Scientific Sessions

104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

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104th Scientific Assembly and Annual Meeting
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SSA01

Breast Imaging (Update on Screening)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E450A

BR

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

Participants
Catherine S. Giess, MD, Wellesley, MA (*Moderator*) Nothing to Disclose
Debra L. Monticciolo, MD, Temple, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSA01-01 Interval Cancers in a Large Prospective Breast Tomosynthesis Screening Trial

Sunday, Nov. 25 10:45AM - 10:55AM Room: E450A

Participants
Kristin Johnson, MD, Lund, Sweden (*Presenter*) Nothing to Disclose
Kristina Lang, MD,PhD, Malmo, Sweden (*Abstract Co-Author*) Travel support, Siemens AG Speaker, Siemens AG
Debra M. Ikeda, MD, Stanford, CA (*Abstract Co-Author*) Scientific Advisory Board, Grail, Inc; Reviewer, Siemens AG
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Sophia Zackrisson, Malmo, Sweden (*Abstract Co-Author*) Speaker, AstraZeneca PLC ; Speaker, Siemens AG; Travel support, AstraZeneca PLC; Travel support, Siemens AG

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PURPOSE

To assess interval cancer rate in a large, prospective digital breast tomosynthesis (DBT) screening trial in comparison with a concurrent screening population and to assess tumor characteristics of interval cancers in DBT-screening.

METHOD AND MATERIALS

The prospective ****Trial, comparing digital breast tomosynthesis (DBT) with digital mammography (DM) in 14,848 women has shown a significantly increased sensitivity with DBT. Interval cancer rate in the trial was compared with a concurrent screening population; i.e. women participating in DM screening at the same screening site during the same time period (2010-15, n=100,273 screens). Interval cancers and concurrent screens were identified through linkage with the Radiology Information System, the **Cancer Registry and the National Quality Register Breast Cancer. Confidence intervals (CI) 95 % were calculated for rates and difference between rates. Tumor characteristics were retrieved from pathology reports and invasive cancers classified according to St Gallen subtypes.

RESULTS

In total, there were 22 interval cancers in the ****Trial. The interval cancer rate was 1.5 per 1000 screens [22/14,848] (95% CI 0.9-2.2) in the ****Trial and 1.8 per 1000 screens [179/100,273] (95% CI 1.5-2.1) in the concurrent population. Although the interval cancer rate was lower in the trial, the difference of 0.3 was not statistically significant (95 % CI -0.5-0.9). Among the interval cancers in the ****Trial, the mean cancer size was 17 mm (range 2-37 mm), 2 were DCIS (grade 2 and 3), 5 luminal A-like, 9 luminal B-like HER2-, 2 luminal B-like HER2+ and 4 triple negative.

CONCLUSION

The slightly lower interval cancer rate in the trial might indicate that DBT-screening leads to the detection of clinically relevant cancers. Still, a relatively large proportion of the interval cancers had unfavorable prognostic characteristics.

CLINICAL RELEVANCE/APPLICATION

Analysis of interval cancers is important in order to elucidate the future value of DBT in screening.

SSA01-02 Does Tomosynthesis Work For Everyone?

Sunday, Nov. 25 10:55AM - 11:05AM Room: E450A

Participants
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Karen E. Gerlach, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare the performance of full-field digital screening mammograms (FFDM) with and without digital breast tomosynthesis (DBT) in women with and without breast implants.

METHOD AND MATERIALS

An IRB-approved, HIPAA-compliant retrospective review was performed of 103,070 consecutive screening mammograms obtained from February 2011 through June 2014. Recall rates (RRs), cancer detection rates (CDRs), and positive predictive values for recall (PPV1s) were analyzed.

RESULTS

The following data compare FFDM and FFDM-DBT: 67,331 FFDM and 28,835 FFDM-DBT from women *without* implants yielded RRs of 8.0% and 6.3%, respectively ($p<0.00001$); CDRs of 4.1 and 5.0 per 1000 exams, respectively ($p=0.07$); and PPV1s of 5.1% and 8.0%, respectively ($p<0.0001$). 4325 FFDM and 2579 FFDM-DBT from women *with* implants yielded RRs of 5.2% and 4.1%, respectively ($p=0.040$); CDRs of 1.8 and 2.7 per 1000 exams, respectively ($p=0.46$); and PPV1s of 3.6% and 6.7%, respectively ($p=0.25$). The same data is also used to evaluate the effect of implants on screening: 67,331 FFDM *without* implants and 4325 FFDM *with* implants yielded RRs of 8.0% and 5.2%, respectively ($p<0.00001$); CDRs of 4.1 and 1.8 per 1000 exams, respectively ($p<0.00001$); and PPV1s of 5.1% and 3.6%, respectively ($p=0.30$). 28,835 FFDM-DBT *without* implants and 2579 FFDM-DBT *with* implants yielded RRs of 6.3 and 4.1, respectively ($p<0.00001$); CDRs of 5.0 and 2.7, respectively ($p=0.11$); and PPV1s of 8.0 and 6.7, respectively ($p=0.63$).

CONCLUSION

Tomosynthesis improves the performance of digital screening mammography, while the presence of implants reduces its performance. Specifically, tomosynthesis improved RRs, CDRs, and PPV1s for all women (*with* and *without* implants), though statistically significant differences were seen only for RRs in women *without* implants, RRs in women *with* implants, and PPV1s for women *without* implants. Implants were associated with decreased RRs, worse CDRs, and worse PPV1s for all screening exams (FFDM and FFDM-DBT), but statistically significant differences were seen only for RRs for all screening exams and CDR for FFDM. Further study with larger populations is warranted.

CLINICAL RELEVANCE/APPLICATION

The benefit of tomosynthesis has been incompletely studied in screening mammography patients with implants. This research suggests that tomosynthesis is useful for screening women *with* implants in addition to those *without* implants.

SSA01-03 Disparities in Screening Mammography Cost-Sharing and Utilization Before and After the Affordable Care Act (ACA) and the Revised USPSTF Guidelines

Sunday, Nov. 25 11:05AM - 11:15AM Room: E450A

Awards
Trainee Research Prize - Resident

Participants
Soudabeh Fazeli Dehkordy, MD, MPH, San Diego, CA (*Presenter*) Nothing to Disclose
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PURPOSE

To assess changes in screening mammography cost-sharing and utilization before and after the Affordable Care Act (ACA) and the revised USPSTF guidelines by race and income level.

METHOD AND MATERIALS

We used patient-level analytic files between 2004 and 2014 from Optum™ Clinformatics™ Data Mart. We included women 40-74 years 1) without a history of breast cancer or mastectomy with 2) at least one year of continuous enrollment in a given plan, examining out-of-pocket payments and utilization for screening mammography. Trends for screening mammography utilization and cost sharing elimination over time by race and income level were visually inspected. We then specifically calculated the slopes and compared trends before and after 2009 and 2010 to assess the impact of ACA implementation and USPSTF guideline revisions on screening mammography cost sharing elimination and utilization.

RESULTS

We identified an average of 2,173,686 commercially insured women ages 40-74 years with at least 12 months of continuous enrollment in a given plan per year. Overall, an upward trend was seen in the proportion of women with zero cost sharing over time among all races and income level. Comparing trends for cost-sharing elimination before and after 2010, a statistically significant upward but small trend was found among all races and income levels with no racial or income disparities evident. Screening mammography utilization plateaued or showed a significant decline after 2009 in all income and racial groups except for African Americans in whom screening rates continued to increase after 2009.

CONCLUSION

Impact of ACA cost-sharing elimination did not differ among various racial and income groups. Among our population of employer-based insured women, the racial gap in screening mammography appeared to have closed and potentially reversed among African American women.

CLINICAL RELEVANCE/APPLICATION

It is important to continue monitoring screening mammography utilization as health care policies and guidelines change, as these changes may affect disparities in screening between different racial and income groups.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ruth C. Carlos, MD, MS - 2015 Honored EducatorRuth C. Carlos, MD, MS - 2018 Honored Educator

SSA01-04 Screening Mammography: There is Value in Screening Women Aged 75 and Over

Sunday, Nov. 25 11:15AM - 11:25AM Room: E450A

Participants
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PURPOSE

To review outcomes of screening mammography performed in women 75 and over to determine the rate of cancer diagnosed and associated histology and surgical excision performed.

METHOD AND MATERIALS

Patients 75 years of age and over who presented for screening mammography and underwent biopsy with resultant malignant pathology were retrospectively collected and analyzed to record patient demographics, lesion information, pathology results and treatment. Cases of non-breast malignancy, cases of breast cancer diagnosed by modality other than mammography, and cases with missing or incomplete records were excluded.

RESULTS

From 2007-2016 there were a total of 679,168 screening appointments, with 3,480 patients diagnosed with screen-detected cancers (5.1/1000). 68,218 (10%) screenings were performed in women aged 75 and over; 530 of these women were diagnosed with 560 breast cancers, for a cancer detection rate of 7.8/1000. Average patient age 80.3 (range 75-98). Lesions most frequently presented as a mass (74%). A large majority (81%) of the malignancies diagnosed were invasive; 55.7% grade 2 or 3. Positive lymph nodes were reported at surgical excision in 7.0% of patients. Tumor stage was largely stage 0 or 1 (64%); 12% were determined to be stage II or III. 98% of cancers were surgically excised; twelve cancers were not due to advanced patient age or overall degraded patient health.

CONCLUSION

For the relatively small percentage of our screening population that women 75 and over comprise (10%), the patients diagnosed in this population made up 16% of all patients diagnosed with screen-detected cancers, a substantial cancer detection rate (7.8/1000). Most of the cancers diagnosed were low grade, a significant number were invasive (81%), over half were grade 2 or 3, and a majority were lower stage (0 or I). Most (98%) underwent surgical excision, suggesting that most women 75 and over are in good health and want to pursue surgical excision. Screening mammography should be performed in this age group given the incidence of breast cancer that exists.

CLINICAL RELEVANCE/APPLICATION

Ongoing debate exists regarding the age to cease screening mammography, citing lack of research in the aging population. Our study demonstrates the value of screening women 75 and over.

SSA01-05 Risk of Breast Cancer After a False-Positive Screening Mammogram in Relation to Mammographic Abnormality: Potential for Prevention?

Sunday, Nov. 25 11:25AM - 11:35AM Room: E450A

Participants
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PURPOSE

False positive recall rates have consistently been identified as a harm of organized breast cancer screening. The extent to which these recalled women are at increased risk of future breast cancer remains unclear.

METHOD AND MATERIALS

All women who had two or more screening mammograms between 1988-2013 in a large organized breast screening program were included in the study. They were followed until a breast cancer diagnosis, last screen date +5 years, or end of follow-up on Dec 31, 2013, whichever came first. The relative risk (RR) of breast cancer for women with a false-positive test compared with women with negative tests was estimated with Poisson regression, adjusted for age, and five calendar periods.

RESULTS

A total of 772,289 women with 4.82 million screening mammograms and a median follow up of 11.8 years were included. There were 238,860 women with false positive findings and 26,950 cancers of which 16,084 screen detected and 10,866 non screen detected. The adjusted RR [Value (95% CI)] of breast cancer after the first false-positive test was 1.73(1.68-1.77) for all, 1.65(1.61-1.70) for invasive, and 2.13(2.01-2.27) for in situ cancers respectively. The RR remained increased beyond 8 years after the first false-positive test. Of the 5157 screen detected cancers after the first false positive test, 3358 (65%) were on the ipsilateral breast while 1799 (35%) were on the contralateral breast. Women with breast density >50% at the time of false positive test had a twofold risk of breast cancer; RR 2.07(1.99-2.14) while those with breast density <50% had a RR of 1.58(1.54-1.63). When stratified for mammographic features found on the first false positive mammogram, architectural distortion plus mass had the highest RR 4.68(3.16-6.93) for invasive cancers while calcifications alone and calcifications plus asymmetry had highest RR 5.57(4.88-6.36) and 4.07(2.49-6.66) for in situ cancers. These findings would require further validation.

CONCLUSION

False positive mammogram correlates with an increased risk of developing breast cancer. Screen detected breast cancers post false positive mammogram most likely to occur in the ipsilateral breast.

CLINICAL RELEVANCE/APPLICATION

Mammographic features at the time of recall predict the risk of subsequent cancer and may warrant increased surveillance and/or chemo-prevention.

SSA01-06 Stratification of Ductal Carcinoma in Situ in a Screening Population by Age and Grade Over a 16-Year Period

Sunday, Nov. 25 11:35AM - 11:45AM Room: E450A

Participants
Angela Sie, MD, Long Beach, CA (*Presenter*) Nothing to Disclose
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PURPOSE

To determine if there is a correlation between age and grade of screening-detected ductal carcinoma in situ (DCIS).

METHOD AND MATERIALS

We performed an IRB approved, retrospective review of screening-detected cases of DCIS at our large, community-based breast center, diagnosed between 2001 and 2016. All cases of DCIS diagnosed from 2001 through 2016 were collated. Odds ratios were produced from logistic regression analyses.

RESULTS

DCIS accounted for 20.9% (372/1781) of all cancers detected in our screening practice between 2001 and 2016.The total number of cases in our study was 372, with a mean age of 60.6 years, median age of 60.0 years, mean size of 2.1 cm, median size of 1.8 cm. Age distribution showed 31.7% (118/372) were <55 years old, and 68.3% (254/372) were >= 55 years old. The tumor grade was identified in 366 (98.4%) of the cases and included 6.8% (25/366) low grade, 46.4% (170/366) intermediate grade, and 46.7% (171/366) high grade. Mammographic findings were 80.9 % (301/372) calcifications and 16.9% (63/372) mass or focal asymmetry. Estrogen receptor (ER)/Progesterone receptor (PR) status was identified in 240 (64.5%) cases and included 81.3% (195/240) ER + and 72.9% (175/240) PR+ cases. Logistic regression analysis revealed that for each unit decrease in age, the odds ratio of intermediate versus low grade was 4 times higher (p=0.038), and high versus low grade was 5 times higher (p=0.009). No patient (0/19) under 45 years old had low grade DCIS. Younger women were slightly more likely to have DCIS that was ER+ and PR+.

CONCLUSION

The vast majority of screening-detected DCIS cases (93.1%) were intermediate or high grade. Younger patients had a statistically significant greater chance of intermediate or high grade DCIS versus low grade DCIS.

CLINICAL RELEVANCE/APPLICATION

Grade and age have an inverse relationship in the screening-detected DCIS at our institution during the 16 year period studied. Since screening- detected DCIS in younger patients tends to be high or intermediate grade, screening mammography in younger

patients remains clinically important.

SSA01-07 Frequency and Cancer Yield of Probably Benign Breast Findings in Clinical Practice in the National Mammography Database (BI-RADS Category 3)

Sunday, Nov. 25 11:45AM - 11:55AM Room: E450A

Participants
Mai A. Elezaby, MD, Madison, WI (*Presenter*) Research Grant, Exact Sciences Corporation
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PURPOSE

The Breast Imaging Reporting and Data System (BI-RADS) assessment category 3 describes a probably benign finding with a low likelihood of malignancy of <= 2%. Since 2013, the BI-RADS Atlas discouraged its use at screening, which was reinforced in Medicare's pay-for-performance Physician Quality Reporting System (PQRS) initiative. However, there are sparse data on the frequency of use and cancer yield of BI-RADS 3 findings in clinical practice. This study assesses the frequency and cancer yield of probably benign findings in screening and diagnostic mammography in the National Mammography Database (NMD), which is the largest national database of mammography.

METHOD AND MATERIALS

This HIPAA-compliant and IRB-exempt study retrospectively analyzed data from screening and diagnostic mammograms performed between 1/1/2009 and 12/31/2015 in the NMD. We calculated the overall frequency and cancer yield of BI-RADS 3 findings in screening and diagnostic mammography. Cancer yield is defined as the number of breast cancers diagnosed among women with probably benign findings within the study period. Exams with BI-RADS 3 findings but lacking biopsy or 12-month follow-up were excluded . Exams from NMD facilities contributing data for < 2 years were excluded to ensure adequate follow-up.

