidney stones, atherosclerosis and bone imaging. We believe that KES at a compact synchrotron source can become an important tool in pre-clinical research and possible future clinical diagnostics.

CLINICAL RELEVANCE/APPLICATION

KES CT solves the clinically faced issue of the discrimination of iodine contrast agent and calcium, providing two CT volumes only showing one of the two materials, respectively.

SSQ18-06 The Potential Effects of Scout Scan Parameters on Image Quality and Radiation Dose in Chest CT on a 16cm Wide-Detector Dual-Energy CT

Thursday, Dec. 5 11:20AM - 11:30AM Room: E353A

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PURPOSE

To explore the effects of scout scan parameters (tube position, tube voltage, mA) on image quality and radiation dose of chest CT scan under Smart mA and KV Assist modes on a chest phantom

METHOD AND MATERIALS

The CT scan was performed on a chest phantom by a 16cm wide-detector dual-energy CT (Revolution CT, GE Healthcare, Milwaukee) under Smart mA and KV Assist modes. During the scout scanning,the tube was positioned at 0°, 90 and 180°, separately corresponding to 5 different tube voltages (70, 80, 100, 120 and 140kV); 5-6 mA values were selected from a range of 10-110mA. Scan parameters were set as follows: KV Assist, Smart mA, detector width: 80mm, pitch: 0.992:1, rotation time: 0.5s/r, slice thickness: 5mm, NI: 10. The mA values atpulmonary apex, tracheal bifurcation, nipple, and right diaphragmatic dome were recorded. The CT dose index-volume (CTDIvol) in each scan was recorded as well. The radiation dose of breast in each scan was measured by the thermal leak detector (TLD). The regions of interest (ROIs) were placed at the tracheal bifurcation and right diaphragmatic dome to calculate the contrast-to-noise ratio (CNR).

RESULTS

Under Smart mA and KV Assist modes with tube positions at 90° and 180°, a tube voltage of 100kV was automatically selected for scanning. With the scanning parameters of 70kV and 10mA at the tube position of 0°, the automatically selected tube voltage was 100kV as well. For other scanning conditions, tube voltage was automatically selected as 80kV. At the tube position of 0°, the mean CTDIvol was 3.33mGy, the mean breast dose was 6.79mGy, and the mean CNR were 120.34 and 124.81 at a level of tracheal bifurcation and diaphragmatic dome, respectively . At the tube position of 90°, the above measurements were 4.87mGy, 8.42mGy, 168.00 and 144.33, respectively. At the tube location of 180°, measurements were 4.38mGy, 7.45mGy, 143.35 and 141.48, respectively.

CONCLUSION

In chest CT scout scan, the tube position has great influence on the radiation dose and particularly the organ dose of breast.

CLINICAL RELEVANCE/APPLICATION

A proper scan mode shall be selected according to the specific requirements of clinical examinations.

SSQ18-07 Assessment of Texture Feature Reproducibility in Dual-Energy Computed Tomography Virtual Monoenergetic Images

Thursday, Dec. 5 11:30AM - 11:40AM Room: E353A

Participants
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PURPOSE

To explore the reproducibility of radiomic texture features across virtual monenergitic images generated from dual-energy CT (DECT) acquisitions used in clinical practice and clinical trials at our institution.

METHOD AND MATERIALS

A phantom containing liver and lung texture modules was scanned in triplicate with a clinical dual source DECT scanner. Three fixed volumes of interest (VOIs) were drawn in mixed images (weighted images of low (90kV) and high (150kV) energy acquisitions) and monoenergetic images at 8 different energy levels (40,50,60,70,80,100,120,140 keV) to compare four Harlick texture features (energy, entropy, contrast, and homogeneity). Percentage difference of texture values from the mixed image was calculated for each VOI and keV level.

RESULTS

For VOIs placed in the lung portion of the phantom, texture value difference from mixed the image was on average 10% (range:1-17%) for energy, 4% (range:0.5-8%) for contrast, 3% (range:0.3-6%) for correlation, and 1% (range:0.1-2%) for homogeneity. In liver these values included 7% (range: 0.4-16%) for energy, 11% (range: 0.4-39%) for contrast, 10%(range: 2-29%) for correlation, and 2%(range: 0.3-6%) for homogeneity.

CONCLUSION

All four texture features reviewed showed variance across monoenergetic images of DECT.

CLINICAL RELEVANCE/APPLICATION

Defining imaging device characteristics and their effect on imaging features with an empirical manner is a critical step for utilization of radiomics in the precision medicine era.

SSQ18-09 Image-Domain Synthesis of Spectral CT Virtual Monoenergetic Images Using Stacked Deep Convolutional Neural Networks

Thursday, Dec. 5 11:50AM - 12:00PM Room: E353A

Participants
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PURPOSE

To develop a deep convolutional neural network (CNN) based technique to synthesize virtual monoenergetic images (VMIs) from spectral CT data and to compare results to conventional VMIs created from the same data.

METHOD AND MATERIALS

The developed technique consists of a VMI-synthesis CNN (CNNVMI) and a texture-synthesis CNN (CNNTEXT), with fully-customized architecture and loss functions. A two-stage training strategy was used. CNNVMI was trained using spectral CT polychromatic images and theoretical monoenergetic linear attenuation coefficients as inputs and labels, respectively. After CNNVMI training, the parameters were fixed, and CNNTEXT was stacked to the end of CNNVMI. CNNTEXT was trained to synthesize the image noise texture of a low noise image, using water phantom images as labels. CT images of an abdomen-sized water phantom with varying inserts were used to train and validate the CNNs. Additional porcine CT images were acquired to evaluate the generalizability of the CNNs for anatomical features. Images were acquired on a whole-body research photon-counting-detector (PCD) CT, using 140 kV and a two-threshold (25 and 65 keV) data acquisition mode. Phantom scans were acquired multiple times across three radiation dose levels (CTDIVOL: 23 mGy, 11.5 mGy, 5.75 mGy) and animal scans were acquired with 23 mGy. Results were compared with baseline images created using a conventional least-squares-based two-material decomposition.

RESULTS

Relative to baseline VMIs, CNN-synthesized VMIs demonstrated substantially lower noise and improved contrast resolution at all dose levels, especially for low-contrast inserts or tissues. Image details and noise texture were well maintained using the CNN synthesis compared to that of routine dose input images. The proposed CNNs accurately estimated the CT numbers of all inserts (mean absolute percent difference <5%), across all dose levels. Importantly, noise of the CNN VMIs was not substantially affected by the dose level of the input CT images (noise in water 12.6±0.14 HU across all dose levels).

CONCLUSION

The proposed CNN-based VMI synthesis provided high quality VMI images with accurate CT number, suppressed image noise, and improved contrast resolution.

CLINICAL RELEVANCE/APPLICATION

The clinical value of low keV VMIs could be dramatically increased by use of the described method to suppress image noise with maintaining CT number accuracy.

SSQ19

Physics (Deep Learning - Dose Reduction and Image Quality)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E353B

AI CT PH SQ

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SSQ19-01 Radiation Dose Reduction for CT Assessment of Urolithiasis Using Deep Learning Reconstruction Algorithm: A Prospective Intra-Individual Study

Thursday, Dec. 5 10:30AM - 10:40AM Room: E353B

Participants
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PURPOSE

To assess the performance of ASIR-V and Deep learning reconstruction algorithm(DL) in patients with urolithiasis at ultralow-dose CT

METHOD AND MATERIALS

13 patients scheduled for unenhanced abdominal CT for follow-up of urolithiasis were prospectively included. Routine dose acquisition was followed by two low-dose acquisitions at 60% and 90% reduced doses. All images were reconstructed with FBP, ASIR-V and DL. Urolithiasis detection rates, gall bladder, appendix and rectosigmoid evaluation and overall subjective image quality were evaluated by two observers.

RESULTS

52 stones were present in 13 patients. 65% stones were not detected on FBP at the lowest dose level, but this improved with DL to a sensitivity of 100%. ASIR-V resulted in a slight decrease in sensitivity at the lowest dose to 82 %, but out performed FBP. Evaluation of other structures with ASIR-V at 60% and with DL at 90% dose reductions was comparable to FBP at routine dose, but 80% and 90% dose reduction resulted in non-evaluable images.

CONCLUSION

CT radiation dose for urolithiasis detection can be safely reduced by 60(ASIR-V)-90(DL)% without affecting assessment of urolithiasis, possible extra-urinary tract pathology or overall image quality.

CLINICAL RELEVANCE/APPLICATION

The most frequent cause of acute flank pain is urolithiasis, which affects 3-5% of the population.Technical advancements like iterative reconstruction (IR) algorithms have resulted in substantial radiation dose reduc- tions. IR results in reduced noise, allowing acquisition ofim- ages at reduced radiation dose levels without intrinsically hampering image quality.

SSQ19-02 Radiation Dose Reduction in Chest CT at a Micro-Dose (mD) Level by Noise Simulation and Noise-Specific Anatomic Neural Network Convolution (NNC) Deep-Learning (DL) with K-Means Clustering

Thursday, Dec. 5 10:40AM - 10:50AM Room: E353B

Participants
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PURPOSE

Radiation dose reduction in chest CT is highly demanded since current radiation dose is high for lung cancer screening. Our purpose was to develop new noise-specific 3D NNC DL experts by means of K-means clustering with mDCT simulation to convert mDCT to 'virtual' high-dose (HD) CT where noise and artifacts are significantly reduced.

METHOD AND MATERIALS

We developed a mixture of noise-specific, anatomical NNC experts, employing volume-based neural network regression in a convolutional manner, with soft-gating layers to convert mDCT to HD-like CT. We trained 9 noise-specific, anatomical NNC models for 3 noise-specific clusters in 3 anatomic areas by means of K-means clustering. We trained our NNCs with simulated mDCT as input and corresponding HDCT (120 kVp, 92 mAs, 3.0 mSv) from our diagnostic CT database as 'teaching' images. Our mDCT simulation consisted of forward-projection of HDCT, addition of photons and electric noise to sinogram images, filtered back-projection of the noise component, and addition of the noise image to the original HDCT. Through training, our noise-specific, anatomical NNCs learned to convert lower-dose CT to HD-like CT, where noise and artifacts are substantially reduced; thus, termed 'virtual' HD (VHD) CT. To evaluate the performance, we collected mD (120 kVp, 5 mAs, 0.2 mSv) and full-dose (120 kVp, 50 mAs, 2.0 mSv) CT (Aquilion One, Toshiba, Japan) of 50 clinical cases including 30 cases with solid nodule and ground-glass (GG) nodule.

RESULTS

Our new VHD technology with clustering converted mDCT to 'virtual' HDCT and improved the image quality by reducing noise and artifacts substantially, while anatomic structures and pathological characteristics of both solid and GG nodules were well preserved. With our NNCs trained with simulated mDCT, contrast-to-noise-ratio (CNR) of mDCT of clinical cases was improved from 4.1±3.9 dB to 22.9±3.4 dB, which was also higher than that of 'reference-standard' full-dose CT (CNR: 13.4±5.1 dB).

CONCLUSION

Our noise-specific anatomical NNC models trained with simulated mDCT images was able to convert thin-slice mDCT of clinical cases to VHDCT that have higher image quality (in terms of CNR) than 'reference-standard' full-dose CT, achieving 90% dose reduction.

CLINICAL RELEVANCE/APPLICATION

Substantial reduction of radiation dose in CT by our new noise-specific VHD technology would potentially make mDCT screening possible, and it would be beneficial to screening population.

SSQ19-03 A Deep-Learning-Based Framework for Synthesizing Virtual CT Exams in the Image Domain

Thursday, Dec. 5 10:50AM - 11:00AM Room: E353B

Participants
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PURPOSE

To develop a deep convolutional-neural-network (CNN) based framework to synthesize virtual patient CT exams having varying lesion characteristics and simulating varying radiation dose levels.

METHOD AND MATERIALS

The developed framework consists of a lesion-insertion CNN (CNNLesion) and a noise-insertion CNN (CNNNoise). Both CNNs were implemented with in-house-developed network architectures. CNNLesion inserts lesions into different locations of patient images by fusing multi-scaled features of patient lesion models with anatomical background. A cohort of lesion-free abdominal CT patient cases (n=10) was used to generate training data and validate CNNLesion. A previously-validated projection-based lesion insertion technique was used to generate reference images across 10 conditions: lesion sizes 5 - 11 mm, contrast levels 15 - 25 HU, and reconstruction types (filtered-backprojection and iterative reconstruction). CNNNoise used routine dose CT images and white noise as inputs to synthesize image noise magnitude and texture at lower dose levels. The architecture of CNNNoise approximates the underlying noise correlation in CT images. The loss function of CNNNoise consisted of a perceptual loss, a frequency-spectrum loss, and a diversity loss. Patient cases from the NIBIB/AAPM Low Dose CT Grand Challenge and water phantom scans were used to train and validate CNNNoise.

RESULTS

The CNNLesion-synthesized lesion-present images showed strong perceptual similarity compared to the reference images. The mean structural similarity index and the mean absolute CT number difference between the CNNLesion-inserted lesions and the reference were 0.983±0.004 and 1.9±0.3 HU, respectively. The CNNNoise-synthesized low-dose images had comparable noise texture to that of the reference images. The mean absolute percent difference of noise measured in the liver parenchyma was <3%. The noise power spectra measured from CNNNoise-synthesized water phantom scans were very close to those from real scans (mean absolute difference < 1.1 HU2cm2).

CONCLUSION

The developed deep CNN-based framework accurately and efficiently synthesized virtual patient CT exams with prescribed lesion characteristics and radiation dose levels.

CLINICAL RELEVANCE/APPLICATION

The developed CNN-based method can accurately and efficiently create patient cases with known pathology and dose to perform virtual clinical trials in CT for radiation dose and protocol optimization.

SSQ19-04 Nonlinear Analysis of Machine Learning in CT Image Formation

Thursday, Dec. 5 11:00AM - 11:10AM Room: E353B

Participants
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PURPOSE

The proliferation of nonlinear machine learning algorithms poses significant challenges to image quality assessment. Performance characterization typically relies on qualitative 'beauty contests' or metrics like resolution and structural similarity which may not relate to diagnostic outcome. We propose a quantitative image quality metric for nonlinear algorithm analysis and present example applications in a neural network denoising algorithm in low dose CT imaging of the lung.

METHOD AND MATERIALS

We propose perturbation response analysis as a quantitative measure of image quality suitable for general nonlinear algorithms. Perturbation response is defined as the difference in the mean output between an image with a stimulus and an image without. Such analysis captures the various dependencies of the algorithms, including that on the stimulus itself. We performed the analysis for an example denoising algorithm based on a convolutional neural network. For stimuli inputs, we developed procedurally generated lesions to systematically sample ranges of clinically relevant features, including size, contrast, and speculation characteristics. The lesions were inserted into the projection data and propagated through the imaging chain.

RESULTS

The perturbation response for FBP reconstruction exhibits linear behavior. The denoising algorithm is effective in reducing noise in the image. However, perturbation response analysis reveals highly nonlinear behavior on the lesion stimuli. Spherical lesions of lower contrast may disappear completely (for contrast at ~0.001 mm-1) or appear at the right contrast but smaller in size (for contrast at ~0.005 mm-1). Lesions with thinner and shorter spiculations can appear with smooth boundaries. These results allow quantitative characterization that identify the range of lesion features that cannot be admitted or faithfully represented by the algorithm.

CONCLUSION

We applied perturbation response analysis in identifying the performance limits of an algorithm in terms of lesion contrast, size, and spiculation. This work provides a quantitative method for characterizing the performance of nonlinear algorithms in relation to clinically relevant features.

CLINICAL RELEVANCE/APPLICATION

This work provides an image quality analysis method that is generally applicable to nonlinear image processing. The analysis allows quantitative image quality assessment and can be used to guide algorithm development.

SSQ19-05 Quantitative Comparison of a Deep Learning-Based CT Reconstruction Algorithm (AiCE) to Other Reconstruction Techniques

Thursday, Dec. 5 11:10AM - 11:20AM Room: E353B

Participants
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PURPOSE

To compare, in pediatric patients, a deep learning-based (DL) CT reconstruction algorithm (AiCE) to filtered back projection (FBP), statistical-based (AIDR3D), and model-based iterative (FIRST) reconstruction algorithms at different contrast levels and object sizes using quantitative image analysis.

METHOD AND MATERIALS

Patient raw image data acquired on a Genesis CT scanner (Canon Medical Systems) were reconstructed axially using FBP, AIDR3D, FIRST, and AiCE at 0.5mm and 3mm thicknesses. AiCE used a Deep Convolutional Neural Network (DCNN) in the regularization term of its iterative reconstruction algorithm. The DCNN was trained to differentiate signal from noise to reduce noise in the image. A non-prewhitening matched observer model with eye filter (d'NPWE) was used to characterize the signal-to-noise ratio (SNR) of objects of varying sizes (1-10mm) at three different CT contrast levels (-100, 100, & 350HU). To calculate d'NPWE, a Task Transfer Function for each reconstruction algorithm and contrast level was calculated using a water phantom with sensitometry inserts. A power spectrum was calculated by sampling noise characteristics from uniform regions of the patients' liver parenchyma.

Object signal differentiation due to reconstruction algorithm was estimated by calculating the area under the curve (AUC). AUC results for FBP, FIRST, and AiCE were normalized to AIDR3D, the routinely clinically employed reconstruction algorithm for this scanner.

RESULTS

Power spectrum magnitude for 3mm AiCE images were an average 58% lower (range: 45-70%) than 3mm AIDR3D images. Power spectrum frequency content of AiCE agrees to better than 28% with AIDR3D compared to 50% for FIRST. On average, AiCE 3mm images demonstrated greater distinction for all object sizes and contrast levels than all other algorithms. AiCE 0.5mm SNR agreed with 3mm AIDR3D to better than 0.4%.

CONCLUSION

Analysis demonstrates substantial improvement of object signal detection and noise magnitude using DL CT reconstruction (AiCE) leading to less noisy images with noise texture comparable with AIDR3D. Noise magnitude of AiCE 0.5mm images is comparable to AIDR 3mm images showing substantial dose reduction potential of AiCE.

CLINICAL RELEVANCE/APPLICATION

Deep learning-based CT reconstruction (AiCE) improves image signal detection of objects down to 1 mm in diameter at all contrast levels with the potential to substantially reduce dose without compromising image quality.

SSQ19-06 The Image Quality of the Newest Deep Learning Image Reconstruction on Chest CT

Thursday, Dec. 5 11:20AM - 11:30AM Room: E353B

Participants
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PURPOSE

To assess the image quality of the newest deep learning image reconstruction (DLIR) on chest CT in comparison with filtered back projection (FBP) and iterative reconstruction (IR).

METHOD AND MATERIALS

Thirty-six patients were evaluated retrospectively. All patients underwent routine contrast enhanced CTs (Revolution CT, GE Healthcare, WI) and images with 0.625-mm slice thickness were reconstructed using FBP, hybrid IR (ASiR-V), and DLIR (Truefidelity, GE Healthcare). The three settings of DLIR (low, medium, and high) and ASiR-V 60% were used. Regions of interest were placed at the axillary fat and the pectoralis major muscle, and the standard deviation (SD), the signal-to-noise ratio (SNR), and the contrast-to-noise ratio (CNR) were calculated objectively on the five image sets (FBP, ASiR-V, DLIR-low, DLIR-med, and DLIR-high). Two independent radiologists evaluated ASiR-V, DLIR-low, DLIR-med, and DLIR-high comparing with FBP on a 5-point scale (1=worst<2<3<4<5=best) in terms of noise, streak artifact, the visibility of lymph nodes, the clarity of small vessels in the chest wall, and overall image quality on mediastinum window setting (width 400 HU; level 60 HU). The objective parameters were analyzed statistically using one-way repeated measures ANOVA and the post hoc Tukey-Kramer test. The subjective scores were analyzed using the Wilcoxon signed-rank test with the Bonferroni correction.

RESULTS

DLIR-high significantly showed the least SD and the largest SNR and CNR among the reconstructions ($p<0.001$). The higher the DLIR setting, the lower the SD and the higher the SNR and CNR ($p < 0.01$). In the subjective analysis, DLIR-high showed the best score in terms of noise, streak artifact, and overall image quality among the reconstructions (significant in both readers' result: $p < 0.001$). The scores of DLIR-med and DLIR-high tended to be better in terms of lymph nodes and poor in terms of small vessels compared with ASiR-V (significant in 1 reader's result: $p <= 0.005$).

CONCLUSION

DLIR-high improved the objective parameters and the subjective image quality compared with ASiR-V by reducing noise and streak artifact on chest CT.

CLINICAL RELEVANCE/APPLICATION

With improved image quality, the DLIR may contribute to the diagnosis and the clinical practice on the chest CT.

SSQ19-07 Quantitative Comparison of Noise Texture between CT Images Reconstructed Using Filtered Back-Projection (FBP), Iterative Reconstruction, and Deep Learning Techniques

Thursday, Dec. 5 11:30AM - 11:40AM Room: E353B

Participants
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PURPOSE

To quantitatively compare noise texture via noise power spectra of computed tomography (CT) images reconstructed using filtered back-projection (FBP), iterative reconstruction (ASiR-V), and TrueFidelity (TF) deep learning image reconstruction (DLIR) at different dose levels.

METHOD AND MATERIALS

To measure the noise texture across image reconstruction algorithms, we calculated the normalized noise power spectra (nNPS) of uniform phantom images acquired at six dose levels (CTDIvol 2.5, 4.9, 7.4, 10.2, 12.6, 15.1mGy), and reconstructed using FBP, iterative reconstruction (ASiR-V, 100%), and deep learning (TrueFidelity DLIR, high). A 20cm water phantom was scanned on Revolution CT (GE Healthcare, five scans per condition), and images were reconstructed using the three algorithms above. From each scan, the difference-image was calculated between two 2.5mm-thick slices 2.5mm above and below the axial center. Then, the 2D NPS of the difference image was calculated, normalized to its own area, and radially averaged to yield the final 1-D normalized NPS (nNPS). To compare the nNPS, the average frequencies fa were calculated as first-order moments of nNPS normalized by the area under the curves. In addition, the root-mean squared of nNPS difference (RMSD) between nNPS of ASiR-V/TF and the corresponding nNPS of FBP was calculated.

RESULTS

nNPS of Images reconstructed with TF DLIR and FBP show a close match, with a slight shift towards lower frequencies occurring in TF images at CTDIvol of 2.5mGy. For all dose levels studied, fa of TF images was only 0.20 +/- 0.08lp/cm below that of FBP (a 6% difference), while fa of ASiR-V was 1.37+/- 0.01lp/cm below FBP (42% difference). RMSD_TF was 0.10+/-0.04mm2 and RMSD_ASiR-V was 1.14+/-0.01mm2.

CONCLUSION

Consistent with previous reports, normalized NPS of ASiR-V images is shifted towards lower spatial frequencies. The normalized NPS of TrueFidelity DLIR closely matches that of traditional high dose FBP images across a wide range of dose levels as quantified via RMSD and average frequency.

CLINICAL RELEVANCE/APPLICATION

Without the typical compromises in image texture occasioned by iterative methods even when the dose is reduced, deep learning image reconstruction (TrueFidelity, GE Healthcare) should help accelerate the adoption of low dose techniques into routine clinical practice.

SSQ19-08 Deep Learning-Based Metal Artifact Reduction in CT for Total Knee Arthroplasty

Thursday, Dec. 5 11:40AM - 11:50AM Room: E353B

Participants
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PURPOSE

To investigate the metal artifact reduction (MAR) performance of deep learning (DL)-based MAR technique in the evaluation of postoperative CT of total knee arthroplasty (TKA) patients

METHOD AND MATERIALS

The training dataset consisted of 640 image pairs obtained from 10 lower extremity CT scans without a metal prosthesis. Each image pair consists of a metal artifact-free image with a virtual metal shape embedded in the original image and a metal artifact image simulated through sinogram handling. Our DL network is a convolutional neural network (CNN) with encoder-decoder structure and skip connections. The summation of MSE and SSIM losses were implemented for parameter updating. For the test dataset, we used 10 lower extremity CT examinations from 10 patients who had a previous history of TKA (7 patients with unilateral TKA; 3 patients with bilateral TKA), and a total of 13 knee joints were used for analysis. To evaluate the metal artifacts quantitatively, the area, mean attenuation, and artifact index (AI) within the dark streak artifacts were calculated in the original, O-MAR, and DL-MAR images. For qualitative analysis, images were rated with a 5-point Likert scale regarding the degree of overall metal artifacts, conspicuity of bone cortex and trabeculae, and assessment of soft tissue around the prosthesis. Continuous variables were compared between different MAR protocols using the repeated measures ANOVA and qualitative grading results were analyzed by using the Friedman test.

RESULTS

The O-MAR showed a 24% reduction in metal artifact area, while the DL-MAR showed an area reduction of more than 99%, almost completely eliminating the dark streak artifact. In terms of mean attenuation and AI, DL-MAR also showed better performance than O-MAR ($P < 0.001$). In qualitative analysis, DL-MAR showed significantly lower overall metal artifacts ($P = 0.008$) and better bone delineation ($P = 0.020$) compared to O-MAR. However, there was no significant difference in the assessment of soft tissue between two MAR protocols ($P = 0.054$), and DL-MAR showed unusual blurring of periarticular soft tissue.

CONCLUSION

The DL-MAR technique has been successfully developed and shown comparable performance with conventional projection

completion algorithm.

CLINICAL RELEVANCE/APPLICATION

The DL-MAR can effectively reduce severe metal artifacts caused by large TKA components, hence enabling its use in the diagnosis of postoperative complications of TKA.

SSQ19-09 Basic CT Physics Scaling Laws for Noise and CNR as a Function of Slice Thickness and Dose for a New Deep-Learning CT Image Reconstruction Method

Thursday, Dec. 5 11:50AM - 12:00PM Room: E353B

Participants
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PURPOSE

The relationships between noise, slice thickness, and dose in CT are well understood for filtered back projection. This work characterizes these relationships for an implementation of TrueFidelity, a new deep learning image reconstruction (DLIR) approach.

METHOD AND MATERIALS

We imaged an ACR phantom at 5 slice thicknesses: 0.625, 1.25, 2.5, 3.75, and 5 mm. We imaged at doses of 16, 8, and 4 mGy using 120 kV, 80 mm collimation, and 0.992:1 pitch. All measurements were repeated 5 times. Images were reconstructed using: filtered back projection (FBP), two levels of a statistical iterative reconstruction (ASiR-V), and three levels of a vendor's deep learning image reconstruction (DLIR) approach. The ASiR-V levels were chosen based on institution (20%) and vendor (50%) recommendations. We fit image noise and CNR as a function of dose and slice thickness. Confidence intervals for all fit parameters were determined.

RESULTS

FBP and ASIR-V 20%/50% had similar scaling exponents: for CNR as a function of slice thickness 0.47(0.43-0.51) and 0.46(0.43-0.50)/0.45(0.36-0.54) and for noise as a function of slice thickness -0.49(-0.50 -0.48) and -0.49(-0.52 -0.47)/-0.49(-0.59 -0.39) respectively. DLIR low/medium/high had exponents of 0.37(0.23-0.51)/0.37(0.20-0.53)/0.36(0.15-0.56) for CNR as a function of slice thickness and of -0.39(-0.51 -0.28)/-0.38(-0.51 -0.26)/-0.37(-0.51 -0.23) for noise as a function of slice thickness. For noise and CNR as a function of dose, all methods had similar scaling exponents across slice thickness. As a function of dose at 5 mm, the image noise exponents for FBP and ASIR-V 20%/50% were: -0.48(-0.66 -0.30) and -0.48(-0.65 -0.31)/-0.47(-0.65 -0.29). DLIR low/medium/high for noise as a function of dose at 5 mm had scaling exponents of -0.44(-0.72 -0.17)/-0.44(-0.88 0.00)/-0.42(-1.08 0.23).

CONCLUSION

The CNR and noise scaling laws for FBP were found to hold for all recon methods. TrueFidelity DLIR did tend to have smaller changes in CNR and noise as the slice thickness/dose was reduced. The performance of DLIR was predictable and better than FBP and ASiR-V at all slice thicknesses and doses.

CLINICAL RELEVANCE/APPLICATION

New deep-learning based CT reconstruction (TrueFidelity, GE Healthcare) follows the noise and CNR rules of FBP reconstruction. This new reconstruction approach can mitigate some of the noise penalty incurred by reducing slice thickness or dose.

SSQ20

Vascular/Interventional (Lymphatic, AVM, and Venous Interventional Radiology)

Thursday, Dec. 5 10:30AM - 12:00PM Room: S503AB

VA IR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Nikunj R. Chauhan, MD, Cleveland, OH (*Moderator*) Nothing to Disclose
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Sub-Events

SSQ20-01 Comparison of Indocyanine Green Lymphangiography and Magnetic Resonance Lymphangiography for Planning Lymphaticovenous Anastomoses

Thursday, Dec. 5 10:30AM - 10:40AM Room: S503AB

Participants
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PURPOSE

Lymphedema is a prevalent disease, often misdiagnosed, without a defined gold standard treatment. However supermicrosurgical lymphaticovenular anastomosis (LVA), where collecting lymphatic vessels are anastomosed to a cutaneous vein under surgical microscopy, is demonstrated a valid treatment alternative of lymphedema compared to compression treatment. The purpose of this study is to compare two dynamic imaging modalities employed to study the lymphatic system, Magnetic Resonance Lymphangiography (MRL) and Indocyanine Green Lymphangiography (IGL), evaluating their role for planning LVA treatment in patients with lymphedema.

METHOD AND MATERIALS

We conducted a retrospective study of 32 patients (26 women) with a mean age of 38 years (range 18-73) enrolled from January 2014 to December 2018; 20 out of 32 were affected by lower limb lymphedema with 6 cases of primary lymphedema; 84% of them have a disease stage >=II. All the patient underwent IGL and MRL, by injecting different contrast medium into interdigital web spaces, between 18 and 72 hours before LVA supermicrosurgical treatment. In each patient we rated the number of lymphatic vessels visualized, considering the region of forearm for the upper limb and the leg for the lower limb. Student's t-test was applied.

RESULTS

All patients completed both the diagnostic examinations without any significant complications. A statistically significant difference ($p<0.05$) was found between the number of lymphatic vessels identified on the leg/forearm (34 on IGL vs 70 on MRL and 82 on IGL vs 26 on MRL, considering affected and healthy limbs respectively). In particular dermal backflow in advanced lymphedema seems to hinder lymphatic vessels detection on IGL. Conversely, on healthy limbs, MRL hardly identify lymphatics, because of their fast lymphatic flow, that limited contrast medium detection by MR sequences.

CONCLUSION

Both MRL and IGL are dynamic diagnostic modalities that permit an effective evaluation of lymphatic vessels anatomical and functional status in extremities lymphedema. They may be considered complementary in the preoperative planning for identyfing suitable functional lymphatic vessels for LVA treatment.

CLINICAL RELEVANCE/APPLICATION

MRL and IGL are two complementary imaging modalities for the surgical planning of LVA treatment.