RESULTS

Data from 6,421,365 screening and 1,264,929 diagnostic mammograms performed in 3,345,013 women at 261 NMD facilities in 31 states were analyzed. A total of 215,403 mammograms had probably benign findings, with frequency of 0.3% (20,060/6,421,365) in screening and 15% (193,850 /1, 264,929) in diagnostic mammograms. Among the 101,025 women with BI-RADS 3 findings and at least one follow up , 948 (0.94%, 95%CI 0.91, 1.03) women had a diagnosis of malignancy. Rates of BI-RADS 3 use were stable over the 6 calendar years analyzed.

CONCLUSION

A probably benign, BI-RADS 3, assessment was rarely used in screening but common in diagnostic mammography in the NMD. The overall cancer yield of probably benign findings was 0.94%, consistent with BI-RADS Atlas threshold of <= 2%. These results support use of probably benign assessment in clinical practice for findings with low risk of malignancy.

CLINICAL RELEVANCE/APPLICATION

In the NMD, BI-RADS 3 showed appropriately low cancer yield of 0.9%. Proper use of BI-RADS 3 helps reduce cost, morbidity and patient anxiety while increasing cost-effectiveness of screening.

SSA01-08 Digital Breast Tomosynthesis Improves Performance Metrics of Screening Mammogram in Women Aged 40 to 54 Compared to Full Field Digital Mammogram

Sunday, Nov. 25 11:55AM - 12:05PM Room: E450A

Participants
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PURPOSE

The starting age for screening mammogram has been a controversial subject mostly due to reported low cancer detection rate (CDR) and high false positive recall rate (RR) in younger women. However, digital breast tomosynthesis (DBT) may improve performance of screening mammogram and change the justification of screening guidelines. The purpose of this study is to compare the performance of screening mammogram in women aged 40-54 between full field digital mammogram (FFDM) and DBT.

METHOD AND MATERIALS

In an IRB approved study, we retrospectively analyzed screening mammograms performed in women aged 40-54 at 2 of our imaging

centers from August 2008 through April 2017. We included all FFDM screening mammograms performed before and all DBT screenings performed after installation of DBT at each site. DBT screening was offered to all women after installation at no additional charge. RR, CDR, and characteristics of screen-detected cancers were compared between FFDM and DBT screening in 3 age groups: 40-44 (group 1), 45-49 (group 2) and 50-54 (group 3).

RESULTS

16938 FFDM and 28313 DBT were performed in women aged 40-54. In FFDM, RR significantly decreased from group 1 (17.4%) to group 2 (14.0%) and group 3 (11.3%); however, in DBT screening, RR was only significantly decreased from group 1 (12.2%) to group 2 (9.1%) and there was no significant difference between group 2 and group 3 (8.4%). RR of all 3 age groups were significantly lower for DBT compared to FFDM. CDR per 1000 exams in FFDM was significantly lower in groups 1 and 2 (2.4 and 2.3) compared to group 3 (5.0), but in DBT, there was no significant difference in CDR among the 3 groups (3.0, 4.4, and 3.8 in groups 1,2, and 3, respectively). There was significant increase in CDR from FFDM to DBT in women aged 45-49 (p=0.03). The ratio of invasive to in-situ carcinomas were similar in FFDM and DBT subgroups.

CONCLUSION

DBT screening decreases RR and increases CDR compared to FFDM in women aged 40-49, and more prominently for 45-49 age group. As a result, unlike FFDM, there is no significant difference in RR and CDR of ages 45-49 and 50-54 with DBT screening.

CLINICAL RELEVANCE/APPLICATION

Improved performance of DBT screening in women aged 40-49 compared to FFDM screening, may further justify recommendations for starting screening mammogram at younger age.

SSA01-09 Six Years of Consecutive, Population-Based Screening with Digital Breast Tomosynthesis: Outcomes by Screening Year and by Screening Round

Sunday, Nov. 25 12:05PM - 12:15PM Room: E450A

Participants
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PURPOSE

Digital breast tomosynthesis (DBT) improves screening outcomes by decreasing recalls and increasing cancer detection. However, most DBT studies have analyzed prevalence rather than incidence screening. We investigate outcomes from 6 years of consecutive DBT screening, at both the population level by year (DBT Y1-6) and patient level by round (DBT R1-6).

METHOD AND MATERIALS

71535 consecutive DBT screens in 33245 women were performed from 10/2011 to 9/2017 with 31246, 17801, 11067, 6560, 3553, and 1308 screens in rounds 1-6, respectively. Recall rate % (RR), cancer detection (CDR), biopsy (BX) and false negative (FN) rates per 1000 screens for each year (DBTY1-Y6) and each round (R1-R6) were analyzed. Outcomes were compared the prior year of digital mammography (DM) screening (DMY0, n=10765). Cancer registry data was used to determine FN (defined as cancer diagnosed <1 yr after negative screen) for DMY0-DBTY5 and DBT R1-R5.

RESULTS

At the Population Level, RR for DBTY1-6 was lower than DMY0 (7.9 vs 10.4%). However, DBT RR increased in DBTY1-3 (8.8, 9.0, 9.2%) before decreasing in DBTY4-6 (7.1, 6.1, 7.4%). CDR increased in DBTY1-3 (5.5, 5.8, 6.5) then decreased in DBTY4-6 (6.3, 5.1, 5.5) however, DBT CDR was higher in each year than DMY0 (4.8). Invasive CDR for DBTY1-4 and DBTY6 (3.9, 4.5, 4.5, 4.9, respectively) were also higher than DM0 (3.4) however, DBTY5 was lower (2.9). BX increased from DMY0 of 1.9 to 2.2, 1.9, 2.0 in DBTY1-3; in DBTY4-6, BX rates were lower (1.5, 1.3, 1.5). FN remained without significant change from DMY0 (1.1) to DBT1-5 (0.5, 0.3, 0.4, 0.8, 1.0). By Screening Round, RR decreased from DBTR1 to R5 from 10.6, 7.0, 5.1, 4.5, 4.1 until R6= 4.2%. CDR for R1-6 were 6.4, 5.5, 6.1, 4.4, 4.2, 3.1, respectively. BX rate decreased after DBTR1 (2.5) for R2-6 (1.4, 1.4, 1.0, 0.8, 1.0). FN were 0.5, 0.5, 1.3, 0.6, 0.8 for R1-5. Whether by year or round, DBT PPV1 was higher than DM.

CONCLUSION

At the population level, DBT screening had higher overall CDR and lower RR than DM with FN rates remaining relatively stable. Little data exists on outcomes by round of screening, however, our data may help guide DBT screening benchmarks.

CLINICAL RELEVANCE/APPLICATION

Consecutive years of DBT screening show decreased recall and increased PPV1 compared to DM alone. Further long term DBT outcome data may help guide new, personalized screening algorithms by age, density and risk.

Honored Educators

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November 25–30 | McCormick Place, Chicago

SSA02

Breast Imaging (Contrast Enhanced Spectral Mammography)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E450B

BR CT OI

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

Participants
John M. Lewin, MD, Denver, CO (*Moderator*) Nothing to Disclose
Maxine S. Jochelson, MD, New York, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSA02-01 Background Parenchymal Enhancement at Contrast-Enhanced Spectral Mammography (CESM) as a Breast Cancer Risk Factor

Sunday, Nov. 25 10:45AM - 10:55AM Room: E450B

Participants
Yael Yagil, MD, Ramat Gan, Israel (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To assess the extent of background parenchymal enhancement (BPE) at contrast-enhanced spectral mammography (CESM), inter-reader agreement in BPE classification, and correlation between BPE and breast cancer.

METHOD AND MATERIALS

Between 2012 and 2015 a total of 516 women underwent CESM imaging for screening and diagnostic purposes. BPE on CESM images was retrospectively, independently and blindly graded by 4 reviewers using the following scale: minimal, mild, moderate or marked. Inter-reader agreement was estimated using correlation coefficient (ICC). Associations between BPE and clinical factors, biopsy rate and histopathology results were examined using a multivariate logistic regression analysis.

RESULTS

A total of 412 (80%) of women underwent CESM for screening purposes. Mean age was 53 (range 28-77) years and 86.2-94% had a breast density BI-RADS score of C-D. Most women (76.4-90.5%) had minimal or mild BPE at CESM. Overall inter-reader agreement on BPE scores was good (ICC 0.88, 95%CI 0.81-0.92). A total of 122 (24%) biopsies were performed with a malignant histopathology result in 45 (37%) cases. On a multivariate analysis BPE demonstrated a significant association with age (P=0.004, OR 0.942, 95%CI 0.905-0.981) and with biopsy performance rate (P=0.006, OR 2.646, 95%CI 1.319-5.307). Moderate or marked BPE was predictive of a malignant biopsy result (P=0.002, OR 3.105, 95%CI 1.541-6.259).

CONCLUSION

CESM BPE is correlated with age and biopsy rate. Moderate or marked BPE is associated with malignant biopsy results, and hence may predict an increased risk for breast cancer.

CLINICAL RELEVANCE/APPLICATION

CESM BPE grading may be used as an additional risk assessment tool for breast cancer.

SSA02-02 Contrast Enhanced Digital Mammography (CEDM) Helps to Safely Reduce Benign Breast Biopsies

Sunday, Nov. 25 10:55AM - 11:05AM Room: E450B

Participants
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PURPOSE

One criticism of breast imaging is the harm caused by the relatively high rate of biopsy of benign breast lesions -- particularly BIRADS 4A and 4B lesions. The purpose of this project is to assess if CEDM during diagnostic evaluation could increase biopsy PPV for soft tissue density lesions by reducing benign biopsies while not impacting biopsy of cancers.

METHOD AND MATERIALS

This HIPPA compliant IRB approved protocol accrued 57 consenting women aged 34-74 (avg 49) years with 60 BIRADS 4A or 4B soft tissue lesions scheduled for ultrasound (US), stereotactic or tomosynthesis (DBT) directed biopsy from April 2016-November 2017. CEDM was performed immediately prior to biopsy. The cohort included 46 masses, 6 asymmetries and 8 distortions. Pathology confirmed 9 cancers and 51 benign concordant lesions. Four MQSA qualified radiologists reviewed and provided a BIRADS score 3 times for each lesion: first for mammography (M)/DBT only, next with US added and third with CEDM added. Readers recorded if the lesion enhanced, how enhancement compared to background and background parenchymal enhancement. Differences in BIRADS ratings were compared.

RESULTS

After M/DBT and US, prior to CEDM, 173/240 (72%) ratings were classified as > BIRADS 4. After viewing CEDM, 60 of these were re-classified as < BIRADS 3; a 35% average [range 0-59%] reduction in biopsy recommendation ($p<0.05$). Cancers enhanced in 32/36 (89%) ratings and 32/36 cancers were rated as BIRADS >4 before and after CEDM. Benign lesions enhanced in 77/204 (38%) (false positives). With US 3/36 cancer and 44/204 benign were converted to BIRADS>4 and 2/36 cancer and 10/204 benign to BIRADS <3 rating. With CEDM, 1/36 cancer and 8/204 benign were converted to BIRADS>4 and 1/36 cancer and 60/204 benign to BIRADS<3. Hence 1/36 cancer ratings (2.7%) were adversely affected (false negative) by CEDM.

CONCLUSION

CEDM use during diagnostic evaluation of BIRADS 4A or 4B lesions may result in a significant increase in PPV with minimal impact on cancer diagnosis rates.

CLINICAL RELEVANCE/APPLICATION

CEDM use during diagnostic evaluation of BIRADS 4A or 4B soft tissue lesions may significantly reduce the number of women recommended for benign biopsy while missing very few cancers.

SSA02-03 Diagnostic Performance of Contrast-Enhanced Spectral Mammography for Suspicious Malignant Microcalcifications (BI-RADS 4)

Sunday, Nov. 25 11:05AM - 11:15AM Room: E450B

Participants
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PURPOSE

To assess the diagnostic performance of contrast-enhanced spectral mammography (CESM) for evaluation of suspicious malignant microcalcifications (BI-RADS 4) comparing with full-field digital mammography (FFDM).

METHOD AND MATERIALS

Patients with mammographic calcifications without associated mass or distortions and were originally reported as BI-RADS 4 during Jan 2015 to Jan 2018 were retrospectively collected. Lesions that proven through pathological diagnosis either by biopsy or operation were included in the study and grouped as FFDM or CESM according to the examination they received. The microcalcification morphology and associated enhancement (CESM group) were reviewed by two radiologists to analyse the accuracy of the diagnosis . Diagnostic accuracy was assessed respectively for FFDM and CESM versus the results of pathology. Statistical differences of the two methods were compared using Chi-square test.

RESULTS

48 lesions (13 malignant and 35 benign) from 48 patients were enrolled in FFDM group, and 31 lesions (10 malignant and 21 benign) from 30 patients were in CESM group. The diagnostic sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 92.3%, 42.9%, 37.5%, 93.8%and 56.3% for FFDM group, and were 100%, 71.4%, 62.5%, 100% and 80.6% for CESM group, respectively. The specificity and accuracy of CESM were significantly higher than that of FFDM ($p<0.05$). All 10 cancers including 8 DCIS in CESM group were judged as enhancement (table 1).

CONCLUSION

Comparing with FFDM, CESM improve the diagnostic performance on BI-RADS 4 mammographic calcifications, especially on specificity and overall accuracy. The detectability of all DCIS lesions in this small cohort may validate its potential use in previously "calcification only" disease, but still need further large sample to confirm.

CLINICAL RELEVANCE/APPLICATION

CESM improve the diagnostic performance on BI-RADS 4 mammographic calcifications, and decrease unnecessary biopsies.

SSA02-04 Participants

Quantitative Objective Evaluation of Contrast-Enhanced Spectral Mammogram in Predicting Response to Neo-Adjuvant Chemotherapy: A Comparative Study with RECIST 1.1 and Combined Evaluation Methods

Sunday, Nov. 25 11:15AM - 11:25AM Room: E450B

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PURPOSE

Initiating a new objective quantitative tool for evaluation of residual disease after neoadjuvant chemotherapy using CESM in comparison to RECIST 1.1 and combind evaluation methods.

METHOD AND MATERIALS

The study was approved by the ethical commitee of a multidisciplinary breast cancer hospital. It included 42 patients scheduled for receiving NAC. They underwent 2 CESM examinations; prior to and after NAC and maximum10 days prior to surgery. All patients were assessed using the RECIST 1.1 criteria, a combined approach (RECIST+ qualitative subjective assessment) and a new quantitaive approach using an image analysis software (MATLAB and Simulink, Release 2013b). The technique consists of 3 main steps: 1-preprocessing 2. extracting the region of Interest (ROI) and 3- Assessing the response to chemotherapy depending on the analysis of the tumour number of pixels included within the ROI. The difference in the intensity of enhancmenet between the pre and post NAC enahncement is calculated and compared between the 3 assessment methods in correlation to postoperative pathology using the Miller-Payne grading. For statistical evaluation, patients were classified into responders and non-responders.

RESULTS

The calculated correlation coefficient when comparing the residual disease on CESM and Miller payne grade using RECIST 1.1, the combined approach and the proposd quantitative method was 0.59, 0.89 and 0.69 respectively. According to Miller Payne grading 39/42 cases were classified as responders (Miller payne III, IV, and V). Using the new quantitive approach all 39/39 cases (100%) were considered responders in comparison to 38/39 using the combined approach and 34/39 using the RECIST 1.1 criteria. The calculated sensitivity, positive and negative predictive values of the quantitative objective evaluation (100, 97.5,100 % respectively) was higher than the RECIST method (87.2%, 97.1% 28.6%) and the combined response method (97.4%,97.4% and 66.7%).

CONCLUSION

Quantitative objective analysis of CESM allows accurate objective evaluation of the response of breast cancer to chemotherapy and evaluation of residual tumor prior to surgery.