SSQ20-02 Ear Arteriovenous Malformation Management

Thursday, Dec. 5 10:40AM - 10:50AM Room: S503AB

Participants
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PURPOSE

To determine the efficacy of Ethanol Endovascular Repair of Ear Arteriovenous Malformation (AVMs).

METHOD AND MATERIALS

14 patients (9 female, 5 males; age range 6-39 years; mean age: 22 years) with ear AVMs presented for therapy. Two patients had failed prior embolizations (PVA/coils/nBCA/steroids) and 2 patients had other therapies (laser/excisions/grafting). All presented with a grossly enlarged painful ear, and 5 patients had intermittent bleeding. All patients underwent transcatheter and direct puncture ethanol treatments. (86 procedures).

RESULTS

All 14 patients were cured of their AVM at long-term follow-up (mean follow-up: 52 months). One patient had transient partial VII nerve palsy. Two patients had minor blisters and ear injuries that healed on the outer tragus. The longest follow-up demonstrating cure was 12 years.

CONCLUSION

Ethanol endovascular repair of Ear AVMs can achieve cures in this vexing lesion that previously was treated with resection of the ear and with high recurrence rates. This series documents long-term cures of AVMs of the ear and scalp that were not treatable by endovascular approaches as previously documented in the world's literature. Permanent treatment of the auricular AVMs is documented and no recurrence occurred in any patient. Only one article is published (group from Shanghai, China) emulating this technique.

CLINICAL RELEVANCE/APPLICATION

This series documents long-term cures of AVMs of the ear and scalp that were not treatable by endovascular approaches as previously documented in the world's literature.

SSQ20-03 An Alternative Method for Adrenal Venous Sampling in Cases in which Right Adrenal Vein Sampling is Difficult

Thursday, Dec. 5 10:50AM - 11:00AM Room: S503AB

Participants
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PURPOSE

Catheterization of the right adrenal vein (rt.AdV) to obtain blood samples can often be difficult, reducing the feasibility of adrenal venous sampling (AVS). The aim of present study was to investigate whether blood sampling from the IVC at its juncture with the rt.AdV can be an alternative method to sampling of blood directly from the rt.AdV.

METHOD AND MATERIALS

This study included 44 patients diagnosed with primary aldosteronism (PA) in whom AVS with adrenocorticotropic hormone (ACTH) was performed for a local diagnosis of the lesion, resulting in a diagnosis with idiopathic hyperaldosteronism (IHA) (n=24), and patients diagnosed with unilateral aldosterone-producing adenoma (APA) (n=20; rt.APA=8, lt.APA=12) who had improved PA postoperatively. In addition to regular blood sampling, blood was also sampled from the IVC at its confluence with the rt.AdV, as the substitute rt.AdV [S-rt.AdV]. The local diagnostic performance with the conventional lateralized index (LI) and the Modified LI ((Lt.AdV A/C ratio) / (S-rt.AdV A/C ratio)) using S-rt.AdV was compared to examine the utility of the Modified LI.

RESULTS

Both conventional LIs of rt.APA (23.3±25.8) and lt.APA (7.0±5.3) were significantly higher than that of IHA (1.8±2.5) ($p=0.003$ and $p<0.001$). Modified LI of rt. APA (0.4±0.4) were significantly lower than those of IHA (1.4±0.7) ($p<0.001$) and lt.APA (3.5±2.0) ($p<0.001$). Modified LI of lt.APA were significantly higher than those of IHA ($p<0.001$) and rt.APA ($p<0.001$). The results of ROC curve analysis for diagnostic performance of conventional LI was area under the curve (AUC) of 0.90 in unilateral APA, whereas modified LI was AUC of 0.92 in rt.APA and 0.81 in lt.APA. Sensitivity and specificity to diagnose unilateral APA using conventional LI were 95% and 83% in threshold value was set at 1.9, and to diagnose rt.APA and lt.APA using modified LI were 87% and 75%, and 94% and 94% in threshold values were set at 0.7 and 2.2 respectively.

CONCLUSION

Modified LI has the potential to be an alternative method for rt.AdV sampling in cases in which rt.AdV sampling is difficult. Modified LI is an extremely simple procedure, it might complement conventional AVS.

CLINICAL RELEVANCE/APPLICATION

Modified LI using blood sampled from the IVC at the juncture of the right adrenal vein, which can be done easily in such patients, is a potentially useful clinical method.

SSQ20-04 Participants

Abnormal Pulmonary Lymphatic Perfusion in Patients with Plastic Bronchitis and Non-Traumatic Chylothorax on Dynamic Contrast-Enhanced Magnetic Resonance Lymphangiography and Thoracic Duct Catheterization Suggesting a Common Etiology

Thursday, Dec. 5 11:00AM - 11:10AM Room: S503AB

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PURPOSE

To evaluate imaging findings of dynamic contrast-enhanced magnetic resonance lymphangiography (DCMRL) and thoracic duct catheterization (TDC) in patients with lymphatic plastic bronchitis and nontraumatic chylothorax.

METHOD AND MATERIALS

This is a retrospective review of 33 patients (M/F = 15/18, median age 59 years) who presented in our institution with plastic bronchitis (n=20) or nontraumatic chylothorax (n=13). DCMRL was performed following US-guided administration of gadolinium-based contrast material into the groin lymph nodes. Time resolved contrast-enhanced dynamic lymphangiography and post contrast steady state 3-D IR FLASH sequences were performed. Intranodal lymphangiography with oil based iodinated contrast and TDC were subsequently performed.

RESULTS

DCMRL demonstrated the thoracic duct (TD) and abnormal pulmonary lymphatic perfusion (APLP) in 19/20 plastic bronchitis patients. Corresponding findings were seen on TDC. In 1/20 patients with non-visualization of TD on DCMRL, TDC showed delayed filling of TD with APLP. DCMRL demonstrated the TD and APLP in 11/13 non-traumatic chylothorax patients. TDC showed corresponding findings in 11/13. In 1/13 patients, DCMRL demonstrated TD with no APLP, however, APLP was seen on TDC. In 1/13 patients, the TD was not seen on DCMRL but APLP was visualized on TDC.

CONCLUSION

Lymphatic imaging (DCMRL / TDC) demonstrated abnormal pulmonary lymphatic perfusion in all patients with plastic bronchitis and non-traumatic chylothorax. In both entities, imaging findings were strikingly similar suggesting a common etiology. We hypothesize that the clinical presentation depends on the proximity of abnormal lymphatic vessels to the pleural cavity, resulting in chylothorax; or bronchial surface, resulting in plastic bronchitis. DCMRL offers a sensitive, minimally invasive diagnostic alternative to TDC in demonstrating the TD and abnormal pulmonary lymphatic flow in the majority of cases. In cases with negative DCMRL, there was a slow progression of contrast from the inguinal area to the TD. Extension of DCMRL imaging duration in cases of TD non-visualization is suggested as a technical modification.

CLINICAL RELEVANCE/APPLICATION

Abnormal pulmonary lymphatic perfusion can result in severe morbidity and mortality. DCMRL provides a minimally-invasive dynamic evaluation of the lymphatic system that can further our understanding of the mechanism of pulmonary lymphatic perfusion syndromes

SSQ20-05 Investigation of Hepatic Venous Anatomy and Its Variations in Donors of Our Population Using 320 Slice Computed Tomography Before Live Donor Liver Transplantation

Thursday, Dec. 5 11:10AM - 11:20AM Room: S503AB

Participants
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PURPOSE

To delineate details of hepatic venous drainage with its variation and details of accessory hepatic veins in live donor liver transplant (LDLT) donors.

METHOD AND MATERIALS

After IRB approval a retrospective study was conducted, analyzing 106 potential liver donors from hospital database from January 2013 to December 2016. CT scans were obtained using Toshiba acquilon 320 slice CT scanner, transferred and reviewed on Vitrea Enterprise 7.7 by two radiologists. Quantitative assessment of hepatic veins was done in which mean caliber of hepatic veins, main venous drainage of segment IV, presence of accessory hepatic veins, their number and calibers, along with their distance from inferior vena cava (IVC) was assessed. Data analysis was done using SPSS version 21 and results were complied.

RESULTS

Out of 106 donors, conventional hepatic venous anatomy with three hepatic veins was seen in 99 subjects. 7 showed more than three main hepatic veins. Out of these 6 showed two left hepatic veins (LHV) and 1 showed a small right hepatic vein (RHV). Mean calibers of RHV, middle hepatic vein (MHV) and LHV were 14.5, 9.9 and 9.5 mm respectively. Classic segment IV drainage from both

MHV and LHV was in 79 donors (74.5%). Segment IV was mainly drained by MHV and LHV in 19 (17.9%) and in 8 (7.5%) it was mainly from LHV. 69 subjects had accessory hepatic veins with caliber of 5 mm or more. Out of these 36 cases (33.9%) had single accessory hepatic vein while 17 (16%) had two or more accessory hepatic veins. The results showed that caliber of RHV in donors having single accessory vein was larger than in those donors having two or more accessory hepatic veins, 9.57 mm +/- 1.87 vs 8.21 mm +/- 1.73, p =0.007.

CONCLUSION

Multidetector CT with image post processing, allows accurate identification of areas at risk for venous congestion and devascularization. Presence of accessory hepatic veins or variation in main hepatic veins may influence surgical planning with regard to the extent of hepatic resection or the need for vascular reconstruction including PTFE grafts, allowing surgeon to prepare well in time and anticipate the possible alterations in surgical management.

CLINICAL RELEVANCE/APPLICATION

Image aquisition on multidetector CT with post processing on Vitrea beautifully delineates hepatic venous anatomy in this pilot study which will provide a guideline to the radiologists and surgeons aspiring to start liver transplant program at their centers.

SSQ20-06 Pre-Interventional Determination of the Right Renal Vein to Right Adrenal Vein Distance Reduces Procedure Time and Contrast Agent Exposure during Adrenal Vein Sampling

Thursday, Dec. 5 11:20AM - 11:30AM Room: S503AB

Participants
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PURPOSE

To reduce procedure time and contrast agent exposure during adrenal vein sampling (AVS) by pre-interventional determination of the right renal vein (RRV) to right adrenal vein (RAV) distance.

METHOD AND MATERIALS

20 patients were included in this study undergoing AVS. The RRV-RAV-distance was determined for 10 patients (study group) in CT and MRI pre-interventionally. During AVS a radiopaque planning ruler was placed underneath each patient. The RRV was probed and delineated by injection of contrast agent. Probing of the RAV was then focused at the height of the pre-interventionally determined RRV-RAV-distance. The angiographically measured RRV-RAV-distance was then correlated with the cross-sectional-derived pre-interventional distances. Procedural parameters such as fluoroscopy time, contrast agent, cumulative air kerma (AK), and cumulative dose area product (DAP) were compared to a control group of 10 patients undergoing conventional AVS without pre-interventional measurement using two-tailed t-tests.

RESULTS

The angiographic RRV-RAV-distance of 4.2±0.7 cm (95%-CI: 3.7-4.8 cm) was 0.5±0.4 cm lower than cross-sectional-derived measurements of 4.7±0.8 cm (95%-CI: 4.2-4.9 cm) and showed a good correlation (r=0.852, 95%-CI: 0.4335-0.9683; p<0,01). Fluoroscopy time (48±19 vs. 22 ±11 min, p<0.001) and contrast agent (235±88 vs. 142 ±44 ml, p<0.001) of the study group were significantly decreased by 56% and 39%, respectively. Radiation doses of AK (1429±1683 vs. 960±843 mGy, p=0.44) and DAP (242±256 vs. 158±151 Gycm2, p=0.38) were decreased by 32% and 34%, however without reaching statistical significance.

CONCLUSION

Pre-interventional estimation of the RRV-RAV-distance reduces procedure time and contrast agent exposure during adrenal vein sampling.

CLINICAL RELEVANCE/APPLICATION

Pre-interventional planning before AVS does not only reduce radiation and contrast agent dose during intervention, it could also benefit younger colleagues in training complex angiographic interventions.

SSQ20-07 Diagnosis and Management of Thoracic and Shoulder Arteriovenous Malformations

Thursday, Dec. 5 11:30AM - 11:40AM Room: S503AB

Participants
Wayne F. Yakes, MD, Englewood, CO (*Presenter*) Nothing to Disclose

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PURPOSE

To determine the efficacy of Endovascular Repair of Thoracic and Shoulder Arteriovenous Malformations (AVMs). Previous reports have documented the utter futility of Onyx, Coils, and nBCA and amputation of the extremity was required.

METHOD AND MATERIALS

13 patients (9 female, 4 male) presented for repair of shoulder and thoracic AVMs. 3 patients had extension of AVM to the supraclavicular and axillary areas. 3 patients had multiple AVMs. 7 patients had previous failed therapies (embo: PVA/coils/gelfoam;

Onyx, nBCA; surgeries: excisions/arterial bypass Left subclavian Axillary, Brachial, and Radial). All patients underwent ethanol endovascular AVM repair; 4 patients had additional coil embolizations (132 treatments). Patient age range 18-76 years; mean age 36.

RESULTS

12 patients are cured at long-term arteriographic follow-up (follow-up 22 - 192 months; mean follow-up: 42 months). 1 patient with bilateral shoulder AVM and multiple other AVMs therapy is on-going. Complications include 2 patients with minor superficial blisters, 1 patient with transient left radial nerve injury with complete recovery and 1 patient with clot embolus to hand, Rx with urokinase w/distal 3rd phalanx removed. Thus, major complications were 2/132 procedures, 1 being transient. 1 patient at 27-year arteriographic follow-up remains cured.

CONCLUSION

A JVIR report of shoulder AVM endovascular repair documented total failure of the current approaches even when coupled with shoulder quadrant amputation whereby recurrence was universal. These authors stated that shoulder AVMs were not possible to treat. This report documents that cure of these difficult lesions is possible with ethanol endovascular approaches and direct puncture approaches. No other publications in the world literature documents cure of AVMs in this anatomy consistently. Long-term cures are noted with the use of ethanol, and ethanol and coils to successfully treat these complex, problematic lesions. A low major complication rate is noted. This patient series finally documents a curative procedure for this daunting lesion.

CLINICAL RELEVANCE/APPLICATION

Long-term cures are noted with the use of ethanol, and ethanol and coils to successfully treat these complex, problematic lesions. A low major complication rate is noted.

SSQ20-08 The Retrograde Vein Approach as a Curative Treatment Strategy for Yakes Type I, IIb AVMs, Type IIIa AVMs, and Type IIIb AVMs

Thursday, Dec. 5 11:40AM - 11:50AM Room: S503AB

Participants
Wayne F. Yakes, MD, Englewood, CO (*Presenter*) Nothing to Disclose

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PURPOSE

To evaluate the role of Retrograde Vein and Direct Puncture Retrograde Vein Endovascular Repair of Large Peripheral AVMs.

METHOD AND MATERIALS

Eighty-seven patients (45 males, 42 females; age: 14 - 72, mean age: 27 years) presented for repair of AVMs involving head and neck, shoulder, chest wall, intra-thoracic, abdominal, renal, pelvic, buttock, and extremities. Ethanol and ethanol/coils were the embolic agents used. Retrograde transvenous catheterizations and vein direct puncture retrograde vein approaches were used in all patients.

RESULTS

Eighty-five of 87 patients are cured at long-term follow-up (f/up: 14 months to 138 months; mean: 42 months) and 2 patients' therapy is on-going. Complications include 1 pelvic AVM post-Rx small bleed not requiring transfusion; 1 pelvic AVM coils eroded into bladder wall removed uneventfully via trans-urethra endoscopy; 2 infections treated with antibiotics; 2 patients' coils superficially eroded and uneventfully removed; and 1 patient subcutaneous hematoma removed (7/87 patients; 8% minor complications).

CONCLUSION

Retrograde vein and direct puncture vein access and embolization of AVMs in many anatomic locations have proven curative at long-term f/up of AVMs in multiple anatomic locations with a low complication rate. Reproducible and consistent results of this technique have been reported only in 3 publications in the world's literature: by Yakes (1990), Jackson (1996) and Cho (2008). In the Yakes AVM Classification System, these approaches can routinely effect AVM cures in Yakes Types I, IIa, IIIa, and IIIb.

CLINICAL RELEVANCE/APPLICATION

Retrograde vein and direct puncture vein access and embolization of AVMs in many anatomic locations have proven curative at long-term f/up of AVMs in multiple anatomic locations with a low complication rate.

SSQ20-09 Facilitating Successful Adrenal Venous Sampling with Pre-Procedural CT to Localize the Right Adrenal Vein and Intra-Procedural CT to Verify Correct Catheter Placement

Thursday, Dec. 5 11:50AM - 12:00PM Room: S503AB

Participants
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PURPOSE

Adrenal venous sampling (AVS) is associated with failure rates as high as 30-40% due to difficulties in cannulating the right adrenal vein (RAV). Our purpose was: (1) to evaluate the accuracy of pre-AVS computed tomography (CT) imaging to localize the RAV and (2) to assess whether intra-procedural CT imaging would improve success rates of RAV catheterization.

METHOD AND MATERIALS

A total of 100 AVS procedures on 85 patients with primary aldosteronism from 2000 to 2018, were included in this retrospective study. Successful cannulation of the RAV and left adrenal vein (LAV) was defined by a selectivity index > 3. Comparison of RAV location on pre-AVS CT and during AVS was performed if the RAV was identified on pre-AVS CT and RAV sampling during AVS yielded a SI > 3. Using the spine as a stationary reference, the location of the RAV was compared between the pre-AVS CT and fluoroscopic images acquired during AVS. AVS procedures were also classified according to whether intra-procedural CT (i.e. C-arm CT) was used and success rates of successful RAV cannulation were compared (Fisher's exact test).

RESULTS

Concomitant identification of the RAV on pre-AVS CT and successful RAV catheterization during AVS occurred in 48 (56.5%) of 85 patients. The RAV was located at the same spinal level in 20 patients (41.7%) and within two-thirds of a vertebral body level in 43 patients (89.6%). Intra-procedural CT was used in 39 of 100 procedures (Figure 1). Successful cannulation of the RAV occurred in 35 of 39 (89.7%) procedures in which intra-procedural CT was used compared to 39 of 61 (63.9%) procedures in which intra-procedural CT was not used (P=0.0047). A reformatted image (attached) obtained during an intra-procedural CT scan with the catheter tip in the RAV and contrast injected through the catheter demonstrates opacification of the right adrenal gland indicating successful RAV cannulation. Successful cannulation of the LAV occurred in 99 of 100 (99%) procedures, and intra-procedural CT was not used to delineate the location of the LAV.

CONCLUSION

Pre-AVS CT imaging can be used to predict the location of the RAV during AVS. Intra-procedural CT imaging during AVS significantly improves rates of successful RAV catheterization.

CLINICAL RELEVANCE/APPLICATION

Successful cannulation of the right adrenal vein can be improved with adjunctive use of intra-procedural CT imaging during adrenal venous sampling for diagnosis of primary hyperaldosteronism.

Printed on: 10/29/20

SST01

Breast Imaging (Interventional and Pathological Correlation)

Friday, Dec. 6 10:30AM - 12:00PM Room: E450A

BR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Colleen H. Neal, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose
Hiroyuki Abe, MD, Chicago, IL (*Moderator*) Nothing to Disclose

Sub-Events

SST01-01 Accuracy of MRI Biopsy in Diagnosing a Breast Cancer Pathologic Complete Response Following Neoadjuvant Chemotherapy

Friday, Dec. 6 10:30AM - 10:40AM Room: E450A

Participants
Elizabeth J. Sutton, MD, New York, NY (*Presenter*) Nothing to Disclose
Mahmoud A. El-Tamer, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Neoadjuvant chemotherapy (NAC) has changed the management of breast cancer. The best outcome post-NAC is a pathologic complete response (pCR). There remains no minimally-invasive approach with sufficient accuracy to diagnose a pCR so surgery remains the standard of care. The purpose of this proof-of-concept clinical trial is to evaluate the accuracy of MRI-biopsy in diagnosing a pCR post NAC compared to reference-standard breast surgery specimen.

METHOD AND MATERIALS

Between 2017-2019, our IRB approved this pilot study that accrued 15 women with biopsy-proven operable invasive breast cancer who met the following inclusion criteria: (a) standard-of-care NAC, (b) pre- and post-NAC MRI, (c) imaging complete response defined as no residual enhancement on post-NAC MRI and (d) planned definitive surgery at our institution. A post-NAC standard of care MRI-guided biopsy was performed of the 15 treated tumor beds without intravenous contrast. The primary endpoint is to estimate the negative predictive value (NPV) of MRI biopsy to reference-standard breast surgery specimen. In this context, NPV is defined as the number of true pCR (biopsy negative, i.e. no disease found on the percutaneous biopsy and pCR at surgery) divided by the number of all biopsy negatives. The positive predicitve value (PPV), sensitivity, and specificity of the biopsy were also calculated.

RESULTS

15 patients with an MR imaging complete response post-NAC underwent MRI biopsy. Reference standard surgical pathology demonstrated a pCR in 10/15 (67%) and no-pCR in 5/15 (33%). The accuracy of MRI biopsy was 14/15 (93%). MRI biopsy was false in 1/15 (7%). In this false negative case surgical pathology identified 0.2mm of invasive disease, a true positive (no-pCR). All no-pCR tumor beds demonstrated very small volume residual disease with the largest invasive cancer measuring 3mm. The statistical measurements of MRI-guided biopsy in diagnosing a pCR compared with the reference standard surgical pathology are: NPV 91%, PPV 100%, Sensitivity 80% and Specificity 100%.

CONCLUSION

The accuracy of MRI-guided biopsy in diagnosing a pCR post-NAC in this pilot study is very high when compared to reference standard surgical pathology, which supports the need for a larger study.

CLINICAL RELEVANCE/APPLICATION

MRI-guided biopsy is a promising minimally-invasive approach with accuracy in diagnosing a pCR post-NAC to potentially obviate surgery in this subset of patients.

SST01-02 Compliance and Utility of 6 Month Follow-Up MRI After a Benign Concordant MR Breast Biopsy

Friday, Dec. 6 10:40AM - 10:50AM Room: E450A

Participants
Shruthi Ram, MD, Providence, RI (*Presenter*) Nothing to Disclose
Helaina Regen-Tuero, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Grayson L. Baird, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
Ana P. Lourenco, MD, Foxboro, MA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the utility and compliance of 6 month follow up MRI following benign concordant MRI guided breast biopsy and investigate potential causes for noncompliance.

METHOD AND MATERIALS

IRB approved retrospective review of all benign concordant MRI biopsies from 1/1/2013 to 1/1/2018. Biopsy results with high risk lesions or malignancy were excluded. For each benign concordant MRI biopsy, the following was collected from the electronic medical record: patient age, pathology from MRI biopsy, any recommendation for 6 month follow up MRI, any documented communication to thereferring physician, available follow up imaging, repeat biopsies, subsequent malignancies, insurance type, and referring physician's institution and specialty.

RESULTS

There were 139 benign concordant MRI biopsies in 127 patients during the study period. Mean patient age was 47.6 years (range 25 to 73). Follow-up MRI was performed at 6 months in 31.5% (40/127) and at 12 months in 18.1% (23/127) (Table 1). A 6 month follow up MRI was recommended in 63/127 (49.6%). Of these, 33/63 (52.4%) had a 6 month follow up MRI. Communication of the 6 month follow up recommendation was documented in only 6/63 (9.5%). Most patients without subsequent MRI in our system (n=50) had follow-up benign mammography at a mean of 0.9 years following MRI biopsy (range 0.2 to 2.2 years). There were no repeat biopsies or subsequent malignancies at the site of benign MRI biopsy. No correlation was observed between likelihood of 6 month follow up MRI and patient insurance type, ordering provider specialty or institution.

CONCLUSION

When 6 month follow-up MRI was recommended following a benign concordant biopsy, compliance was 52.4%. Lack of communication of the recommendation between the radiologist and referring physician may at least partially explain the low compliance. There were no false negative biopsies identified in this study, raising questions about the utility and cost-effectiveness of routine 6 month follow-up MRI following benign concordant MRI biopsy.

CLINICAL RELEVANCE/APPLICATION

Careful assessment of each benign concordant MRI biopsy may be more appropriate than routine 6 month follow-up MRI recommendation.

SST01-03 The Feasibility of Breast Conservation Therapy in Multifocal/Multicentric Breast Cancer Using Multiple Radioactive Seeds: A Paradigm Shift

Friday, Dec. 6 10:50AM - 11:00AM Room: E450A

Participants
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PURPOSE

Our study aims to validate breast conservation therapy in multifocal/multicentric (MF/MC) breast cancer (BC) using multiple radioactive seeds for localization.

METHOD AND MATERIALS

We retrospectively reviewed all radioactive-seed-localized segmentectomies at our institution between January 1, 2014 and April 26, 2017, where two or more radioactive seeds were used in the same breast. Patients with benign breast disease, unifocal BC and noncontinguous multicentric BC were excluded. Patient's age, demographics, pathology, and imaging were reviewed. Pre-operative diagrams were provided denoting the number and location of radioactive seeds, which were then examined intraoperatively using handheld gamma probes prior to segmentectomy. Intraoperative margin assessment was performed for all cases, including whole specimen radiography and gross-sectioning. Positive or close margins were re-excised intraoperatively and examined by permanent pathology,

RESULTS

Ninety-two patients underwent breast conservation therapy for MF/MC BC, using two or more radioactive seeds for preoperative localization without technical problems. Mean patient age was 56.8 years (range 33-80), and 55% of patients received neoadjuvant chemotherapy. Forty-six percent of patients had invasive ductal carcinoma and ductal carcinoma in situ (DCIS), 30% invasive ductal carcinoma, 10% invasive lobular carcinoma, 9% DCIS, and 5% invasive mammary carcinoma. Forty-nine percent of patients underwent localization using three seeds, 45% with 2 seeds, and 6% with 4 or more seeds. The mean distance between seeds was 4.8 cm (range 1-10). Seventy-five percent (69/92) had negative final margins, 15% (14/92) close or 2 mm margins, and 10%

(9/92) positive margins. Of those with positive margins, 3 underwent margin re-excision, and 6 completion mastectomy. One patient with close margins underwent re-excision, while the remaining patients with close margins did not require repeat surgery and were treated with adjuvant radiation therapy.

CONCLUSION

Preoperative localization of MF/MC BC with multiple radioactive seeds can successfully achieve clear surgical margins in 75% of cases.

CLINICAL RELEVANCE/APPLICATION

Patients with MF/MC BC can achieve breast conserving surgery, instead of mastectomy, if meticulous preoperative localization is performed using multiple radioactive seeds.

SST01-05 Tomosynthesis-Guided Breast Biopsy versus Stereotactic Biopsy: What's So Different?

Friday, Dec. 6 11:10AM - 11:20AM Room: E450A

Participants
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PURPOSE

To compare biopsy outcomes from two years preceding and following implementation of digital breast tomosynthesis (DBT)-guided biopsy.

METHOD AND MATERIALS

IRB-approved, HIPAA compliant retrospective review of all vacuum-assisted core breast biopsy procedures using 2D stereotactic guidance from 2013-2015 and DBT-guided biopsy from 2015-2017. All screening and diagnostic mammography was performed with DBT during the study period. Patient demographics, biopsy target type, pathology from 9G vacuum assisted core biopsy, surgical excision pathology when available, breast density, and imaging follow-up results were recorded. Biopsy targets and radiology-pathology discordance rate were compared between the two groups. Generalized mixed modeling was used to examine pre/post DBT biopsy results using SAS 9.4.

RESULTS

There were 1405 breast biopsy procedures in 1313 patients; 643 using 2D stereotactic guidance (2013-2015) (median age 56) and 762 using 3D DBT guidance (2015-2017) (median age 58). Of the 2D group, 55.6% had dense breast tissue as compared with 57.5% in the DBT group. Calcifications were the most common biopsy target for both groups constituting 89.9% (578/643) of 2D biopsies and 71.1% (542/762) of DBT biopsies (p<.0001). For 2D biopsies, architectural distortion (AD) was the least common biopsy target at 2.0% (13/643) but increased to 17.7% (135/762) for the DBT group (p<.0001). Overall radial scars identified increased from 1.7% [1.0, 3.1] to 8.3% [6.5, 10.5] (p<.0001). The discordance rate increased from 1.4% [1.0, 2.7] to 4.5% [3.2, 6.2] following the implementation of DBT-guided biopsy (p=.0021). Of the 34 discordant DBT-guided biopsies, 30 of the biopsy targets were architectural distortions.

CONCLUSION

With the transition from 2D stereotactic biopsy to DBT biopsy, there was a significant increase in the number of architectural distortions targeted for biopsy, the number of radial scars identified, and the radiology-pathology discordance rate.

CLINICAL RELEVANCE/APPLICATION

While DBT biopsy has enabled the targeting of very subtle lesions such as architectural distortion, radiologists should be cognizant of the potential for radiology-pathology discordance.

SST01-06 Radial Scars in the Era of Digital Breast Tomosynthesis: What is the Rate of Upgrade to Malignancy?

Friday, Dec. 6 11:20AM - 11:30AM Room: E450A

Participants
Pamela Yan, Providence, RI (*Presenter*) Nothing to Disclose
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PURPOSE

To determine the rate of upgrade for radial scars (RS) diagnosed at core needle biopsy and to assess how the radiologist's recommendation for excision based on imaging features compares with excisional biopsy results.

METHOD AND MATERIALS

IRB approved, HIPAA compliant retrospective review of radiology and pathology databases at a tertiary breast center to identify all "radial scar" and "complex sclerosing lesions" between March 2012 and December 2017. During the study period, all mammography was performed with digital breast tomosynthesis. Patient demographics, initial imaging, needle and excisional biopsies, and follow-up

imaging data were collected. Upgrade to malignancy was defined as discovery of DCIS or invasive carcinoma at the same site as the RS upon surgical excision. Initial imaging leading to the discovery of the radial scar was reviewed by a fellowship trained breast radiologist. Based on the imaging findings, this radiologist recommended excisional biopsy or imaging follow-up for each case.

RESULTS

There were 146 biopsy-proven radial scars in 142 patients. Median patient age was 57 (range 26-87). Presenting imaging findings on mammography were mass 49 (34%), architectural distortion 40 (27%), calcifications 37 (25%), asymmetry 4 (3%); 5 (3%) mass on ultrasound; on MRI 7 (5%) mass and 4 (3%) non-mass enhancement. 117 (80%) demonstrated radial scar as the most ominous histological finding at that biopsy site (no atypia or cancer). The remaining 29 cases had associated atypia (n=15) or cancer (n=14) and were excluded. Of the 117 RS without associated atypia, 1 (0.8%) was upgraded to invasive ductal carcinoma at excision. Of these 117 RS without atypia, 72 were excised, 19 underwent benign imaging follow-up for a median of 3 years (range 1 to 5.5 years) and 16 were lost to follow-up. Based on initial imaging review, the radiologist recommended excision in 87%. No malignancy would have been missed if the remaining cases had not been excised.

CONCLUSION

Radial scars without atypia had an upgrade rate of 0.8% in this study. Radiologist assessment of imaging findings and recommendation for excision vs imaging follow-up would not have missed the one malignancy in this study.