CLINICAL RELEVANCE/APPLICATION

Objective analysis of CESM is an accurate tool for evaluation of the response of breast cancer post neo-adjuvant chemotherapy and is recommended as part of pre-operative work up

SSA02-05 Diagnostic Value of Contrast-Enhanced Spectral Mammography in Comparison to MRI in a Population of Breast Lesions

Sunday, Nov. 25 11:25AM - 11:35AM Room: E450B

Participants
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Amiee Chen, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Huizhi Cao, PhD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the diagnostic value between contrast-enhanced spectral mammography (CESM) and breast magnetic resonance imaging (MRI).

METHOD AND MATERIALS

Between July 2017 and February 2018, 235 patients who were suspected of breast abnormalities by clinical examination or mammography were underwent CESM and MRI examination. The image of CESM and MRI and the pathological specimens were analyzed. All lesions were evaluated independently by three experienced radiologists. Using histopathological results as the gold standard, the diagnostic performance of CESM and MRI were investigated. The areas under ROC curves was applied to analyze diagnostic efficiency. The data on maximum tumor size measurements were gathered on CESM and MRI. The Pearson's correlation coefficients and 95% confidents intervals between CESM vs. pathology and MRI vs. pathology were calculated.

RESULTS

263 breast lesions were found in 235 patients, in which 177 were malignant and 86 were benign. By evaluating the diagnostic value,

the sensitivity, positive prediction value, negative predictive value, and false-negative from CESM examination was comparable to that from MRI (91.5%,94.7%,83.7%,8.5% versus 91.5%,90.5%,82.1%,8.5%). Importantly, the accuracy and the specificity were higher for CESM than that for MRI (81%,89.5% Vs. 80.2%,71.7%) while the the false-positive was lower(10.5% Vs. 19.8%). The areas under ROC curves of CESM and MRI were 0.950 and 0.939, displaying the equivalent diagnostic efficiency (p=0.48). For the agreement between measurements, mean tumor size was 3.1 (range 0-16) cm for CESM and 3.4 (range0-17) cm for MRI compared with 3.2 (range 0-16) cm on histopathological results, the average difference of diameters between CESM, MRI and Histopathologic size was -0.01, -0.05cm, respectively, with 95% consistency interval range of -0.34 to 0.31, -0.87 to 0.22cm, respectively. The Pearson's correlation coefficients of CESM versus histopathology (r=0.774, p=0.000) was consistent with MRI (r=0.771, p=0.000).

CONCLUSION

Our results show better accuracy, specificity and the lower false-positive of CESM in breast cancer detection than MRI. CESM displayed a good correlation with histopathology in assessing the lesion size of breast cancer, which is consistence with MRI.

CLINICAL RELEVANCE/APPLICATION

CESM provides additional enhancement information for diagnosing breast lesions and measuring cancer sizes with high correlation to surgicohistology.

SSA02-06 Usefulness of Low-Dose Perfusion Breast CT: Quantification of Tumor Vascularity and Prediction of Histologic Biomarkers in Invasive Breast Cancer

Sunday, Nov. 25 11:35AM - 11:45AM Room: E450B

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PURPOSE

To investigate the usefulness of low-dose perfusion breast computed tomography (CT) for quantification of tumor vascularity and for prediction of histologic biomarkers in invasive breast cancer.

METHOD AND MATERIALS

This prospective study was approved by IRB with informed consent. A total of 139 patients with invasive breast cancers were enrolled. Low-dose perfusion CT was performed in the prone position with a spectral CT (iQon, Philips Healthcare) after contrast injection (Xenetix350, Guerbet). Effective dose was less than 1.2 mSv. Perfusion parameters were measured using a Philips Advanced Perfusion and Permeability application prototype in breast cancers, normal breast tissue, and fat; peak enhancement intensity (HU), perfusion on deconvolution model (mL/min/100/g), mean transit time (sec), time to peak (sec), blood volume (mL/100/g), permeability (mL/min/100/g), and blood volume permeability on Patlak model (mL/100/g). CT perfusion parameters of cancers and normal tissue or fat were compared using Mann-Whitney test. Correlation analysis was performed between CT perfusion parameters of cancers and histologic biomarkers including tumor grade, estrogen receptor (ER), progesterone receptor (PR), human epidermal growth factor receptor 2 (HER2), and Ki67 using Mann-Whitney or Kruskal-Wallis test.

RESULTS

In breast cancers, peak enhancement intensity, perfusion, blood volume, permeability, and blood volume permeability were significantly higher, and mean transit time, time to peak were shorter than those values in normal glandular tissues and fat ($P<.001$ for all). Peak enhancement intensity significantly increased in cancers with ER-, PR-, HER2+, Ki67+ or more than 20 mm ($P<.05$ for all). Time to peak decreased in cancers with ER-, PR-, HER2+, Ki67+, high grade, or more than 20 mm ($P<.05$ for all). Blood volume permeability increased in cancers with ER-, PR-, Ki67+, or high grade ($P<.05$ for all). HER2-enriched cancers showed higher peak enhancement intensity and blood volume permeability than luminal type cancers ($P<.02$ for all).

CONCLUSION

Low-dose perfusion breast CT can be useful in quantifying tumor vascularity and predicting prognostic biomarkers of invasive breast cancer.

CLINICAL RELEVANCE/APPLICATION

Low-dose perfusion breast CT can be used to quantify tumor vascularity and to predict biomarkers of invasive breast cancer and for patients who have difficulty with magnetic resonance imaging.

SSA02-07 Contrast-Enhanced Cone-Beam Breast-CT without Prior Non-Contrast Scan: Can We Reduce Radiation Exposure While Maintaining Diagnostic Accuracy?

Sunday, Nov. 25 11:45AM - 11:55AM Room: E450B

Participants
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Uwe Fischer, MD, Goettingen, Germany (*Abstract Co-Author*) Nothing to Disclose
Joachim Lotz, MD, Gottingen, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Contrast-enhanced cone-beam breast-CT (CE-CBCT) is a novel breast imaging technique with comparably high radiation dose. The current diagnostic standard includes one non-contrast scan (NC-CBCT) followed by intravenous contrast media injection and a contrast-enhanced scan (CE-CBCT). Performing only the CE-CBCT scan might reduce radiation exposure. Our study aims to evaluate whether CE-CBCT alone is comparable to combined NC + CE-CBCT regarding diagnostic accuracy while reducing radiation exposure.

METHOD AND MATERIALS

This prospective IRB-approved study included 48 women (61 breasts, 100 lesions) with median age 57.9 years (IQR: 49-66 years) and BI-RADS 4/5 lesions diagnosed on mammography/ultrasound in ACR density types c/d breasts. Two blinded breast radiologists read CE-CBCT alone versus NC-CBCT + CE-CBCT in consensus. Intra-observer variability was assessed by one reader performing independent double reading. Sensitivity, specificity and AUC were measured separately for CE-CBCT alone versus NC + CE-CBCT.

RESULTS

Of 100 lesions, 51 were rated as malignant, 6 as high risk and 43 as benign. Histopathological assessment was performed in 63 breast lesions and imaging follow-up over at least 1 year in another 37 lesions. Diagnostic accuracy for both CBCT approaches was comparable: AUC, sensitivity and specificity showed no significant differences comparing CE-CBCT alone versus NC + CE-CBCT (AUC: 0.84 vs. 0.83, p=0.643; sensitivity: 0.89 vs. 0.85, p=0.158; specificity: 0.73 vs. 0.76, p=0.655). Inter- and intra-observer agreement on BI-RADS readings were excellent (ICC=0.76, ICC=0.83, respectively). Radiation dose was significantly lower for CE-CBCT alone versus NC + CE-CBCT (median average glandular radiation dose 5.9 mGy vs. 11.7 mGy, p<0.001).

CONCLUSION

The diagnostic accuracy of CE-CBCT alone is comparable to that of combined NC + CE-CBCT in ACR type c/d breast. At the same time, CE-CBCT significantly reduces radiation exposure to the breast. Further research is warranted to confirm these findings in a larger and generalizable population.

CLINICAL RELEVANCE/APPLICATION

Assessment of CE-CBCT alone yields comparable diagnostic accuracy to combined NC + CE-CBCT and reduces radiation exposure by up to 50%. Additional acquisition of NC-CBCT might therefore be unnecessary.

SSA02-08 Automatic Classification of Breast Lesions in Contrast Mammography Using Deep Learning in Conjunction with Multimodal Information: BIRADS Lexicon Features and Raw Image Features

Sunday, Nov. 25 11:55AM - 12:05PM Room: E450B

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PURPOSE

To assess the combined usage of BIRADS lexicon and pixel data for multimodal automatic classification of breast lesions in dual energy contrast enhanced spectral mammography (CESM) and evaluate its potential for biopsy sparing in benign breast lesion.

METHOD AND MATERIALS

130 biopsy proven CESM breast lesions, (65 benign and 65 malignant) were manually contoured and described by the BIRADS lexicon. BIRADS data was encoded by a binary vector for each lesion which, together with the lesion pixels, formed a multimodal representation. A deep neural network was designed to process pixel data from its entry layer and merge it with BIRADS data in its deepest layers to better balance between low-level pixel information and high-level BIRADS data that need to be merged. The network was validated in a 5-folds cross-validation (CV) scheme, to tell apart benign/malignant lesions. In each fold, a different subset of 25 lesions was used for testing, and the rest for training. This CV was conducted using 3 different configurations, in order to assess and compare the contributions of different information modalities. (a) BIRADS-only classifier using SVM (BOC), (b) pixel-only network (PON), (c) and the multimodal BIRADS+pixels network (MBPN).

RESULTS

The results are shown in Fig.1, where blue is benign and red is malignant. The classification score (y axis) reflects malignancy probability. We seek a threshold, below which there are only benign lesions, so that no malignancy is missed, i.e. sensitivity=100% (green line Fig.1). With this condition in mind, the maximal specificities (SP) are: (a) BIRADS only, SP=12%; (b) pixel-only network, SP=37%; (c) multimodal BIRADS and pixel network (MBPN), SP=60%. This means that with MBPN we can safely spare unnecessary biopsy for 60% of benign lesions without missing any malignancies.

CONCLUSION

This research showed that the combined usage of BIRADS data, provided by the radiologist, with pixel data extracted from CESM strongly improves the specificity obtained for automatic lesion classification on pixel or BIRADS data alone.

CLINICAL RELEVANCE/APPLICATION

Multimodal lesion classification in CESM may significantly reduce benign breast biopsies, thus reducing cost and improving patient experience.

SSA02-09 Preoperative Diagnosis of Metastatic Axillary Sentinel Lymph Nodes in Breast Cancer with Quantitative Parameters Derived from Dual-Energy Spectral CT

Sunday, Nov. 25 12:05PM - 12:15PM Room: E450B

Participants
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Jun Shen, MD, Guagnzhou, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The purpose of this study was to evaluate the diagnostic performance of gemstone spectral imaging (GSI) quantitative parameters derived from dual-energy spectral computed tomography (DEsCT) for the preoperative diagnosis of metastatic sentinel lymph nodes (SLNs) in patients with breast cancer.

METHOD AND MATERIALS

This prospective study was approved by the ethics committee, and all patients provided written informed consent. From June 2015 to December 2017, dual-phasic contrast-enhanced DEsCT was performed in 193 female patients with breast cancer. Quantitative GSI and morphological parameters were compared between metastatic and non-metastatic SLNs. The quantitative parameters were fitted to univariate and multiple logistic regression models. Their diagnostic abilities were analyzed by receiver operating characteristic curves and compared by the McNemar test.

CONCLUSION

DEsCT can be used as a complementary means for the preoperative identification of SLN metastases in patients with breast cancer.

CLINICAL RELEVANCE/APPLICATION

The slope of the Hounsfield unit curve in venous phase derived from dual-energy spectral CT, can be used to differentiate metastatic from non-metastatic axillary sentinel lymph nodes of breast cancer.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSA03

Science Session with Keynote: Cardiac (Coronary CTA: Flow and Fractional Flow Reserve)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S404AB

CA CT

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

FDA Discussions may include off-label uses.

Participants

Belinda D'Souza, MD, New York, NY (*Moderator*) Nothing to Disclose
U. Joseph Schoepf, MD, Charleston, SC (*Moderator*) Research Grant, Astellas Group; Research Grant, Bayer AG; Research Grant, Siemens AG; Research support, Bayer AG; Consultant, Guerbet SA; Consultant, General Electric Company; Consultant, HeartFlow, Inc; Consultant, Bayer AG; Consultant, Siemens AG; ; ;
Bernd J. Wintersperger, MD, Toronto, ON (*Moderator*) Speaker, Siemens AG; Research support, Siemens AG; Institutional research agreement, Siemens AG; Speaker, Bayer AG

Sub-Events

SSA03-01 The Relationship of Coronary Endothelial Shear Stress (ESS) at Baseline and Hyperemia, and Its Association to Invasive Fractional Flow Reserve (FFR) and Computed Tomography Angiography FFR (CT-FFR)

Sunday, Nov. 25 10:45AM - 10:55AM Room: S404AB

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

Low baseline ESS promotes development of high-risk plaque features. High ESS in one CTA-based hyperemic simulation technology (Heartflow FFRCT) was also recently shown to predict invasive FFR<=0.8. We determined the relationship of resting to hyperemic ESS using non-proprietary CTA-based rest/stress simulation algorithms, and whether flow state affects the ability of ESS to predict FFR<=0.8. Neither of these relationships have been previously assessed for data derived entirely from CTA.

METHOD AND MATERIALS

Computational fluid dynamics (CFD) was performed for 63 adults from CTA prior (<90d) to invasive FFR. Rest-state CFD used only CTA data (myocardial mass, Murray's law). Stress CFD coupled the epicardial arteries to a microvascular resistance model using 1/4 the resistance values obtained by the rest CFD. Only commercial CTA segmentation and CFD software was used. Rest and stress ESS at relevant locations (eg, coronary segments, across lesion, min lumen diameter, every 3 mm, min/max ESS) were compared (t-test) between FFR<=0.8 vs >0.8 vessels. Receiver operating characteristic area-under-the-curve (AUC) to predict FFR<=0.8 in all vessels was compared for diameter stenosis (%DS) and plaque volume (%PV) by CTA, CT-FFR, and rest and stress ESS.

RESULTS

In vessels where CT-FFR differed <0.05 from FFR (ie, stress CFD matched the patient's true hyperemic conditions), most ESS metrics differed significantly for FFR<=0.8 vs >0.8 vessels, eg lesion rest ESS=4.2 vs 1.9 Pa (p=0.012) and stress ESS=17.0 vs 9.6 (p=0.001), or, maximum ESS (rest: 9.5 vs 4.1, p=0.001; stress: 37.0 vs 19.6, p<0.001). Notably, the minimum ESS did not differ for FFR<=0.8 vs >0.8 vessels (rest p=0.184, stress p=0.454), but the location of minimum ESS differed in 31 of 40 vessels between rest and stress. AUC to detect FFR<=0.8 was 0.57 for CTA %DS, 0.74 for %PV, 0.9 for CT-FFR, and 0.86 for rest and 0.85 for stress ESS across the lesion. The AUC of rest and stress ESS was not inferior to that of CT-FFR (p=0.446); CT-FFR statistically significantly improved only upon the AUC of %PV.

CONCLUSION

High ESS across a lesion at either baseline or hyperemia is associated with lesion-specific ischemia, and both have similar diagnostic accuracy as CT-FFR to detect FFR<=0.8. Low ESS regions differ between rest and stress.

CLINICAL RELEVANCE/APPLICATION

ESS from CTA can detect lesion-specific ischemia similarly to CT-FFR, with or without the need to simulate hyperemia.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Frank J. Rybicki III, MD, PhD - 2016 Honored Educator

SSA03-02 Comparison Between Stress Cardiac Computed Tomography Perfusion versus Fractional Flow Reserve CT Derived in the Evaluation of Suspected Coronary Artery Disease: PERFECTION Prospective Study

Sunday, Nov. 25 10:55AM - 11:05AM Room: S404AB

Participants
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PURPOSE

The PERFECTION study is a longitudinal, prospective and consecutive cohort study to compare the feasibility and accuracy of FFRCT versus stress-CTP for the diagnosis of functionally significant CAD.

METHOD AND MATERIALS

One-hundred-forty-seven consecutive symptomatic patients (Mean age: 65.8±9.2; Male: 105) for chest pain who were referred for non-emergent, clinically indicated ICA plus invasive FFR were enrolled. The primary endpoint was to compare the diagnostic accuracy of cCTA versus cCTA+FFRCT versus cCTA+stress-CTP for the detection of significant CAD in a vessel and patients-based analysis defined by ICA with an invasive FFR <= 0.80 or coronary artery stenoses >= 80% or totally occluded vessels.

RESULTS

Rest cCTA was successfully performed in all patients, FFRCT was performed in 143 out of 147 patients and stress-CTP was performed in 144 out of 147 patients. cCTA demonstrated a vessel and patient-based sensitivity (SE), specificity (SP), negative predictive value (NPV), positive predictive value (PPV) and diagnostic accuracy (ACC) of 99%, 76%, 100%, 61%, 82% and 95%, 54%, 94%, 63%, 74%, respectively. The diagnostic performance of integrated protocol of rest cCTA+FFRCT showed a vessel and patient-based SE, SP, NPV, PPV and ACC of 88%, 94%, 95%, 84%, 92% and 90%, 85%, 92%, 83%, 87%, respectively. Finally, the diagnostic performance of integrated protocol of rest cCTA+stress-CTP showed a vessel and patient based SE, SP, NPV, PPV and ACC of 92%, 95%, 97%, 87%, 94% and 98%, 87%, 99%, 86%, 92%, respectively. Both FFRCT and stress-CTP significantly improved SP, PPV and overall ACC in both per-vessel and per-patient based model when added to cCTA, while no differences were found between cCTA+FFRCT versus cCTA+stress CTP.

CONCLUSION

Both FFRCT and stress-CTP are valid tool in addition to cCTA to evaluate the functional relevance of CAD. Based on these results, in patients with suspected CAD, cCTA alone or with integrated FFRCT might be sufficient to exclude relevant stenosis with the advantage to require a single acquisition with a low radiation exposure and low amount of contrast agent. Nevertheless, it might be reasonable to combine stress-CTP data in some patients with positive integrated cCTA+FFRCT exam thanks to the better specificity.

CLINICAL RELEVANCE/APPLICATION

FFRCT and CTP in addition to cCTA can be helpful to evaluate the functional relevance of CAD

SSA03-03 CT Myocardial Perfusion Imaging and CT Angiography-Derived Coronary Fractional Flow Reserve for the Prediction of Major Adverse Cardiac Events in Patients with Coronary Artery Disease

Sunday, Nov. 25 11:05AM - 11:15AM Room: S404AB

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PURPOSE

To determine the prognostic value of dynamic CT perfusion imaging (CTMPI) and CT coronary angiography (CCTA)-derived fractional flow reserve (CT-FFR) for the prediction of major adverse cardiac events (MACE).

METHOD AND MATERIALS

Data was included from four institutions using patients who underwent CCTA and stress dynamic CTMPI on a 3rd generation dual-source CT system with a follow up period of 18 months or until MACE occurred. On-site CT-FFR was computed for each coronary artery. Using CTMPI data, a myocardial blood flow (MBF) index was calculated, for which each vessel territory was normalized to global MBF. The lowest CT-FFR and MBF index was recorded for each patient. The prognostic value of CTA, CT-FFR, MBF index, as well as the combination of the three was evaluated for the prediction of MACE using binary logistic regression and measures of diagnostic accuracy.

RESULTS

Of the 81 total patients included, 25 (31%) experienced MACE during the follow up period. CCTA alone had an area under the curve (AUC) of 0.655 for predicting MACE, with a corresponding sensitivity and specificity of 56% and 75%, respectively. The CT-FFR AUC for the prediction of MACE was 0.703 with a sensitivity and specificity of 64% and 80%, respectively. The optimal threshold computed with the Youden index was 0.75. Dynamic CTMPI had an AUC of 0.812 using the index MBF with a sensitivity and specificity of 88% and 75%, respectively. Using the Youden index, the optimal threshold for index MBF was 0.88. In cases with a negative CTMPI and positive CT-FFR, index MBF was most predictive of outcome (83% of patients). The combination of CCTA, CT-FFR, and CTMPI resulted in an improved AUC of 0.857 compared to CT-FFR and CTMPI alone.

CONCLUSION

Combined CT-FFR and dynamic CTMPI analysis based on cardiac CT imaging is a promising approach for the prediction of MACE in patients with coronary artery disease. While both techniques individually demonstrate good diagnostic accuracy, an integrated approach using both modalities improved the diagnostic accuracy for predicting MACE.

CLINICAL RELEVANCE/APPLICATION

This study shows the benefit of a combined CT-FFR/CTMPI approach to predict MACE. The correct identification of patients at risk of MACE can improve the efficiency and cost-effectiveness of treatment.

SSA03-04 Machine Learning Based CT-FFR Integrating With Quantitative Myocardial Mass Subtended By Coronary Stenosis Outperforms Plaque Features for Predicting Hemodynamical Significance of Lesions

Sunday, Nov. 25 11:15AM - 11:25AM Room: S404AB

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PURPOSE

To study the diagnostic performance of the ratio of subtended myocardial mass to the minimal lumen diameter (MLD) at coronary computed tomographic angiography (CCTA) and machine learning based CT-FFR for differentiating functionally significant from insignificant lesions, with reference to fractional flow reserve (FFR).

METHOD AND MATERIALS

Patients who underwent both coronary CTA and FFR measurement at invasive coronary angiography (ICA) within 2 weeks were retrospectively included in our study. CT-FFR, subtended myocardial mass (V sub), percentage of V sub, V ratio/MLD, along with other parameters, including minimal luminal area (MLA), MLD, lesion length (LL), diameter stenosis, area stenosis, plaque burden, and remodeling index, low attenuation plaque, napkin-ring sign, spotty calcification of lesions were recorded. Lesions with FFR <= 0.8 were considered to be functionally significant.

RESULTS

One hundred and seventy-two patients with 196 lesions were ultimately included for analysis. The LL, diameter stenosis, area stenosis, plaque burden, V sub , V ratio and V ratio/MLD were all significantly longer or larger in the group of FFR <= 0.8 ($p < 0.001$ for all), while smaller MLA, MLD and CT-FFR value were also noted ($p < 0.001$ for all). There were no significant differences between the hemodynamic significant subgroup and insignificant subgroup with respect to the risky plaque features The area under the curve (AUC) of V ratio/MLD was comparable to that of CT-FFR (AUC=0.84 vs 0.88; p=0.28) and was significantly better than other parameters and for diagnosing functionally significant stenosis. For vessels with CT-FFR values below 0.70, 0.70 to 0.79, 0.80 to 0.89, and above 0.89, diagnostic accuracy of CT-FFR was 92.6%(25/27), 61.8%(34/55), 83.9%(47/56), 94.8%(55/58), respectively. For lesions with CT-FFR values ranging from 0.70 to 0.79, the accuracy could be improved to 80.0% (44/55) if these lesions were evaluated with Vratio/ MLD instead of CT-FFR.

CONCLUSION

The "grey-zone" lesions, which have CT-FFR values ranging from 0.7 to 0.8, showed lower diagnostic performance. A stepwise

approach, reserving Vratio/ MLD for "grey-zone" lesions instead of CT-FFR, can improve diagnostic accuracy.

CLINICAL RELEVANCE/APPLICATION

integrating ML based CT-FFR and V ratio/MLD allowed the most accurate discrimination between flow-limiting and non flow-limiting coronary lesions.

SSA03-05 Coronary Computed Tomography Angiography-Derived Fractional Flow Reserve in Anomalous Origin of the Right Coronary Artery from the Left Coronary Sinus

Sunday, Nov. 25 11:25AM - 11:35AM Room: S404AB

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PURPOSE

To examine fractional flow reserve derived from computed tomographic angiography (FFRCT) in patients with anomalous origin of the right coronary artery from the left coronary sinus with interarterial courses (AORLIC), its relationship with patient demographics, anatomical features of AORLIC on coronary computed tomographic angiography (CCTA) images, and its clinical relevance.

METHOD AND MATERIALS

Ninety-four patients with AORLIC who underwent CCTA were retrospectively included. Anatomic features (including RCA ostium location relationship with the pulmonary valve [high or low interarterial courses], takeoff angle, degree of stenosis, etc.) associated with abnormal FFRCT values (<0.8) on CCTA were analyzed. Patient demographics and anatomical data were analyzed using binary logistic regression analysis. Receiver operating characteristic analyses were performed to describe the diagnostic performance in detecting AORLIC with normal or abnormal FFRCT values.

RESULTS

Compared to patients with normal FFRCT values, more patients with high interarterial courses and greater proximal RCA stenosis were found to have abnormal FFRCT values (all P < 0.05). AORLIC with high interarterial courses was found to be the main contributor to abnormal FFRCT values (odds ratios =4.61, 95% confidence interval [CI], 1.51-14.08; P=0.007). The corresponding sensitivity and specificity for predicting abnormal FFRCT were 57.4% and 76.6%, respectively (area under the curve=0.670, 95% CI: 0.560-0.781). AORLIC patients with abnormal FFRCT values showed a higher prevalence of typical angina (19.1% vs 4.3%, P=0.025) and atypical angina (23.4% vs 6.4%, P=0.026) compared to patients with normal FFRCT values.

CONCLUSION

AORLIC patients with abnormal FFRCT values have a higher prevalence of high interarterial courses, typical angina, and atypical angina than patients with normal FFRCT values.

CLINICAL RELEVANCE/APPLICATION

Patients with AORLHIC were more likely to have abnormal FFRCT, showing a higher prevalence of typical angina and atypical angina compared to patients with normal FFRCT values. Thus, this noninvasive FFRCT method may have potential to identify patients at risk for sudden cardiac death.

SSA03-06 Building-Block-Based 3D Deep Learning: Fully Automated Estimation of Fractional Flow Reserve from Coronary CT Angiography

Sunday, Nov. 25 11:35AM - 11:45AM Room: S404AB

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PURPOSE

To evaluate the accuracy of a building-block-based fully automated 3D deep-learning model for estimating fractional flow reserve

(FFR) from whole coronary CT angiography (CCTA) data, with catheter FFR as the reference standard.

METHOD AND MATERIALS

This HIPAA-compliant, IRB-approved retrospective study of 1052 consecutive patients (mean age, 63 ± 17 years) included 131 patients whose CCTA studies showed 30%-90% stenosis in at least one segment and underwent catheter FFR, and 921 patients who underwent clinically indicated CCTA without catheter FFR. We designed a fully automated building-block-based 3D deep-learning model that inputs whole CCTA data and outputs FFR without requiring any manual segmentations. The model was trained with all 1052 CCTAs. The model comprised lumen extraction, residual extraction, and prediction blocks. In the first and second blocks, a conditional generative adversarial network and a 3D convolutional ladder network, respectively, were used to extract specific features from the CCTA by eliminating image inputs less related to FFR estimation. The prediction block estimated FFR via two independent neural networks with integrated virtual adversarial training and a self-consistency check to reduce overfitting. We used Monte Carlo cross-validation to evaluate the accuracy of the deep-learning model for estimating FFR, with catheter FFR as the reference standard.

RESULTS

Abnormal catheter FFR values (<=0.8) were observed in 55% of the labeled data (72/131). The deep-learning FFR achieved area under the curve (AUC) of the receiver-operating curve of 0.72 for detection of abnormal FFR, which is significantly higher than for CTA > 50% stenosis (AUC = 0.56). The deep-learning FFR model achieved 76% accuracy for detecting abnormal FFR, with sensitivity of 86.2% (95%CI: 80.5%-90.7%) and specificity of 61.2% (52.4%-69.5%).

CONCLUSION

The building-block-based 3D deep-learning model, performing fully automatic estimation of FFR from whole cardiac CT data, achieved accuracy of 76% for the detection of abnormal FFR.

CLINICAL RELEVANCE/APPLICATION

Our deep-learning model estimates FFR without time-consuming vessel segmentation and may greatly improve the clinical workflow when selecting patients suitable for revascularization procedures.

SSA03-07 Prediction of Lesion-Specific Ischemia from Machine Learning-Derived Fractional Flow Reserve

Sunday, Nov. 25 11:45AM - 11:55AM Room: S404AB

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PURPOSE

This study evaluate the diagnostic performances of machine learning-based model for predicting fractional flow reserve (ML-FFR) and computed tomography (CT) derived-FFR (CT-FFR) in patients with coronary artery diseases with reference standard of invasive FFR.

METHOD AND MATERIALS

In 472 patients with coronary artery diseases, CT angiography (CTA) and invasive coronary angiography were performed with FFR in 555 lesions. CTA data were visually analyzed to evaluate the location, stenosis degrees and plaque types, and analyzed by semi-automated software to quantify computational fluid dynamics (CFD)-based CT-derived FFR. The trained ML-FFR at each point along the centerline of the coronary tree, was obtained by automated feature selection and model building from quantitative CTA. Correlation between CT-FFR and ML-FFR was obtained. The diagnostic performance of CFD-based CT-FFR and ML-FFR were compared using invasive FFR as reference standard.

RESULTS

A total of 270 lesions showed ischemia by invasive FFR (FFR <= 0.80). The correlation between CFD-based CT-FFR and ML-FFR was high (r= 0.60 - 0.99, P<0.001). CT-FFR showed moderate to high sensitivity and specificity for all lesions including left main, left anterior descending, left circumflex and right coronary arteries (Sensitivity: 55.4 - 83.3; specificity 65.1 - 73.9). For intermediate (visual stenosis grading 30-80%) lesions and tandem lesions, moderate sensitivity and specificity were observed (sensitivity: 65.1 and 62.5; specificity: 70.7 and 58.0, respectively). ML-FFR showed comparable results to CT-FFR for all lesions (Sensitivity: 57.1 - 83.3; specificity 66.5 - 77.3), and also in intermediate or tandem lesions (sensitivity: 65.1 and 62.5; specificity: 71.3 and 59.1, respectively). Compared with the CFD-based CT-FFR, the time to perform ML-FFR was shortened to a few seconds.

CONCLUSION

ML-FFR showed comparable results to CFD-based CT-FFR for the prediction of lesion-specific ischemia confirmed by invasive FFR.

CLINICAL RELEVANCE/APPLICATION

ML-FFR can be used as additional information after obtaining CTA for evaluation of coronary artery stenosis with equivalent diagnostic performance of CFD-based CT-FFR.

SSA03-08 Cardiac Keynote Speaker: Value of CTA for Fractional Flow Reserve

Sunday, Nov. 25 11:55AM - 12:15PM Room: S404AB

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SSA04

Science Session with Keynote: Cardiac (Nonischemic Cardiomyopathies)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S404CD

CA MR

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

SSA04-01 Cardiac Keynote Speaker: Prognostic Role of MR Imaging in Nonischemic Myocardial Disease

Sunday, Nov. 25 10:45AM - 11:05AM Room: S404CD

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SSA04-03 Prevalence, CMR Characteristics, and Outcomes of Hypertrophic Cardiomyopathy with Restrictive Phenotype

Sunday, Nov. 25 11:05AM - 11:15AM Room: S404CD

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PURPOSE

Previous reports indicated that there was a subgroup of HCM with restrictive phenotype, which was defined by restrictive filling and reduced diastolic volumes. However, the CMR characteristics and prognosis of the restrictive phenotype has not been systematically investigated. The aim of this project was to investigate the prevalence, clinical significance, CMR characteristics and outcomes of hypertrophic cardiomyopathy (HCM) with restrictive phenotype .

METHOD AND MATERIALS

A total of 2892 consecutive patients with HCM were evaluated to identify individuals who fulfilled diagnostic criteria for restrictive phenotype. 32 patients of HCM with restrictive phenotype and 32 age and gender matched patients with typical non obstructive HCM were retrospectively enrolled.