CLINICAL RELEVANCE/APPLICATION

The very low upgrade rate of RS without atypia supports imaging follow-up rather than excision, which could reduce the number of benign surgeries patients undergo.

SST01-07 Evaluation of Pathological Results of Tomosynthesis Guided Vacuum Assisted Breast Biopsy

Friday, Dec. 6 11:30AM - 11:40AM Room: E450A

Participants
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PURPOSE

Digital breast tomosynthesis (DBT) guided vacuum assisted breast biopsy (TVAB) can target not only the calcified lesions detected on 2D mammogram but also non-calcified lesions only visualized on DBT. It is unknown if TVAB will result in more malignant or invasive cancer. In this study, we aimed to evaluate the pathological results of tomosynthesis guided vacuum assisted breast biopsy (TVAB) and compare to those of conventional stereotactic vacuum assisted biopsy (SVAB).

METHOD AND MATERIALS

All women who underwent TVAB (from May 2013 to April 2015) or SVAB (from June 2015 to May 2017) procedure were included in this retrospective study. Patients' demographics, lesion mammographic appearance, and biopsy pathologic results were compared between these two groups. The significance level was accepted as $p<0.05$.

RESULTS

389 patients with 410 lesions underwent SVAB and 540 patients with 579 lesions underwent TVAB. The mean ages in SVAB and TVAB groups are 55.9±10.3 and 57.9±10.5, respectively. TVAB is found to have a higher biopsy rate of non-calcified lesions than SVAB (26% vs 16%, $P < 0.05$). No statistically significant differences were found between the two groups with respect to histological results of lesions such as breast tissue, benign changes, high risk lesions, or malignant lesions ($p=0.161$). Similar high-risk lesion upgraded rate was also observed. Among the malignant lesions, the rate of ductal carcinoma in situ (DCIS) is high in both SVAB group (88.6%) and TVAB group (77.9%), but no difference in the rate between these two groups is identified either ($p=0.26$).

CONCLUSION

TVAB group can biopsy more non-calcified lesions compared to conventional SVAB because it can target not only the calcified lesions detected on 2D mammogram but also non-calcified lesions only visualized on DBT. However, no significant histological differences (malignant vs benign or DCIS vs invasive cancer) in the biopsied lesions were found in these two groups.

CLINICAL RELEVANCE/APPLICATION

With increasing utilization of digital breast tomosynthesis and DBT guided vacuum-assisted biopsy (TVAB) in clinical practice, understanding this new technology and predicting biopsy results are important for the radiologist.

SST01-08 Digital Breast Tomosynthesis (DBT)-Guided Vacuum-Assisted Biopsy (VAB) with Integrated Real-Time Radiography System (IRRS): Initial Single-Center Experience

Friday, Dec. 6 11:40AM - 11:50AM Room: E450A

Participants
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PURPOSE

We reviewed our experience with a DBT-guided VAB with IRRS to evaluate technical success, time for completing the procedure and added value of real-time specimen radiographs.

METHOD AND MATERIALS

The institutional review board approved this retrospective study and informed consent was waived. From January 2018 to October 2018 consecutive patients with suspicious mammographic calcifications (BI-RADS >=4) were referred to DBT-guided VAB with an IRRS (Brevera®, Hologic, Bedford, Mass). A 9-gauge VAB device was used and 12 specimens were always acquired in a clockwise manner; real time specimen radiography was measured for all biopsied lesions. 95% confidence interval (CI) and chi-squared statistics were used.

RESULTS

A total of 74 patients with median age of 51 years (range 38-82) with 74 suspicious lesions underwent DBT-guided VAB. Technical success was achieved in 74 of 74 lesions (100%, 95% CI 95%, 100%). The time to complete the procedure was 15.54 ± 8.47 min (mean ± standard deviation) including identification, targeting, sampling, and real-time specimen radiography. No major complications were observed. Pathology of specimens resulted into: 45 B2, 5 B3 and 24 B5 lesions. Only one B2 lesion was upgraded to high-grade DCIS at final pathology. While of 471 specimens with calcifications, 105 (22%) were found with cancer and 361 (78%) were cancer-free, of 417 specimens without calcifications 56 (13%) were found with cancer and 361 (87%) were cancer-free ($P < 0.001$).

CONCLUSION

DBT-guided VAB with IRRS using a 9-gauge needle allowed for a safe, rapid, and adequate sampling of lesions with mammographic suspicious calcifications. Even though a significant difference in cancer prevalence was observed between specimens with (22%) or without calcifications (13%), a strategy for reducing the number of samples based the IRRS result (presence or absence of calcifications) is not feasible due to the too overall high probability of non-cancer specimens (727/888, 82%, 95% CI 79%, 84%).

CLINICAL RELEVANCE/APPLICATION

The IRRS makes the operator more confident that the sample is adequate and may allow for sparing subsequent control mammogram after the procedure, with a better patient compliance. Nevertheless, an earlier completion of the procedure, reducing the number of samples, does not seem to be feasible.

SST01-09 Results of a Phase I, Prospective, Non-Randomized Study Evaluating a Magnetic Occult Lesion Localization Instrument (MOLLI) for Excision of Non-Palpable Breast Lesions

Friday, Dec. 6 11:50AM - 12:00PM Room: E450A

Participants
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Mia Skarpathiotakis, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose
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Nicole Look Hong, MD,MSc, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The purpose of this first-in-human study was to evaluate the clinical feasibility of using a Magnetic Occult Lesion Localization Instrument (MOLLI) for localizing non-palpable breast lesions.

METHOD AND MATERIALS

A pilot study of 20 women with non-palpable lesions visualized under ultrasound received a lumpectomy using the MOLLI guidance system at a single institution. Patients were co-localized with magnetic and radioactive markers up to 3 days before excision under ultrasound guidance by a dedicated breast radiologist . Both markers were localized intraoperatively using dedicated hand-held probes. The primary outcome was successful excision of the magnetic maker, confirmed both radiographically and pathologically. Demographic data, margin positivity, and re-excision rates are reported. Surgical oncologists, radiologists and pathology staff were surveyed for user satisfaction using 5-point Likert scale questionnaires.

RESULTS

Demographic data can be found in Table 1. *Post-Radiological Analysis*: Post-implant mammograms verified that 17/20 markers were placed directly in the lesion center and 20/20 had minimal to no migration. Radiologists reported that all marker implantations procedures were 'easy' or 'very easy' following a single training session. *Post-Surgical Analysis*: All MOLLI markers were removed with the specimen during surgical excision; no cases required final verification using the radioactive marker. Measurement of the distance of the MOLLI marker from anterior, posterior, superior, inferior, medial and lateral aspects of the excised tissue specimen agreed with radiological imaging estimates to within 2 mm. In all cases, surgeons ranked the MOLLI guidance system as 'very easy' for lesion localization. *Pathologic Analysis*: All patients had negative margins and did not require re-excision. All Anatomic Pathology staff ranked the MOLLI system as 'very easy' to use and localize markers.

CONCLUSION

The MOLLI guidance system is a reliable, accurate, and non-radioactive method for localization and excision of non-palpable breast lesions. Further clinical evaluation of the MOLLI system in comparative studies against current standards of care are required to demonstrate efficacy and patient-reported outcomes.

CLINICAL RELEVANCE/APPLICATION

MOLLI guided lumpectomy results in similar re-excision and margin positivity rates are radioactive-seed localization.

Printed on: 10/29/20

SST02

Chest (Artificial Intelligence - Machine Learning)

Friday, Dec. 6 10:30AM - 12:00PM Room: E451A

AI CH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SST02-01 Combining Effects of Advanced Image Processing for Automatic Disease Classification on Chest X-Rays by Ensembling and Deep Learning

Friday, Dec. 6 10:30AM - 10:40AM Room: E451A

Participants
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PURPOSE

This study investigates the effect of combining two different advanced image processing (AIP) techniques, initially developed for chest X-ray reading by radiologists, on the disease classification accuracy of a Convolutional Neural Network (CNN): Bone Suppression (BS) and Lung Field Cropping (LFC).

METHOD AND MATERIALS

Following early work in this domain, BS and LFC have a positive effect on chest disease classification by CNNs. In this study, we propose ensembling to combine the effects of multiple CNNs optimized for different image inputs - i.e. normal, BS, LFC and the combination of BS and LFC. Like a radiologist, the information of multiple input sources is combined in this way. We pretrain our CNN, optimized for X-ray analysis, on a large publicly available X-ray dataset (ChestX-ray14) and fine-tuned it afterwards on a new dataset. For evaluation and testing, two radiologists annotated the Indiana dataset (3125 DICOM images) with eight different classes: pleural effusion, infiltrate, congestion, atelectasis, pneumothorax, cardiomegaly, mass and foreign object.

RESULTS

In a five-fold cross-validation, we use ROC statistics to evaluate the effect of ensembling. To have a fair comparison, we compare our AIP ensemble against an ensemble build with four CNNs trained on normal images. Overall the AIP ensemble increased the average AUC significantly by 1.56 % (from 0.898±0.013 to 0.912±0.011). Furthermore, for selected classes - i.e. mass - a total of 0.068 (8.84 %) AUC increase was achieved.

CONCLUSION

We have presented a novel ensemble of advanced image processings to train a CNN. It outperforms a standard ensemble in 6 out of 8 classes and increased the average AUC. Leveraging the information of different advanced processed images help to increase the AUC significantly.

CLINICAL RELEVANCE/APPLICATION

Automatic disease classification on chest X-rays can be improved by applying different methods of advanced image preprocessing and not focusing on a single input source.

SST02-02 Performance of the Unsupervised Anomaly Detection with Generative Adversarial Networks in Disease Detection on Chest Radiograph

Friday, Dec. 6 10:40AM - 10:50AM Room: E451A

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PURPOSE

To compare the performance of disease detection on chest radiographs with that of unsupervised anomaly detection with generative adversarial networks (AnoGAN) model and that of preexisting supervised anomaly detection with convolutional neural net (CNN) model.

METHOD AND MATERIALS

Total of 100 chest radiographs were obtained from one hospital to validate the model. The 100 examinations were composed of 12 classes as follows: nodule (n=8), calcification (n=9), consolidation (n=6), interstitial opacity (n=9), atelectasis (n=9), mediastinal widening (n=6), pleural effusion (n=8), pneumothorax (n=9), rib fracture (n=10), pneumomediastinum (n=10), subcutaneous emphysema (n=6), and pneumoperitoneum (n=10). AnoGAN model and 6-class CNN system (6-class: normal, nodule, consolidation, interstitial opacity, pleural effusion, and pneumothorax) were used for disease detection of the images. For these 100 query images, AnoGAN model generated normal fake image most similar to that image and then detected disease by subtraction of two images. After the test set, one board certified cardiothoracic radiologist reviewed the images to evaluate the model performance.

RESULTS

Of 100 chest radiographs, 90 diseases were detected using AnoGAN model as follows: Nodule 100.0% (8/8), calcification 100.0% (9/9), consolidation 100.0% (6/6), interstitial opacity 100% (9/9), atelectasis 88.9% (8/9), mediastinal widening 83.3% (5/6), pleural effusion 87.5% (7/8), pneumothorax 100.0% (8/9), rib fracture 80.0% (8/10), pneumomediastinum 60.0% (6/10), subcutaneous emphysema 83.3% (5/6), and pneumoperitoneum 100.0% (10/10). The 6-class CAD system detected 37 of 40 diseases for trained classes (92.5%) whereas that detected only 14 of 60 disease for untrained classes (23.3%). Overall detection rate was higher in AnoGAN model than that of 6-class CAD system (90.0% vs. 51.0%, $p < 0.001$).

CONCLUSION

AnoGAN model can detect diseases on chest radiograph without training for each disease. We propose that AnoGAN model can overcome the limitation of current CAD system.

CLINICAL RELEVANCE/APPLICATION

Using AnoGAN model, disease detection of chest radiographs can be helpful for evaluation of chest radiograph.

SST02-03 Deep Learning-Based Automatic Classification of the Normal, Active Tuberculosis and Other Abnormal Patterns on Chest Radiographs

Friday, Dec. 6 10:50AM - 11:00AM Room: E451A

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PURPOSE

To develop a deep learning-based automatic algorithm for classifying active pulmonary tuberculosis (TB) from other pulmonary abnormalities and normal looking lung with chest radiographs (CR).

METHOD AND MATERIALS

We collected a total of 3804 CRs comprising 2414 normal CRs and 1390 abnormal CRs with active TB (n = 590) and other five abnormal patterns including nodule, consolidation, pleural effusion, pneumothorax, interstitial opacity (n = 800). All CRs were randomly split into three datasets; training dataset (n = 2027; 1000 normal and 1027 abnormal CRs), validation dataset (n = 352; 200 normal and 152 abnormal CRs), and test dataset (n = 1425; 1214 normal and 211 abnormal CRs). The algorithm was designed using densenet201, convolutional neural network (CNN) for classifying normal and abnormal CRs, and then using YOLOv2-densenet201 model deeply fine-tuned for the differentiation of active TB, other abnormal patterns and normal CRs from the classified abnormal CRs. Diagnostic performance including sensitivity, specificity and accuracy of the algorithm was investigated per-CR classification and for per-region of interest (ROI) detection. All CRs were annotated by 5 - 10 years experienced thoracic radiologists.

RESULTS

In the test dataset, the algorithm showed 98.18% accuracy in the classification of normal and abnormal CR. For differentiation of classified abnormal CRs to active TB, other abnormal patterns and normal CRs, the diagnostic

accuracies were 78.5% for per-CR and 82.7% for per-ROI. The overall accuracy of the algorithm was 95.61% for per-CR and 93.29% for per-ROI. Sensitivity and specificity of the algorithm for active TB were 79.73% and 96.96% for per-CR and 77.83% and 95.38 for per-ROI.

CONCLUSION

Deep learning with CNN demonstrated high diagnostic performance in the classifying normal, active TB and other abnormal patterns CRs.

CLINICAL RELEVANCE/APPLICATION

Deep learning with CNN can be useful in the screening of the active TB with CR, thereby improving diagnostic-flow efficacy.

SST02-04 Deep Neural Network to Determine the Activity of Pulmonary Tuberculosis on Chest Radiograph

Friday, Dec. 6 11:00AM - 11:10AM Room: E451A

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PURPOSE

Determining the activity of pulmonary tuberculosis on chest radiograph is difficult even for tuberculosis experts. We aimed to develop a deep neural network for determining the activity of pulmonary tuberculosis on chest radiographs.

METHOD AND MATERIALS

From January 2011 through December 2017, we retrospectively collected a total of 6,647 baseline and post-treatment chest radiographs in 2,052 adult patients with sputum smear- or culture-proven tuberculosis who were successfully treated from five tertiary or secondary hospitals. Baseline and post-treatment chest radiographs were labeled as active and inactive tuberculosis, respectively. A deep neural network was trained with those radiographs to output the percentage score regarding the activity of tuberculosis. The validation dataset consisted of a series of 619 monthly radiographs during the treatment from 46 patients with the same inclusion criteria in 2018. Baseline and post-treatment radiographs in the validation dataset were read by the network and by a pulmonologist and thoracic radiologist with 20 and 10 years of dedicated experience to tuberculosis regarding the activity of tuberculosis in a five-point scale. Receiver operating characteristic curves and areas under the curve (AUROC) were used to evaluate the performance. One-sample t test and linear regression analysis were used to analyze a tendency of tuberculosis activity score during anti-tuberculosis treatment.

RESULTS

The preliminary results showed that the AUROC of deep neural network was 0.80 (95% confidence interval [CI]: 0.71 ~ 0.89), which was comparable with thoracic radiologist (0.71 (95% CI: 0.60 ~ 0.82)) and pulmonologist (0.74 (95% CI: 0.64 ~ 0.84)). During the period of anti-tuberculosis treatment, Log odds of Tb activity score gradually decreased with mean decrease of 2.82 (95% CI: 1.55 - 4.09) at 2 months (P<.001) and 5.10 (95% CI: 2.28 - 7.91) at 6 months (P= .001).

CONCLUSION

The deep neural network could accurately determine the activity of tuberculosis on chest radiograph, and the network was comparable to tuberculosis experts.

CLINICAL RELEVANCE/APPLICATION

The deep neural network can be used to determine the activity of tuberculosis in settings with limited tuberculosis experts and to monitor the response of anti-tuberculosis treatment, potentially in patients with drug-resistant tuberculosis.

SST02-05 Development of a Deep Learning-Based Algorithm for Independent Detection of Chest Abnormalities on Chest Radiographs

Friday, Dec. 6 11:10AM - 11:20AM Room: E451A

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PURPOSE

To independently detect 10 abnormal radiologic findings commonly found in chest radiographs (Atelectasis, Calcification, Cardiomegaly, Consolidation, Fibrosis, Nodule, Mediastinal Widening, Pleural Effusion, Pneumoperitoneum, and Pneumothorax), we developed a deep learning based automatic detection (DLAD) algorithm and evaluated its performance with large-scale chest radiographs (CRs).

METHOD AND MATERIALS

We collected a total of 151228 CRs comprised of 79113 cases with abnormal findings (M:F=0.51:0.49; mean age=56.19±16.55). The dataset was made up of 12173 atelectasis, 1617 calcification, 4059 cardiomegaly, 7915 consolidation, 2473 fibrosis, 14422 nodule, 264 mediastinal widening, 11412 pleural effusion, 5304 pneumoperitoneum, 8286 pneumothorax, and 72115 normal cases. The dataset was randomly split into training (70353 normal, 73753 abnormal), validation (881 normal, 2680 abnormal) and test (881 normal, 2680 abnormal) sets. We developed a deep convolutional neural network with 34 layers and 16 residual connections, and it generates 10 separate 2D maps which indicate the location of each abnormality. The dataset was labeled by 18 radiologists and 16194 cases were further annotated to specify the locations of the findings. Each case in the test set has been annotated by 5 radiologists. The annotations used for the test set were taken by a majority vote. We verified the network's performance by measuring the area under the ROC curve (AUC) and jackknife alternative free-response receiver operating characteristics (JAFROC). AUC measures classification performance and JAFROC measures localization performance.

RESULTS

Our network's performance for combined abnormalities was calculated to be AUC: 0.958, JAFROC: 0.912. For the settings comparing each abnormality to the normal cases, the AUC and JAFROC were 0.983, 0.965 for atelectasis, 0.981, 0.966 for consolidation, 0.985, 0.954 for calcification, 0.984, 0.984 for cardiomegaly, 0.995, 0.988 for fibrosis, 0.971, 0.918 for nodule, 0.981, 0.978 for mediastinal widening, 0.997, 0.994 for pleural effusion, 0.999, 0.998 for pneumoperitoneum, and 0.997, 0.994 for pneumothorax.

CONCLUSION

DLAD can accurately detect and localize 10 abnormal findings in the CRs.

CLINICAL RELEVANCE/APPLICATION

Since DLAD can detect abnormal findings commonly found in CRs, it can help radiologists accurately interpret various abnormalities and may also be used to distinguish between normal and abnormal CRs.

SST02-06 Too-Sensitive Error Caused by Label Noises for Training Classification Network with Deep Convolutional Neural Net in Chest PA X-ray

Friday, Dec. 6 11:20AM - 11:30AM Room: E451A

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PURPOSE

Clean labels are considered as a vital condition in deep learning based classification. However, since labels of many large public dataset are preprocessed by natural language processing, they contain inaccurate, noisy labels to some extent. To evaluate robustness of classification network with deep-learning based chest X-ray(CXR) we measured deep convolutional neural network model by making labels inaccurate intentionally.

METHOD AND MATERIALS

CXR collected from two hospitals, which consisted of 10137 healthy subjects and 3244 patients and 1035 healthy subjects and 4404 patients with various kinds of diseases including nodule(ND), consolidation(CS), interstitial opacity(IO), pleural effusion(PE), and pneumothorax(PT), respectively. Every abnormal lesion was confirmed with its corresponding computed tomography(CT) image by expert thoracic radiologists with more than 10 years experiences. We split this dataset into two groups including normal and abnormal. Fine-tuned resnet-50 architecture for this classification with labels changed randomly at 0%, 1%, 2%, 4%, 8%, 16%, 32% rates were evaluated. Every training was done by 20 epochs and test set performances for every epoch were recorded. To assess the accuracies, we compared it with Receiver Operating Characteristic(ROC) curve and Area Under the Curve(AUC).

RESULTS

CXR classification model with noisy labels was not robust to any noise levels. Accuracies fall continuously when noises were given. ROCs were 0.94, 0.91, 0.90, 0.88, 0.86, 0.81, 0.78 at 0%, 1%, 2%, 4%, 8%, 16%, 32% rate, respectively which dropped linearly when semi-log scale plot was drawn.

CONCLUSION

As every CXR was confirmed with CT image by expert radiologists, our dataset was regarded as nearly absolute clean labels. In this study, the classification network was very sensitive to any degree of label noise rate. This implies that labels are needed as accurate as we can achieve.

CLINICAL RELEVANCE/APPLICATION

Developing algorithms for Computer-Aided Detection(CAD) of CXR diseases is challenging problem. Many newly

developed algorithms are based on large public datasets, which contain inaccurate labels. This study indicates algorithms based on noisy dataset cannot be valid models regardless of noise levels. Therefore CAD developers should contemplate using clean label datasets for lung nodule detection as well as other various diseases.

SST02-07 Deep Learning for Pulmonary Nodule Diagnosis on Computed Tomography: Comparison with 126 Physicians

Friday, Dec. 6 11:30AM - 11:40AM Room: E451A

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PURPOSE

To compare the diagnostic performance of a deep learning algorithm with a large panel of physicians for pulmonary nodules diagnosis at unenhanced CT.

METHOD AND MATERIALS

The deep learning algorithm was developed using 1186 pathologically confirmed pulmonary nodules found in local hospital between 2009 and 2018 and 620 nodules from National Lung Cancer Screening Trial (NLST). Internal (local set, n = 100, NLST set, n = 200) and external validation (multi-center set, n = 242) of the algorithm were performed. The performance of the algorithm was evaluated by using the area under the receiver operating characteristic curve (AUC), sensitivity and specificity. An observer performance test involving 126 board-certified physicians was conducted using local set. All physicians individually reviewed the nodules and scored them from 1-4. Spearman's correlation coefficient was used to calculate the consistency between the scores ranked by physicians and the algorithm. The nodules in the local set were further divided into easy-to-diagnose and hard-to-diagnose group according to the proportion of physicians who diagnosed it correctly. The performance of algorithm in the two groups was compared with that of the physicians.

RESULTS

The AUC of the algorithm was 0.968 and 0.855 on internal and external validation set, respectively. The mean AUC of results from 126 physicians (0.759 ± 0.080, $p < 0.001$) was outperformed by the algorithm (0.927) on local set. The scores rated by physicians were highly related with the algorithm ($r = 0.663$, $p < 0.001$). Taken an arbitrary of 80% as the threshold, the AUC of the algorithm were higher than that of the physicians both in the easy-to-diagnose group (0.9921 vs. 0.9108 ± 0.0854, $p < 0.001$) and hard-to-diagnose group (0.8541 vs. 0.6203 ± 0.0860, $p < 0.001$), respectively.

CONCLUSION

This deep learning-based diagnostic algorithm exhibited strong performance on internal and external validation and outperformed a large panel of physicians in pulmonary nodule classification.

CLINICAL RELEVANCE/APPLICATION

Deep learning exhibits great cognitive consistency with physicians in pulmonary nodule diagnosis and may have the potential for clinical applications.

SST02-08 Evaluation of Deep Learning-Based Automatic Classification of Pneumothorax on Frontal Chest X-Ray Images

Friday, Dec. 6 11:40AM - 11:50AM Room: E451A

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PURPOSE

To evaluate the performance of AI algorithms to automatically detect the presence of pneumothorax (PTX) on frontal chest x-ray images.

METHOD AND MATERIALS

A dataset of 808 adult frontal chest x-ray images was formed from an American (51%) and a Canadian hospital (49%) comprising of AP view/portable system (62%) and PA view / fixed system (38%). Images were generated systems manufactured by GE (67%), Phillips (32%), and Agfa (1%). Initially, ground truth for the presence, laterality, and size of a PTX was determined by two blinded radiologists, with a subsequent blinded arbitrator in cases of disagreement. Inferencing was then performed by two deep learning-based AI algorithms that were developed from independent datasets of over 44,000 images; a frontal chest x-ray classifier and a PTX classification algorithm - detecting the presence or absence of a PTX.

RESULTS

Radiologist's deemed PTX present as ground truth in 47% of the data set, with laterality of right for 53%, left for 44%, and bilateral for 3%. PTX size was determined to be small for 56%, large for 43%, and small + large for 1% in bilateral cases. The frontal chest x-ray classifier correctly identified 99.5% of the images as frontal chest, only the 804 images correctly identified as frontal chest were then subsequently inferenced by the PTX classifier. The PTX classifier had an AUC of 0.96 (0.95, 0.97) with AUC of 0.96 (0.95, 0.98) for AP and 0.96 (0.94, 0.98) for PA images. Balanced accuracy was achieved with overall sensitivity and specificity of 89% (82% sensitivity for small and 97% for large). Alternative ROC operating points offer high overall sensitivity performance of 94%, specificity of 80% (sensitivity of small and large PTX of 90% and 99% respectively), or high specificity with overall sensitivity of 84%, specificity of 93% (sensitivity of small and large PTX of 75% and 96% respectively).

CONCLUSION

Deep learning-based algorithms can effectively detect PTX in frontal x-ray images with high accuracy.

CLINICAL RELEVANCE/APPLICATION

A deep learning-based PTX algorithm could be an effective triaging tool for identifying exams that need a prioritized review, contributing towards improved workflow efficiency and patient outcomes.

SST02-09 Is the Juice Worth the Squeeze? Learning Curve of a Chest Radiograph Semantic Labeling DCNN versus Training Time

Friday, Dec. 6 11:50AM - 12:00PM Room: E451A

Participants
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PURPOSE

The purpose of this study was to determine the learning and training time curves of a DCNN trained to classify frontal chest radiographs (CXRs) into AP or PA views based on increasing dataset sizes.

METHOD AND MATERIALS

We obtained 112,120 CXRs from the NIH ChestX-ray14 database which contained 44,810 (40%) AP and 67,420 PA (60%) CXRs. We created datasets based on random selection, each balanced to have 50% AP and 50% PA CXRs which would gradually increase by a factor of 2; accordingly, the largest dataset we used was 89,620 CXRs with 11 other smaller datasets (Table 1). Each dataset was randomly split into training (70%), validation (10%), and test (20%) sets, which were used to train, validate, and test the ResNet-50 DCNN pretrained on ImageNet. During each training epoch, each image was augmented by a random rotation between -5 and 5 degrees, random cropping, and horizontal flipping. All DCNN development and testing was performed using PyTorch on a 2.5 GHz Intel Haswell dual socket (12-core processors) with 128 GB of RAM and 2 NVIDIA K80 GPUs. Receiver operating characteristic (ROC) curves with area under the curve (AUC) and total training time was plotted to dataset size with regression analysis performed.

RESULTS

DCNNs trained to classify AP vs. PA CXRs achieved high AUC of 0.88 with the smallest utilized sample size of 44 and reached a consistent plateau of AUC of 1 with 350 CXRs, with no improvement in performance thereafter (Table 1). Interestingly, there was a linear increase in training time required as dataset size increased; in fact, there was a linear relationship defined by the equation, $y = 1.1x - 286$ ($R^2=0.999$).

CONCLUSION

Semantic labeling of radiographs only require small datasets on the scale of hundreds to train a diagnostically-perfect DCNN. Accordingly, curating large datasets for these purposes is not worthwhile, especially given the increased training

time required for larger datasets. For the development of CXR-classification DCNNs, we propose that 350 CXRs is a reasonable starting point.

CLINICAL RELEVANCE/APPLICATION

Semantic labeling of radiographs only require small datasets on the scale of hundreds to train a diagnostically-perfect DCNN. Accordingly, curating large datasets for these purposes is not worthwhile, especially given the increased training time required for larger datasets.

Printed on: 10/29/20

SST03

Gastrointestinal (Advanced Ultrasound Techniques)

Friday, Dec. 6 10:30AM - 12:00PM Room: E352

GI US

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SST03-01 Non-Enhanced Magnetic Resonance Imaging versus Ultrasonography for Surveillance of Hepatocellular Carcinoma: Intraindividual Comparison in a Prospective Cohort

Friday, Dec. 6 10:30AM - 10:40AM Room: E352

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PURPOSE

We aimed to compare the performance of non-enhanced MRI and US as a surveillance tool for hepatocellular carcinoma (HCC) by making intraindividual comparisons in a prospective cohort at high risk of HCC.

METHOD AND MATERIALS

This prospective cohort included 382 patients with an estimated annual HCC risk > 5% who underwent paired gadoxetic acid-enhanced MRI and US between 2011 and 2013. Non-enhanced MRI consisted of diffusion-weighted images (DWI) (b = 0, 50, and 500 s/mm2) and T2-weighted images (T2WI), and was considered positive when a lesion >= 1 cm showed diffusion restriction or mild-moderate T2 hyperintensity on a retrospective analysis. On US, a discrete mass >= 1 cm or a suspicious tumor thrombus was regarded as positive. HCC was diagnosed pathologically and/or radiologically. Sensitivity and positive predictive value (PPV) obtained on a per-lesion and per-patient basis, and specificity and negative predictive value (NPV) obtained on a per-patient basis, were compared between modalities using generalized estimating equations, McNemar tests, and Fisher's exact tests, as appropriate.

RESULTS

Thirty-two HCCs were diagnosed in 28 patients. The per-lesion and per-patient sensitivities of non-enhanced MRI were 84.5% (27/32) and 85.7% (24/28), respectively, and were higher than those of US (34.6% [11/32] and 39.3% [11/28], respectively, P <= 0.001). PPVs were higher on non-enhanced MRI (65.9% [27/41] per-lesion and 64.9% [24/37] per-patient) than on US (32.4% [11/34] and 35.5% [11/31], P <= 0.028), while the specificity of non-enhanced MRI was not significantly different from that of US (96.3% [341/354] for non-enhanced MRI vs. 94.4% [334/354] for US, P = 0.377). The NPV of non-enhanced MRI (98.8% [341/345]) was higher than that of US (95.2% [334/351], P = 0.006).

CONCLUSION

Non-enhanced MRI consisting of DWI and T2WI showed better sensitivity, PPV, and NPV than US. Non-enhanced MRI is a promising option for HCC surveillance.

CLINICAL RELEVANCE/APPLICATION

In patients at high risk of HCC, non-enhanced MRI consisting of DWI and T2WI can be considered an alternative surveillance tool to US.

SST03-02 Comparison of Sound Touch Elastography (STE) and Shear Wave Elastography (SWE) Using Liver

Biopsy as Reference for Diagnosis of Chronic Liver Disease

Friday, Dec. 6 10:40AM - 10:50AM Room: E352

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PURPOSE

Chronic Liver Disease (CLD) is currently one of the major causes of death and the major cause of Hepatocellular Carcinoma development. Therefore, accurate diagnosis regarding CLD progress is very important. Although Liver Biopsy (LB) is considered as 'Gold Standard' for diagnosis, several non-invasive methods exist in order to avoid LB complications. Sound Touch Elastography (STE) that is available in Resona 7 Ultrasound (US) device and is similar to Shear Wave Elastography (SWE), seems promising but needs to be validated. The aim of this study is to compare the diagnostic performance between the STE and SWE for CLD assessment, using LB as "Gold Standard".

METHOD AND MATERIALS

290 subjects, 68 normal (F0) and 222 with CLD (F1-F4), were included in the study. a B-Mode and Elastographic examination was performed on each patient with Resona 7 and Aixplorer US devices. The STE (Resona 7) and SWE (Aixplorer) measurements were performed on the Right Lobe (RL) of each patient and were compared to LB results according to the Metavir Classification System (F0-F4). Receiver Operating Characteristic (ROC) analysis was then performed for each of the two methods to obtain best cut-off stiffness values.

RESULTS

ROC analysis showed AUCSTE=0.9741 and AUCSWE=0.9854 for F=F4 Cirrhosis, AUCSTE=0.9723 and AUCSWE=0.9755 for F>=F3 Fibrosis Stage, AUCSTE=0.9675 and AUCSWE=0.9662 for F>=F2 Fibrosis Stage, AUCSTE=0.8889 and AUCSWE=0.9288 for F>=F1 Fibrosis Stage. Best cut-off stiffness values were calculated for each method (STE/SWE) compared to Metavir fibrosis stages: F=F4: 12.2/13.5 kPa, F>=F3: 9.5/8.7 kPa, F>=F2: 9.15/8.55 kPa, F>=F1: 6.5/6.05 kPa respectively.

CONCLUSION

Both STE and SWE can differentiate between the 5 Metavir fibrosis stages. SWE seems more reliable in differentiating normal subjects from subjects with CLD (F>=F1) and Cirrhotic patients (F=F4) but less accurate in diagnosing intermediate stages (F>=F2, F>=F3).

CLINICAL RELEVANCE/APPLICATION

Many Elastography technologies emerged with liver in focus. Comparison between them is useful in order to make Elastography reliably applicable to patients regardless of the underlying technology.

SST03-03 ACR US LI-RADS: Outcomes of Category US-2 Observations

Friday, Dec. 6 10:50AM - 11:00AM Room: E352

Participants
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PURPOSE

To evaluate the outcomes of ACR US LI-RADS Category 2 (US-2) observations detected at ultrasound performed for hepatocellular carcinoma (HCC) screening and surveillance.

METHOD AND MATERIALS

In this retrospective, single center study, 138 patients at high risk for HCC (77 men and 61 women; mean age 58.7 years) underwent screening liver ultrasound between January 2017 and December 2018 and were assigned US-2 observations on a prospective clinical basis. Results of follow-up imaging studies and/or histopathology were recorded. Statistical analysis was performed.

RESULTS

The most common indications for HCC screening were cirrhosis (111/138, 80%), chronic hepatitis B virus without cirrhosis (15/138, 11%), and chronic hepatitis C virus without cirrhosis (7/138, 5%). Reasons for US-2 observations were a measureable mass (116/138, 84%; mean size 0.7 ± 0.2 cm; range 0.3-0.9 cm) and a subcentimeter area of parenchymal heterogeneity (22/138,

16%). 72% (99/138) of patients had imaging follow-up and management was discordant with US LI-RADS recommendations in 56% (55/99) of these patients. Confirmatory tests including multiphase contrast-enhanced CT or MRI (61/80), histopathology (6/80), or negative ultrasound follow-up for at least 1 year (13/80) were available for 59% (80/138) of patients. Etiologies of US-2 observations in the subset of 67 patients with CT, MRI, or histopathology included no mass/benign tissue (48/67, 72%), hemangioma (5/67, 7.5%), regenerative nodule (5/67, 7.5%), cyst (3/67, 4%), HCC (2/67, 3%), granuloma (2/67, 3%), LR-3 observation (1/67, 1.5%), and focal steatosis (1/67, 1.5%). Positive predictive value of a US-2 observation for HCC was 2.5%.

CONCLUSION

The positive predictive value of a US-2 (subcentimeter) observation for the detection of HCC is very low. As per US LI-RADS guidelines, US-2 observations can be safely followed with ultrasound rather than escalating workup to contrast-enhanced imaging.

CLINICAL RELEVANCE/APPLICATION

The vast majority of US LI-RADS Category 2 (US-2) observations are benign and can be safely followed with ultrasound.

SST03-04 Subharmonic Aided Pressure Estimation (SHAPE) for Long-Term Follow up of Patients with Portal Hypertension

Friday, Dec. 6 11:00AM - 11:10AM Room: E352

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PURPOSE

To verify if noninvasive contrast-enhanced ultrasound (US) in the form of subharmonic aided pressure estimation (SHAPE) can accurately monitor disease progression or treatment response in patients identified with portal hypertension.

METHOD AND MATERIALS

SHAPE is based on the inverse relationship between the subharmonic amplitude of US contrast microbubbles and ambient pressure. A modified Logiq 9 scanner with a 4C curvi-linear probe (GE, Waukesha, WI) was used to acquire SHAPE data (transmitting/receiving at 2.5/1.25MHz) using Sonazoid (GE Healthcare, Oslo, Norway; IND 124,465). This IRB approved study has enrolled 177 subjects undergoing a transjugular liver biopsy, 22 patients have been identified with clinically significant portal hypertension (median age 59 yrs; 13 Males) based on their HVPG results. These subjects had follow-up clinic visits or CT/MRI scans every 6 months and at those times a repeat SHAPE examination was performed collecting data from the portal and hepatic vein in triplicate. The SHAPE gradient was calculated as the difference between subharmonic signals in the two vessels. Liver function tests (albumin, bilirubin and coagulation panel), MELD scores and presence of ascites and varices were used to establish clinical treatment response.

RESULTS

Of the 22 portal hypertensive cases, 1 patient has had four follow up scans, 1 has had three follow up scans, 3 have had two follow up scans, 7 have had one follow up, 7 have not had any follow up yet and 3 were lost due to death or refusal to follow up. There was a significantly higher signal reduction in the group who were classified as responders according to the SHAPE study compared to the SHAPE non-responders ($p < 0.001$). The mean change in the SHAPE gradient for the responders ($n = 9$) was -4.70 ±3.27 dB vs 1.77±0.55 dB in the SHAPE non-responders ($n = 3$). Results matched the corresponding clinical outcomes of improved MELD scores, improvement in underlying cause of portal hypertension, decreased bilirubin and reduced ascites indicating a reduction in portal hypertension amongst responders.

CONCLUSION

SHAPE can noninvasively monitor disease progression in portal hypertensive patients and hence, may help clinicians in patient management.

CLINICAL RELEVANCE/APPLICATION

Serial SHAPE can be a cost-effective and noninvasive technique to differentiate between portal hypertension treatment responders and non-responders and reduce the need for repeat catheterizations.

SST03-05 Inter-System Agreement and Repeatability of Two-Dimensional Shear Wave Elastography Measurements in Elastic Phantoms and In Vivo Human Livers Across Six Commercially-Available Ultrasound Systems

Friday, Dec. 6 11:10AM - 11:20AM Room: E352

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PURPOSE

To determine inter-system agreement and repeatability of two-dimensional (2D) shear wave elastography (SWE) shear wave speed (SWS) measurements in elastic phantoms and in vivo human livers across six ultrasound systems.

METHOD AND MATERIALS

This HIPAA-compliant study was institutional review board-approved; informed consent was obtained. Serial 2D SWE exams were performed using six commercially-available ultrasound systems (Aplio i800, Canon Medical Systems; LOGIQ E10, GE Healthcare; Resona 7, Mindray North America; EPIQ Elite, Philips Healthcare; ACUSON Sequoia, Siemens Medical Solutions; Aixplorer MACH 30, SuperSonic Imagine). Exams were performed on four elastic phantoms (Model 039, Shear Wave Liver Fibrosis Phantoms; CIRS, Inc., SWS range:0.82-3.51 m/s) by two operators (20 measurements/operator, 1 cm circular region-of-interest [ROI], 4 cm depth) and on 24 fasting adults (14 healthy volunteers, 10 with known liver stiffening) by one operator/system (2 non-sequential exams/system, 10 measurements/exam, 1 measurement/breath-hold, 1 cm circular ROI in right hepatic lobe, 1.5-5 cm deep to capsule). Intra-class correlation coefficients (ICC) were calculated to assess inter-system and test-retest agreement. Interquartile range (IQR)/median and coefficient of variation (COV) values were used to assess patient-level variance.

RESULTS

ICCs for overall inter-system agreement of SWS were 0.99 (95% CI:0.96-1.0) in phantoms and 0.66 (95% CI:0.47-0.81) in humans (Figure). Pairwise ICCs for inter-system agreement in participants across two systems ranged from 0.41 to 0.91. Average patient level variance (IQR/median SWS) across all 288 examinations (24 participants, 12 exams/participant) was 0.07 (mean inter-system range:0.045-0.09), with an average COV of 6.0% (mean inter-system range:4.0-7.5%). Test-retest repeatability in humans was excellent for all systems, with ICCs of: 0.87-0.97.

CONCLUSION

There is good to excellent inter-system agreement of measured SWS in elastic phantoms and in vivo human livers across six 2D SWE ultrasound systems. Test-retest agreement for all systems is excellent. Average patient-level variance of SWS measurements is minimal.

CLINICAL RELEVANCE/APPLICATION

Commercially-available 2D ultrasound shear wave elastography systems exhibit satisfactory inter-system agreement and test-retest repeatability in phantoms and in vivo human livers.

SST03-06 Is There a Role for Ultrasound in the Evaluation of Transplant Graft Small Bowel?

Friday, Dec. 6 11:20AM - 11:30AM Room: E352

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PURPOSE

Intestinal graft recipients are subjected to significant doses of radiation. MRI studies may not be feasible acutely. Endoscopic examination of the intestine is usually limited to small sections of the graft. Ultrasound (US) is an established technique in the evaluation of disease extent in patients with small bowel Crohn's, therefore we have utilized US for several years to evaluate the graft small bowel and retrospectively reviewed our findings.

METHOD AND MATERIALS

This is a retrospective review of small bowel US studies performed post operatively for our cohort of 97 patients receiving an intestine-containing transplant (IT) between 2007 and 2019. Imaging interpretation was based of grey-scale images and Doppler imaging. US images were reviewed with subsequent clinical, imaging, endoscopy and histology findings.

RESULTS

97 patients received an IT between 2007 and 2019. There were 45 US studies undertaken in 27 patients. The majority of studies (23 studies in 9 patients) were undertaken in those with biopsy-proven acute cellular rejection (ACR). Imaging findings of mural thickening, loss of mural stratification, reduced peristalsis and mesenteric hypervascularity were observed in 7 patients with ACR. 2 patients with a history of ACR had normal US appearances at follow up, which correlated with endoscopic findings of recovery. Of the US performed for ACR, concurrent endoscopy (within 1 week) occurred in 11 US studies. 8 endoscopies demonstrated features related to rejection confirmed at histology. 3 demonstrated recovery. 5 patients underwent US immediately post-surgery with normal findings consistent with concurrent CT or endoscopy findings. 11 studies in 6 patients demonstrated minimal mural thickening but no further features to suggest rejection, 4 were followed with endoscopy with no features of rejection. The remainder were

followed clinically and radiologically.

CONCLUSION

Small bowel US is a useful technique in establishing normal appearances of the bowel. When interpreted in conjunction with clinical and endoscopic findings in patients with ACR it could have a role in surveillance.

CLINICAL RELEVANCE/APPLICATION

Ultrasound (US) is established in imaging of Crohn's disease. Rejection in intestinal transplantation is evaluated with endoscopic surveillance. We hypothesize that US may be use as an adjunct.

SST03-07 Spleen Elastography as a Predictor of Esophageal Varices

Friday, Dec. 6 11:30AM - 11:40AM Room: E352

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PURPOSE

To evaluate the diagnostic performance of splenic elastography and other non-invasive methods to detect high-risk esophageal varices in patients with cirrhosis. The verification of the existence of varices was performed with upper digestive endoscopy, which is the gold standard.

METHOD AND MATERIALS

A prospective study was performed with 100 patients with a recent diagnosis of cirrhosis who were evaluated with upper abdomen ultrasound, hepatic Doppler, liver elastography, upper digestive endoscopy and that complied with the following criteria: no history of digestive bleeding, no treatment with beta-blockers, no thrombosis of the holder. Splenic elastography was performed by a radiologist with training in elastography using shear wave point elastography with a 5-7MHz convex probe. After the imaging studies, upper digestive endoscopy was performed by two hepatologists who were blinded to the information and the diagnosis of esophageal varices was obtained as well as the classification of patients into three groups: those who had no varices, low-risk varices and high-risk varices. A cross-sectional, unicentric study was carried out from April 2017 until December 2018. The data was organized in frequency tables. The comparison with the gold standard included the use of Chi square and ROC curves were obtained to present sensitivity and specificity data.

RESULTS

Spleen elastography proved to be a good predictive study of the presence of esophageal varices (AUC 0.84, CI 95%: 0.71-0.97), followed by the diameter of the spleen (AUC 0.81, 95% CI: 0.66-0.96), while the congestivity index (AUC 0.46, 95% CI: 0.27 - 0.64) and liver elastography (AUC 0.39, 95% CI: 0.21 - 0.58) proved to be the parameters with less precision. The cut-off point of 3.8m/s in the splenic elastography was able to identify high risk varices with a sensitivity of 90.9%.

CONCLUSION

Splenic elastography demonstrated sensitivity and specificity values similar to the ones published in international studies with adequate correlation with endoscopy for diagnosing high-risk esophageal varices.

CLINICAL RELEVANCE/APPLICATION

Bleeding is the most common and dangerous complication of esophageal varices. With early detection of high-risk varices using a non-invasive technique such as spleen elastogrpahy, patients can start prophylaxis with beta-blockers.

SST03-08 A Diagnostic Role of US-Guided Percutaneous Biopsy in Patients at Risk for Hepatocellular Carcinoma: Comparison with Noninvasive Diagnostic Approaches

Friday, Dec. 6 11:40AM - 11:50AM Room: E352

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PURPOSE

To explore a diagnostic role of US-guided percutaneous biopsy for suspicious focal hepatic lesions in patients at risk for hepatocellular carcinoma (HCC) and to compare the results with noninvasive diagnostic approaches using the Liver Imaging Reporting and Data System (LI-RADS) classification

METHOD AND MATERIALS

We retrospectively included 169 lesions in 160 patients at risk for HCC who underwent US-guided percutaneous biopsy for newly developed suspicious hepatic malignancy in 2016. Each target lesion on biopsy was evaluated on CT and/or MRI and was assigned to the LI-RADS v2018 categories. We compared the biopsy results with the LI-RADS categories and evaluated the agreement by using percent agreement and Cohen's kappa statistic after recategorization of the LI-RADS into three groups: (a) favoring HCC (including LR-4, 5, and TIV without targetoid mass) (b) favoring non-HCC malignancy (including LR-M and TIV with targetoid mass)

(c) indeterminate (LR-3). In 30 patients subsequently undergoing surgical excision, agreements with surgical pathology were compared between biopsy results and CT/MRI LIRADS categories by using percent agreement.

RESULTS

US-guided biopsy achieved successful diagnostic results in 81.7% (138/169) without difference across the LI-RADS categories (CT, p = 0.35; MRI, p = 0.86). Among these 138 lesions, 73 lesions were evaluated both on CT and MRI, whereas 65 were solely assessed by using either CT or MRI. Biopsy showed fair-to-good agreement with noninvasive categorization by CT and MRI (κ=0.61 for each) with substantial percent disagreement (CT, 24%; MRI, 23%). Three of LR-3 lesions each on CT (20%) and MRI (27%) were diagnosed with malignancy on biopsy; 3 (7%) on CT and 3 (7%) on MRI favoring HCC were benign on biopsy; 4 (11%) on CT and 3 (7%) on MRI favoring HCC were non-HCC malignancy on biopsy. Biopsy showed higher percent agreement (90%) with surgical pathology than the diagnostic categories on CT (75%) and MRI (70%).

CONCLUSION

Despite its substantial non-diagnostic results, US-guided percutaneous biopsy showed superior diagnostic performance for focal hepatic lesions than noninvasive imaging diagnosis using the LI-RADS classification.

CLINICAL RELEVANCE/APPLICATION

If diagnostically adequate samples are obtained, US-guided percutaneous biopsy poses an important role for classifying hepatic nodules which even show the typical HCC hallmarks on imaging in patients at risk for HCC.

SST03-09 Diagnostic Benefit of Oral Contrast Administration (Small Intestine Contrast-Enhanced Ultrasonography [SICUS]) over Conventional Enteric US in Crohn's Disease

Friday, Dec. 6 11:50AM - 12:00PM Room: E352

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PURPOSE

Enteric ultrasound (US) following an oral contrast agent (SICUS) may facilitate better visualisation of the bowel wall compared to unprepared US. The purpose of this study was to compare the diagnostic accuracy of unprepared US and SICUS for detecting small bowel Crohns disease (CD).

METHOD AND MATERIALS

The study utilised patients recruited to a prospective trial comparing the diagnostic accuracy of MRE and US for CD (either newly diagnosed or with relapsing disease) recruited across 8 hospitals. A construct reference standard (multidisciplinary panel diagnosis) was used in the trial, incorporating 6 months of patient follow up. 64 patients underwent standard US followed by SICUS (using 1l of hyperosmolar luminal contrast), performed by the same practitioner, blinded to all clinical data. Practitioners recorded findings on the presence of small bowel/colonic CD after each US examination. Sensitivity and specificity for small bowel disease extent (i.e. presence and correct segmental location) was compared to the trial construct reference standard using bivariate multilevel patient specific random effects models, from paired data using meqrlogit in STATA 14.2.

RESULTS

Sensitivity and specificity for small bowel disease extent was identical between SICUS and unprepared US (71% [58-81] and 86% [49-97] respectively). SICUS specificity for colonic disease was 92%[80-97] and 82%[68-91] for unprepared US, a non-significant difference of 10% (95% CI -2 to 22), p=0.125. Both US and SCIUS detected 9/14 (64%) of segments deemed to be stenosed and causing obstruction by the consensus reference standard . There were numerically fewer false positive diagnoses of obstructing stenosis on SICUS compared to US (7 vs. 11 respectively).

CONCLUSION

We found no evidence that SICUS increases diagnosed accuracy for small bowel disease extent compared to conventional US. Stenosis detection was not improved by SICUS but false positive diagnoses may be reduced.

CLINICAL RELEVANCE/APPLICATION

SICUS offers no significant advantage over standard US for detecting small bowel CD. Given the patient symptom burden induced by ingesting hyperosmolar fluid, first line SICUS cannot be recommended.

SST04

Genitourinary (Urographic Imaging)

Friday, Dec. 6 10:30AM - 12:00PM Room: E350

GU

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

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Sub-Events

SST04-01 Evaluation of Asymptomatic Microscopic Hematuria by Renal Ultrasound to Detect Upper Tract Malignancy: A 20-Year Experience in a Community Hospital

Friday, Dec. 6 10:30AM - 10:40AM Room: E350

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PURPOSE

Asymptomatic microscopic hematuria (AMH) can be a sign of upper tract (UT) malignancy and requires evaluation. However, the preferred imaging modality of the UT is controversial. Our healthcare system is an integrated medical center with 30 regional clinics serving 21 counties over a tri-state region has routinely used renal ultrasound (RUS) for the initial evaluation of the UT in patients with AMH because of cost and performance. The purpose of this study was to evaluate the sensitivity of RUS for detecting UT malignancy in patients with AMH.

METHOD AND MATERIALS

An IRB approved, retrospective study was performed of all patients who received a renal ultrasound in our health system from January 1, 1997 to July 1, 2015. Patients were excluded if they had <3 years of follow-up, <18 years old, history of prior UT genitourinary cancer, catheter, inpatient status, pregnant status, gross hematuria (GH) or spotting, or if the health record did not contain sufficient detail to rule out GH. The initial RUS was considered positive if findings led to a diagnosis of UT malignancy. Regardless of the RUS results, health records were then reviewed to determine whether any UT cancer was subsequently diagnosed to assess for false negatives.

RESULTS

Of the 4871 patients who underwent a RUS during the study period, 2124 met eligibility criteria. The average follow-up was 11.6 years (range: 3-21.6, stdev: 4.9). Twelve (0.6%) patients were diagnosed with UT malignancy (9 renal cell carcinoma and 3 urothelial carcinomas) during their initial evaluation, all of whom had an initial RUS positive for malignancy for an overall sensitivity of 100% and negative predictive value of 100%. Four patients were diagnosed with UT malignancy >3 years after an initially negative RUS.

CONCLUSION

We have demonstrated that the sensitivity of RUS is adequate for detection of UT malignancy in patients with AMH, a low-risk population. This study represents a general population from a community outpatient setting with reliable long-term follow-up. Patients whose RUS and cystoscopy findings are negative for signs of malignancy can safely be advised to return for further evaluation if they develop GH, flank pain, or irritative voiding symptoms.

CLINICAL RELEVANCE/APPLICATION

Renal ultrasound is highly sensitive for detection of upper tract malignancies and can be used for initial screening in low-risk patients with asymptomatic microhematuria.

SST04-02 The Diagnostic Yield of CT Urography in the Workup of Hematuria with Negative Cystoscopy

Friday, Dec. 6 10:40AM - 10:50AM Room: E350

Participants

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PURPOSE

Current American Urological Association (AUA) guidelines recommend risk-stratified cystoscopy in the workup of hematuria. However, due to insufficient evidence for risk-stratified upper urinary tract imaging, the AUA recommends multiphasic computed tomography urography (CTU) for all patients. The aims of this study are to determine the diagnostic yield of CTU in patients evaluated for hematuria with negative cystoscopy, and to identify those at highest risk of urinary tract malignancy, who would benefit most from upper urinary tract imaging.

METHOD AND MATERIALS

A retrospective study was conducted of patients who underwent CTU within 12 months of negative cystoscopy for workup of hematuria at our institution between January 2017-December 2017. Patients were grouped according to etiology of hematuria. Clinical diagnoses were correlated with patient characteristics, including age, sex, smoking history, and type of hematuria, as well as renal ultrasound (US) and CTU results. Diagnostic concordance of renal US and CTU was compared.

RESULTS

258 patients met the inclusion criteria. Of these, only 1 patient was diagnosed with an upper urinary tract malignancy. 6 other malignancies were diagnosed including 3 renal cell carcinomas (RCC), 2 prostate adenocarcinomas, and 1 metastatic gynecologic malignancy. All malignancies were diagnosed in patients over 50 years of age. 60 patients were diagnosed with urolithiasis, and 56 were diagnosed with benign prostatic hyperplasia (BPH). There was no etiology identified in 109 patients, including 21 of 30 patients age 50 years and under. Renal US was performed in 93 patients. Renal US was diagnostic and concordant with CTU in 56 patients. Renal US failed to detect the diagnosis identified on CTU in 18 cases, including 1 RCC, 7 urolithiasis, 7 BPH, and 3 other benign findings. Both renal US and CTU were non-diagnostic in 11 patients in whom the etiology of hematuria was identified on cystoscopy.

CONCLUSION

Renal US with or without computed tomography of the kidneys, ureters, and bladder (CT KUB) should be considered as an alternative to multiphasic CTU in the workup of hematuria in patients with negative cystoscopy.

CLINICAL RELEVANCE/APPLICATION

Risk-stratified upper tract imaging in the workup of hematuria may reduce radiation exposure with no significant effect on detection of upper urinary tract malignancy or other significant findings.

SST04-03 Multi-Vendor Performance for Determination of Renal Stone Composition: Comparison with Six Dual-Energy CT Scanners

Friday, Dec. 6 10:50AM - 11:00AM Room: E350

Participants
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PURPOSE

The aim of this in-vitro study was to compare the performance of six dual-energy CT (DECT) scanners in determination of stone composition

METHOD AND MATERIALS

A total of 71 urinary stones (size: 2 mm - 16 mm) of known chemical composition (51calcium, 4 struvite, 4 cystine and 12 urate) were placed in a custom-made cylindrical phantom. Consecutive scans with manufacturer-recommended protocols were performed on second-generation dsDECT (S1: SOMATOM Definition Flash, Siemens;100/Sn140kVp), third-generation dsDECT (S2: Force,Siemens;100/Sn150kVp), sfDECT (S3: Edge, Siemens;AuSn120kVp), first-generation rsDECT (S4: Discovery750HD, GE; 80/140kVp), second-generation rsDECT (S5: Revolution, GE; 80/140kVp) and dlDECT (S6: IQon, Philips; 120kVp). Data sets were analysed using effective atomic number (Zeff) and dual-energy ratio indices (DEI) of maximally available spectra (40/190keV for dsDECT and sfDECT, 40/140 keV for rsDECT and 40/200keV for dlDECT) and comparable spectra (40 keV/140 keV) all S1-S6 were computed. Agreement of Zeff and DEI among the scanners was assessed with inter-class coefficient test.

RESULTS

Both Zeff and DEI could differentiate between non-urate and urate stones. For all stone compositions, Zeff showed excellent agreement between scanners (ICC:0.90, 95% CI : 0.86- 0.93). DEI showed lower agreement compared to Zeff. Both, DEI computed by maximally separated spectra (40/140-200keV) and similar spectra (40/140keV for all) showed comparable agreement (ICC:0.63, 95 % CI:0.49-0.75 vs. ICC:0.62, 95 % CI:0.47-74).

CONCLUSION

Overall cross-vendor measurements for determination of stone composition were comparable with all DECT techniques. Zeff is a better quantitative measure than DEI for stone characterization.

CLINICAL RELEVANCE/APPLICATION

In a busy practice with multivendor setting it is important to cross validate the performance for stone composition to provide consistent results since patients can be scanned at different scanners.

SST04-04 Automated Radiomic Analysis of Ureteral Stones Using ER Renal Stone CT Images Predicts Likelihood of Spontaneous Passage

Friday, Dec. 6 11:00AM - 11:10AM Room: E350

Participants
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PURPOSE

To quantify the ability of automated radiomic analysis of CT images to predict the likelihood of spontaneous passage of symptomatic renal stones, and to compare the results with the performance of manual measurements.

METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant, retrospective study included symptomatic patients undergoing emergency renal stone CT who had one stone in the kidney or ureters; patients with bladder stones were excluded. Spontaneous passage (or not) was documented based on review of clinical records, patient report, follow-up CT scans, or the need for stone extraction during 6 months of follow-up. Radiologists-in-training manually measured axial and coronal stone dimensions. Automated quantitative stone analysis software computed stone length, width, height, maximum dimension, volume, and CT number, as well as morphologic parameters related to stone heterogeneity and roughness. Univariate logistic regression was used to define odds ratios (OR) of spontaneous passage and ROC analysis was used to assess the ability to predict stone passage. Independent variables identified using multivariable logistic regression were used to create models that incorporated parameters such as patient age and sex, stone volume and dimensions, and morphological features.

RESULTS

Of 195 patients, spontaneous passage was documented in 58% (114/195). Univariate analysis demonstrated numerous significant stone parameters (from the CT data) associated with stone passage ($p<0.001$), including OR (95% CI) of 10.1 (5.11, 19.9) for axial dimension < 4.6 mm and 9.40 (4.84, 18.2) for coronal dimension < 4.9 mm (manual measurements), and 11.14 (5.21, 23.8) for volume < 81 mm3 and 10.58 (5.37, 20.8) for mean curvature < -0.14 (automated measurements). Area under the ROC curve was 0.83 for manual measurements and increased to 0.88 when patient and morphological stone features were included.

CONCLUSION

Automated radiomic analysis quickly and reproducibly predicted stone passage better than manual radiologist measurements. Prospective clinical validation of the developed model is needed.

CLINICAL RELEVANCE/APPLICATION

Automated radiomic analysis of CT data can quickly provide reproducible objective data for guiding management of patients with acute ureterolithiasis.

SST04-05 Dose Independent Characterization of Renal Stones by Means of Spectral Detector Computed Tomography and Machine Learning

Friday, Dec. 6 11:10AM - 11:20AM Room: E350

Participants
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PURPOSE

To predict the main component of both, pure and compound kidney stones using dual energy computed tomography and machine

learning.

METHOD AND MATERIALS

200 kidney stones with a known composition as determined by infrared spectroscopy were examined using a non-anthropomorphic phantom on a spectral detector computed tomography scanner. Stones were of either pure (monocrystalline, n=116) or compound (dicrystalline, n=84) composition. Image acquisition was repeated twice using both, normal and low-dose protocols, respectively (ND/LD). Conventional images and low and high keV virtual monoenergetic images were reconstructed. Stones were semi-automatically segmented. Further analysis was conducted on a per-voxel basis. using a shallow neural network (SNN). ND data was imported in the SNN and split in training (70%), testing (15%) and validation-datasets (15%). LD data then was analyzed by the same network. Accuracy on a per-voxel and a per-stone basis was calculated.

RESULTS

Main components were: Whewellite (n=80), weddellite (n=21), Ca-phosphate (n=39), cysteine (n=20), struvite (n=13), uric acid (n=18) and xanthine stones (n=9). Stone size ranged from 3 - 18 mm. Overall diagnostic accuracy attained with test/training dataset for determining stone composition was 91.1%. On independently tested LD-acquisitions accuracy was 87.1-90.4%.

CONCLUSION

Even in compound stones, the main component can be reliably determined using dual energy CT and machine learning, irrespective of dose protocol.

CLINICAL RELEVANCE/APPLICATION

After transfer to patients, spectral detector CT and machine learning may enable a detalied analysis of renal stone composition and therefore a targeted therapy of different types.

SST04-06 Estimating Differential Renal Function in Patients with Upper Urinary Tract Stones Using Non-Enhanced Computed Tomography

Friday, Dec. 6 11:20AM - 11:30AM Room: E350

Participants
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PURPOSE

For chronic urinary tract stones patients, differential renal function (DRF) is a key indicator for assisting urologists in selecting treatment options (lithotripsy versus nephrectomy). The wide popularity and short acquisition time of unenhanced computed tomography (CT) make it a first-line examination method for imaging patients with ureteral stonesTherefore, this study aimed to determine whether Unenhanced CTimaging can estimate DRF in patients with chronic unilateral obstructive upper urinary tract stones.

METHOD AND MATERIALS

This was a retrospective study of 76 patients, and all patients underwent nonenhanced CT and nuclear renography (RG) at an interval of 4 to 6 weeks due to chronic unilateral obstructive urinary stones. Renal CT measurements (RCMs), consisting of residual parenchymal volume (RPV) and volumetric CT texture analysis parameters, were obtained using a semiautomated method. The percent RCM were calculated using the general format '100*(Left RCM/[Left RCM+Right RCM])'. Then percent RCMs were evaluated for theircorrelation power to DRFderived from RG.