RESULTS

The left and right atrium diameter were 55.4±4.8 mm and 61.4±8.7 mm, which were significantly larger than those of the controls ($p<0.001$); The left ventricular end-diastolic volume index, the cardiac index, and the left heart ejection fraction of patients with restrictive phenotype were all significantly less than those of the controls. The segments with late gadolinium enhancement(LGE) were 7.8±2.4 in restrictive phenotype group, which were significantly greater than controls (4.6±2.3, $p=0.004$). The 62-month survival rate was 54.1% in HCM with restrictive phenotype, compared with 91.7% in control group.

CONCLUSION

Restrictive phenotype is a special subtype of HCM. The MR features of this phenotype include mild-to-moderate left ventricular hypertrophy, severely enlarged atria, normal or small ventricles, pericardial effusion and a wide range of LGE. These patients have severe clinical symptoms and poor prognosis. MRI shows high diagnostic value in the identification of this phenotype.

CLINICAL RELEVANCE/APPLICATION

MRI shows high diagnostic value in the identification of hypertrophic cardiomyopathy with restrictive phenotype and will help indicate patients' prognosis.

SSA04-04 The Prognostic Significance of Subclinical Myocardial Deformation for Heart Failure in End-Stage

Renal Disease

Sunday, Nov. 25 11:15AM - 11:25AM Room: S404CD

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PURPOSE

This study aimed to investigate the subclinical myocardial deformation of left ventricle (LV) in end stage renal disease (ESRD) patients by cardiac magnetic resonance (CMR) tissue tracking and explore its prediction of HF.

METHOD AND MATERIALS

Sixty-two consecutive ESRD patients with preserved LV ejection fraction (LVEF>50%) and 21 age- and sex- matched healthy volunteers were prospectively recruited and underwent 3.0T CMR examination. A series of SSFP cine sequence, including short axis, horizontal 4-chamber and vertical 2-chamber long axis were scanned. LV function variables were measured. LV myocardial strain parameters such as global peak strain (PS), peak strain rate, peak velocity indices were automatically computed. After examination, patients were followed up for a duration of 11-30 months to assess HF outcome by phone contact.

RESULTS

ESRD patients with preserved LVEF had decreased radial, circumferential and longitudinal PS compared with normal controls (42.11±12.53% vs. 48.01±11.22%, -17.89±2.73% vs. -19.67±2.23%, -15.25±2.49% vs. -17.18±2.52%; respectively, all P<0.05). After a 11-30-month follow-up, 30 of 62 patients had HF. By analyzing myocardial strain data, it showed that ESRD patients suffered from HF was already found to have lower values of PS in three directions than both normal controls and patients free from HF (all P<0.05). The global circumferential and longitudinal PS were proven to be significant risk factors of HF (OR 1.294, 1.228; 95% confidence interval 1.100-1.522, 1.035-1.457; respectively, all P<0.05). A significantly lower survival rate and higher risk of HF were displayed in patients with circumferential and longitudinal PS lower than the median value. Cut-off values of PS -18.78% for circumferential and -14.54% for longitudinal to discriminate HF outcome was identified with relatively high sensitivity and specificity (AUC of 0.840, 0.821, respectively).

CONCLUSION

CMR tissue tracking provided subclinical and prognostic information to predict HF in ESRD patients before notably decreased LVEF. LV global circumferential and longitudinal PS were demonstrated to be independent risk factors of HF in ESRD patients.

CLINICAL RELEVANCE/APPLICATION

Our study proved the ability of CMR tissue tracking parameters to provide subclinical and prognostic information to predict heart failure in ESRD patients before notably decreased LVEF which may give a guidance of appropriate and early cardiovascular treatment.

SSA04-05 Value of Fractal Analysis in Identification and Further Discrimination of Isolated Left Ventricular Non-Compaction and Dilated Cardiomyopathy by Cardiac Magnetic Resonance

Sunday, Nov. 25 11:25AM - 11:35AM Room: S404CD

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PURPOSE

The aim of this study was to compare cardiac magnetic resonance imaging (MRI) features between isolated left ventricular non-compaction (IVNC) and dilated cardiomyopathy(DCM).

METHOD AND MATERIALS

A consecutive series of 35 patients with IVNC (males,n=23) and 30 patients with DCM (males,n=21) from a tertiary university hospital were reviewed. 20 healthy volunteers (males,n=13) were selected as control group.All groups were matched for age, gender, and body surface area. The degree of LV trabeculation was evaluated by a semi-automatic tool based on fractal analysis (FA).The resulting FD is a unitless measure value of how completely the object fills space. Myocardial deformation and Left ventricular (LV) function was assessed by feature tracking.

RESULTS

IVNC group had higher max apical FD and mean global FD than DCM group (max apical FD:1.433±0.074 vs. 1.341±0.062,P < 0.001; mean global FD:1.323±0.036 vs.1.267± 0.041, p<0.001, respectively). FDs show positively correlation with the ratio of NC/C . Compared with controls, both patient groups showed significantly reduced strain and strain rate values of all LV segments. Of note,The global longitudinal strain value of the left ventricle (GPSL) was different in the IVNC group -6.49(-11.41, -4.90) and the

DCM group -4.61(-5.87, -3.61) (P < 0.01). and Left ventricular (LV) function . The diagnostic accuracy is equivalent in univariable, but the accuracy is higher when using FDs in coordination with myocardial deformation(AUC=0.93,CI 95% [0.86; 0.98], P<0.001).

CONCLUSION

Fractal analysis can measure quantitatively the extent of non-compacted myocardium of the left ventricle, and have a definite value in the identification of pathological non-compacted myocardium and normal trabeculation. Fractal dimension combined with myocardial strain is a superior predictor of distinguishing IVNC from DCM.

CLINICAL RELEVANCE/APPLICATION

(dealing with isolated ventricular non-compaction) 'Fractal analysis based on Cine MR studies has a definite value in the identification of pathological non-compacted myocardium and normal trabeculation .'

SSA04-06 Native T1 Mapping Distinguishes Patients with Arrhythmogenic Right Ventricular Cardiomyopathy from Control Subjects

Sunday, Nov. 25 11:35AM - 11:45AM Room: S404CD

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PURPOSE

Arrhythmogenic right ventricular cardiomyopathy (ARVC) is an inherited heart disease characterized by fibrofatty replacement of the myocardium. Native T1 mapping is a promising technique to quantify changes in cardiac microstructure on cardiac magnetic resonance imaging (CMR). We aimed to analyze the diagnostic value of native T1 mapping in ARVC.

METHOD AND MATERIALS

We analyzed short-axis cine 1.5 Tesla CMR images obtained using a MOLLI sequence in 51 subjects (15 ARVC patients fulfilling the 2010 diagnostic Task Force Criteria, 23 phenotype negative ARVC relatives, and 13 control subjects with right ventricular outflow tract ventricular tachycardia [RVOT VT]). Global and regional fibrosis of the left ventricle (LV) were measured as native T1 times using cvi42 (version 5.6.6, Calgary, Canada). LV segmentation was according to the 16-segment American Heart Association recommendation. We also assessed dispersion of regional T1 times, defined as the standard deviation of regional T1 times within the same patient over all analyzed segments. Diagnostic performance was assessed using ROC curve analysis.

RESULTS

Mean age was 39±17 years and 49%(25/51) were male. Mean global native T1 times were not significantly different among ARVC patients (1061±40ms p=0.085) and relatives (1053±23ms p=0.181) compared to controls (1038±27ms). However, in comparison to controls (67±12), the dispersion of regional T1 times was significantly higher in ARVC patients (91±32ms p=0.014) and relatives (77±15ms p=0.044). This was reflected in longer regional T1 times in the basal (p=0.037) and mid (p=0.013) segments in ARVC patients; and only in the basal (p=0.042) segment in relatives. More specifically, ARVC patients had longer posterolateral, inferior and anterior T1 times (p<=0.027) while relatives had longer posterolateral and inferior T1 times (p<=0.009) compared to controls. ROC analyses revealed the highest AUC for the diagnosis of ARVC using posterolateral native T1 time in both ARVC patients (AUC=0.794) and relatives (AUC=0.790).

CONCLUSION

Native T1 mapping distinguishes ARVC patients and at-risk relatives from RVOT VT controls using regional (posterolateral and inferior) T1 times.

CLINICAL RELEVANCE/APPLICATION

Early detection of ARVC is pertinent as life-threatening ventricular arrhythmias can occur. Native T1 mapping has a possible role in differentiating ARVC patient and at-risk relatives from controls.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored EducatorStefan L. Zimmerman, MD - 2012 Honored EducatorStefan L. Zimmerman, MD - 2015 Honored Educator

SSA04-07 The Study of T1-Mapping and Extracellular Volume (ECV) Quantification of Myocardial Fibrosis Caused by Iron Deposited in a Pig Model

Sunday, Nov. 25 11:45AM - 11:55AM Room: S404CD

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PURPOSE

To explore the relationship between myocardial extracellular volume(ECV) and myocardial fibrosis index--collagen volume fraction(CVF) using an iron overloaded pig model by 3T MRI.

METHOD AND MATERIALS

27 pigs underwent iron dextran loading from 1 to 15 weeks. 4 controls were studied as well. T1 values were measured using a ShMOLLI sequence at 3T. Gd-DTPA was used to enhance. Measured the T1 values of the ventricular septum and left ventricular blood pool at the short axial slices of the papillary muscle respectively at plain scan and enhanced scan at the time of 20 minutes after injecting Gd-DTPA contrast medium, then calculated the ECV. Ex vivo cardiac pathology was obtained for all pigs studied. Pathological fibrosis index-collagen volume fraction(CVF) was acquired. Postmortem assessments of cardiac iron concentration(CIC) was conducted in an atomic absorption spectrophotometer. MRI measures were fitted against CVF using linear regression for the first 22 pigs. The remaining 5 were used to test the accuracy of the derived model.

RESULTS

In the experimental pigs, as dextran iron injection increased over time, the cardiac iron content increased, and myocardial collagen fibrils increased accordingly. ECV was linearly correlated to CVF (r= 0.990) in this study at 3T. By regression, the linear equations were determined as Y=-0.010+0.467X (F=1139.33,P<0.001) (Y:CVF, X:ECV). In the 5 test pigs, the predicted CVFs using the derived equations agreed well with the results quantified by pathology.

CONCLUSION

ECV are highly correlated with CVF in a novel iron overloaded pigs model. MRI quantification of myocardial fibrosis caused by iron deposited is feasible at 3T.

CLINICAL RELEVANCE/APPLICATION

Used MRI method to assess the degree of myocardial fibrosis caused by iron deposited in iron overloaded patients and developed a reliable and noninvasive techniques to measure myocardial fibrosis.

SSA04-08 Texture Analysis of Magnetic Resonance T1 Mapping with Dilated Cardiomyopathy: A Machine Learning Approach

Sunday, Nov. 25 11:55AM - 12:05PM Room: S404CD

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PURPOSE

Diagnosis of dilated cardiomyopathy is a challenge in clinical radiology. We want to find out whether texture analysis parameters on magnetic resonance T1 mapping can be helpful for the diagnosis of dilated cardiomyopathy (DCM).

METHOD AND MATERIALS

We screened 50 dilated cardiomyopathy cases retrospectively and recruited 24 healthy controls prospectively between March 2015 and July 2017. T1 maps were acquired using Modified Look-Locker Inversion Recovery (MOLLI) sequence at 3.0 T MR scanner. Endocardium and epicardium were drawn on short-axis slices of T1 maps by an experienced radiologist. Twelve histogram parameters and five gray-level co-occurrence matrix (GLCM) features were extracted during texture analysis. Differences in texture features between DCM patients and healthy controls were evaluated by T-tests. Support vector machine (SVM) was used to calculate the diagnosis accuracy of those texture parameters.Schematic diagram of this study is shown on figure one.

RESULTS

Most histogram features were higher in DCM group as compared to healthy control, and nine of them had significant differences between DCM group and healthy control. As for GLCM features, energy, correlation, and homogeneity were higher in DCM group than that of the healthy control. Also, Entropy and contrast were lower in DCM group. Entropy, contrast, and homogeneity had significant differences between two groups. The diagnosis accuracy using SVM classifier with all those histogram features and GLCM features was 0.85±0.07.

CONCLUSION

A computer-based texture analysis and machine learning approach of T1 mapping could provide an objective tool for the diagnosis of dilated cardiomyopathy.

CLINICAL RELEVANCE/APPLICATION

Texture analysis of T1 mapping could provide an objective tool for the diagnosis of dilated cardiomyopathy.

SSA04-09 Fully Automated Diagnosis of Cardiomyopathy from Cardiac MR Imaging Using Convolutional Neural Networks

Sunday, Nov. 25 12:05PM - 12:15PM Room: S404CD

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PURPOSE

Primary cardiomyopathies are diseases of the myocardium that are characterized by remodeling of the left ventricle and impaired cardiac function. Dilated cardiomyopathy (DCM) is a leading cause of heart failure while hypertrophic cardiomyopathy (HCM) is a common cause of sudden death. Diagnosis is made on imaging criteria but relies on manual volumetric analysis of the data and requires expertise to differentiate from other conditions which mimic cardiomyopathy. Deep learning approaches have shown promise in image classification tasks, and here we designed and evaluated a convolutional neural network (CNN) for fully-automated diagnosis of cardiomyopathy in a large sample of cardiac magnetic resonance (CMR) datasets.

METHOD AND MATERIALS

The study cohort consisted of 1,069 adult participants: 311 patients with DCM, 396 patients with HCM and 362 healthy volunteers (HV) matched by gender, age and body surface area. All subjects had a conventional CMR including retrospectively-gated cine imaging. The 4-chamber cine sequence was used for analysis and passed to a 6-layer convolutional neural network implemented in TensorFlow. Five convolutional layers, with between 64 and 128 nodes, were followed by a fully-connected 128-node layer. A predicted classification was obtained from an output later with a SoftMax activation function. The model was trained over 100 epochs using a Titan X GPU. Four-fold cross validation was performed with results reported as mean accuracy.

RESULTS

All subjects were included in the analysis. Processing time per subject was approximately 2 seconds. In total 80/82 DCM, 84/97 HCM and 87/87 HV participants were correctly classified in the held-out data. Overall, 251/266 participants were correctly classified (94.3%).

CONCLUSION

Cardiomyopathy can be diagnosed with a high degree of accuracy through direct analysis of time-resolved CMR imaging using a CNN. This includes correctly excluding disease in every healthy adult. Future work will include simultaneous analysis of cine sequences in different cardiac planes and external validation of the model on an independent cohort.

CLINICAL RELEVANCE/APPLICATION

These findings demonstrate the potential of an automated method to efficiently and objectively diagnose cardiomyopathy on cardiac MRI.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
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SSA05

Chest (Emphysema/COPD)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E451A

BQ CH CT MR

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

Participants
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Sub-Events

SSA05-01 High-Resolution Chest CT Imaging of the Lung: Impact of High Matrix Reconstruction and Photon-Counting-Detector CT

Sunday, Nov. 25 10:45AM - 10:55AM Room: E451A

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PURPOSE

To evaluate the impact of 1024 matrix size and photon-counting-detectors (PCDs) relative to 512 matrix size and energy-integrating-detectors (EIDs) for chest CT.

METHOD AND MATERIALS

22 adult patients undergoing clinically indicated chest CT received dose-matched PCD CT after written informed consent. 1.5 mm images were reconstructed at a 1mm overlap with our routine clinical kernel (B46) at both 512 and 1024 matrix sizes for EID scans. For PCD, B46 and an additional sharp kernel (Q65, not available for EID) was reconstructed at a 1024 matrix. Two chest radiologists compared only the right lung of B46/EID/1024; B46/PCD/1024 and Q65/PCD/1024 images in a side-by-side fashion to the routine clinical B46/EID/512 images, noting the highest level bronchus clearly identified in each lobe. The 3rd and 4th order bronchi were specifically evaluated and any lung nodules were compared to the B46/EID/512 images using a 5 point Likert scale (+2 = improved detection confidence, +1=preferred but no confidence change, 0 = similar, -1=worse but no confidence change, -2=worse with decreased confidence). Statistical analysis was performed using a Wilcoxon signed rank test with a $p < 0.05$ considered significant.

RESULTS

Compared to B46/EID/512, readers detected higher order bronchi using Q65/PCD/1024 images for every lung lobe ($p<0.002$). For B46/EID/1024 reconstruction, higher order bronchi were only significantly better seen in the right middle lobe ($p=0.007$). Readers were able to better identify bronchial walls of the 3rd and 4th order bronchi better using Q65/PCD/1024 (mean Likert-scores of 1.1 and 1.5), which was significantly higher compared to B46/EID/1024 or B46/PCD/1024 (mean difference 0.8; $p<0.0001$). Of 49 non-calcified pulmonary nodules (8 part solid, 41 solid), Q65/PCD/1024 had a slightly but significantly higher mean visualization score of 0.8 compared to 0 for B46/EID/1024 and 0.2 for B46/PCD/1024 ($p<0.0002$).

CONCLUSION

Lung PCD-CT with 1024 matrix using a sharp Q65 kernel increase visualization of higher order bronchi and bronchial walls without compromising nodule detection. Softer kernels and further work are needed to examine the internal density characteristics of nodules at PCD-CT.

CLINICAL RELEVANCE/APPLICATION

PCD-CT with 1024 matrix improves visualization of medium and small bronchi compared to current routine chest CT, creating an opportunity for radiologists to better characterize lung pathology.

SSA05-02 Normalized Emphysema Score Progression: An Improved CT Biomarker for Mortality

Sunday, Nov. 25 10:55AM - 11:05AM Room: E451A

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PURPOSE

Normalized emphysema score (normES) is a protocol-robust and validated CT biomarker for mortality. We aimed to improve mortality prediction by modelling its change over time.

METHOD AND MATERIALS

CT scans from all 1810 deceased participants from the National Lung Screening Trial were selected. Of these, 445 died from lung cancer. A random selection of 4190 surviving participants were sampled with replacement up to 24432 to approximate the full cohort. The normES was obtained by computing the emphysema scores after resampling, normalization, and bullae cluster analysis. The reference models contained solely the baseline (T0) normES. To investigate if progression of emphysema provides additional information, normES from the first (T1) and second annual screening rounds (T2) and normES progression (normESprog) were added to the base model. normESprog was calculated by subtracting the T0 log(normES) from the T1 or T2 log(normES) and dividing by the time in between. Proportional hazard models predicting all-cause and lung cancer mortality were compared by calculating the continuous net reclassification improvement (NRI) for each year of follow-up.

RESULTS

The analysis of T0 and T1 data was performed on 22695 samples; 3547 lacked T0 or T1 scans, or had corrupted data. NRI improvement for all-cause and lung cancer mortality prediction compared to the base models were 4.5% (95%CI: -7.3 to 8.4%) and 4.1% (-9.3 to 14.6%) 3 years after baseline, 6.1% (-5.3 to 9.4%) and 0.1% (-7.1 to 12.2%) after 5 years, and 6.1% (-6.2 to 8.7%) and -0.4% (-5.6 to 11.3%) after 7 years, respectively. When modelling the T0 to T2 interval, another 2603 samples were excluded. For all-cause mortality, the 3, 5, and 7 year time points showed respective NRI improvements of -0.5% (-6.7 to 8.0%), 10.8% (5.5% to 14.7%), and 12.2% (7.1% to 15.6%). Improvements in lung cancer mortality prediction were -6.1% (-24.0 to 12.6%), 19.6% (10.6 to 29.2%), and 24.1% (15.4% to 31.7%), respectively. All hazard models had a logrank test p<.001.

CONCLUSION

Two normES measurements are better than one at predicting mortality over longer periods of time. The time between normES measurements should be sufficiently distant to account for the slow progression of emphysema.

CLINICAL RELEVANCE/APPLICATION

Normalized emphysema score progression is an automatic emphysema quantification method which can better predict the long-term mortality than a single baseline measurement.

SSA05-03 Comparison of Two Independent Visual Assessment Protocols for the Detection of Emphysema in the National Lung Screening Trial Cohort

Sunday, Nov. 25 11:05AM - 11:15AM Room: E451A

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PURPOSE

To investigate the variability in assessing the presence of emphysema in a lung cancer screening population using low-dose CT scans and compare this to rates of spirometry-detected airflow obstruction.

METHOD AND MATERIALS

Baseline low-dose CT scans from 6,352 NLST participants enrolled in the CT arm who also underwent spirometry were evaluated. Emphysema was visually assessed in NLST as present or absent. In our study, two readers visually assessed CT scans using a modified NETT protocol that divided the lung into upper, middle, and basal zones and graded emphysema as none (0%), trace (1-25%), mild (25-50%), moderate (50-75%), or severe (75%+). In this protocol, a subject was scored as positive if any region was scored trace or greater. Results were compared to emphysema and spirometry data from the Pittsburgh Lung Screening Study (PLuSS).

RESULTS

Among the 6,352 subjects, emphysema was identified in 55.4% (3518/6352) of subjects in NLST and 40.4% (2566/6352) of subjects using our protocol (agreement Kappa=0.4990). Emphysema severity in the current study was reported as none, trace, mild, moderate, and severe in 59.6%, 27.4%, 7.0%, 4.1%, and 1.9% of the subjects, respectively. Inter-reader agreement for the presence of emphysema between the two readers in our study in 200 CT scans was moderate to substantial (K=0.6073). Using the McNemar test statistic, there was a statistically significant difference between our visual assessment of emphysema and the NLST assessment of emphysema ($p < 0.001$). Spirometry-detected airflow obstruction was reported in 32.0% of the NLST subjects. In PLuSS (n=3638), emphysema and airflow obstruction were identified in 42.5% and 42.7% of the subjects, respectively.

CONCLUSION

Our study revealed a significant disagreement in emphysema assessment between two independent visual interpretations of low-dose CT scans. The discrepancy between emphysema and airflow obstruction (55.4% versus 32.0%) in the NLST-ACRIN subcohort appears to be from overdetection of emphysema. Our visual emphysema assessment of NLST CT scans is more consistent with rates of spirometry-detected airflow obstruction and with previously published rates of emphysema in lung cancer screening populations.

CLINICAL RELEVANCE/APPLICATION

Since emphysema is recognized as a significant risk factor for lung cancer, our study demonstrates the need to standardize and improve emphysema assessment in low-dose lung cancer screening CT scans.

SSA05-04 Visual Presence of Emphysema Predicts Progression of Emphysema and Air Trapping in Cigarette Smokers

Sunday, Nov. 25 11:15AM - 11:25AM Room: E451A

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PURPOSE

Visual categorization of emphysema on CT has been shown to correlate with symptomatic impairment and with mortality. However, the relationship between presence of emphysema and subsequent progression of disease has not previously been evaluated.

METHOD AND MATERIALS

We studied 4126 subjects enrolled in the COPDGene study, who had visual CT scores at baseline, and quantitative inspiratory and expiratory CT at baseline and at 5 years. Trained research analysts performed visual classification of parenchymal emphysema on baseline volumetric CT scans of these subjects using the Fleischner Society classification system. Each scan was independently evaluated by two analysts; discordances between analysts were adjudicated by a thoracic radiologist. Statistical analysis used a linear mixed model, adjusted for age, height, gender, race, smoking status, scanner make, and reconstruction algorithm, with dependent variables being inspiratory lung density at 15th percentile (adjusted for lung volume) as a measure of emphysema, and % of lung voxels < -856 HU on expiratory CT (LAA-856) as a measure of air trapping. Analysis was stratified by presence or absence of COPD at baseline.

RESULTS

In subjects with COPD, those with parenchymal emphysema at baseline showed a lung density decline of 4.7 g/l (95% CI 3.9, 5.4, $p<0.0001$), compared with 1.4 g/l (0.5, 2.4, $p=0.003$) for those without emphysema. For subjects without COPD, corresponding values were 4.0 (3.2, 4.9, $p<0.0001$) and 0.8 (0.25, 1.4. $p=0.005$). In subjects with COPD, those with baseline emphysema showed increase of 3.8% (2.9, 4.6, $p<0.0001$) in LAA-856, compared with 0.5% (-0.6, 1.5, n.s.) for those without. For subjects without COPD, those with emphysema had an increase in LAA-856 of 1.7% (1.1, 2.4, $p<0.0001$), while those without emphysema had a slight decrease of 0.5% (0.1, 0.9, $p=0.01$).

CONCLUSION

The presence of parenchymal emphysema at baseline is associated with a higher rate of progression in emphysema and air trapping at 5 year follow-up, in cigarette smoking subjects with and without COPD.

CLINICAL RELEVANCE/APPLICATION

The presence of visible emphysema on CT in cigarette smokers is an important predictor of subsequent progression.

SSA05-05 3D Oxygen-Enhanced MRI at 3T System versus Thin-Section CT: Quantitative Capability for Pulmonary Functional Loss Assessment and Clinical Stage Classification in Smokers

Sunday, Nov. 25 11:25AM - 11:35AM Room: E451A

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PURPOSE

To prospectively and directly compare the quantitative capability for pulmonary functional loss assessment and clinical stage classification between 3D oxygen-enhanced MR imaging (O2-enhanced MRI) and thin-section CT in smokers.

METHOD AND MATERIALS

Twenty consecutive smokers (12 men and 8 women; age rang 56-85 years) underwent 3D O2-enhanced MRI, thin-section CT and pulmonary function test (FEV1/FVC%, %FEV1% and %DLCO/VA). All smokers were classified into four stages ('Without COPD', 'Mild COPD', 'Moderate COPD', 'Severe or very severe COPD') according to the GOLD guideline. For 3D O2-enhanced MRI in each smoker, 3D Fast Field Echo sequence with variable flip angles was performed with and without 100% oxygen inhalation at a 3T MR system. With non-rigid registration software, regional T1 value change map was generated from O2-enhanced MR data by pixel by pixel analyses. Then, ROIs were placed over the lung on all slices, and averaged to determine mean T1 value change (ΔT1) in each subject. On quantitative CT in each subject, percentage of low attenuation area within entire lung (LAA%) was also measured. To compare the capability for pulmonary functional loss assessment, both indexes were correlated with each parameter. Then, both indexes were compared four clinical stages by Tukey's HSD test. Finally, discrimination analyses were performed, and accuracy was compared each other by McNemar's test.

RESULTS

ΔT1 and LAA% were significantly correlated with FEV1/FVC% (ΔT1: r=-0.70, p=0.0006; LAA%: r=-0.75, p=0.0002), %FEV1 (ΔT1: r=-0.84, p<0.0001; LAA%: r=-0.67, p=0.0013) and %DLCO/VA (ΔT1: r=-0.69, p=0.0009; LAA%: r=-0.63, p=0.0029). ΔT1 had significant difference between 'Severe or very severe COPD' group and others (p<0.05), although LAA% had significant difference between 'Severe or very severe COPD' and 'Without COPD' (p<0.05) or 'Mild COPD' (p<0.05) groups. Discrimination accuracies of ΔT1 (73.7 [14/19] %) was significantly higher than that of LAA% (42.1 [8/19] %, p=0.03).

CONCLUSION

3D O2-enhanced MRI has a better capability for pulmonary functional loss assessment and clinical stage classification in smokers than quantitative CT.

CLINICAL RELEVANCE/APPLICATION

3D O2-enhanced MRI has a better capability for pulmonary functional loss assessment and clinical stage classification in smokers than quantitative CT.

SSA05-07 Using Deep Learning to Predict Emphysema in Early Lung Cancer Screening Low-Dose CT Scan

Sunday, Nov. 25 11:45AM - 11:55AM Room: E451A

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PURPOSE

The patients who are recommended for annual lung cancer screening are at a higher risk for other cardiopulmonary diseases. Therefore, it would be beneficial to use the low-dose CT scans (LDCT) to identify other conditions. This work aims to demonstrate the feasibility of using deep learning method to identify findings, specifically emphysema.

METHOD AND MATERIALS

The dataset consists of 860 cases of LDCT scans from a lung screening program. Emphysema was identified on each scan as none, mild, moderate, or severe. To evaluate the effect of potential labeling error caused by per case rating system, three different approaches were taken: 1) using the entire lung region, 2) using only the top 50% of the lung since emphysema due to smoking tends to affect the upper lobes more than the lower lobes, and 3) using only the bottom 50% of the lung as a control. Deep learning consisted of feature extraction using a pre-trained VGG-19 network followed by a support vector machine binary classifier that predicted the presence of emphysema (none vs. moderate and severe). The predictions were first performed on a per slice basis and averaged to acquire per case prediction. The area under the receiver operating characteristic curve (AUC) was used to evaluate the performance.

RESULTS

Per slice prediction for the entire lung region, the top 50%, and the bottom 50% produced an AUC of 0.76 (SE: 0.01), 0.77 (0.01), and 0.74 (0.01), respectively. Per case prediction produced an AUC of 0.84 (0.03), 0.83 (0.03), and 0.80 (0.03). The higher AUCs for per case prediction demonstrates that aggregating the predictions on slices help reduce the effect of labeling errors. The AUCs for the bottom 50% are lower, but still on par, which is likely due to the fact emphysema does not completely spare the bottom lobes.

CONCLUSION

We have demonstrated the potential of transfer learning to predict the presence of emphysema on LDCT scans. Fine-tuning work is currently on-going, and given the high performance already achieved with transfer learning, fine-tuning is likely to achieve even higher performance.

CLINICAL RELEVANCE/APPLICATION

LDCT provides an opportunity to identify other pathologies that may otherwise go undiagnosed. Having a suite of algorithms that automatically searches for multiple incidental findings has the potential to increase efficiency and prevent missing important findings.

SSA05-08 Inspiratory/Expiratory Xenon-Enhanced Area-Detector CT with and without 3D Motion Analysis: Capability for Pulmonary Functional Loss Assessment and Clinical Stage Classification of COPD

Sunday, Nov. 25 11:55AM - 12:05PM Room: E451A

Participants
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PURPOSE

To prospectively evaluate the utility of 3D lung motion assessment on inspiratory/expiratory xenon-enhanced area-detector CT (Xe-enhanced ADCT) for pulmonary functional loss assessment and clinical stage evaluation of chronic obstructive pulmonary disease (COPD).

METHOD AND MATERIALS

Twenty-eight consecutive patients with and without COPD (18 men and 10 women; mean age, 72 years old) prospectively underwent inspiratory/expiratory Xe-enhanced ADCT examinations as well as pulmonary function tests. Then, all patients were classified by GOLD classification as follows: 'Without COPD', 'Mild COPD', 'Moderate COPD' and 'Severe or Very Severe COPD'. In each subject, Xe-enhanced ADCT data was transferred to our proprietary software to generate xenon ventilation maps such as wash-in (WI), wash-out (WO) and ventilation ratio (VR: VR=[WI-WO]/WI) maps as well as 3D motion magnitude maps at X-, Y- and Z-axes as well as expansion rate (ER) map by Jacobian method by pixel-by-pixel analyses. Then, each regional index was assessed by ROI measurements, and each final value was determined as averaged value. To determine the relationship between xenon ventilation- and 3D motion-based indexes, Pearson's correlations were performed. Then, step-wise regression analyses were performed between all indexes and %FEV1. Finally, discrimination accuracies were performed among xenon-ventilation indexes, 3D-moion based indexes and combined method by McNema's test.

RESULTS

WO had significant and correlations with X, Y and Z-axis motion magnitudes (-0.53 **CONCLUSION**

3D lung motion assessment is useful for pulmonary functional loss and clinical stage classification of COPD, when applied with inspiratory/expiratory Xe-enhanced ADCT.

CLINICAL RELEVANCE/APPLICATION

Inspiratory/expiratory xenon-enhanced area-detector CT with 3D lung motion assessment is more useful than that without 3D lung motion assessment for pulmonary functional loss and clinical stage classification of COPD.