RESULTS

The strongest Pearson coefficient between percent RCM and DRF was reflected by RPV (r=0.957, P<0.001). Combinations of RPV and other parameters did not significantly improve the correlation compared with RPV alone (Pearson's r=0.957 versus r=0.957, 0.957, 0.887, 0.815, and 0.956, for combinations of Hounsfield unit, parenchymal voxel, skewness, kurtosis, and entropy, respectively; all P<0.001). Percent RPV was subsequently introduced into linear regression, and the equation y = -2.66+1.07*x (P < 0.001) was derived to calculate predicted DRF. No statistically difference was found between predicted DRF using the equation and observed DRF according to RG (P=0.959).

CONCLUSION

Unenhanced CT imaging can estimate DRF and may reduce unnecessary use of RG for most patients with chronic unilateral obstructive upper urinary tract stones.

CLINICAL RELEVANCE/APPLICATION

Unenhanced CT can be used as a convenient tool to predict DRF and RPV should be considered as part of routine CT reporting in patients with chronic unilateral obstructive upper urinary tract stones.

SST04-07 Computed Tomography Findings of Upper-Urinary-Tract Lesions in Immunoglobulin G4-Related Disease: Comparison with Urothelial Carcinoma

Friday, Dec. 6 11:30AM - 11:40AM Room: E350

Participants
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PURPOSE

Immunoglobulin G4-related disease (IgG4-RD) can sometimes involve the upper urinary tract and mimic urothelial carcinoma

clinically. There have been indeed quite a few reports mentioning that unnecessary radical nephroureterectomy was performed to those patients. The purpose of this study was to investigate computed tomography (CT) findings of IgG4-RD lesions involving the upper urinary tract and to compare them with those of urothelial carcinomas.

METHOD AND MATERIALS

Pretreatment CT images of 13 consecutive patients of IgG4-RD with urinary tract lesions and 80 consecutive patients with urothelial carcinoma were retrospectively evaluated by two board-certified radiologists. Clinical information of each group was obtained by chart review.

RESULTS

Upper-urinary-tract findings between two groups is summarized in the table. Bilaterality ($P < 0.0001$), symmetry ($P < 0.0001$), extramural growth pattern ($P < 0.0001$), longer lesions($P = 0.04$) and gradual dynamic enhancement pattern ($P < 0.001$) were statistically more frequent in IgG4-RD patients compared to urothelial carcinoma patients. Concerning extra-urinary-tract findings, following findings were significantly common among IgG4-RD patients; paraaortic fat stranding ($P = 0.03$), presacral fat stranding ($P < 0.001$), and fat stranding of pelvic walls ($P < 0.001$). Aortic lesions were significantly more frequent in IgG4-RD patients ($P < 0.001$), on the other hand kidney lesions was seen in only one patient of IgG4-RD and patients with urothelial carcinoma tended to present with direct tumoral invasion to renal parenchyma, although there was no significant difference. There was no significant difference on frequency of hydronephrosis and coexisting pancreatic lesions between each group.

CONCLUSION

Compared to urothelial carcinoma, bilateral, symmetric, and longer involvement, extramural growth pattern, ill-defined margin, gradual enhancement pattern in dynamic CT are suggestive findings of IgG4-RD urinary tract lesions. IgG4-RD can also manifest as ipsilateral asymmetric lesion, which could overlap with those of urothelial carcinoma. Extra-urinary-tract findings such as fat stranding in paraaorta, presacral or pelvic wall area are also useful findings in differentiating IgG4-RD lesions from urothelial carcinoma.

CLINICAL RELEVANCE/APPLICATION

CT is useful in differentiating urinary tract lesions of IgG4-RD from urothelial carcinoma and can prevent unnecessary ureteronephrectomy.

SST04-08 The Feasibility of Compressed Sensing With and Without Breath-Holding on Magnetic Resonance Urography: A Comparison with Conventional 3D Magnetic Resonance Urography Looking at Acquisition Time, Image Quality, and Diagnostic Performance

Friday, Dec. 6 11:40AM - 11:50AM Room: E350

Participants
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PURPOSE

To investigate the feasibility of prototypical 3D magnetic resonance urography (MRU) with a compressed sensing (CS) technique for patients with or without breath-holding (BH) capabilities.

METHOD AND MATERIALS

MRU was performed in 66 patients on a 3T system, including BH with CS, navigator-triggered (NT) CS, and conventional NT (cNT) protocols. The patients were divided into two groups, Group1 (the BH group, $n = 56$) and Group II (the compromised BH group, $n = 10$), according to the image quality of a BH-T1-weighted protocol. The quality of urinary tract sharpness and background suppression were scored with a scale of 1 to 5 (poor to good). Urinary tract lesions were detected on reconstructed maximum intensity projections, multiplanar reconstructions, and source images, and graded with the same scale. Comparative analyses of acquisition time and image quality were performed. Receiver operating characteristic (ROC) curve analysis was performed, and sensitivity, specificity, and the area under the ROC curve (AUC) were calculated to determine diagnostic performances.

RESULTS

BH-CS MRU showed reductions of 88.1% and 96.7% in acquisition times compared with NT-CS MRU and cNT MRU in Group1. The acquisition time was reduced by 71.2% for NT-CS MRU compared with cNT MRU in Group II. BH-CS MRU had the best urinary tract sharpness in Group 1, and NT-CS MRU had the least background signal in both groups (both $P < 0.05$). BH-CS MRU presented superior urinary tract sharpness and background suppression in Group1 than Group II (both $P < 0.05$). Group II had better urinary tract sharpness with NT-CS MRU and less background suppression with cNT MRU than Group1 (both $P < 0.05$). Diagnostic efficiencies of all protocols were comparable in Group1 (all $P > 0.05$), while the diagnostic efficiency of BH-CS MRU was significantly lower than the other two protocols in Group II (both $P < 0.05$).

CONCLUSION

BH-CS MRU showed great potential for urinary tract imaging with the shortest acquisition times and excellent image qualities in patients that can hold their breath. For patients that cannot hold their breath, NT-CS MRU would be helpful.

CLINICAL RELEVANCE/APPLICATION

Compressed sensing magnetic resonance urography (MRU) can shorten MR acquisition time with better image quality compared with

conventional MRU.

SST04-09 Validation of Vesical-Imaging Reporting and Data System (VI-RADS): A Single-Centre Retrospective Evaluation of Interobserver Agreement and Diagnostic Accuracy of Multiparametric MRI (mpMRI) in the Setting of Bladder Cancer

Friday, Dec. 6 11:50AM - 12:00PM Room: E350

Participants
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PURPOSE

Vesical Imaging-Reporting and Data System (VI-RADS) has been developed to standardize multiparametric MRI (mpMRI) approach to bladder cancer (BC). The aim of this study was to evaluate interobserver agreement and diagnostic accuracy of mpMRI with the use of VI-RADS to discriminate between non-muscle invasive bladder cancer (NMIBC) and muscle-invasive bladder cancer (MIBC).

METHOD AND MATERIALS

Between September 2017 and March 2019, 138 patients referred for suspected bladder cancer underwentmultiparametric MRI of the bladder (mpMRI) prior to transurethral resection of bladder tumor (TURBT). All mpMRI were reviewed by two radiologists, who scored each lesion according to VI-RADS. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for each VI-RADS cutoff. Receiver operating characteristics curves were used to evaluate the performance of mpMRI. The k statistics was used to estimate inter-readeragreement.

RESULTS

One hundred twenty-six patients were included in the final analysis, 88 with NMIBC and 38 with MIBC. Sensitivity and specificity were 93% and 91% for reader 1 and 86% and 85% for reader 2 respectively when the cutoff VI-RADS > 2 was used to define MIBC. At the same cutoff, PPV and NPV were 81% and 97% for reader 1 and 75% and 94% for reader 2. When the cutoff VI-RADS > 3 was used, sensitivity and specificity were 84% and 95% for reader 1 and 79% and 91% for reader 2. Corresponding PPV and NPV were 85% and 92% for reader 1 and 79% and 92% for reader 2. Area under curve was 0.918 and 0.886 for reader 1and 2 respectively. Inter-reader agreement was good for the overall score (k =0.748).

CONCLUSION

VI-RADS is accurate in differentiating MIBC from NMIBC. The optimal cutoff is VI-RADS >2 to maximize sensitivity and NPV. Inter-reader agreement is overall good.

CLINICAL RELEVANCE/APPLICATION

Magnetic resonance imaging (MRI) scans for bladder cancer with the use of a standardized and validated score as the VI-RADS may help improve patient care.

SST05

Musculoskeletal (Spine)

Friday, Dec. 6 10:30AM - 12:00PM Room: E450B

AI MK

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SST05-02 Dose Optimization in Spinal Computed Tomography for Planning of Scoliosis Surgery

Friday, Dec. 6 10:40AM - 10:50AM Room: E450B

Participants
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PURPOSE

To assess the potential for dose optimization in patients undergoing spinal CT for planning of scoliosis surgery.

METHOD AND MATERIALS

Ten patients (3 male, 7 female, 18±11 years) were included in this prospective, IRB-approved study. CT examinations were performed with automated exposure control (mean CTDIvol 4.1±0.9mGy; DLP: 192±50mGyxcm). Dose reduction to 50%, 20 %, 10% and 5% was simulated using dedicated reconstruction software. Two spinal surgeons blinded to the dose level independently and randomly measured the length and the width of each pedicle for screw size selection. Additionally, the confidence in the measurements was assessed (5=very confident in the measurement, 1=measurement cannot be performed with any confidence). Two radiologists rated the image quality for the assessment of bone and soft tissue structures (5=excellent, 1=non-diagnostic). Bonferroni was used to correct for multiple testing ($p<0.0125$).

RESULTS

Pedicle length and width measurements were comparable between 100% and 50% reconstructions (36.4mm/4.1mm vs 36.6mm/4.1mm) whereas both measurements decreased with further dose reduction (20%: 36.1mm/4.1mm; 10%: 35.5mm/4.0mm; 5%: 34.6mm/3.9mm). Confidence in the measurements was excellent at 100% and 50% (all ratings of 5) and decreased with further dose reduction (20%: 4.7; 10%: 3.7; 5%: 2.5). Image quality decreased with decreasing dose (4.9±0.4 for 100 % to 1±0 for the 5% reconstructions; $p<0.001$, respectively). For bone assessment, image quality was comparable between 100% and 50% reconstructions (4.9±0.4 vs 4.7±0.5;).

CONCLUSION

Dose of preoperative spinal CT for planning of scoliosis surgery can be reduced to 50% without impairment of pedicle size measurements or surgeons' confidence in planning the operation.

CLINICAL RELEVANCE/APPLICATION

CT dose in preoperative spine CT can be reduced to 50% for patients undergoing scoliosis surgery.

SST05-03 Making Spine MR Reports More Clinically Appropriate: A Questionnaire-Based Survey of Sub-Specialty Spine Surgeons

Friday, Dec. 6 10:50AM - 11:00AM Room: E450B

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PURPOSE

MR reports have been unchanged for a long time, and clinical relevance of MR findings are being challenged in literature. We assess the weightage that spine surgeons give to certain aspects of the MR report, their preference for report structure and towards different modalities.

METHOD AND MATERIALS

An anonymous online survey, created in consultation with 5 spine surgeons, which included questions related measurement of spinal canal dimensions, information about nerve root impingement, anomalies and take-off, annular fissures, Modic changes, scoliosis and listhesis, was circulated amongst sub-specialist spine surgeons. Preference for report format (every level reported, significant levels reported, pain chart diagram), and modality of investigation before surgery for lumbar degenerative disc disease was also recorded.

RESULTS

24 sub-specialist spine surgeons, with average 13.9 years' experience (range: 3 - 30 years) from 6 cities, completed the questionnaire. Responses were weighted towards surgically relevant details such as effective spinal canal measurement (79%), nerve root impingement (91%), obvious anomalies at the level of significant disc (61%), level of nerve root take-off (75%), only details of posterior annular fissures (50%), and 25% surgeons preferred "hyperintense zone terminology". Surprisingly, equal number of responses for Modic changes (62%), and for the possibility of inflammatory spondyloarthropathy (58%) or infection (67%) we obtained. On reporting formats, majority asked for only involved levels (71%) while 33% asked for every level. 33% asked for a diagrammatic pain chart. There was no consensus on reporting of scoliosis cases. Also, majority asked for information about cause of listhesis. As expected, for presurgical assessment for degenerative disc disease, MR (87%) with and X ray spine with flexion and extension (75%) was preferred while only 8.3% asked for plain CT and none asked for CT myelography.

CONCLUSION

These results highlight clinically relevant information that should be included on an MR report, including effective spinal canal dimensions, details of nerve root anomalies at the level of disc herniation, details of nerve root impingement. There was lack of consensus on Modic changes, format of report, and scoliosis assessment.

CLINICAL RELEVANCE/APPLICATION

Two-way communication between spine surgeons, and radiologists helps in generation of effective reports, that improve clinical outcomes.

SST05-04 Deep Learning-Based Reconstruction of Osseous Structures of the Cervical Spine Using Bone MRI: A Qualitative Analysis

Friday, Dec. 6 11:00AM - 11:10AM Room: E450B

Participants
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PURPOSE

To qualitatively assess deep learning-based synthetic CT (BoneMRI) derived from MRI scans of the cervical spine.

METHOD AND MATERIALS

Paired MRI and CT data were collected from 25 consecutive outpatients of 50 years or older presenting with cervical radiculopathy. Patients with osteosynthesis material in the cervical spine or known pathological bone disorders were excluded. The MRI exam (Ingenia 1.5T, Philips Healthcare, the Netherlands) included a T1 multiple gradient echo sequence for BoneMRI reconstruction (3 minutes, 53 seconds). The deep learning-based method (BoneMRI, MRIguidance, the Netherlands) was previously developed based on data from 25 patients from a similar cohort. In this study we qualitatively assessed BoneMRI on an independent cohort. BoneMRI images and conventional CT images were independently evaluated by a neurosurgeon, neuroradiologist and musculoskeletal radiologist. A four-point Likert scale (1=poor, 4=excellent) was used to assess image quality of various structures at two cervical

levels (C3-C4 and C6-C7: cortical delineation, intervertebral joints, neural foramina, trabecular bone). Cut-off value for the qualitative assessment in BoneMRI imges was a score of 3 or higher in 80% of the assessed components.

RESULTS

A score of 3 or higher for BoneMRI was achieved for cortical delineation (C3-C4 100%, C6-C7 93.3%), intervertebral joints (both levels 100%) and neural foramina (both levels 100%). The cut-off value of 3 or higher was not met for visualization of the trabecular bone (C3-C4 65.3%, C6-C7 48%).

CONCLUSION

BoneMRI of the cervical spine is a promising tool for 3D morphological assessment of osseous structures without the need for ionizing radiation. Implementation of BoneMRI could facilitate an easier workflow, provide additional information for clinicians, reduce costs and lower patient burden by obviating the CT; and therefore contribute to value-based healthcare. Future work will prospectively investigate BoneMRI in an unrestricted population to further explore the performance of the method.

CLINICAL RELEVANCE/APPLICATION

BoneMRI of the cervical spine offers osseous visualization without the use of ionizing radiation and provides structural information regarding both soft and osseous tissues in a single examination.

SST05-05 Dixon Imaging of the Spine - Comparison of T1 VIBE and T2 TSE Derived Relative Fat Fraction

Friday, Dec. 6 11:10AM - 11:20AM Room: E450B

Participants
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PURPOSE

A comparison between the quantitative relative fat fraction (rFF) derived from T1 VIBE Dixon and T2 TSE two-point Dixon MRI of vertebral metastases and healthy vertebrae.

METHOD AND MATERIALS

MRI of the spine including T1 VIBE (10° flip angle) and T2 TSE (120° flip angle) two-point Dixon sequences with dedicated in- on opposed echo timing of 25 patients with vertebral metastases of known primary tumor and 25 healthy individuals without conspicuous vertebral lesions were retrospectively reviewed. MRIs were performed on the same 1.5T scanner. Patients with history of malignancy were excluded from the healthy cohort. rFF was calculated by dividing the fat-only through the water- plus fat-only images. Volumes of interest (VOIs) of one vertebral metastasis of each patient of the tumor group and one vertebra of each patient in the healthy cohort were generated. The VOI was created on the T1 VIBE Dixon rFF image and copied onto the T2 TSE rFF image. Mean rFF value and VOI volume were noted. Additionally a region of interest (ROIs) was drawn in the VOI and the subcutaneous gluteal fat and copied onto the T2 TSE rFF image. Mean rFF values were noted. Intraclass correlation coefficients testing for absolute agreement and t-tests were performed comparing rFF mean values in the healthy and malignant cohort. A p-value <0.05 was deemed statistically significant.

RESULTS

For malignant vertebrae VOI measurement based mean T1 VIBE rFF was 11%, mean T2 TSE rFF was 9% ($p < 0.001$). In healthy patients mean vertebral T1 VIBE rFF was 67% and T2 TSE rFF was 73% ($p < 0.001$). There was no significant difference in mean VOI size between the malignant and healthy cohort ($p = 0.53$). Mean T1 VIBE and T2 TSE rFF were significantly smaller in the malignant cohort (each $p <0.001$). Mean T1 VIBE rFF of the subcutaneous fat was 93% and T2 TSE rFF was 91.5% ($p = 0.02$). There was moderate correlation between T1 VIBE and T2 TSE VOI, T1 VIBE VOI and ROI and T2 TSE VOI and ROI rFF measurements (each intraclass correlation coefficient > 0.67). Less correlation was found between subcutaneous T1 VIBE rFF and T2 TSE rFF (pearson correlation coefficient = 0.55).

CONCLUSION

There was significant difference between the T1 VIBE Dixon rFF and T2 TSE Dixon rFF in vertebral metastases as well as healthy vertebrae. While each technique allows approximatization of fat content absolute values are not comparable.

CLINICAL RELEVANCE/APPLICATION

While T1 VIBE and T2 TSE Dixon rFF each allow approximatization of the fat content and aid characterization of vertebral lesions, absolute rFF values cannot be compared between both sequences.

SST05-07 Machine Learning Classification of Spinal Lesions: Compared Accuracy of Texture Parameters Extracted with Different Software

Friday, Dec. 6 11:30AM - 11:40AM Room: E450B

Participants
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PURPOSE

To compare the accuracy of machine learning (ML) algorithms for classification of spinal lesions based on texture analysis (TA) parameters extracted by different software from unenhanced Magnetic Resonance images (MRI).

METHOD AND MATERIALS

We retrospectively enrolled 146 patients with 146 spinal lesions (49 benign, 57 metastatic and 40 primary malignant lesions) imaged using MRI. Of them, 117 were histopathologically confirmed after surgery while 29 benign lesions were confirmed by follow-up. Patients were randomly divided in training (n=100) and test groups (n=46), respectively for classification model development and testing. Lesions were manually segmented on T1-weighted and T2-weighted images by drawing a bi-dimensional polygonal region of interest. These were used for first order and texture feature extraction on two software, 3D-Slicer heterogeneity CAD module (hCAD) and Pyradiomics. For each of them, different data subsets, obtained by four feature selection methods were analyzed by 9 ML classification algorithms to evaluate their accuracy in identifying benign vs. malignant lesions and benign vs. primary malignant vs. metastatic lesions.

RESULTS

In the test group, a random forest algorithm correctly classified 89% of lesions as benign or malignant, based on hCAD TA, while a Support Vector Machine could achieve an accuracy of 87% from Pyradiomics TA. For the classification of benign, primary malignant and metastatic lesions, RF models accurately classified 70% of lesions for both TA software.

CONCLUSION

ML algorithms show good accuracy in spinal lesion classification based on non-contrast MRI exams. Furthermore, feature extraction performed using different software has shown consistent results at subsequent ML analysis.

CLINICAL RELEVANCE/APPLICATION

This is the first study that compares the accuracy of different softwares for texture analysis in msk field.

SST05-08 Automatic Spine Segmentation for Detection of Abnormal Vertebra and Differentiation of Benign and Malignant Fracture on CT Using Deep Learning

Friday, Dec. 6 11:40AM - 11:50AM Room: E450B

Participants
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PURPOSE

To evaluate the performance in detection of abnormal vertebra and differentiation of benign and malignant vertebral fracture on CT using deep learning.

METHOD AND MATERIALS

A dataset of 296 patients with malignant and 137 patients with benign fracture was generated from our spinal CT database. The CT was acquired using a GE Discovery CT 750HD scanner with 120 kV, 137~543 mAs, and 3 mm thickness. The acquired images were reformatted to Sagittal view for further analysis. An experienced radiologist performed reading by evaluating eight features. A subset of 69 benign and 76 malignant patients with a clearly distinguishable abnormality involving only one spinal segment were selected for deep learning analysis. An ROI was placed, and the smallest square bounding box containing the entire affected vertebra was used as input in ResNet50. The diagnostic performance was tested using 10-fold cross-validation. After obtaining the malignancy probability for all slices of one patient, the highest probability was assigned to that patient, and the prediction of benign or malignancy was done by using the threshold of 0.5. In order to develop an automatic detection scheme, the spine was segmented first, and then ResNet50 was applied to detect the abnormal vertebra. The labeled vertebral fractures and randomly selected normal vertebral bodies were used for training.

RESULTS

The entire dataset of 433 patients were randomly presented to a radiologist for reading, and the accuracy was very high at 99%. The soft tissue mass and bone destruction were highly suggesting malignancy; the presence of transverse fracture line and trauma history were highly suggesting benign. In per-slice diagnosis using ResNet50, sensitivity=0.90, specificity=0.79, and accuracy=0.85. In per-patient diagnosis, sensitivity=0.95, specificity=0.80, and accuracy=0.88. In differentiation of normal vs. abnormal segments, the accuracy was much worse.

CONCLUSION

When the abnormal area was identified as inputs, differentiation of benign and malignant fracture on CT using deep learning achieved a high diagnostic accuracy. When the entire spine was evaluated, the automatic detection of abnormality was challenging.

CLINICAL RELEVANCE/APPLICATION

Deep learning using ResNet yields a high accuracy to distinguish benign from malignant fracture on CT, but more research is needed to develop automatic detection methods to identify abnormal segments.

SST05-09 Clinical-Radiomics Nomograms for Preoperative Prediction of Tumor Type of Sacrum Based on Computed Tomography and Multiparametric Magnetic Resonance Imaging

Friday, Dec. 6 11:50AM - 12:00PM Room: E450B

Participants
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PURPOSE

To develop and validate clinical-radiomics nomograms based on 3D computed tomography (CT) and multiparametric magnetic resonance imaging (mpMRI) for preoperative differentiation of sacral chordoma (SC) and sacral giant cell tumor (SGCT).

METHOD AND MATERIALS

A total of 83 SC and 54 SGCT patients diagnosed through surgical pathology were retrospectively analyzed and divided into a training set and validating set by the ratio of 7:3. We built six models based on CT, CT enhancement (CTE), T1-weighted, T2-weighted, diffusion weighted imaging (DWI), and contrast-enhanced T1-weighted features, two radiomics nomograms and two clinical-radiomics nomograms combined radiomics mixed features with clinical data. The area under the receiver operating characteristic curve (AUC) and accuracy (ACC) analysis were used to assess the performance of the models.

RESULTS

SC and SGCT presented significant differences in terms of age, sex, and tumor location (tage = 9.00, X2sex = 10.86, X2location = 26.20; $P < 0.01$). For individual scan, the radiomics model based on DWI features yielded the highest AUC of 0.889 and ACC of 0.885, followed by CT (AUC=0.857; ACC=0.846) and CTE (AUC=0.833; ACC=0.769). For the combined features, the radiomics model based on mixed CT features exhibited a better AUC of 0.942 and ACC of 0.880, whereas mixed MRI features achieved a lower performance than the individual scan. The clinical-radiomics nomogram based on combined CT features achieved the highest AUC of 0.948 and ACC of 0.920.

CONCLUSION

The radiomics model based on CT and mpMRI present a certain predictive value in distinguishing SC and SGCT, which can be used for auxiliary diagnosis before operation. The clinical-radiomics nomograms performed better than radiomics nomograms.

CLINICAL RELEVANCE/APPLICATION

Clinical-radiomics nomograms based on CT and mpMRI features can be used for preoperative differentiation of SC and SGCT.

Printed on: 10/29/20

SST06

Nuclear Medicine (Thoracic Oncology Nuclear Medicine and PET)

Friday, Dec. 6 10:30AM - 12:00PM Room: E353B

CH NM OI

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

Participants
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Sub-Events

SST06-01 TNM Sub-Stage Does Not Predict Survival in Surgical Patients with Both Clinical and Pathological Stage I Non-Small Cell Lung Cancer

Friday, Dec. 6 10:30AM - 10:40AM Room: E353B

Participants
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Daniel E. Appelbaum, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine if TNM sub-stage (IA1-IB) and PET tumor measurements are predictive of survival in surgical patients with both clinical and pathological stage I non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

This study reviewed surgical patients with clinical and pathological stage I NSCLC and a baseline FDG PET/CT between Feb 2004 and Dec 2014. The pathological staging was based on the prevailing staging system at the time of the surgery. The clinical stage (8th edition) was determined retrospectively by radiologists based on FDG PET/CT and contrast CT. The metabolic tumor volume (MTV), total lesion glycolysis (TLG), and SUVmax from PET/CT were measured. The primary endpoint was overall survival (OS). Kaplan-Meier and Cox survival analyses were performed.

RESULTS

172 surgical patients with pathological stage I also had clinical stage I (9 with IA1, 63 with IA2, 63 with IA3 and 37 with IB) (111 females and 61 males), with 44.8% who expired during follow-up, median OS was 69.1 months; and the 1-year, 2-year, and 5-year OS rates were 96.0%, 88.3% and 71.7 %, respectively. The median follow-up among survivors was 79.2 months. Univariate analysis showed that age [hazard ratio (HR) of age for every year= 1.04, p=0.001] and ECOG performance status (p=0.027) were associated with OS. Clinical TNM sub-stage (p=0.702), gender (p=0.405), smoking status (0.171), histology (p=0.111), ln(MTV) (p=0.120), ln(TLG) (p=0.147) and ln(SUVmax) (p=0.316) were not significantly associated with OS. The statistically significant association of age (HR= 1.04, p=0.002) and ECOG performance status (p=0.027) with OS persisted in multivariate Cox regression analyses after adjusting for clinical TNM sub-stage and ln(MTV). However, there was no significant association of clinical TNM sub-stage (p=0.451) and ln(MTV) (p=0.08) with OS. Kaplan-Meier survival analysis showed statistically significant association of MTV (>=3.5 ml vs <3.5ml, p=0.049), age (p=0.001) and ECOG performance status (p=0.02) with OS.

CONCLUSION

Clinical TNM sub-stage is not associated with OS in the surgical patients with both clinical and pathological stage I NSCLC. Age, MTV (>=3.5 ml vs <3.5ml) and ECOG performance status are significantly associated with OS in such patients.

CLINICAL RELEVANCE/APPLICATION

Patients with clinical stage 1 as determined with CT and PET, and pathologic stage 1 do well after surgery. Clinical TNM sub-stages add little prognostic information in this group.

SST06-02 Mediastinal Lymph Nodal Staging by 18 F FDG PET CT in Patients with Co-Existent Carcinoma Lung and Tuberculosis: A Tertiary Care Centre Experience

Friday, Dec. 6 10:40AM - 10:50AM Room: E353B

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PURPOSE

The aim of this study is to evaluate the imaging characteristics of metastatic and benign (Tubercular) lymph nodes on 18 F FDG PET/CT, in patients with co-existent Carcinoma lung and Tuberculosis, and correlation with histopathological analysis.

METHOD AND MATERIALS

A retrospective analysis of 25 patients (19 males, 6 females; mean age 62.4+/- 10.08 years) with co-existent Carcinoma lung and Tuberculosis was done. All the subjects underwent F-18 FDG PET/CT scanning and subsequently the mediastinal lymph nodes were biopsied. SUV Max-Tumour, SUV Max-Lymph node and SUV Max-Ratio (SUV Max Lymph node / SUV Max Tumour) for each lymph node station on 18F-FDG PET/CT was determined and then each station was classified into one of the three groups based on SUV Max -Tumour (low, medium and high SUV Max -Tumour groups). Diagnostic performance was assessed based on receiver operating characteristic (ROC) curve analysis, and the optimal cut-off values that would best discriminate metastatic from benign lymph nodes were determined for each method.

RESULTS

A total of 115 lymph node stations with a mean of 4.6 lymph node station per patient and total of 540 lymph nodes with a mean of 21.6 lymph nodes per patient were resected and biopsied. 79 nodes were reported positive for metastasis and 27 nodes were reported as granulomatous. On pre-treatment 18F-FDG PET/CT scan, the mean SUV Max-Tumour of squamous cell carcinoma was significantly higher than that of adenocarcinoma (9.9±3.97 vs. 5.76±3.48, P<0.001). The mean SUVmax of malignant lymph nodes was significantly higher than that of tubercular lymph nodes (6.7±0.94 vs. 2.7± 0.84 P<0.001). The mean SUV Max -Ratio in patients with malignant lymph nodes was significantly higher than in those with tubercular lymph nodes (0.91±0.36 vs. 0.41±0.28, P<0.001).

CONCLUSION

The overall diagnostic accuracy of 18 F FDG PET CT in mediastinal lymph nodal staging in patients with co-existent Tuberculosis and Carcinoma lung carcinoma is 67.4 %, if SUV Max of 2.5 is taken as the cut off criteria, however if SUV Max-Ratio is taken into consideration, the overall diagnostic accuracy increases to 74.8%, thus helping in the accurate staging of patients

CLINICAL RELEVANCE/APPLICATION

Carcinoma lung with co-existing Tuberculosis results in false positive mediastinal lymph nodes and fallacies in pre-operative staging.

SST06-03 Improving Accuracy of FDG PET/CT to Diagnose Mediastinal Nodal Involvement in Non Small Cell Lung Cancer (NSCLC): Utility of Using various Predictive Models

Friday, Dec. 6 10:50AM - 11:00AM Room: E353B

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PURPOSE

Accurate nodal staging is crucial in deciding the therapy for NSCLC patients. PET using FDG as well as CECT scan have not been proven to be sufficiently accurate in predicting mediastinal nodal disease, particular in infection endemic regions of the world. The purpose of the study was to determine a predictive model that could improve the accuracy for identifying mediastinal (N2) nodal metastases based on both PET and CT findings seen on baseline FDG PET/CT.

METHOD AND MATERIALS

This retrospective study includes 339 patients with NSCLC who underwent FDG PET/CT within 6 weeks prior to surgery. PET parameters obtained were 1) number of visual PET positive N2 nodes (FDG uptake more than mediastinal blood pool), 2) maximum standardized uptake value (SUVmax) of nodes and 3) ratio of node to aorta (N/A) SUVmax. CT parameters obtained were 1) short axis diameter and 2) Hounsfield units (HU) of PET positive nodes. Cutoff value of N/A ratio and HU for predicting metastases were obtained from ROC curve analysis. PET and CT parameters were correlated with nodal histopathology alone and in combination to find out the sensitivity, specificity, PPV and NPV. 3 different predictive models (PM) were devised and the incremental improvement in accuracy was determined.

RESULTS

PET positive N2 nodes were seen in 139 patients. Pathologically proven N2 disease was seen in 54 patients. 285 patients were negative for N2 nodal metastases. Predictive model (PM1) based on visual PET positivity showed sensitivity, specificity, PPV, NPV and accuracy of 70.3, 64.6, 27.3, 92 and 65.5 respectively. Predictive model (PM2) which combined visual PET positivity and N/A ratio >= 2 showed sensitivity, specificity, PPV, NPV and accuracy of 57.4, 92.2, 55.4, 91.9 and 85.8 respectively. Predictive model

(PM3) which combined visual PET positivity, N/A ratio >= 2 and HU < 75 showed sensitivity, specificity, PPV, NPV and accuracy of 55.5, 96.5, 75, 92 and 90 respectively.

CONCLUSION

Predictive model (PM3) which combined visual PET positivity, N/A ratio >= 2 and HU < 75 showed much improved accuracy in the preoperative diagnosis of mediastinal nodal metastases.

CLINICAL RELEVANCE/APPLICATION

Predictive model combining PET and CT parameters can identify N2 nodal involvement with high accuracy than either alone. The specificity and NPV appears excellent. However the sensitivity and PPV is only modest, demanding invasive nodal sampling especially in infectious endemic areas

SST06-05 FDG-PET/MRI versus Whole-Body MRI versus FDG-PET/CT versus Conventional Radiological Examination: Diagnostic and Prediction Capabilities for Postoperative Recurrence in Non-Small Cell Lung Cancer Patients

Friday, Dec. 6 11:10AM - 11:20AM Room: E353B

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PURPOSE

To compare the utilities of diagnostis and prediction for postoperative recurrence among FDG-PET/MRI, whole-body MRI, FDG-PET/CT and conventional radiological method in non-small lung cancer (NSCLC) patients.

METHOD AND MATERIALS

484 consecutive postoperative NSCLC patients (289 men, 195 women; mean age 69 years) prospectively underwent whole-body MRI, integrated PET/CTs and conventional radiological method as well as follow-up and pathological examinations. Then, all patients were divided into recurrence (n=42) and non-recurrence (n=484) groups based on pathological and follow-up examination results. All co-registered PET/MRIs were generated by means of our proprietary software. Then, probability postoperative recurrence in each patient was visually assessed on all methods by means of 5-point visual scoring system. To compare diagnostic performance among all methods, receiver operating characteristic analyses were performed. Then, diagnostic accuracy of postoperative recurrence was statistically compared each other by using McNemar's test. Finally, multivariate analysis was performed to determine predictors for postoperative recurrence.

RESULTS

Area under the curves (Azs) of PET/MRI (Az=0.99) was significantly larger than that of MRI (Az=0.97, $p<0.05$), PET/CT (Az=0.97, $p<0.05$) and conventional radiological examination (Az=0.94, $p<0.05$). When applied feasible threshold values, accuracy of PET/MRI (97.7%) was significantly higher than that of others (MRI: 96.3%, p=0.004; PET/CT: 94.8%, p=0.0001; conventional radiological method: 90.0%, $p<0.0001$). Accuracy of MRI was also significantly higher than that of PET/CT (p=0.02) and conventional radiological method ($p<0.0001$). Moreover, accuracy of PET/CT was significantly higher than that of conventional radiological method ($p<0.0001$). As the results of multivariate analysis for prediction of postoperative recurrence, histological subtype (p=0.005), tumor marker ($p<0.0001$), PET/MRI result (p=0.001) and conventional radiological method result (p=0.002) were determined as significant predictors.

CONCLUSION

FDG-PET/MRI has better potential for diagnosis of postoperative recurrence than others and considered as one of the predictors in postoperative NSCLC patients.

CLINICAL RELEVANCE/APPLICATION

FDG-PET/MRI has better potential for diagnosis of postoperative recurrence than others and considered as one of the predictors in postoperative NSCLC patients.

SST06-06 Radiomics Features of Lung Adenocarcinoma Based on 18F-FDG PET/CT for Predicting the Mutation Status of EGFR and Its Correlation Analysis with Prognosis

Friday, Dec. 6 11:20AM - 11:30AM Room: E353B

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PURPOSE

To investigate whether the radiomics features of 18F-FDG PET-CT in lung adenocarcinoma combining with relevant clinical

characteristics can predict the EGFR mutation status, and to explore the association with the prognosis of patients with different mutation status.

METHOD AND MATERIALS

A total of 174 patients with lung adenocarcinoma who received PET/CT scan and EGFR gene test were retrospectively analyzed. 1672 Radiomics features were extracted from PET/CT images using a Radiomics prototype (Frontier, VB10, Siemens Healthineers). The clinical and pathological datas were retrospectively analyzed and a combination of radiomics signature with clinical factors model was constructed using the Randon Forest (RF) method to identify EGFR mutants from wild types. The mutant/wild model was trained on a set of 149 patients and validated on an independent test group (n=35) using the AUC. A subset of 99 patients with EGFR mutation were further analyzed. The second model was built with RF classifier to predict 19/21 mutation site. The performance of training group (n=79) and test group (n=20) were evaluated by AUC. And then, and the COX proportional hazard model of multivariate analysis was established.

RESULTS

56.9% (99/174) of patients showed EGFR mutation. EGFR mutation of exon 21wa the most common mutation type (57/99) . We identified a combined radiomics signature and clinical factor model to discrimated between EGFR mutant and wild type in the training group (AUC=0.77) and the validation group (AUC=0.71). (Figure1)The performance of the second model for the identification of 19/21 mutation site reached an AUC of 0.82 and 0.73 in the training group and validation group, respectively. (Figure2) The average survival time of the mutant and wild-type patients was 54.653 months (95% CI:44.940 - 64.366) and 35.993 months (95% CI: 29.377 -42.608)respectively; the median survival time was 46 months (95% CI: 39.216-52.784) and 28 months (95% CI : 18.842-37.158) respectively. (Table1,2)(Figure3)

CONCLUSION

Radiomics features based on the 18F-FDG PET/CT combining with clinical pathological data could have the potential to predict EGFR mutation type, moreover, associated with patients' prognosis, thus providing reference for individualized molecular targeted therapy.

CLINICAL RELEVANCE/APPLICATION

Radiomics features based on the 18F-FDG PET/CT could have the potential to predict EGFR mutation type.

SST06-07 18F-FDG PET-CT Can Predict the Major Pathologic Response to the Neo-Adjuvant PD-1 Blockade in Resectable Non-Small Cell Lung Cancer

Friday, Dec. 6 11:30AM - 11:40AM Room: E353B

Participants
Xiuli Tao, Beijing, China (*Presenter*) Nothing to Disclose
Ning Wu, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Jie He, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Shugeng Gao, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
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Jie Wang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Jianming Ying, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Yun Ling, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Wei Tang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate if 18F-FDG PET-CT has the potential to predict the major pathologic response to the neoadjuvant PD-1 blockade in resectable NSCLC patients.

METHOD AND MATERIALS

From March 2018 to March 2019, 35 patients with resectable NSCLC (the largest diameter of the pulmonary mass was 2.0 cm or larger) who were eligible to the open-label, single-center, single-arm phase Ib clinical trial with PD-1 blockade (IBI308) as neoadjuvant therapy treatment were enrolled. All patients received two doses of intravenous PD-1 blockade (at a dose of 200mg) every 2 weeks. PET-CT scan was performed before neoadjuvant therapy (baseline) and 4 weeks after the first dose (before surgery). PET responses were classified using PET response criteria in solid tumors (PERCIST). Peak standardized uptake values normalized by lean body mass (SULpeak) were measured, and post-treatment percentage changes in SULpeak (ΔSULpeak%) were calculated. The above metabolic information on FDG-PET was correlated with the surgical pathology.

RESULTS

After 4 weeks of neoadjuvant PD-1 blockade treatment, all 35 patients were under surgery, and the major pathological response (MPR, defined as 10% or less residual viable tumor) occurred in 13 of 35 resected tumors (37%). 13 patients (37%) showed partial metabolic response (PMR), 21 (60%) had stable metabolic disease (SMD), and 1 (3%) had progressive metabolic disease (PMD). There was a significant correlation between the pathological response and the PET responses which were classified using PET response criteria in solid tumors (PERCIST). All (100%) the partial metabolic response (PMR, ΔSULpeak% < -30%) tumors showed the major pathological response (MPR, defined as 10% or less residual viable tumor). The patient who had progressive metabolic disease (PMD, ΔSULpeak% > 30%) was progressive confirmed by the biopsy of the pleural metastasis.

CONCLUSION

18F-FDG PET-CT can predict the major pathologic response to the neoadjuvant PD-1 blockade in resectable non-small cell lung cancer.

CLINICAL RELEVANCE/APPLICATION

Metabolic responses by 18F-FDG uptake which were classified using PET response criteria in solid tumors (PERCIST) are significant associated with therapeutic response at 4 weeks after PD-1 blockade treatment. Even if morphological changes on CT scans are investigated to evaluate the response to PD-1 blockade at an early phase, it is difficult to distinguish between responders and non-

responders. Thus, the uptake of 18F-FDG PET-CT appears to be a promising biomarker for sift patients who probably benefit form immunotherapy.

SST06-08 Relationship between the Expression of PD-L1 and F-FDG Uptake in Advanced Non-Small Cell Lung Cancer (NSCLC)

Friday, Dec. 6 11:40AM - 11:50AM Room: E353B

Participants
Wang Huoqiang, MD, Shanghai, China (*Presenter*) Nothing to Disclose
Zhao Long, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Programmed cell death-ligand 1 (PD-L1) have been identified as novel targets of immunotherapy of lung cancer. To our knowledge, all published studies of the relationship between the 18F-FDG uptake of lung cancer and PD-L1 expression were performed in patients undergoing surgical resection. However, majority of reports have demonstrated the superiority of PD-L1 inhibitors as a therapy for patients with advanced lung cancer. The purpose of this study is to investigate the predictive value of 18F-fluorodoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) in evaluating PD-L1 expression in advanced non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

From January 2017 to December 2018, advanced NSCLCs were retrospectively identified in 154 consecutive patients who underwent 18F-FDG PET/CT scan and PD-L1 expression test. The histopathological results were confirmed by aspirated or biopsied samples. The maximum standardized uptake value (SUVmax) of 18F-FDG uptake were calculated for the primary lesion. Associations between quantitative continuous variables and PD-L1 expression were investigated by using the Mann-Whitney U test. This study was approved by the institutional review board of our hospital.

RESULTS

PD-L1 expression were identified in 77 patients (50%). PD-L1 expression of NSCLC occurred more frequently in larger lesions ($p = 0.039$), higher SUVmax value ($p = 0.019$), KRAS mutation-positive ($p = 0.048$). PD-L1 expression of adenocarcinoma (ADC) occurred more frequently in larger lesions ($p = 0.022$), higher SUVmax value ($p = 0.043$). The receiver operating characteristic (ROC) curve yielded area under the curve (AUC) values of 0.596 (95%CI, 0.506-0.686, $p = 0.039$) and 0.633 (95%CI, 0.509-0.756, $p = 0.043$) for NSCLC and ADC, respectively.

CONCLUSION

We demonstrated that higher 18F-FDG uptake may be helpful in predicting PD-L1 expression of advanced NSCLC, especially advanced ADC.

CLINICAL RELEVANCE/APPLICATION

For the first time, we demonstrated that PD-L1 expression were more frequent in advanced NSCLC with higher 18F-FDG uptake.

SST06-09 The Role of 18F-FDG SPECT/CT in Predicting Expression of PD-1/PD-L1 in Surgically Resected Non-Small Cell Lung Cancer (NSCLC)

Friday, Dec. 6 11:50AM - 12:00PM Room: E353B

Participants
Wang Huoqiang, MD, Shanghai, China (*Presenter*) Nothing to Disclose
Zhao Long, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Although 18F-fluorodoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) has been widely used, there are still many hospitals performing 18F-FDG single photon emission computed tomography/computed tomography (18F-FDG SPECT/CT) scan. In previous studies, 18F-FDG SPECT/CT was a reliable tool in evaluation of malignant tumours, which were concordant with 18F-FDG PET/CT. At present, some studies have demonstrated a correlation between PD-1/PD-L1 expression and SUVmax in NSCLC, but the relationship between PD-1/PD-L1 expression and T/NT value are not clear. The purpose of this study is to investigate the value of 18F-FDG SPECT/CT predicting expression of PD-1/PD-L1 in NSCLC.

METHOD AND MATERIALS

From July 2014 to May 2016, NSCLCs were retrospectively identified in 229 consecutive patients who underwent 18F-FDG SPECT/CT scan and PD-1/PD-L1 expression test. The histopathological results were confirmed by resected samples. Tumor-to-normal tissue (T/NT) uptake ratios of 18F-FDG were calculated for the primary lesion.

RESULTS

PD-1 and PD-L1 expression were identified in 120 patients (52.4%) and 81 patients (35.4%), respectively. PD-L1 expression occurred more frequently in males ($p = 0.013$), larger lesions ($p < 0.001$), higher T/NT value ($p < 0.001$), T3/4 stage ($p = 0.002$), III stage ($p = 0.002$). In multivariate analysis, T/NT was significantly associated with PD-L1 expression. PD-1 expression occurred more frequently only in patients with higher T/NT value ($p = 0.028$). The receiver operating characteristic (ROC) curve yielded area under the curve (AUC) values of 0.685 (95%CI, 0.615-0.756, $p < 0.001$) and 0.568 (95%CI, 0.512-0.659, $p = 0.025$) for PD-L1 and PD-1 expression, respectively.

CONCLUSION

We demonstrated that T/NT value of FDG uptake may be helpful in predicting PD-1/PD-L1 expression, which is consistent with results of 18F-FDG PET/CT. In some countries, 18F-FDG SPECT/CT scan is covered by medical insurance, while 18F-FDG PET/CT is not, which enhances the clinical value of 18F-FDG SPECT/CT scan for cost reasons.

CLINICAL RELEVANCE/APPLICATION

For the first time, we demonstrated that PD-1/PD-L1 expression were more frequent in NSCLC with higher T/NT value.

Printed on: 10/29/20

SST07

Neuroradiology (Vascular and Interventions)

Friday, Dec. 6 10:30AM - 12:00PM Room: E353A

IR NR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Adrien Guenego, MD, Montjoire, France (*Moderator*) Nothing to Disclose
Benjamin Y. Huang, MD, MPH, Chapel Hill, NC (*Moderator*) Nothing to Disclose
Jalal B. Andre, MD, Seattle, WA (*Moderator*) Research Grant, Koninklijke Philips NV Consultant, Hobbitview, Inc Research Grant, Toshiba Corporation

Sub-Events

SST07-01 National Trends in the Use of Initial Imaging for Carotid Stenosis in the Outpatient Setting

Friday, Dec. 6 10:30AM - 10:40AM Room: E353A

Participants
Jina Pakpoor, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Andrew Harris, BS, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Joseph Canner, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Caitilin Hicks, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The Society for Vascular Surgery currently recommends carotid artery duplex ultrasonography (DUS) as the first-line imaging modality for the diagnosis of carotid artery stenosis, and this is in keeping with Appropriateness criteria of the American College of Radiology. We sought to investigate compliance with these guidelines on a national level for the initial work-up of suspected carotid artery stenosis in the outpatient setting.

METHOD AND MATERIALS

Using a national commercial claims database, we identified patients between 18-65 years old who had an outpatient visit with an associated initial diagnosis of carotid stenosis (ICD-9 433.10; ICD-10 165.2) from 2011-2016. Use of imaging was identified by Current Procedural Terminology (codes for DUS, CTA, and MRA associated with the initial outpatient visit. Trends were assessed using logistic regression analyses. Patients with any of the relevant ICD codes or CPT codes for one year prior to the encounter were excluded.

RESULTS

Overall, 229,464 patients with a new diagnosis of carotid artery stenosis were included in the analysis (mean age 55 years, 51.2% male). The majority (95.8%) of patients received DUS as the initial imaging modality, 2.4% received CTA, 1.3% received MRA, and 0.5% had more than one study associated with the encounter. The proportion of patients receiving DUS as the only initial imaging modality decreased from 97% in 2011 to 94% in 2016 ($p<0.001$). The rate of patients receiving CTA as the initial imaging modality increased from 1.6% in 2011 to 4.7% in 2016 ($p<0.001$). Use of MRA relatively stable (1.2%-1.5%) over the course of the study period. Use of initial advanced imaging (MRA/CTA) was highest in the West region of the USA (5.5%) and lowest in the Northeast (2.0%), $p<0.001$.

CONCLUSION

Our findings demonstrate that while the majority of initial imaging studies for suspected carotid artery stenosis are compliant with current recommendations from the Society of Vascular Surgery, the use of CTA is significantly increasing with time ($p<0.001$). Compared to DUS, CTA is associated with radiation exposure to the patient and a significantly higher imaging cost.

CLINICAL RELEVANCE/APPLICATION

Further education of the outpatient provider is needed to shift the current trend of initial CTA use for carotid stenosis; in particular in the setting of increasing availability of CT technology.

SST07-02 Identification of Patients with Carotid Stenosis Using Natural Language Processing

Friday, Dec. 6 10:40AM - 10:50AM Room: E353A

Participants
Xiao Wu, New Haven, CT (*Presenter*) Nothing to Disclose
Yuzhe Zhao, PhD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

This study aims to develop a natural language processing (NLP) model to retrospectively retrieve patients with presence, history and severity of carotid stenosis (CS) using their ultrasound reports.

METHOD AND MATERIALS

Ultrasound reports from our institution between January 2016 and December 2017. To process the texts, we developed a parser to divide the raw text into fields. For baseline method, we use bag of n-grams and term frequency inverse document frequency as the features and use linear classifiers. Logistic regression is performed as the baseline model. Convolution and recurrent neural networks (CNN; RNN) with attention mechanism are applied to the data set to improve the classification accuracy.

RESULTS

We had 1,220 ultrasound reports for training, and 307 for testing, totaling to 1,527 reports. For predicting history of CS, both CNN and RNN-Attention models have a significantly higher specificity than logistic regression. In addition, RNN-Attention also has a significantly higher F1 score and overall accuracy. For predicting presence, all models achieved above 93% accuracy. RNN-attention achieved a 95.4% overall accuracy, although the difference with logistic regression is not statistically significant with. RNN-Attention has a statistically significant higher specificity than logistic regression.

CONCLUSION

We have developed a parser to automatically segment the report text into different sections and predict history, presence and severity of CS. We have demonstrated NLP to be an efficient approach for large-scale retrospective patient identification, with wide applications in long-term follow-up of patients and further clinical research studies.

CLINICAL RELEVANCE/APPLICATION

NLP is shown to be an efficient approach for large-scale retrospective patient identification, with wide applications in long-term follow-up of patients and further clinical research studies.

SST07-04 3D-Arterial Analysis Software and CEUS in the Assessment of Severity and Vulnerability of Carotid Atherosclerotic Plaque in Comparison with CTA and Histology

Friday, Dec. 6 11:00AM - 11:10AM Room: E353A

Participants
Daniele Fresilli, Roma, Italy (*Presenter*) Nothing to Disclose
Giuseppe Schillizzi, Roma, Italy (*Abstract Co-Author*) Nothing to Disclose
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Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Ferdinando D'Ambrosio, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Vito Cantisani, MD, Roma, Italy (*Abstract Co-Author*) Speaker, Canon Medical Systems Corporation; Speaker, Bracco Group; Speaker, Samsung Electronics Co, Ltd;
Giorgia Polti, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Patrizia Pacini, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Olga Guiban, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Eleonora Polito, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Yana Solskaya, MD, Riga, Latvia (*Abstract Co-Author*) Nothing to Disclose
Eleonora Tassone, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Vincenzo Dolcetti, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Nicola Di Leo, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the accuracy of ultrasonographic 3D-Arterial Analysis and CEUS in assessing severity and vulnerability of carotid plaques.

METHOD AND MATERIALS

134 patients were enrolled with the following criteria: (1) asymptomatic stenosis of carotid artery >70% but <100%; or (2) recent transient ischemic attack or ischemic stroke, and ipsilateral carotid stenosis >50%. All the patients underwent endarterectomy and gross and histology evaluation was performed to grade the plaque. 3D-Arterial Analysis provided a colour map to evaluate plaque vulnerability and a 3D volumetric stenosis evaluation. Its diagnostic performance has been compared to histological examination for plaque's vulnerability and to CEUS and CTA for stenosis' grading.

RESULTS

94 vulnerable plaques at histological examination were identified with at least one of the following criteria: fibrous cap < 200 µm, presence of lipid core, intra-plaque haemorrhage, leukocyte recruitment or angiogenesis. 3D-Arterial Analysis software, CEUS and CTA were able to detect 84, 82 and 82 of these 94 vulnerable plaques respectively, with 89%, 87% and 87% sensitivity and 100% specificity. CTA has identified 84 severe stenosis of which 83 were correctly evaluated by 3D-Arterial Analysis software and CEUS, with a sensitivity of 88% and specificity of 100%.

CONCLUSION

3D-Arterial Analysis software and CEUS seem effective tools to assess plaque's vulnerability and stenosis severity, providing useful information for surgery planning. Multicenter prospective evaluation is warranted to clarify the role of US multiparametric evaluation.

CLINICAL RELEVANCE/APPLICATION

Pre-operative evaluation of carotid plaque is crucial for prompt follow-up or treatment. New Ultrasound diagnostic tool may open new further prospects. Multicenter prospective evaluation is warranted to clarify the role of US multiparametric evaluation

SST07-05 Current Challenges and Accuracy of Carotid Plaque Neovascularization Grading with Contrast-

Enhanced Ultrasound Method

Friday, Dec. 6 11:10AM - 11:20AM Room: E353A

Participants
Andrejs Lioznovs, Riga, Latvia (*Abstract Co-Author*) Nothing to Disclose
Maija Radzina, MD,PhD, Riga, Latvia (*Presenter*) Speaker, Canon Medical Systems Corporation

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PURPOSE

One of the stroke risk factors is unstable carotid atherosclerotic plaque with ulceration, soft plaque with surface irregularity as well as presence of nevascularisation. Contrast ultrasound (CEUS) is a new noinvasive method, that can detect vasa vasorum within plaque. The purpose of the study was to analyze CEUS technique ability to confirm plaque instability in correlation with CT angiography (CTA) and histological findings and to determine methods accuracy and limitations.

METHOD AND MATERIALS

Within period of 2 years a prospective study enrolled 54 patients with unstable plaque signs on ultrasound (US), all patients received baseline Duplex scanning, microvascular imaging (SMI) and contrast enhanced US with sulfur hexafluoride 1 ml followed by saline flush. CTA and histology results were used as reference standart. 32 patients underwent endarterectomy surgery. Based on CEUS results 2 groups were identified: poor (Grade 1) neovascularization and well visible (Grade2) vasa vasorum. For determination of CEUS sensitivity and specificity and limitations - two groups were compared - extensive calcified vs. soft plaques.

RESULTS

The neovascularization was diagnosed in 27 (50%) patients by CEUS - in 12 cases (44.4%) plaques showed neovascularization grade 1 and in 15 cases (55.6%) grade 2 plaques were detected. Comparing CEUS method and results of histology statistically significant correlation was found (rs = 0,624; p = 0,002). Comparing 2 groups: soft plaques neovascularization by CEUS was diagnosed in 13 cases (48.1%) with sensitivity - 77.78%, specificity 60%, positive predictive value 77.78%, negative predictive value 60%, accuracy 76.3%; In a group with extensive calcified plaques - neovascularization was detected in 14 patients (51.9%), methods sensitivity 53.33%, specificity 37.5%, positive predictive value 61.54%, negative predictive value 30%, accuracy 47.83% regardless stenosis grade.

CONCLUSION

CEUS is accurate method for confirmation of unstable plaque neovascularization regardless of stenosis grade well corresponding to histological results, but it cannot be recommended in cases of extensive calcinosis

CLINICAL RELEVANCE/APPLICATION

CEUS is a new noninvasive method, that may facilitate early detection of unstable carotid plaque (neovascularization) and may change patient management regardless stenosis grade concept in high stroke risk. Prerequisite is informative, but inconclusive baseline Duplex US and/or CTA findings.

SST07-06 Carotid Plaque Ulceration on Contrast-Enhanced Ultrasound: Diagnostic Accuracy Compared to Angiography

Friday, Dec. 6 11:20AM - 11:30AM Room: E353A

Participants
Ji Eun Park, Seongnam, Korea, Republic Of (*Presenter*) Nothing to Disclose
Yeo Koon Kim, Seongnam-si , Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The plaque ulceration is one of the features of plaque vulnerability and related to the risk for embolic stroke. The purpose of this study was to define the diagnostic accuracy of contrast-enhanced ultrasound (CEUS) for the carotid plaque ulceration.

METHOD AND MATERIALS

This study is a retrospective case series study. Institutional review board approved the study and waived informed consent. Patients who had CEUS and carotid angiography for evaluation of carotid plaque from September 2015 to June 2018 in our institution were consecutively included in this study (184 patients, 142 males, 280 carotid arteries, age 72±8.5 years, age range 32-91 years). The time interval between angiography and CEUS was limited to within six months. Carotid arteries with prior intervention (endarterectomy and stent) were excluded. CEUS was performed in order of 1) Doppler ultrasound, 2) injection of ultrasound contrast agent (SonoVue, Bracco, Italy), and 3) CEUS. A radiologist who was blinded to clinical information reviewed the CEUS images for plaque ulceration and the degree of stenosis. A neuro-intervention radiologist reviewed the angiography images. The plaque ulceration was defined to plaque surface indentation deeper than 2mm on both CEUS and angiography. Sensitivity, specificity and diagnostic accuracy were calculated for the detection of plaque ulceration and the significant (>50%) stenosis.

RESULTS

The prevalence of plaque ulceration was 25% on angiography. The sensitivity of CEUS for detection of plaque ulceration was 85.7% (95% confidence interval [CI]: 75.3% to 93.9%), specificity was 96.2% (95% CI: 92.6% to 98.3%), positive predictive value was 88.2% (95% CI: 79% to 93.7%), negative predictive value was 95.2% (95% CI: 91.9% to 97.2%), and the diagnostic accuracy was 93.6% (95% CI: 90% to 96.1%). The reason of false-negative cases was mainly calcification shadow on CEUS, and the false-positive cases were due to plaque surface irregularity.

CONCLUSION

CEUS can accurately visualize carotid plaque ulceration.

CLINICAL RELEVANCE/APPLICATION

The CEUS showed excellent diagnostic accuracy for carotid plaque surface evaluation.

SST07-07 Elevated Hemoglobin A1c is Associated with Intracranial Plaque Enhancement: Novel Findings from Magnetic Resonance Imaging Study in Stroke Patients

Friday, Dec. 6 11:30AM - 11:40AM Room: E353A

Participants
Xiao Li, Shanghai, China (*Presenter*) Nothing to Disclose
Beibei Sun, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Xiaosheng Liu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Few study reported the association between Hemoglobin A1c (HbA1c) level and intracranial plaque vulnerability by magnetic resonance imaging (MRI). The present study of MRI-identified intracranial atherosclerotic lesions in patients with ischemic symptom therefore sought to determine the association between HbA1c level and intracranial plaque morphological and compositional characteristics and cerebral infarction severity.

METHOD AND MATERIALS

108 patients with intracranial ischemia were recruited. All patients were stratified into high (>6.5%) and low (<6.5%) HbA1c groups and underwent both intracranial vessel wall MRI and brain MRI scans. Intracranial plaque features and intracranial ischemic lesions were assessed.

RESULTS

More intracranial plaques (2.38±1.50 vs. 0.96±0.75, P=0.001), higher incidence rate of intracranial symptomatic plaque enhancement (88.24% vs. 45.95%, P=0.001), more acute cerebral infarct (50.00% vs. 25.67%, P=0.013) and more recurrent infarct (67.65% vs. 45.95%, P=0.036) were in the high as compared to the low HbA1c group. High HbA1c was the independent risk factor for the presence of intracranial symptomatic plaque enhancement [odds ratio (OR)=7.05].

CONCLUSION

Our study suggested that an elevated HbA1c might have an adverse effect on intracranial plaque enhancement, which might induce acute cerebral infarct.

CLINICAL RELEVANCE/APPLICATION

Our findings indicate that determination of HbA1c levels and characterization of intracranial atherosclerotic plaque by MR vessel wall imaging might be useful to better select proper treatment options of stroke subjects.

SST07-08 Digital Variance Angiography Allows 50% Contrast Medium Reduction in Carotid X-Ray Angiography

Friday, Dec. 6 11:40AM - 11:50AM Room: E353A

Participants
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PURPOSE

In previous clinical studies Digital Variance Angiography (DVA) provided higher SNR and better image quality than Digital Subtraction Angiography (DSA). The observed quality reserve might provide opportunity for the reduction of ICM in CXA. Our aim was to evaluate the potential of DVA to reduce iodinated contrast medium (ICM) in carotid X-ray angiography (CXA).

METHOD AND MATERIALS

Our prospective study enrolled 26 patients undergoing carotid percutaneous transluminal angioplasty between January and June 2018. Mean±SD age (years): 67.0±8.1, 23 males 67.3±8.1, 3 females 64.7±9.8. We compared the signal-to-noise ratio (SNR) of DSA and DVA image pairs obtained by a standard (100% ICM) or a low-dose (50% ICM) protocol. Visual evaluation of single DVA or DSA images was performed by specialists using a 5-grade rating scale. The quality of DSA and DVA videos was also compared. Interrater agreement was described by percent agreement and Fleiss' kappa.

RESULTS

DVA provided more than two-fold SNR, the median SNRDVA/SNRDSA ratio was 2.06 (100%) and 2.25 (50%). In the visual evaluation the DVA100% score (3.73±0.06) was significantly higher than the DSA100% score (3.52±0.07, p<0.001), and the DVA50% score (3.64±0.13) was also significantly higher than the DSA50% score (3.01±0.17, p < 0.01). There was no statistical difference between the DSA100% and DVA50% scores. Evaluators preferred DVA50% over DSA100% videos in 61 % of comparisons, the interrater agreement was 81% (Fleiss' kappa 0.35, p<0.001)

CONCLUSION

Our data show, that DVA allows a very substantial (50%) ICM reduction in CXA without affecting the quality and diagnostic value of angiograms.

CLINICAL RELEVANCE/APPLICATION

Digital Variance Angiography (DVA) is a novel medical image processing method that significantly improves the image quality of X-ray angiograms compared to Digital Subtraction Angiography The quality reserve of DVA allows a substantial amount of iodinated contrast medium dose reduction in the carotid X-ray angiography setting without affecting the quality and diagnostic value of angiograms

SST07-09 Readmission after Treatment of Symptomatic Carotid Stenosis: A Nationwide Readmission Database Analysis

Friday, Dec. 6 11:50AM - 12:00PM Room: E353A

Awards
Trainee Research Prize - Fellow

Participants
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Pedram Golnari, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Roxanna M. Garcia, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Hannah K. Weiss, Chicago , IL (*Abstract Co-Author*) Nothing to Disclose
Sameer A. Ansari, MD,PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Ali Shaibani, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Michael C. Hurley, MBBCh, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Matthew B. Potts, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Babak S. Jahromi, MD,PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Carotid endarterectomy (CEA) and stenting (CAS) are two well-described methods for treating symptomatic carotid artery stenosis. However, literature on readmission after CEA and CAS is limited. We therefore utilized the Nationwide Readmission Database (NRD) to characterize the rate and causes of 30 and 90-day unplanned readmissions after CEA and CAS for symptomatic stenosis.