SSA05-09 A Convolutional Neural Network Approach to Imaging-Based Pulmonary Measurements in COPD Patients

Sunday, Nov. 25 12:05PM - 12:15PM Room: E451A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Chronic obstructive pulmonary disease (COPD) affects over 16 million Americans and 251 million people worldwide. Multiple patterns of pathology exist, and imaging measurements are increasingly important for identifying COPD subtypes and prognosis. We hypothesized that a convolutional neural network (CNN) could predict volumetric measurements relating to pulmonary function, based on a subset of chest CT images.

METHOD AND MATERIALS

With HIPAA compliance and IRB approval, we retrospectively identified inspiratory CT scans for 160 COPD patients from our institution enrolled in the COPDGene multicenter study. We used a CNN based on VGG19 to develop regression-based inference predictions of total lung capacity (TLC), functional residual capacity (FRC), and percentage of emphysema. Measurement of these parameters was obtained previously as part of the larger COPDGene dataset, and has been discussed by other groups. A subset of 10 equally spaced axial chest images were selected from the full chest CT and used to train the network, with assessment by five fold cross validation. Correlations between CNN and ground truth are given as R2, and bias was assessed with Bland-Altman plot analysis.

RESULTS

CNN predicted measurements of TLC were correlated with those from the COPDGene dataset with an R2 value of 0.86 (slope 1.10), and mean difference of 0.14L ± 0.57L. FRC was correlated with an R2 value of 0.84 (slope 1.26), and mean difference of -0.06L ± 0.56L. Percent emphysema was correlated at an R2 value of 0.82 (slope 1.04), and mean difference of 0.15% ± 3.34%.

CONCLUSION

Here we show the ability of a CNN to produce well correlated predictions of pulmonary volume measurements, inferred from a subset of chest CT images. Refinement of this CNN can expand it to additional structures or volumes, and may allow automation of quantitative pulmonary function measurements and volumes to streamline disease monitoring.

CLINICAL RELEVANCE/APPLICATION

We present a convolutional neural network capable of making well-correlated, inference-based, predictions of pulmonary volume measurements in COPD patients, based on a subset of 10 chest CT slices.

SSA06

Science Session with Keynote: Emergency Radiology (Imaging Algorithms, Modalities and Techniques)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S405AB

CT ER

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

Participants
Ferco H. Berger, MD, Toronto, ON (*Moderator*) Nothing to Disclose
Jeremy R. Wortman, MD, Boston, MA (*Moderator*) Nothing to Disclose
Howard P. Forman, MD, New Haven, CT (*Moderator*) Nothing to Disclose

Sub-Events

SSA06-01 Emergency Radiology Keynote Speaker: Impact of Dual Energy CT on ED Workflow and Downstream Utilization

Sunday, Nov. 25 10:45AM - 10:55AM Room: S405AB

Participants
Jeremy R. Wortman, MD, Boston, MA (*Presenter*) Nothing to Disclose

Honored Educators

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SSA06-02 Acute Pancreatitis: A Quantitative Analysis of Iodine with Dual-Energy Spectral Computed Tomography

Sunday, Nov. 25 10:55AM - 11:05AM Room: S405AB

Participants
Wei Wei, Hefei, China (*Presenter*) Nothing to Disclose

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PURPOSE

To investigate the correlation between iodine concentration and clinical severity of acute pancreatitis (AP) through the quantitative evaluation with dua-energy spectral computed tomography (DESCT), so as to find out an effective imaging technology in the evaluation of clinical severity of AP.

METHOD AND MATERIALS

Sixty patients with AP confirmed clinically (AP group) and 30 patients with normal pancreas (control group) were retrospectively analyzed. All the patients underwent enhanced CT scan in the spectral imaging mode. Iodine concentration and normalized iodine concentration (NIC) were respectively measured during arterial phase and portal phase in the material-decomposition images by using a spectral imaging viewer (GSI Viewer).

RESULTS

Iodine concentration and NIC were significantly higher in the control group than in the AP group ($P<0.05$, $P<0.001$). In the AP group, according to Ranson grading, 24 patients were in the mild grade, 20 patients were moderate, and 16 patients were severe. Iodine concentration and NIC decreased along with the increase of their Ranson grade. There were significant difference in iodine concentration and NIC among the three subgroups (iodine concentration on arterial phase: $F=8.776$, $P<0.01$; iodine concentration on portal phase: $F=4.019$, $P<0.05$; NIC on arterial phase: $F=12.700$, $P<0.001$; NIC on portal phase: $F=8.732$, $P<0.01$). Iodine concentration and NIC on arterial and portal phases in the mild grade group were both significantly higher than those in the moderate grade group ($P<0.05$); however, iodine concentration on arterial and portal phases, and NIC on arterial phase in the severe grade group were significantly lower than those in the moderate grade group ($P<0.05$).

CONCLUSION

DESCT can analyze hemodynamic changes in AP quantitatively, which is of great value in evaluating changes in AP of each grade.

CLINICAL RELEVANCE/APPLICATION

The quantitative evaluation of iodine with dua-energy spectral computed tomography (DESCT) provide a new method for the prognosis of patients with acute pancreatitis.

SSA06-03 Diagnostic Performance of Dual Energy CT Characterization of Incidental Renal Lesions in Emergency

Room Patients

Sunday, Nov. 25 11:05AM - 11:15AM Room: S405AB

Participants
Jeremy R. Wortman, MD, Boston, MA (*Presenter*) Nothing to Disclose
Ellen X. Sun, MD , Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Jennifer W. Uyeda, MD, Boston, MA (*Abstract Co-Author*) Consultant, Allena Pharmaceuticals, Inc; Invited Speaker, Siemens AG
Roger Lacson, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Daniel I. Glazer, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Aaron D. Sodickson, MD,PhD, Boston, MA (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Speaker, Siemens AG; Speaker, General Electric Company
Daniel A. Souza, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the diagnostic performance of DECT characterization of incidental, indeterminate renal lesions detected on routine contrast-enhanced CT in ER patients, using reference standard of renal mass protocol CT or MRI.

METHOD AND MATERIALS

The study cohort included patients with an indeterminate lesion on portal venous phase DECT (homogeneous lesion of greater than 20 HU, or complex cystic lesion), with reference standard imaging (renal mass protocol CT or MRI) of the lesion performed within 2 years. All DECT scans were performed in the ER setting on the same dual source DECT scanner. Two radiologists with DECT experience used DECT post-processed iodine selective images to characterize lesions as: definitely non-enhancing, equivocal/possible enhancement, or definitely enhancing; readers also measured iodine concentration within lesions. Two expert abdominal radiologists evaluated reference standard imaging of each lesion, categorizing each as definitely non-enhancing (Bosniak I and II cysts), equivocal/possible enhancement (Bosniak IIF or other lesions needing follow up), and definitely enhancing (solid mass, Bosniak III/IV cysts).

RESULTS

66 lesions were included in the study cohort, on reference standard imaging 44 were non-enhancing (11 Bosniak I and 33 Bosniak II cysts) and 22 were lesions with equivocal or definite enhancement (7 Bosniak IIF cysts, 3 Bosnaik III cysts, 3 Bosniak IV cysts, 9 solid masses). Qualitative assessment of lesions as enhancing on by DECT readers on iodine selective images had a sensitivity of 100%, specificity of 43%, positive predictive value of 47%, negative predictive value of 100%, and accuracy of 62%.

CONCLUSION

Characterizing incidental indeterminate renal lesions on portal venous phase DECT as non-enhancing with DECT post-processing was successfully able to exclude enhancement in these lesions (NPV of 100%), indicating that incidental lesions without enhancement on DECT are highly likely to be Bosniak I or II cysts. However, the specificity and positive predictive value of enhancement seen on DECT were relatively low. Further research is needed to assess methods to mitigate false positive enhancement with DECT.

CLINICAL RELEVANCE/APPLICATION

Qualitative assessment of enhancement of incidental renal lesions with DECT had a high negative predictive value, indicating that lesions without enhancement on DECT post-processed images are highly likely to be Bosniak I or II cysts.

Honored Educators

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SSA06-04 The Impact of Socioeconomic Status on CT-Imaging and Management of Acute Appendicitis

Sunday, Nov. 25 11:15AM - 11:25AM Room: S405AB

Participants
Diana Dinh, MD, Boston, MA (*Presenter*) Nothing to Disclose
Matthew Hartman, BS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Heidi Wing, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Tracey Dechert, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Stephan W. Anderson, MD, Cambridge, MA (*Abstract Co-Author*) Nothing to Disclose
Christina A. LeBedis, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the impact of socioeconomic status on CT findings and the management of acute appendicitis.

METHOD AND MATERIALS

Informed consent was waived for this IRB-approved, HIPAA compliant, retrospective study of 18-64 year old patients with acute appendicitis at our institution by MDCT from 1/1/2006-12/31/2016 (n=1886). Insurance, race/ethnicity, primary language, and education level were obtained from the electronic medical record. Multivariate linear regression was performed to determine crude and adjusted parameter estimates for length of stay. For each metric, the estimates generated from linear regression are interpreted as difference in length of stay associated with one unit change in each covariate. Logistic regression models were run and crude and adjusted odds ratio (OR) were calculated for each categorical outcome. A P value of less than 0.05 was considered statistically significant for all analyses. Statistical computations were performed on SAS 9.3 system (SAS Institute, Cary, NC).

RESULTS

Free care/Medicaid/Medicare subjects had 0.4 days increase in length of stay as compared to private insurance (p=0.039). Free care/Medicaid/Medicare subjects were also found to have increase odds of surgical site infection or re-operation (OR=1.93, 95% CI= 1.03-3.63, p=0.041), as compared to private insurance patients. Hispanics were associated with lower odds of complicated CT findings (OR=0.55, 95% CI=0.335-0.898, p=0.017), and both Hispanic and Blacks had lower odds of perforation, abscess, or gangrene by intraoperative report (OR=0.67, 95% CI=0.47-0.97, p=0.035; OR=0.68, 95% CI=0.48-0.97, p=0.033, respectively), as compared to Whites. There were no statistically significant differences in CT findings, length of stay, or post-operative complication by primary language or education level.

CONCLUSION

Acute appendicitis is a common emergent illness presenting across the socioeconomic spectrum. Free care, Medicaid and Medicare patients have increased length of stay and increased odds of post-operative complication. Hispanics show lower odds of complicated CT findings on initial presentation. Hispanics and Blacks have lower odds of having complicated intraoperative findings.

CLINICAL RELEVANCE/APPLICATION

Further investigation on the impact of socioeconomic status within radiology and the potential for radiologists to join the fight in combating health disparity are necessary to eliminate health inequality.

Honored Educators

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SSA06-05 Virtual Monoenergetic Dual-Energy CT for Evaluation of Hepatic and Splenic Lacerations

Sunday, Nov. 25 11:25AM - 11:35AM Room: S405AB

Awards
Student Travel Stipend Award

Participants
Ellen X. Sun, MD , Boston, MA (*Presenter*) Nothing to Disclose
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Roger Lacson, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Aaron D. Sodickson, MD,PhD, Boston, MA (*Abstract Co-Author*) Institutional research agreement, Siemens AG; Speaker, Siemens AG; Speaker, General Electric Company

PURPOSE

To evaluate the utility of virtual monoenergetic imaging in assessing splenic and hepatic lacerations and to determine the optimal energy level to maximize laceration contrast-to-noise ratio.

METHOD AND MATERIALS

We retrospectively examined 26 contrast-enhanced abdominal CT studies performed on a dual-source dual-energy CT (DECT) scanner in our Emergency Department from 2013 to 2017, with liver and/or splenic lacerations. All studies included portal venous phase imaging acquired simultaneously at low (80 or 100 kVp) and high (140 kVp with tin filtration) energy levels. Conventional 120 kVp-equivalent mixed images were generated for routine review by blending the low and high energy acquisitions. Virtual monoenergetic reconstructions were retrospectively generated in 10 keV steps from 40-90 keV. Liver or splenic laceration attenuation, background parenchymal attenuation and noise were measured on each set of monoenergetic and mixed images. Injury-to-parenchyma contrast and contrast-to-noise ratios (CNR) were calculated. Differences between CNR of monoenergetic series and mixed images were assessed with a paired t-test.

RESULTS

Liver laceration was identified in 17 patients, and splenic laceration in 10 patients. Background noise was lower at higher monoenergetic levels, with the lowest noise seen at 90 keV, equivalent to that of mixed images (8.26 for 90 keV and 8.66 for mixed, p=0.035). For liver and splenic lacerations, CNR at 40-60 keV was higher than that of mixed images. Injury-to-parenchyma CNR was highest at 40 keV, significantly higher than mixed images (mean CNR 6.14 for 40 keV, 5.48 for mixed, p=0.024). Subgroup analysis of liver and splenic lacerations demonstrated a significant improvement in CNR at 40 keV compared with mixed images for splenic lacerations (5.89 vs. 4.98, p=0.036); for liver lacerations, the increased CNR at 40 keV compared with mixed images was not statistically significant (6.29 vs. 5.77, p=0.2).

CONCLUSION

With DECT virtual monoenergetic imaging, the optimal energy level for assessing liver and splenic lacerations was 40 keV, which showed improved injury-to-parenchyma CNR compared with traditional polyenergetic reconstructions.

CLINICAL RELEVANCE/APPLICATION

Virtual monoenergetic imaging at low keV can improve contrast to noise ratio of hepatic and splenic lacerations, which may improve

detectability of subtle injuries and aid radiologists in classifying these injuries.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jeremy R. Wortman, MD - 2017 Honored EducatorAaron D. Sodickson, MD,PhD - 2014 Honored EducatorAaron D. Sodickson, MD,PhD - 2017 Honored EducatorAaron D. Sodickson, MD,PhD - 2018 Honored Educator

SSA06-06 Emergency Department Would Become the New Diagnostic Center if the Trend in National Imaging Utilization Continues

Sunday, Nov. 25 11:35AM - 11:45AM Room: S405AB

Participants
Santosh K. Selvarajan, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

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PURPOSE

Policymakers and payers have been concerned with the rapid growth in imaging utilization particularly in the Emergency Departments. Our purpose is to study the trends in utilization of imaging in EDs in recent years, by modality. Secondly, to determine the specialty of the interpreting physicians.

METHOD AND MATERIALS

The nationwide Medicare Part B Physician/Supplier Procedure Summary Master Files for 2004-2016 were the data source. CPT codes for plain radiography (XR), non-cardiac ultrasound (US), CT, MRI, and nuclear medicine (NM) were aggregated by modality. Medicare's place-of-service codes were used to identify those exams done during ED visits, and its specialty codes were used to determine which specialties did the interpretations. Trends from 2004 to 2016 were assessed.

RESULTS

Between 2004 and 2016 in the ED, the utilization of CT increased from 2,842,446 in 2004 to 7,705,340 in 2016 (+103%). MRI studies increased from 69,000 to 286,000 (+204%). The number of non-cardiac ultrasounds grew from 408,000 to 1,024,809 (+151%). The radiographs performed grew from 9,471,777in 2004 to 13,177,023 in 2016 (+31%). The Nuclear Medicine studies showed a slight numerical decline, from 106,792 in 2004 to 65,985 in 2010 (-25%), but this was largely due to code bundling that occurred in myocardial perfusion imaging in 2010. Nuclear Medicine studies slightly increased from 65,985 in 2010 to 78,000 in 2016 (+11%). In each of the first 4 modalities, growth was steady and progressive with no evidence of slowing even after code bundling for CT abdomen and pelvis. Radiologists' share of the interpretations in 2016 were: CT 99%, MRI 99%, XR 98%, US 87.5%, NM 95%

CONCLUSION

The utilization of imaging in EDs grew substantially from 2004 to 2016 in comparision to the utilization in other places where imaging is performed. The largest numerical increases were seen in CT and XR. Radiologists strongly predominate in interpreting in all modalities.

CLINICAL RELEVANCE/APPLICATION

The progressive growth of utilization is of concern and suggests that more interdepartmental cooperation is needed for appropriate use of imaging in EDs.