METHOD AND MATERIALS

Data was extracted from the NRD spanning 2010 to 2015. The population consisted of adult patients who underwent CEA or CAS with a primary diagnosis of occlusion and/or stenosis of carotid artery with cerebral infarction or TIA. Non-elective readmission rates within 30 and 90 days for CEA vs CAS were compared. To calculate 30 and 90-day readmission rates, we included patients within the first 11 and 9 months of each year respectively. Poisson regression was performed using generalized estimating equations and adjusted risk ratio (aRR)s were obtained for factors associated with 30 and 90-day readmission. The adjusted model included terms for patient- and hospital-specific factors, comorbidity scores and disease severity.

RESULTS

Of 54,704 patients treated and discharged alive, 8.0% patients were readmitted within 30 days, and 13.6%) patients were readmitted within 90 days. The 30 and 90-day non-elective readmission rate for CEA vs CAS was 7.7% vs 9.1% ($p<0.0001$) and 12.8% vs 17.0% ($p<0.0001$), respectively (figure). Patients undergoing CAS had a higher adjusted risk of non-elective 30 and 90-day readmission than patients having CEA (aRR=1.16; 95%CI, 1.09-1.23; $p<0.001$ and aRR=1.04; 95%CI, 1.01-1.08; $p=0.024$, respectively). The most common primary diagnoses for non-elective readmission within 30 and 90 days, respectively, were cerebral artery occlusion with infarct, septicemia, TIA, myocardial infarction, pneumonia, carotid artery stenosis/occlusion without infarction, and acute kidney failure.

CONCLUSION

Common reasons for 30 and 90-day non-elective readmission after CEA or CAS for symptomatic stenosis were cerebral artery occlusion with infarct, septicemia and TIA. Adjusted risk and rates of non-elective readmission after 30 and 90 days were higher after CAS than CEA.

CLINICAL RELEVANCE/APPLICATION

Patients undergoing CAS had higher risk of readmission than those undergoing CEA at 30 and 90-day post-procedure.

SPECIAL NOTE

This paper has received the Kuo York Chynn Neuroradiology Research Award. This award is funded in perpetuity by the Chynn Family Foundation. Through the Chynn Family Foundation, Emil William Chynn, MD, FACS, MBA will guide future distributions to support research in radiology.

SST08

Science Session with Keynote: Pediatrics (Artificial Intelligence and Machine Learning)

Friday, Dec. 6 10:30AM - 12:00PM Room: E261

AI PD

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Michael M. Moore, MD, Hershey, PA (*Moderator*) Nothing to Disclose
Raymond W. Sze, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose
Ramesh S. Iyer, MD, Issaquah, WA (*Moderator*) Nothing to Disclose

Sub-Events

SST08-01 Pediatrics Keynote Speaker: Emerging Machine Learning in Pediatric Radiology

Friday, Dec. 6 10:30AM - 10:40AM Room: E261

Participants
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SST08-02 Children's Long Bones Acute Fracture Discrimination Using Multi-View Screening and Trained Deep Network

Friday, Dec. 6 10:40AM - 10:50AM Room: E261

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PURPOSE

Fracture dating (acute vs healing) of various pediatric long bone fracture subtypes is routinely performed by human radiologists by identifying presence of periosteal reaction or callus. We evaluate if fracture acuity or evidence of healing can be accurately categorized in a heterogeneous group of pediatric long bone fractures using a properly designed and trained Convolutional Neural Network (CNN).

METHOD AND MATERIALS

Our IRB approved this retrospective study. Radiographs collected in a large pediatric hospital during 2018 were selected using a search of radiology reports containing keywords: humerus, tibia, fibula, radius, or femur. The radiographs were reviewed and manually labeled by a box overlaying the fracture location to facilitate CNN training. These fractures included Salter-Harris, oblique, transverse, and buckle fractures with or without varying degrees of displacement and angulation. These individual fractures were subclassified as healing or acute by two faculty pediatric radiologists and two radiology physician assistants with reference to the final signed radiology report. Healing was defined as any radiologically visible callus or early periosteal reaction. The resulting 3801 radiographs consisted of 1910 acute and 1891 healing fractures (mean age 7.2 years, male 55.6%). They were patched into 512x512 pixels subdomains, thus building training, validation and test sets with 3001/400/400 patches respectively, and an almost perfect 50/50 class balance in each set. Transfer learning CNN was utilized with an additional four fully connected top layers of the network. A 10-fold cross-validation approach was used by shifting each set (training/validation/test) sequentially. Trained networks classified single views from each study till all available views were classified, and a decision calculated based on the algebraic mean of results from all views.

RESULTS

The 3 best CNN's exhibit stable high accuracy of 92.02%, AUC-ROC of 0.96, with the best performing CNN achieving 94.35% accuracy and 0.97 AUC-ROC. The CNNs performance are summarized in table 1, confirming stable results.

CONCLUSION

CNN based pediatric long bone fracture acuity classification using a multi-view approach is highly accurate. The 10-fold cross-validation approach limits possible bias due to relatively low size of the dataset.

CLINICAL RELEVANCE/APPLICATION

This is the first study showing CNN's are capable of fracture subtype categorization.

SST08-03 Using a Dual-Input Convolutional Neural Network for Automated Detection of Pediatric Supracondylar Fracture on Conventional Radiography

Friday, Dec. 6 10:50AM - 11:00AM Room: E261

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PURPOSE

The purpose of this study was to assess the feasibility and diagnostic performance of using a dual-input convolutional neural network (CNN)-based deep learning algorithm which utilizes both anteroposterior (AP) and lateral elbow radiographs for automated detection of pediatric supracondylar fracture on conventional radiography.

METHOD AND MATERIALS

For the development of deep learning model, 1,266 pairs of AP and lateral elbow radiographs examined between January 2013 and December 2017 at a single institution were split into a training set (1,012 pairs, 79.9%) and a validation set (254 pairs, 20.1%). We used 258 pairs of radiographs examined in 2018 at the same institution as a temporal test set and 95 examined between January 2016 and December 2018 at another hospital as a geographic test set. Images underwent preprocessing including cropping and histogram equalization and were passed into a dual-input neural network constructed by merging two ResNet models. Observer study by radiologists was performed on the geographic test set. The area under the receiver operating characteristic curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the model and human readers were calculated.

RESULTS

Our trained model showed an AUC of 0.976 (95% CI, 0.949-0.991) in the validation set, 0.985 (95% CI, 0.962-0.996) in the temporal test set, and 0.992 (95% CI, 0.947-1.000) in the geographic test set; The AUCs of human readers in the geographic test set showed a range of 0.977 to 0.997. Using the optimal operating point derived from the validation set, the model showed a sensitivity of 93.9%, a specificity of 92.2%, a PPV of 80.5%, and a NPV of 97.8% in the temporal test set and a sensitivity of 100%, a specificity of 86.1%, a PPV of 69.7%, and a NPV of 100% in the geographical test set.

CONCLUSION

A dual-input deep learning model which interprets both AP and lateral elbow radiographs provided an accurate diagnosis of pediatric supracondylar fracture comparable to radiologists.

CLINICAL RELEVANCE/APPLICATION

Our study suggests a potential role of deep learning as triage in the management of pediatric elbow trauma, as our model showed high sensitivity and high negative predictive value in automated detection of a supracondylar fracture on elbow radiography.

SST08-04 Automatic Measurement of Leg Length Discrepancies in Pediatric Patients on X-Ray Imaging Using Deep Learning

Friday, Dec. 6 11:00AM - 11:10AM Room: E261

Participants
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PURPOSE

Leg length discrepancy studies are commonly ordered orthopedic conventional radiographic studies, which are simultaneously labor intensive and cognitively simple studies for pediatric radiologists, representing an inefficient use of the radiologist's time and expertise. The purpose of our study is to demonstrate that measuring and calculating differences in femur and tibia lengths on pediatric leg length discrepancy studies based on X-ray imaging can be automated and performed rapidly by a deep learning algorithm.

METHOD AND MATERIALS

The femora and tibiae of pediatric legs were segmented and measured by a cascaded coarse-fine convolutional neural network (CNN). Specifically, we trained a coarse CNN model to classify the leg to the left and right sides of subject, then the fine leg segmentation was performed on each side. In order to augment the training data and improve the segmentation accuracy, we adopted a leg shape based image registration method to generate more training samples after flipping the left side leg images vertically. The leg length was measured by extracting corresponding pixels on the edges and calculating the distances between

them.

RESULTS

X-ray imaging scans of 103 subjects (48 male/ 55 females, mean age 12.99, SD 2.84) were identified in this study. We randomly selected 70 subjects as training data and 33 images as testing data. After the data augmentation by shape based image registration, the training data had 19600 samples. Results demonstrated that the cascaded coarse-fine deep learning method performed accurate segmentation on pediatric legs. On the testing data, the segmentation accuracy was 0.90, the correlation value between truth measurement from radiology reports and calculated measurements was 0.9772 ($p<0.001$), and the mean squared error was 1.4 mm. The automated measurements took less 1 second for each subject.

CONCLUSION

The deep learning algorithm can quickly perform the task of measuring leg lengths as accurately as subspecialty trained pediatric radiologists.

CLINICAL RELEVANCE/APPLICATION

The rapid and automated measurement of leg length as accurately as subspecialty trained pediatric radiologists will help make more efficient use of the radiologist's time and expertise. The automation of the labor intensive and cognitively undemanding task of measurement can enable radiologists to focus on seeking subtle additional findings such as bone tumors or metabolic disease.

SST08-05 Rethinking Greulich & Pyle: Deep Learning Models for Pediatric Bone Age Assessment

Friday, Dec. 6 11:10AM - 11:20AM Room: E261

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PURPOSE

The Greulich & Pyle (G&P) atlas is the most common standard by which bone age assessment (BAA) is performed. This study compares G&P-based BAA (GP-BAA) with deep learning-based BAA (DL-BAA).

METHOD AND MATERIALS

DL-BAA uses a 3-model MobileNetV2 convolutional neural network (CNN) ensemble trained on 13,769 pediatric trauma hand radiographs (male: 6,889, female: 6,880, age range: 0-18 years, mean age: 11.1 years) from a large academic medical center using the patient's chronological age as ground truth. Separate models were trained for male and female patients. The test set comprised 214 pediatric trauma hand radiographs (male: 100, female: 114, age range: 1-18 years, mean age: 11.7 years) from a geographically distinct large academic children's hospital with chronological age as ground truth. Using mean absolute error (MAE), we compared performance of DL-BAA on the test set with that of 3 GP-BAA ratings, including two board-certified pediatric radiologists who each used G&P, and a CNN ensemble trained on G&P-labeled pediatric hand radiographs from the RSNA Pediatric Bone Age Machine Learning Challenge (RSNA-AI). The RSNA-AI had achieved a MAE of 4.35 months in the challenge. Statistical analysis was performed using the bootstrap method.

RESULTS

The MAE between radiologists 1 and 2 for the test set was 6.3 months; the MAEs between RSNA-AI and radiologists 1 and 2 were 8.6 months and 10.1 months, respectively. The MAEs in months of DL-BAA, radiologist 1, radiologist 2, and RSNA-AI were 11.8, 14.6, 16.0, and 14.2, respectively. For female (male) patients, the MAEs of DL-BAA and GP-BAA were 11.6 (12.0) months and 14.6-16.8 (13.5-15.0) months, respectively. All MAE differences between DL-BAA and GP-BAA were statistically significant with $p < 1e-6$. On average, all ratings overestimated chronological age by 5.2 to 8.3 months. DL-BAA and GP-BAA estimated bone ages within 12, 18, and 24 months of chronological age for 68% vs. 61-68%, 85% vs. 65-78%, and 94% vs. 85-87% of test cases.

CONCLUSION

DL-BAA performed with lower mean absolute error for a normal pediatric population than either pediatric radiologist or automated GP-BAA. Future work will validate this method on other patient populations with more test data.

CLINICAL RELEVANCE/APPLICATION

DL-BAA should be an integral part of the future of BAA, as it can achieve equal-to-superior performance versus conventional methods and easily be adapted to different patient populations.

SST08-06 Prediction of Neurodevelopmental Outcome in Preterm Neonates with Cerebral MR Spectroscopy and DTI Using Feed-Forward Neural Networks

Friday, Dec. 6 11:20AM - 11:30AM Room: E261

Participants
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PURPOSE

We aimed to evaluate if proton magnetic resonance spectroscopy (1H-MRS) and diffusion tensor images (DTI) performed in very preterm neonates (PNs) at term equivalent age (TEA) can predict their neurodevelopmental outcome (NDO) at the corrected age of 12 months using feed-forward neural-networks (fNNs).

METHOD AND MATERIALS

From 346 PNs born before 32 gestational weeks, 246 were excluded due to missing or poor-quality spectroscopy data and/or missing neurodevelopmental tests at 12 months corrected age. The data sets of 100 PNs were considered for motoric and cognitive development, of whom 8 and 5, respectively were categorized as underdeveloped. We evaluated five potentially relevant metabolite ratios and two DTI characteristics, each in six different areas of the brain. We performed a feature selection algorithm for receiving a subset of those characteristics that we could assume as significant. To reduce bias by unbalanced classes, only PNs that share approximate values of those characteristics with ones that had shown underdevelopment were considered for further calculations. On those smaller sets of PNs, we finally constructed predictors using fNNs, which were able to predict underdevelopment in PNs after considering the characteristics selected previously.

RESULTS

The constructed predictors give a 100% accuracy in the case of the motoric underdevelopment. In the case of cognitive underdevelopment, we obtain a true positive rate of 100% and a positive predictive value of 83,3 %.

CONCLUSION

1H-MRS and DTI obtained at TEA in PNs allow prediction of their motoric and cognitive development at the corrected age of 12 months. The proposed approach using fNNs promises its use in clinical practice and could be useful for spotting those PNs, who would mostly benefit from early intervention services.

CLINICAL RELEVANCE/APPLICATION

1H-MRS and DTI obtained at term equvalent age in very preterm neonates allow prediction of their motoric and cognitive development at the corrected age of 12 months, and the proposed approach using fNNs could be useful for spotting those preterm neonates, who would mostly benefit from early intervention services.

SST08-07 MRI Radiomics Profiling of Pediatric Medulloblastoma Improves Risk Stratification Beyond Clinical and Conventional MR Imaging Features

Friday, Dec. 6 11:30AM - 11:40AM Room: E261

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PURPOSE

Radimoics is a powerful and promising approach to predict the disease prognosis. Our purpose was to evaluate magnetic resonance imaging (MRI) radiomics signature in stratifying the risk of pediatric medulloblastoma with overall survival (OS).

METHOD AND MATERIALS

Eighty-two children (mean age: 5.9±3.1 years) with pathologically confirmed medulloblastoma and preoperative MR images were retrieved from the database of our hospital from November 2006 to October 2017 . Three hundreds and eighty-five radiomics features were extracted from postcontrast T1 weighted images and the features correlated with OS of pediatric medulloblastoma were identified using the least absolute shrinkage and selection operator (LASSO) Cox regression model. Five-fold cross validation was used to test steadiness of selected features. The radimoics signature (Ras-score) was generated and the incremental value of the radimoics signature to the clinical and conventional MR imaging features for personalized OS estimation was calculated by comparing the models in different layers. .

RESULTS

Seven selected radiomics features-based Rad-score could enable the stratification of medulloblastoma for OS (HR: 5.8; [CI]: 2.07, 16.27; P<0.01). Among the models from different layers, the integrative model combined Rad-score, clinical and conventional imaging features was the most accurate model in predicting the OS of children with medulloblastoma (C-index:0.928).

CONCLUSION

Rad-score radiomics allow predicting OS of the pediatric patients with medulloblastoma. And the predictive performance can be improved when combined with the clinical and conventional MR imaging characteristics.

CLINICAL RELEVANCE/APPLICATION

Radiomics is an approach which can provide a great deal of quantitative features reflecting intratumoral heterogeneity. Combined with clinical and conventional MR imaging features, radiomics could increase predictive accurancy for children with medulloblastoma.

SST08-08 CT-Based Radiomics Signature: A Potential Non-Invasive Biomarker for Predicting MYCN Amplification in Neuroblastomas in Children

Friday, Dec. 6 11:40AM - 11:50AM Room: E261

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PURPOSE

To develop a CT-based radiomics signature and evaluate its capability for predicting the MYCN-amplification (MNA) in neuroblastomas (NBs) in children.

METHOD AND MATERIALS

This retrospective study included 77 children with histopathological-confirmed neuroblastomas (39 in training group and 38 in test group). Clinical information were recorded for each child.Children underwent MYCN gene detection and contrast-enhanced CT before treatment. Region of interest (ROI) was manually delineated in pre-contrast phase, arterial phase, and venous phase with five slices of primary tumor, and 396 CT-based radiomics features were extracted from each phase respectively. The synthetic minority oversampling technique (SMOTE) was used to balance the sample number in training group (MNA vs non-MNA, 7 vs 32). Four radiomics signatures were built by the least absolute shrinkage and selection operator (LASSO) logistic regression model based on the 3 phases and combined phase, respectively. The receiver operating characteristics curve (ROC) analysis and 10-fold aross validation were conducted to evaluate the predictive performance of them. The developed radiomics signature was further validated for its predictability in the test group.

RESULTS

All of four CT-based radiomics signatures were developed as an independent predictor for MNA in NBs. The best predicting performance of MNA was from the combination of pre- and post-phases. The sensitivity, specificity, accuracy and area under the curve of training group were 96.4%, 100%, 98.0%, and 1.00, while 93.8%, 100%, 94.9%, and 0.98 in the test group,respectively.

CONCLUSION

The proposed CT-based radiomic signature can potentially help in predicting MNA in pretreated NBs in children. Combination of images in the pre- and post-contrast phase can serve as a better non-invasive biomaker for the identification of MNA.

CLINICAL RELEVANCE/APPLICATION

This study is designed to developing a CT-based radiomics signature and evaluating its capability for predicting the MYCN-amplification (MNA) in neuroblastomas (NBs) in children. The proposed CT-based radiomic signature can potentially serve as a non-invasive biomaker for the identification of MNA.

SST08-09 CT-Based Radiomic Analysis Predicts Prognosis in Pediatric Malignant Peripheral Neuroblastic Tumors: A Single Center Retrospective Study

Friday, Dec. 6 11:50AM - 12:00PM Room: E261

Participants
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PURPOSE

The aim of this study was to develop and validate a preoperative radiomics analysis system based on CT images to predict outcome in pediatric malignant PNTs.

METHOD AND MATERIALS

A total of 405 patients (training cohort: n =280; validation cohort: n =121) pathologically diagnosed as malignant PNTs including neuroblastoma (NB) and ganglioneuroblastoma (GNB) were retrospectively studied between January 2010 and June 2018. Every patient underwent post-contrast enhanced CT examination before any treatment. Patients were divided into low-, intermediate-, and high-risk groups according to clinical prognostic factors. All radiomics features were extracted from manually segmented tumors in artery phase of CT images in all cases, and they were derived from first-order histogram, tumor shape, gray-level co-occurrence

matrix (GLCM), gray-level run length matrix (GLRLM), gray-level size zone matrix (GLSZM), neighboring gray-tone difference matrix (NGTDM), gray-level dependence matrix (GLDM). Spearman's rank order correlation with 0.9 threshold and least absolute shrinkage and selection operator (LASSO) were used for redundancy elimination and feature selection, respectively. To build a classifier for stratifying three groups of risk, two logistics regression models were applied in a cascade way. The first model (model1) was used for classifying high-risk group and the rest, while the rest were classified into intermediate- and low-risk groups by the second model (model2). The performance of the predictive models was evaluated with the respect to the receiver operating characteristics (ROC) curve. Above works were completed by IFoundry (Intelligence Foundry 1.1, GE Healthcare).

RESULTS

18 and 32 features were obtained after the process of redundancy elimination and feature selection for model1 and model2 respectively. The models demonstrated good discrimination in both training cohort and validation cohort, with AUC of 0.826 for model1 and that of 0.811 for model2.

CONCLUSION

Radiomics analysis based on preoperative CT images has the potential to predict clinical prognosis and aid to stratify individualized treatments of pediatric malignant PNTs. Future studies are needed to validate these findings.

CLINICAL RELEVANCE/APPLICATION

Radiomics approach may be used to aid intratumoral heterogeneity detection and outcome prediction in malignant PNTs children.

Printed on: 10/29/20

SST09

Physics (CT - Artifact Reduction)

Friday, Dec. 6 10:30AM - 12:00PM Room: E351

CT PH

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
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Sub-Events

SST09-01 A Deep Learning-Based Dual-Domain Model for Reducing Metal Artifacts in Clinical CT Images

Friday, Dec. 6 10:30AM - 10:40AM Room: E351

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CONCLUSION

Our proposed deep learning model yields better metal artifact reduction performance than other state-of-the-art methods and can be applied in the real word.

Background

Metallic implants cause severe streak and beam hardening artifacts in CT scans. Traditional methods, like linear interpolation (LI) and NMAR, inpaint affected sinogram to reduce artifact, but induce secondary artifacts or suffer from false tissue segmentation. Recently, deep learning based method, cGan-CT, tries to reduce artifacts in image domain but the effect is limited. Here, we propose a Dual-Domain Network (DuDoNet) and demonstrate its application to clinical data.

Evaluation

DuDoNet consists of a sinogram enhancement network (SE-Net), a differentiable Radon inversion layer (RIL) and an image enhancement network (IE-Net). The SE-Net learns to restore sinogram data via a mask pyramid U-Net. RIL reconstructs images from sinograms and allows joint learning of the two networks. The IE-Net further refines the images by a U-Net with residual learning. The learning of DuDoNet, which takes metal affected sinograms and corresponding metal traces as inputs, is supervised with clean sinograms and images. We synthesize 360,000 training and 2,000 validation samples based on DeepLesion. In synthesized data, DuDoNet restores the most details among all methods, with a PSNR of 32.29dB and a SSIM of 0.959. Our model successfully reduces the streak and shadowing artifacts and alleviates drawbacks of single domain methods. Then, DuDoNet trained on simulated data is applied to a total of 100 clinical images from DeepLesion and SpineWeb. Visual comparison shows that DuDoNet effectively suppresses the secondary artifacts and avoids false structural segmentation problem in prior based methods. Blinded qualitative evaluation by radiologists shows DuDoNet achieves the best performance (rank: 3.13) and significantly outperforms LI, NMAR, cGan-CT ($p<0.028$).

Discussion

In DuDoNet, SE-Net first recovers inconsistent sinograms and IE-Net further reduces secondary artifacts. Our model effectively reduces metal artifacts in both simulated and clinical scans and achieves better image quality than other single domain approaches.

SST09-02 Reduction of Artifacts from High-Density Moving Objects in C-arm CBCT Using a Deep Learning-Based Segmentation Approach

Friday, Dec. 6 10:40AM - 10:50AM Room: E351

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PURPOSE

Moving, high-density objects in the heart, including catheters and pacemaker leads, cause substantial artifacts in cone beam CT (CBCT) images. The purpose of this work was to exploit a deep learning method to efficiently segment and remove these objects from projection rotational angiography (RA) images, thereby reducing artifacts in cardiovascular CBCT images.

METHOD AND MATERIALS

Segmentation of the high-density objects from the RA images was performed using a deep convolutional neural network with an encoder-decoder architecture based on the VGG-16 network. Synthetic training (3,000) and validation (2,000) images were created by adding augmented RA images of a pigtail catheter to RA images of an anthropomorphic phantom acquired with a clinical angiography system. The model trained with the synthetic images was then used as a starting point to learn to label pacemaker leads and different type of catheters in two real patient data sets. The new image set consisted of 450 and 50 RA images in total for training and validation, respectively. Data was augmented by reflection, translation, size scaling, rotation, and noise addition in both image sets. To remove high-density object artifacts, the segmented image pixels were inpainted by solving the Dirichlet boundary value problem. Correlated Poisson noise was then added to the inpainted pixels to match image texture. The original and modified RA images were reconstructed using filtered back-projection to create CBCT images.

RESULTS

Training for the synthetic and patient images took 25 and 2 hours, respectively. A Sørenson-Dice coefficient of 80.8% and 75.6% was obtained for each set, respectively. These values are partly explained by the model output which extended modestly beyond the edges of the ground truth representation of the objects. Visual inspection of the resultant patient CBCT images demonstrated that artifacts associated with moving catheters and pacemaker leads were nearly completely resolved without introduction of other image defects.

CONCLUSION

A deep learning method to segment catheters and pacemaker leads in projection RA images of the heart was implemented and used to mitigate associated artifacts in CBCT images of the heart.

CLINICAL RELEVANCE/APPLICATION

This work demonstrates a deep learning segmentation method to mitigate the artifacts caused by moving high-density objects in the heart, thereby providing substantially improved CBCT images.

SST09-03 Dental Artifact Reduction Using a Three-Stage Projection-Based Metal Artifact Reduction Algorithm for Spectral Imaging: A Phantom Study

Friday, Dec. 6 10:50AM - 11:00AM Room: E351

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PURPOSE

Dental artifact remains a significant challenge on neck computed tomography. The purpose of this study is to evaluate a novel three-stage projection-based metal artifact reduction (GSI MAR) algorithm for reducing dental artifact using a phantom. The study evaluates the effectiveness of the MAR algorithm on dual energy acquisitions, the impact of radiation dose and the impact of MAR on multiple iodine concentrations.

METHOD AND MATERIALS

Two dental amalgams were inserted in a phantom next to five varying iodine concentrations to simulate the effects of artifact on enhancing tissues. Scans were acquired at five different doses and reconstructed without or with GSI MAR. Quantitative analysis was performed using standard deviation (SD), signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of strategically located regions of interest (ROI). The impact across 40 keV to 140 keV virtual monochromatic image (VMI) were evaluated. Qualitative analysis was performed by two external radiologists, estimating artifact reduction, anatomical and contrast improvement. Lastly, material decomposition maps were used for estimating iodine content.

RESULTS

Quantitative results indicated that the GSI MAR significantly lowered noise at all energy levels. Noise reduction percentage was highest at 70.72 % in the 135 keV VMI and the lowest at 58.70% in the 40 keV VMI. Iodine conspicuity was highest at low energy levels. A 348.58 % CNR and 294.35 % SNR increase was calculated at 40 keV VMI and a 18.5 % CNR and 14.25 % SNR increase in the 140 keV VMI. GSI-MAR improved the iodine estimation error from 146.95% to 62.82%. Subjective analysis indicated that the MAR provided higher quality acquisitions with an average artifact reduction between 51-75%.

CONCLUSION

Quantitative analysis of GSI MAR indicated an improvement of image quality across all energy levels. Lowest noise was found at higher energy levels and highest CNR and SNR was found at lower energy levels. Furthermore, subjective review indicated that MAR reconstructions provided higher quality images. Finally, GSI MAR was found to improve iodine concentration estimation.

CLINICAL RELEVANCE/APPLICATION

Dental artifact remains a significant challenge on neck computed tomography. This study evaluates the effectiveness of a novel metal artifact reduction algorithm.

SST09-04 CT Image Quality for Five Different Metal Artifact Reduction Algorithms

Friday, Dec. 6 11:00AM - 11:10AM Room: E351

Participants
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Anne C. Martinsen, Oslo, Norway (*Presenter*) Nothing to Disclose

PURPOSE

To evaluate the effectiveness of five CT Metal Artifact Reduction (MAR) Algorithms from four vendors in improving the image quality using a novel phantom for Metal Artifact Analysis.

METHOD AND MATERIALS

A Catphan 605 phantom with extension ring was scanned with different inserts (Hard Steel, Titanium, and Water) on 5 CT scanners reconstructed with and without MAR algorithms. The MAR algorithms used; GSI MAR (GE Revolution CT), Smart MAR (GE Revolution Frontier), O-MAR (Philips Ingenuity CT), iMAR (Siemens Somatom Drive) and SEMAR (Toshiba Aquilion One Genesis). Phantom was scanned at 120kV and at 120 kVp equivalent for GSI MAR and iMAR. Image quality was assessed by obtaining Contrast to Noise Ratio (CNR), Metal Artifact Analysis and Noise Power Spectrum (NPS). The parameters were obtained from ImageOwl Catphan QA software and Matlab.

RESULTS

For Titanium, Smart MAR, iMAR and SEMAR images had more noise than the images without MAR algorithms, while GSI MAR and O-MAR images had less noise than the images without MAR. MAR images had a lower CNR than the corresponding images without MAR, except GSI MAR images which had higher CNR than the images without MAR. For water, there was no difference in CNR for images with and without MAR, except iMAR and SEMAR. Metal Artifact Analysis showed artifact reduction around the insert and at a distance from the insert for all MAR algorithms in like manner. For titanium, GSI MAR showed the largest artifact reduction (87%, 73% respectively) followed by Smart MAR, SEMAR, O-MAR and iMAR. For hard steel, Smart MAR showed the largest artifact reduction (92%, 82%) followed by GSI MAR, SEMAR, iMAR, and O-MAR.There was no difference in NPS with and without MAR.

CONCLUSION

GSI MAR showed the most consistent performance under different conditions. Different MAR algorithms compensate differently for metal artifacts under different conditions. Thus, it is important to know the effects of the algorithms on image quality. Images obtained with MAR algorithms should be compared with those without MAR algorithms.

CLINICAL RELEVANCE/APPLICATION

Different MAR algorithms compensate for metal artifacts differently under different conditions. Thus, it is important to know the effects of the algorithms on image quality.

SST09-05 Image Quality Assessment of Metal Artefact Reduction in CT Using a Novel Abdominal Phantom

Friday, Dec. 6 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

To evaluate a novel anthropomorphic abdominal phantom specially designed for qualitative and quantitative metal artefact assessment in CT for two different metal artefact reduction technologies.

METHOD AND MATERIALS

A anthropomorphic abdominal phantom with different inserts (bone with metal, low contrast, spatial resolution and homogeneity) was used in this study. Titanium, Hard and stainless steel inserts were placed in the center of the bone insert. All scans were performed on a GE Revolution CT at 15 and 20 mGy CTDIvol, 40 mm collimation, 120 kVp (+/- HiRes) and spectral imaging (GSI). Images were reconstructed with standard kernel, 2.5 mm slices, ASIR-V 50% and +/- MAR. Four observers evaluated lesion conspicuity and scored artefacts on a 4-point scale for all reconstructions. HU uniformity, coefficient of variation, reduction in noise streaks (range and standard deviations (SD)), noise power spectrum (NPS) and modulation transfer function (MTF) were evaluated for all reconstructions.

RESULTS

Preliminary quantitative and qualitative results showed that both single energy MAR (SMAR) and GSI MAR (GSIMAR) reduced streaks artefacts surrounding (2123-7019 vs 1267-5993 HU) and at a distance (196-251 vs 78-83 HU). Lesion conspicuity was not affected by MAR. HU uniformity and SD around the metals (223.08-438.76 vs 105.02-260.75 HU) and the bone insert (SD: 71.48 -143.17 vs 39.59 - 69.97 HU) were improved by the use of both SMAR and GSIMAR. These improvements were independent of dose. The use of only HiRes without MAR did not reduce streaks artefact, noise or HU uniformity. MAR hardly affected the MTF@50%. NPS profile

was not affected by MAR.

CONCLUSION

Both SMAR and GSIMAR reduced metal artefact and improved image quality. Anthropomorphic phantom designed for qualitative and quantitative image quality analysis evaluation of metal artefact reduction should be used to assess image quality and lesion detection when MAR is introduced in daily routine to ensure that pathology is not missing after MAR has been applied.

CLINICAL RELEVANCE/APPLICATION

New anthropomorphic phantom specially designed for quantitative and qualitative assessment of metal artefact reduction in CT is important to ensure that pathology is not missing when MAR is applied.

SST09-06 Reduction of Cone-Beam Artifacts in Axial CT Systems with Large Detector Coverage

Friday, Dec. 6 11:20AM - 11:30AM Room: E351

Participants
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PURPOSE

We report cone-beam artifact reduction on axial scans with a 16cm coverage CT system using a recursive application of 3D filtered backprojection (FBP).

METHOD AND MATERIALS

Axial CT for voxels outside the acquisition plane does not satisfy a fundamental completeness condition, which leads to cone-beam artifacts. This is particularly evident in systems with large detectors. Previously published re-projection based recursive application of FBP was used to improve image quality in large pitch helical scans. We revisit this approach, apply it to the axial 3D FBP reconstruction and explain the effectiveness of the algorithm using a new argument based on the minimization of Bregman distances. The theoretical result is tested with analytic simulations and clinical data sets, reused from the previous clinical trials.

RESULTS

Recursive FBP algorithm reduced the low frequency artifacts in simulations effectively, returning images which are approaching the analytic ground-truth with every repeated recursive step. In clinical data, cone beam artifacts were considerably reduced with a more pragmatic combination of image processing and one recursive FBP application.

CONCLUSION

Bregman distance minimization algorithm leads to a previously known recursive 3D FBP algorithm, which proves to be effective for axial scans on systems with large detector coverage, offering a strong, new theoretical foundation for this algorithm. A pragmatic combination of recursive FBP with image processing returns high quality results from single-shot axial scans with improved bone clarity and more accurate CT numbers in the soft tissue.

CLINICAL RELEVANCE/APPLICATION

Cardiac scans can be performed within a single heartbeat using an axial CT with 0.25s rotation time and 16cm detector coverage. Tilted single shot axial head scanning ensures an efficient protection against excessive x-ray dose delivered to the eye lenses. Efficient reduction of cone-beam artifacts for both of these protocols is necessary.

SST09-07 Reduction of Artifact Caused by Embolization Coil Implant in Spectral CT Examination by Means of Virtual Monochromatic Imaging (VMI) and Monochromatic Imaging Combined with Metal Artifact Reduction Software (MARs)

Friday, Dec. 6 11:30AM - 11:40AM Room: E351

Participants
Zhipeng Yao, Beijing, China (*Presenter*) Nothing to Disclose
Yahui Peng, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the reduction of artifact from embolization coil implant using VMI and VMI combined with MARs in spectral CT.

METHOD AND MATERIALS

Embolization coil implant was placed in an intermediate tube of the Quantitative Standard Pulsating Phantom (QSP) that contained an Iodine solution of 7 mgI/ml (CT value = 160HU at 120 kVp, representing the portal vein attenuation in the portal vein phase). Subsequently, 20 ml of sodium chloride solution was contained in eight tubes and inserted into the QSP. Two spectral CT scan protocols were used for image acquisition: conventional CT scan with tube voltage of 120 kVp(Group A); Spectral Imaging scan (Group B). A conventional image (CI) and virtual monochromatic images (70 - 140 keV, of 10 keV interval) with and without MARs were reconstructed, respectively. In each of the images, a measurement region of interest (ROI) was placed around the tube , including all pixels contaminated by the metal artifact but excluding the pixels inside the tube(ROItube). Besides, a background ROI was placed above the tube not influenced by the artifact,from where mean CT number(NCT) and standard deviation (SD) were measured. ΔCT was defined as the absolute value of NCT in hyperdense or hypodense artifact minus NCT in background ROI.

RESULTS

VMIMARs showed a significant decrease of hyperdense artifact ($p<0.05$)and hypodense artifact($p<0.05$)in term of lower ΔCT as compared to 120kVp imaging. With increasing of KeV , ΔCT and SD of artifact were decreasing in VMIMARs.In addition, noise image in VMIMARs exhibited a decreasing trend with increasing keV level. Whereas VMI only showed a significant decrease of hyperdense artifact ($p<0.05$). VMIMARs at 70 keV -140keV could show a better effect on the reduction of metal artifact as compared VMI at 140keV($p<0.05$).

CONCLUSION

Compared with conventional CT scanning, VMIMARs by using spectral CT could significantly reduce metal artifacts caused by embolization coil implants and provide better image noise.

CLINICAL RELEVANCE/APPLICATION

When using spectral CT for patients underwent Gastric coronary vein embolization(GCVE) produre, VMIMARs could significantly reduce metal artifacts caused by embolization coil implants in portal vein phase.

SST09-08 Ability of a Single Adaptive Iterative Metal Artifact Reduction Algorithm to Improve CT Image Quality in Patients with Multiple Metal Implants

Friday, Dec. 6 11:40AM - 11:50AM Room: E351

Participants
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PURPOSE

To compare performance of a single, adaptive iterative metal artifact reduction (AiMAR) algorithm applied to an entire patient's CT exam to 7 anatomically specific iMAR presets, in patients with multiple metal implants.

METHOD AND MATERIALS

In 30 patients with 72 types of implants, CT images were reconstructed with different strength settings of a single AiMAR algorithm and 2 - 3 iMAR presets (selected for body part/implant). The AiMAR algorithm enables real-time image-based measurements to adapt the degree and level of artifact reduction. In separate sessions, 2 trained radiologists evaluated artifacts (0 - 5), visualization of critical anatomic structures (1 - 5) and diagnostic confidence (1 - 5) in the region of each implant, also assigning an overall 'whole body' image quality score (1 - 5), considering all evaluated regions, with lower values for all scales being better. The optimal AiMAR strength was determined by comparing whole body image quality scores with individual iMAR presets in each body region. Significance was tested by Wilcoxon Signed rank test for paired samples.

RESULTS

Optimized results using AiMAR were achieved using strength settings 4 and 5 for head&neck, thoracic and extremity areas (dental, neuro, cervical spine,shoulder, thoracic spine, cardiac,arms/elbow, legs/knee). For abdomen/pelvis (hip, lumbar spine), preferred AiMAR strengths varied between 2 - 5, with the lower strengths providing higher diagnostic confidence and the higher strengths providing better artifact reduction. AiMAR strength 5 setting was preferred over lower strengths ($p<0.05$) when evaluating whole body image quality scores. For every body region, AiMAR strength 4 and 5 settings demonstrated widely overlapping ($p>0.05$) diagnostic confidence, visualization and artifact performance with the dedicated anatomically specific iMAR presets (figure).

CONCLUSION

In patients with multiple metal implants, a strength based adaptive implementation of artifact reduction (AiMAR) permits a single reconstruction of the entire body that provides a diagnostic quality anatomic evaluation and metal artifact reduction of similar quality compared to multiple reconstructions using separate body part specific iMAR presets.

CLINICAL RELEVANCE/APPLICATION

AiMAR can dramatically improve clinical workflow by minimizing the need for body-part specific iMAR reconstructions without compromising image quality, diagnostic confidence or artifact reduction.

SST09-09 Reproducibility and Validity of Approaches for Artifact Quantification in CT Imaging

Friday, Dec. 6 11:50AM - 12:00PM Room: E351

Participants
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PURPOSE

To objectify metal artifact reduction, numerous methods and approaches have been suggested. We aimed to compare results of such methods to visual perception of artifacts in order to establish a standard for artifact quantification in CT imaging.

METHOD AND MATERIALS

Two titanium rods (5 and 10mm) were examined with 25 different scanning and image reconstruction parameters to obtain a reference database of different types and extents of artifacts. 4 radiologists separately evaluated every image against each other (2-pair forced choice) using an in-house developed software. Rating was repeated two times (2400 comparisons = 2 times x 4 readers x 300 comparisons). Rankings were combined to obtain a reference ranking reaching from best to worst image. Proposed approaches for artifact quantification have been identified in literature, including manual measurement of artifact attenuation, standard deviation and noise as well as sophisticated algorithm-based approaches within the image- and frequency-domain (ImgD and FreqD, respectively). Two radiologists conducted manual measurements twice while the aforementioned algorithms were developed within the Matlab-Environment allowing for automated image analysis. The reference ranking was compared to all aforementioned methods for artifact quantification to identify suited and less-suited approaches. Besides visual analysis, Kappa-statistics were used to evaluate agreement between quantitative methods and visual perception. Intraclass correlation coefficients (ICC) indicated intra- and interreader agreement.

RESULTS

Intra- and Interreader agreement of visual artifact perception were excellent (ICC 0.85-0.92). No quantitative method was able to represent the exact ranking of visually perceived artifacts; however, ICC for manual measurements were low (ICC 0,25-0,97). The methods that showed best correspondence and reproducibility were ImgD and FreqD-based.

CONCLUSION

Artifact quantification in CT is challenging. Manual measurements show a limited reproducibility. We propose two methods that quantify artifacts in the image- and frequency-domain and that correspond closely to visual artifact perception.

CLINICAL RELEVANCE/APPLICATION

Automated measurements of artifact extent should be preferred over manual measurements as they correspond close to visual perception while the latter show a limited reproducibility.

Printed on: 10/29/20

SST10

Vascular/Interventional (Tumor Ablation & Biopsy)

Friday, Dec. 6 10:30AM - 12:00PM Room: E451B

IR VA

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants
Jennifer Montgomery, MD,PhD, Cleveland, OH (*Moderator*) Nothing to Disclose
Nikunj R. Chauhan, MD, Cleveland, OH (*Moderator*) Nothing to Disclose

Sub-Events

SST10-01 Accuracy and Effectiveness of Transoral Contrast-Enhanced Ultrasound Guided Core Needle Biopsy for Oral Lesions

Friday, Dec. 6 10:30AM - 10:40AM Room: E451B

Participants
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Man Lu, PhD, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To determine the accuracy and effectiveness of transoral contrast-enhanced ultrasound (CEUS) guided core needle biopsy (CNB) for oral lesions that could not be accurately identified or had a previously non-diagnostic cyto-histological biopsy.

METHOD AND MATERIALS

A consecutive series of 29 patients (age range, 31-81 years; mean 61±12 years;18 male and 11 female) who underwent transoral CEUS-guided CNB of oral lesions at our hospital were evaluated retrospectively. Among them, 10(34.5%) lesions were inconspicuous and 19(65.5%) patients had a previously non-diagnostic cyto-histological exam by endoscopic or surgical incisional biopsy. Transoral CEUS-guided CNB was performed by using an endocavitary transducer and needle guide device attached to the transducer shaft. The CEUS characteristics, successful biopsy rate, diagnostic performance and complications were assessed and recorded.

RESULTS

Of the 29 lesions (median size: 31.5±14.3 mm; range: 9-58mm), 18 lesions were located in oral cavity (oral tongue (n=6), floor of the mouth (n=5), gingiva (n=5), hard palate (n=1) and lip (n=1)) and 11 lesions were located in oropharynx (base of the tongue (n=6), parapharyngeal space (n=4), and tonsil (n=1)). CEUS improved the conspicuity of target lesions and detection rate of internal liquefied necrosis comparing with transoral US ($p < 0.05$). Successful biopsy rate was 100%. Based on the final diagnosis: 19 malignant lesions (15 squamous cell carcinomas, 2 adenoid cystic carcinomas, one mucoepidermoid carcinoma and one melanoma) and 10 benign lesions (5 inflammatory lesions, 3 pleomorphic adenomas, one schwannoma and one hematoma), the diagnostic sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of this technique for the diagnosis of oral lesions were 94.7%, 100%, 100%, 90.9% and 96.6% respectively. No serious complications were observed.

CONCLUSION

Transoral CEUS-guided CNB can be considered as a complementary technology for pathological diagnosis of oral lesions that could not be accurately identified or had a previously non-diagnostic cyto-histological biopsy.

CLINICAL RELEVANCE/APPLICATION

Transoral CEUS-guided CNB can serve as a safe, feasible and accurate technique for pathological diagnosis and decision making of oral lesions.

SST10-02 HighNoon CT-Guided Needle Navigation Device: Preliminary Experience

Friday, Dec. 6 10:40AM - 10:50AM Room: E451B

Participants
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PURPOSE

To establish the clinical utility in terms of safety,less time consumption & practicality of high noon in simple & complex CT guided needle placement - biopsies & procedures.

METHOD AND MATERIALS

HighNooN - Shadow based needle navigation device is used to perform high precision percutaneous CT guided needle placement. The devices is ceiling mounted and can be guided easily to area of action. Device has central camera, four sources of light at right angle to each other and a laser source which project a crosier on the patient. The device can make left to right and head to toe swinging motion.140 biopsies were performed on mannequins under Ct guidance following which detailed results were presented to the ethics committee. After approval from ethics committee 55 cases are done using HighNoon prototype.

RESULTS

We are presenting here the results of our initial 55 patients. In these 55 Patients Average target accuracy achieved was 1mm as compared to 5mm without needle guidance device . Average manipulations done was 3% , average no of check scans was 1.24 using High Noon when compared to free hand biopsies where it was 5-10% & 0.4 - 6 respectively. Average wheel in & wheel out time was 26 mins with High noon and between 35 to 50 mins without needle guidance. Patient movement can be identified and corrected and respiratory misregisteration can be avoided using visual feedback for raddiologist & bagging anestheteist .

CONCLUSION

The ' High noon device ' helps to place the needle/device with precise angles of incidence from the point of entry in both axis (X & Z axis), thereby adding to accuracy, reducing the number of insertions, pain, discomfort, radiation, and complications.

CLINICAL RELEVANCE/APPLICATION

WHO states that 9.6 million deaths occurred globally in 2018 , 30 % increase in cancer cases is expected in 2030. As the cancer mortality is decreased by early detection -the action plan of WHO is to develop tools to help early detection.HighNooN can help in assessing the smaller lesions in easy & difficult locations to be biopsied and reach the final histopathological diagnosis leading to timely, correct treatment saving lives. Also in countries like India where tuberculosis including extra pulmonary tuberculosis mimicking malignancy is very common - deep seated mediastinal lymph nodes & vertebral lesions can be easily accessed by HighNoon alleviating the unnecessary apprehension and and initiating the correct medication .

SST10-03 Video Augmented Reality Percutaneous Needle Intervention Decreases Radiation Dose While Maintaining Accuracy Compared to C-Arm Cone Beam CT with Fluoroscopy Overlay: A Prospective Clinical Study with a Matched Control

Friday, Dec. 6 10:50AM - 11:00AM Room: E451B

Participants
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PURPOSE

To compare navigational accuracy and radiation dose during percutaneous needle intervention for video augmented reality (AR) guidance (study group) versus c-arm cone beam computed tomography (CT) with fluoroscopy overlay (control group)

METHOD AND MATERIALS

This is an IRB approved prospective study with a retrospective matched-control group. Matching was performed for clinical indication. Patients requiring c-arm cone beam CT and integrated fluoroscopy overlay guidance for biopsy, drainage, injection, or ablation were eligible to be prospectively enrolled for the procedure to be performed with video AR. Three interventional radiologists performed 15 video AR procedures in 11 patients. The video AR procedures were compared to an equal number of procedures and patients using c-arm cone beam CT with fluoroscopy overlay. Accuracy of needle guidance was defined as distance between the needle tip and planned anatomic target. Target depth from skin surface, fluoroscopy time, and complications were recorded. Correlation between accuracy and depth of target was assessed using Pearson correlation coefficient. Student's t-test was applied to evaluate statistical difference between groups for each continuous variable.

RESULTS

Age in the study and control groups was 19±6 yrs and 14±4 yrs ($p<0.05$), respectively. There were 6 biopsies (3 ilium, 1 femur, 1 tibia, 1 sternum) and 9 injections (4 pars interarticularis, 3 sacroiliac, 1 hip, 1 sternum) in each group. Accuracy in the study group was superior to the control group (2.9±2.3 mm vs. 5.6±5.0 mm) although not statistically significant ($p=0.07$). Fluoroscopy time was significantly lower in the study group compared to the control group (0.8±1.0 min vs. 2.1±2.0 min, $p<0.05$). Target depth in the study group (48±20 mm) and control group (60±27 mm) were not statistically different ($p=0.18$). There was higher negative correlation between the accuracy and the depth of the anatomic target in control group compared to the study group. There were no complications in either group.

CONCLUSION

Video augmented reality percutaneous needle intervention decreases radiation dose while maintaining accuracy compared to c-arm cone beam CT with fluoroscopy overlay.

CLINICAL RELEVANCE/APPLICATION

Replacing fluoroscopy with video AR guidance decreases x-ray dose to patients and interventionalists without compromising accuracy or clinical outcome.

SST10-04 Comparison of the Complications of Percutaneous versus Transjugular Liver Biopsies Performed at a Single Institution

Friday, Dec. 6 11:00AM - 11:10AM Room: E451B

Participants
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PURPOSE

Transjugular liver biopsy (TJLB) is safer than percutaneous liver biopsy (PLB) in patients with increased risk for hemorrhage. Few clinical studies have directly compared the complication rates between the two procedures. The aim of this study was to retrospectively review patients who underwent liver biopsy and compare the incidence of adverse events and patient factors that were associated with complications.

METHOD AND MATERIALS

Institutional approval was obtained for this study. Data was collected from 158 patients diagnosed with cirrhosis that underwent non-targeted liver biopsies from January 2016 to April 2018. Information included patient demographics, coagulation status, biopsy method, operative findings, and immediate complications (<30 day). Statistical analyses with Fisher's exact test and Wilcoxon rank sum test were then performed to compare the outcomes of the two procedures.

RESULTS

Complications occurred in 7.3%(7/96) who underwent TJLB and included self-limiting post-operative pain (n=4, 4.2%) and major vascular complications (n=3, 3.1%) such as AV fistula and hemoperitoneum. 4.8% (3/62) of patients in the PLBs developed procedural complications including post-operative pain (n=2, 3.2%) and major vascular complications (n=1, 1.6%). The difference in complication rates between the two techniques was not statistically significant (p = 1), nor was there a clinically significant difference in patient demographics, INR, PTT, or PT between the two groups. A larger number of patients who received TJLB were on anticoagulation therapy.

CONCLUSION

Our results show that both TJLB and PLB are safe procedures and there is no significant difference in complication rates between the two biopsy techniques. Although not statistically significant, there was a higher number of major vascular complications with TJLB biopsies. This suggests that the conventional belief of TJLB being the inherently safer approach is not necessarily true in clinical practice.

CLINICAL RELEVANCE/APPLICATION

Transjugular and percutaneous liver biopsies are minimally invasive techniques that allow for hepatic tissue sampling and both are used in the diagnosis and management of cirrhosis.

SST10-05 Power of Lipiodol-Enhancement in CT-Guided Biopsies of Unspecified Suspect Intrahepatic Lesions: Improvement of Accuracy and Safeness

Friday, Dec. 6 11:10AM - 11:20AM Room: E451B

Participants
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PURPOSE

To evaluate the power of Lipiodol in improving the rate of successful biopsies of suspect intrahepatic lesion which is often challenging in native CT-scans. Lipiodol, commonly applied in angiography for tumor embolization, might improve the success rate.

METHOD AND MATERIALS

Six-hundred-seven patients (men: 358, women: 259) with unclear suspect liver lesions were retrospectively evaluated. All patients received a CT-guided liver biopsy and results were histopathological analysed. Successful punctuations were defined by positive pathological findings. Data were ascertain regarding the use of contrast media, lipiodol or common intravenous contrast, or native performance. Lesion hitting rate and influencing factors like lesion size or liver cirrhosis were insulated. Procedure was performed with the same 128-multislice CT-scanner. Correlation was calculated according to Spearman-Rho, results compared using Wilcoxon-Man-Whitney t-test and Chi-square-test. P<0.05 was considered as statistically significant.

RESULTS

Lesion hitting rate was significantly higher using Lipiodol (78.6%) compared to native biopsy (73.2%) or the use of intravenous

Lesion hitting rate was significantly higher using Lipiodol (78.6%) compared to native biopsy (73.2%) or the use of intravenous contrast agent (65.2%) (p=0.038). For lesions with a size <20mm, the benefit regarding the hitting rate was even higher for Lipiodol (71.2% vs 47.7% vs. 65.5%) (p=0.021). For patients with an existing liver cirrhosis in comparison of all three groups were seen. (p=0.97). No major complications occurred during the interventions.

CONCLUSION

Pre-puncture marking using Lipiodol in angiography increases the lesion hitting rate significantly, especially for small suspect liver lesions (<20mm), combines with a lower rate of re-biopsy and a higher safeness for the patient.

CLINICAL RELEVANCE/APPLICATION

Pre-puncture marking of unclear intrahepatic lesions using Lipiodol increases the hitting rate and safeness of liver biopsies and is recommended for hardly detectable liver lesions in CT.

SST10-06 Real-Time Intravascular Device Guidance for Procedures in the Thorax and Abdomen Using Motion-Compensated Roadmaps

Friday, Dec. 6 11:20AM - 11:30AM Room: E451B

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PURPOSE

Vascular roadmaps have limited utility for intravascular procedures in the thorax and abdomen due to severe subtraction artifacts and changes in vessel shape and position caused by respiratory motion. Instead, most interventional radiologists navigate devices (eg. guidewires and catheters) without vascular overlay. This procedure is time consuming and requires experienced interventional radiologists. The purpose of this study was to test the accuracy of a recently developed system that provides real-time motion-compensated vascular overlays for device navigation.

METHOD AND MATERIALS

The proposed system creates a dynamic motion model from contrast enhanced x-ray images acquired under free breathing conditions. During device navigation, a motion-compensated vessel roadmap is created based on respiratory motion estimations from live x-ray images. The device is extracted from the x-ray images and superimposed on the motion compensated roadmap. Alternatively, the system can apply respiratory motion compensation to the device and display a static vascular roadmap. A porcine study was conducted with 3 animals, where a real-time prototype of the system was used to navigate a guidewire within the hepatic arteries. An EM-tracking sensor was placed in different branches of the vasculature to measure motion and compare it to the deformation estimated by the proposed approach.

RESULTS

The average difference between the measured EM-sensor motion and the estimated vessel motion was 1.59 ± 0.64 mm at the detector. The Pearson correlation was 0.94 ($p < 0.01$). The prototype was able to display the guidewire within the correct vascular branches despite respiratory motion. In some cases, the proximal and less flexible part of the device deforms the surrounding vessels, but the distal part, most relevant for device navigation, is still displayed correctly.

CONCLUSION

Our real-time motion compensated device guidance system provides an intuitive way to accurately navigate devices during intravascular procedures in the abdomen. This could reduce procedure times and therefore decrease risk and radiation exposure to the patient.

CLINICAL RELEVANCE/APPLICATION

Real-time motion compensated roadmaps provide the device position in the vasculature during procedures in the abdomen. This could reduce procedure times and decrease radiation and risk to patients.

SST10-07 Role of Contrast-Enhanced Ultrasound (CEUS) in the Detection of Complications Ensuing US-Guided Interventional Procedures: A Multi-Center Study

Friday, Dec. 6 11:30AM - 11:40AM Room: E451B

Participants
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PURPOSE

Aim of this study was to assess the contribution of CEUS to the detection of complications ensuing US-guided hepatic interventional procedures in field practice of 7 interventional ultrasound centers

METHOD AND MATERIALS

The participating centers retrospectively selected all patients in whom CEUS detected complications after US-guided liver biopsy for diffuse liver disease or focal liver lesions (FLL) and after ablation of liver tumors over the last decade.

RESULTS

22 patients (13 M/ 9F, median age 73 yrs.) experienced complications after 5 liver biopsies with 18g cutting needles (3 for FLL) and 17 ablations of liver tumors (16 HCC) carried out with PEI (2), MW (2), RF (13). Median size of the 20 biopsied/ablated nodules was 22.5 mm (range 15-39 mm). In 10 cases CEUS was performed at the end of ablation (2 PEI, 2 MW,6 RF) and demonstrated 6 sub-segmental/segmental infarcts, 3 active bleedings (2 capsular tears with hemoperitoneum, 1 hemobilia), and 1 subcapsular hepatic hematoma (SHH). Only 2 patients underwent RF to achieve hemostasis. In 5 symptomatic cases CEUS was performed within 6 hours after biopsy and displayed 1 actively bleeding capsular tear with hemoperitoneum, 1 hemobilia and 3 SHHs, one of which actively bleeding. In the latter case transarterial embolization (TAE) was carried out and another patient needed blood transfusion (BT). Finally, in 7 cases CEUS was performed 24-48 hours after interventional maneuvers. In 5 symptomatic cases CEUS showed 1 actively bleeding capsular tear with hemoperitoneum, 1 hemothorax (due to actively bleeding intercostal artery), 1 pseudoaneurysm of a right arterial branch, 1 segmental infarct, 2 abscessed ablated areas; in the remaining case, routine CEUS check at 24 hours displayed 1 SHH. 5 out of 7 patients in this group were treated with TAE (2 cases), percutaneous abscess drainage (2 cases), and BT plus TAE (1 case).

CONCLUSION

This multicenter survey highlights the potential role of CEUS in the detection of immediate and early (<6 hours) complications ensuing US-guided liver biopsy or ablation. Iatrogenic hemorrhagic complications even with active bleeding and ischemic segmental areas can be successfully demonstrated by CEUS and promptly treated if clinically needed.

CLINICAL RELEVANCE/APPLICATION

CEUS should be considered as an useful tool to detect iatrogenic complications mainly of ischemic and hemorrhagic type occurring after US-guided hepatic interventional procedures.

SST10-08 Detection of Bleeding Complications After Instituting a 1-Hour Post-Procedure Recovery Time Following Renal Transplant Biopsy

Friday, Dec. 6 11:40AM - 11:50AM Room: E451B

Participants
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PURPOSE

To analyze the timing of major bleeding complications following renal transplant biopsy in the context of a standardized 1-hour post-procedure observation protocol.

METHOD AND MATERIALS

We retrospectively reviewed the electronic medical record for 4519 consecutive US-guided renal transplant biopsies (769 women, 1055 men) from 01/01/2012 to 12/31/2017, after initiating a post-procedural protocol limited to 1 hour of routine observation, additional observation only if symptoms present at 1 hour, and subsequent patient contact within 24 hours after discharge. The development of a major bleeding complication (CTCAE Class 3 or higher) was recorded, along with all available details regarding the time course of patient symptoms and presentation.

RESULTS

There were 11 CTCAE Class 3 complications (11/4519, 0.24%). Seven patients (7/11, 63.6%) were asymptomatic after 1 hour of observation and were discharged. Of these, two (2/11, 18.2%) were admitted after symptoms began 4-8 hours after biopsy; the remaining five (5/11, 45.5%) were admitted after developing symptoms more than 8 hours after biopsy. Four patients (4/11, 36.3%) had symptoms in the 1 hour observation period; of these, two (2/11, 18.2%) had pain combined with hemodynamic alterations, leading to hospital admission. The other 2 patients (2/11, 18.2%) had pain without hemodynamic alterations, leading to an additional hour of observation, and subsequent discharge due to successful pain control with oral analgesics; these 2 patients were later admitted when symptoms returned 4- 8 hours after biopsy.

CONCLUSION

Major bleeding complications following US-guided renal transplant biopsy are rare, occurring in 0.24% of patients in this study, and most are not clinically apparent within 4 hours of biopsy. One-third of patients who develop significant hemorrhage have early manifestations, but approximately two-thirds of patients do not have unusual symptomatic manifestations of hemorrhage until more than 4 hours after biopsy. Almost half of all patients do not have unusual symptoms until more than 8 hours after biopsy.

CLINICAL RELEVANCE/APPLICATION

A recovery protocol with only 1 hour of routine observation after uneventful renal transplant biopsy can be safely implemented when combined with routine follow-up patient contact. Requiring routine post-procedure observation for 4 hours as used at some facilities uses more resources without improving care.

SST10-09 High-Intensity Focused Ultrasound (HIFU) Focal Therapy to Primary Treatment of Localized Prostate Cancer Using 68Ga-PSMA PET/MR as Main Guidance: Innovative Experience in 14 Patients

Friday, Dec. 6 11:50AM - 12:00PM Room: E451B

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PURPOSE

To identify candidates to High-intensity focused ultrasound (HIFU) focal therapy (FT) for localized prostate cancers (pCa), the following inclusion criteria are commonly used: serum PSA (<15 ng/ml), Gleason score (ISUP 1-3), multiparametric magnetic resonance imaging (mpMRI) with no extracapsular extension, no seminal vesicle invasion or pelvic lymph node disease and negative bone scintigraphy; however, to the best of our knowledge, no prior study has used 68Ga-PSMA PET/MR as the main feature to indicate and guide HIFU procedures.

METHOD AND MATERIALS

A single-center prospective analysis of initial 14 patients, candidates for FT (hemi-gland or super-focal ablation) as the primary treatment option, from August 2018 to March 2019. All patients were re-evaluated by mpMRI and transrectal US/MR fusion prostate biopsy and follow-up 68Ga-PSMA PET/MR to better understand the indication of HIFU before the procedure.

RESULTS

Mean prostatic volume, age, PSA and region of interest volumes were: 47.9 cc, 68 years, 4.56 ng/dl and 1.1 cm; respectively. Pre-procedure mpMRI showed 7.1% of PIRADS 2, 21.4% of PIRADS 3, 57.3% of PIRADS 4 and 14.2% of PIRADS 5. US-guided fusion + systematic biopsy showed 3 patients with unilateral ISUP 1, 8 patients wth unilateral ISUP 2 and 3 patients with ISUP 3. Ten patients (71.4%) had concordant findings between pre-procedure mpMRI, 68Ga-PSMA PET/MR and biopsy. Four patients (28.5%) had discordant findings, altering the treatment planning or contraindicating the procedure, for the following reasons: 2 patients had larger unilateral multifocal disease on 68Ga-PSMA PET/MR than on MRI or US-MR fusion biopsy, with need to extend the treatment area; One patient presented a smaller extent of disease in 68Ga-PSMA PET/MR than in MRI, allowing a reduction of the expected area of treatment; One patient had extensive bilateral disease in 68Ga-PSMA PET/MR that was not suspected in MRI, confirmed by biopsy, contraindicating the procedure.

CONCLUSION

In conclusion, 68Ga-PSMA PET/MR may play a fundamental role in the indication and planning of focal ablative prostatic therapy and might be introduced in the inclusion criteria for cases indicated for HIFU.

CLINICAL RELEVANCE/APPLICATION

High-intensity focused ultrasound is a promising novel technique but new diagnostic procedures, such as 68Ga-PSMA PET/MR for selection of patients and correct planning of the procedure may alter the oncological outcome and mortality.