SSA06-07 The Value of the Radiologist as Consultant to Improve Patient Care in the Emergency Department

Sunday, Nov. 25 11:45AM - 11:55AM Room: S405AB

Participants
Sarvenaz Pourjabbar, MD, New Haven, CT (*Presenter*) Nothing to Disclose
Joseph J. Cavallo, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose
Amir Imanzadeh, MD, Shelton, CT (*Abstract Co-Author*) Nothing to Disclose
Scott Blanchette, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose
Kevin Connell, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose
Syed A. Bokhari, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

In the emergency department (ED), imaging studies are requested by a wide spectrum of healthcare providers, many of whom are not educated in the finer details of imaging protocols. This lack of expertise leads to suboptimal diagnostic imaging; this results in decreased diagnostic accuracy, unnecessary cost and added radiation, among other potential inefficiencies. While order entry algorithms been implemented, they are not a comprehensive solution. This study demonstrates the value of radiologists' input on diagnostic imaging at the time of order entry.

METHOD AND MATERIALS

Contrast enhanced CT/CT Angiogram (CTA) exams ordered in our ED are subject to validation by radiologist/radiology physician assistant. If the ordered study is deemed to be suboptimal, the provider is contacted and better options are discussed. Subsequently, the optimal study is protocolled. Per IRB, this quality improvement study was not subject to review. Ordered CT/CTA exams of the chest, abdomen or pelvis were reviewed over the course of 90 ED shifts (10pm-7am) spanning from 9/2017-3/2018. Total CT exam orders placed and the number of exams that were ultimately modified were recorded.

RESULTS

During the study, 631 eligible exam orders were reviewed. 14% (88/631) of the requests were modified. Of these modifications, 15% (13/88) were cancellations. In 84% (63/75) of alterations, contrast was improperly used. Suggested order alterations were more often related to oral contrast (52%, 38/75) than intravenous contrast (31%, 23/75). The anatomic area scanned was changed in 15% (11/75) of modified exams. In 13% (10/75) of modified exams, the type of study was changed entirely (Fig. 1).

CONCLUSION

In the era of value-based health care, it is essential to tailor patients' imaging to address specific clinical questions. Our results demonstrate that approximately 14% of diagnostic CT orders requested in the ED are not optimized. Most commonly, mistakes are related to contrast. Having radiology staff available to identify suboptimal diagnostic CT orders can add value to patient care by optimizing contrast protocols, ensuring the clinical question will be addressed and avoiding redundant examinations.

CLINICAL RELEVANCE/APPLICATION

In the ED, active monitoring of CT scan requests by a radiologist/trained radiology staff can further optimize diagnostic imaging, despite the availability of clinical decision support.

SSA06-08 National Trends of Non-Cardiac Ultrasound in the Emergency Department: What's the Contribution of Non-Radiologists?

Sunday, Nov. 25 11:55AM - 12:05PM Room: S405AB

Participants
Santosh K. Selvarajan, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

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PURPOSE

The Accreditation council for Graduate Medical Education (ACGME) requires Point of Care Ultrasound (POCUS) training to be part of Emergency Medicine. Our purpose was to determine recent trends in Non-cardiac ultrasound utilization in Emergency Departments. Secondly, assess the contribution of Non-Radiologists interpretations from 2004 to 2016.

METHOD AND MATERIALS

The Medicare Physician/Supplier Procedure Summary Master Files for 2004-2016 were used. The codes for ED Ultrasound were selected for 2004 and 2016. The procedure volumes in ED settings were calculated. Then Medicare provider specialty codes were used to identify those exams interpreted by Radiologists and other specialties.

RESULTS

The number of non-cardiac ultrasounds grew from 408,000 in 2004 to 1,024,809 in 2016 (+151%). Radiologists interpreted 87.5% of all ED non-cardiac ultrasounds. The vascular surgeons and emergency physicians interpreted 4% each, cardiologists and other surgical subspecialties interpreted the remaining 4.5%. There is 181% increase in the studies interpreted by vascular surgeons (15820 in 2004 to 44,369 in 2016), 1117% increase in the studies interpreted by emergency physicians (3459 in 2004 to 41400 in 2016), 26% increase by surgical specialties (14502 in 2004 to 18351 in 2016), and 140% increase by cardiologists (5270 in 2004 to 12470 in 2016).

CONCLUSION

The utilization of non-cardiac ultrasound grew substantially from 2004 to 2016. Radiologists continue to predominate in interpreting ED ultrasounds. There is small but substantial growth of emergency physicians and vascular surgeons' interpretations. Although much small in number the interpretations by cardiologists and other surgical specialties have also slowly increased.

CLINICAL RELEVANCE/APPLICATION

Although Non-Radiologists interpreting non-cardiac Emergency ultrasound has slowly grown, future studies are needed to assess the complexity of studies interpreted by them.

SSA06-09 Tiered Response Algorithm for Endovascular Management of Traumatic Hemorrhage

Sunday, Nov. 25 12:05PM - 12:15PM Room: S405AB

Participants
Bahman Sadeghi, MD, Orange, CA (*Presenter*) Nothing to Disclose
Hanna Javan, MD, Orange, CA (*Abstract Co-Author*) Nothing to Disclose
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Dayantha Fernando, MD, Orange, CA (*Abstract Co-Author*) Nothing to Disclose
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Michael Lekewa, Orange, CA (*Abstract Co-Author*) Nothing to Disclose
Nadine Abi-Jaoudeh, MD, Orange, CA (*Abstract Co-Author*) Research collaboration, Koninklijke Philips NV; Research collaboration, Teclison Cherry Pharma Inc; Research support, SillaJen, Inc

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PURPOSE

Hemorrhagic shock represents the second-leading cause of early death in traumatic injury with endovascular therapy as an integral part of the therapeutic armamentarium. The emphasis on a rapid response is balanced with the judicious utilization of resources that led to the creation of a tiered algorithm. The purpose of this study is to assess the efficacy of such a response for the

management of non-operative traumatic hemorrhage.

METHOD AND MATERIALS

A retrospective review of after-hour trauma activations was performed at a level 1 trauma center from July 2015 to July 2017. Activation of the interventional team was initiated either immediately ("EmboNow"), prior to imaging review and attending interventional radiologist (IR) approval, or after review and discussion with IR ("EmboSoon"). The need for transfusion and overall technical clinical success (defined as lack of re-intervention) were collected. Length of stay (LOS) and overall mortality, as well as overall morbidity, was evaluated. Pearson chi-square and Wilcoxon Rank-Sum (WRS) analyses were performed on various parameters to determine the significant clinical efficacy of a tiered response system.

RESULTS

A total of 73 trauma activations with EmboNow (n=27) and EmboSoon (n=46) occurred in the study time frame. Of the EmboSoon activations, 28 instances did not require the mobilization of the team and 3 instances required the mobilization of the team but did not progress to intervention. No significant difference was determined when assessing the necessity of hemostatic intervention within the groups. Of the cases requiring embolization (n=31), no difference in the clinical success rate was noted. Overall mortality for the EmboNow and EmboSoon groups was not significantly different, 3.7% and 6.7%, respectively. Also, no significant difference observed between the response groups for average LOS, EmboNow = 10.1 days and EmboSoon = 13.3 days.

CONCLUSION

A tiered response algorithm did not increase overall mortality nor length of stay in patients who ultimately underwent embolization but prevented unnecessary mobilization in 28 cases.

CLINICAL RELEVANCE/APPLICATION

Efficient use of IR resources as well as cooperation and communication among a multidisciplinary trauma team is essential to improve and maintain high-quality clinical services, and to get the best clinical outcomes in management of traumatic hemorrhage.

SSA07

Science Session with Keynote: Gastrointestinal (Radiomics)

Sunday, Nov. 25 10:45AM - 12:15PM Room: N226

CT GI MR OI

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

Participants
Alexander R. Guimaraes, MD, PhD, Portland, OR (*Moderator*) Consultant, Agfa-Gevaert Group
Aya Kamaya, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Aliya Qayyum, MD,MBBS, Houston, TX (*Moderator*) Spouse, Founder, In Context Reporting

Sub-Events

SSA07-01 Gastrointestinal Keynote Speaker

Sunday, Nov. 25 10:45AM - 10:55AM Room: N226

Participants
Alexander R. Guimaraes, MD, PhD, Portland, OR (*Presenter*) Consultant, Agfa-Gevaert Group

Honored Educators

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SSA07-02 Added Value of Radiomic Analysis in Gadoxetic Acid-Enhanced MRI for Prediction of Postoperative Early and Late Recurrence of Single Hepatocellular Carcinoma

Sunday, Nov. 25 10:55AM - 11:05AM Room: N226

Participants
Sungwon Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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Jin-Young Choi, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the added value of the radiomic model in predicting early and late recurrence after resection in a single HCC of less than 5 cm using preoperative gadoxetic acid-enhanced MRI, compared to clinical-only model.

METHOD AND MATERIALS

This retrospective study included 214 patients with surgically resected and pathologically confirmed single HCC (<5cm; 1-2cm [n = 47]; 2-5cm [n = 167]) between January 2010 and December 2015 who underwent preoperative gadoxetic acid-enhanced MR imaging. All prediction models were made with training set and performance was evaluated with temporally independent validation set (training set vs. validation set; 1-5cm, 162 vs 52; 2-5cm, 128 vs. 39). Independent predictors for early and late disease-free survival (DFS) in clinicopathologic information were identified using the Cox regression model, respectively. Three dimensional radiomic features for predicting DFS were selected in each early (<2 years) and late period (2-5 years). A combined radiomic-clinical model (CMB) and a clinical-only model (CLN) were created using a random survival forest and additional values of radiomic features were evaluated using bootstrapping method (n = 1000) in each of the following conditions: early DFS vs. late DFS; tumor size 1-2cm vs. 2-5cm; all combinations of the three dynamic phases (arterial, portal, hepatobiliary phase); the peritumoral border extension included in the radiomic feature extraction (0mm vs. 3mm vs. 5mm).

RESULTS

The combined radiomic-clinical model showed a higher C-index than the clinical-only model in the prediction of early DFS but showed a lower C-index than the clinical-only model in the prediction of late DFS. The combined model using the radiomic features from 2-5cm size tumors, all three phases, 3mm peritumoral border extension showed the highest C-index value (CMB, C-index 0.716 [0.627-0.799]; CLN, C-index 0.696 [0.557-0.799]).

CONCLUSION

Radiomic features combined with clinical factors may improve the prediction of postoperative early recurrence of HCC, but they do not affect the prediction of late recurrence.

CLINICAL RELEVANCE/APPLICATION

Combined analysis of radiomic and clinicopathologic features may influence the postoperative management of patients by increasing the predictive power of postoperative early recurrence of HCC.

SSA07-03 Auto-Encoder and Multilayer Perceptron Assisted Radiomics Approach for Prediction of Early Intrahepatic Recurrence After Radiofrequency Ablation in Hepatocellular Carcinoma

Sunday, Nov. 25 11:05AM - 11:15AM Room: N226

Participants
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PURPOSE

After radiofrequency ablation (RFA), > 50% of early stage hepatocellular carcinoma (HCC) patients undergo intrahepatic recurrence (IHR) within 2-3 years. To optimize the selection of most profitable patients to receive RFA, better prediction algorithms are needed to identify early IHR after RFA. Radiomics allows noninvasively extracting three-dimensional and quantitative features of tumor phenotypes from radiographic images. Recent advances in deep neural network also provide powerful tools for features selection and classification. The present study aims to combine those approaches to establish prediction model to identify patients with a low predicted IHR and suitable for RFA as first-line treatment.

METHOD AND MATERIALS

Patients who initially underwent RFA for single nodular HCC <= 5 cm with Child-Pugh grade A or B were included. A total of 6568 triphasic CT-based features of pretreatment tumors were obtained from 176 patients in the experimental cohort (EC). A Radiomic based prediction model (RPM), trained with variational autoencoder (VAE) and multilayer perceptron (MLP), was developed to predict the 2-year IHR, and validated in an independent validation cohort (VC) of 57 HCC patients. Imaging traits including tumor encapsulation, tumor necrosis, lack of fast wash-in or wash-out, multi-segment involvement were analyzed and correlated to the neurons of the encoder layers as an approach to explain the black box of hidden layers.

RESULTS

The VAE, with 16 neurons in encoder layers, held the task of noise reduction for high dimensional radiomic features, and MLP, with 4 hidden layers, was used to train the model. The RPM, trained with 1,711,457 parameters, outperformed the traditional volumetric predictors of maximal tumor diameter in the prediction of 2-year IHR, with a C-index of 0.757 / 0.707 (EC / VC), compared to 0.540 / 0.510. Imaging traits of tumor necrosis and lack of fast wash-in were associated with neuron_A and neuron_B in the encoder layers. Multivariate analysis showed only RPM and pre-RFA AFP level were significantly associated with 2-year IHF.

CONCLUSION

The radiomics approach provides a novel and convenient way to predict 2-year IHR in patients with early stage HCC who received RFA. The VAE and MLP help denoise high dimensional data and shed the light on the explanation of deep neural network.

CLINICAL RELEVANCE/APPLICATION

The RPM will select most profitable patients to receive RFA

SSA07-04 Development of a Liver Tumor Diagnosis Tool with Deep Neural Networks: Radiologist-Level Performance with Artificial Intelligence

Sunday, Nov. 25 11:15AM - 11:25AM Room: N226

Participants
Charlie Hamm, Berlin, Germany (*Presenter*) Nothing to Disclose
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Marc Ferrante, MD, N New Hyde Pk, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To develop and evaluate the performance of a 3D deep convolutional neural network (CNN) system compared to board-certified radiologists in automatically classifying hepatic lesions on contrast-enhanced multi-phasic magnetic resonance images (MRI).

METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant analysis included 296 patients with a total of 494 focal hepatic lesions of different entities

(simple cyst, hemangioma, focal nodular hyperplasia, hepatocellular carcinoma [HCC], intrahepatic cholangiocarcinoma, and colorectal carcinoma metastasis). Lesions were defined on T1-weighted MRI scans (arterial, portal venous, delayed phase) and divided into training (n=434) and test sets (n=60). The training set was provided to a 3D CNN to learn how to classify each lesion type. The system's performance on the test set was compared with that of two board-certified radiologists.

RESULTS

Over 20 iterations, the CNN model achieved an overall average accuracy of 92%, a sensitivity (Sn) of 92%, and a specificity (Sp) of 98%. The model showed the lowest performance for colorectal carcinoma metastasis (89% Sn, 98% Sp) while the highest performance was achieved in classifying simple cysts (99% Sn, 100% Sp). The model's performance in a single run on the test set showed an average Sn of 90% and Sp of 98% across the six lesion types, compared to an average Sn of 82.5% and Sp of 96.5% for the radiologists. Specifically, the model achieved a 90% Sn for classifying HCC compared to 65% for radiologists. The model showed a true positive rate of 93.5% and false positive rate of 1.6% for HCC classification, with a receiver operating characteristic area under the curve (AUC) of 0.992. The model computation time per lesion was 1 millisecond.

CONCLUSION

This novel 3D CNN system demonstrates the feasibility of AI decision-support to accurately classify several classes of liver lesions on multi-phasic MRI, providing a tool to potentially augment radiologists' performance and efficiency.

CLINICAL RELEVANCE/APPLICATION

As the volume demands of radiology increase, a synergistic workflow that combines a radiologist's experience and intuition with the computational power of AI may enhance efficiency and quality.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jeffrey C. Weinreb, MD - 2018 Honored Educator

SSA07-05 Utility of Radiomics Analysis of Gadoxetic Acid-Enhanced Hepatobiliary Phase MR Images: A Noninvasive Method for Accurate Diagnosis and Staging of Hepatic Fibrosis

Sunday, Nov. 25 11:25AM - 11:35AM Room: N226

Participants
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PURPOSE

To develop and validate a radiomics-based index for staging liver fibrosis using gadoxetic acid-enhanced hepatobiliary phase (HBP) MR images.

METHOD AND MATERIALS

The institutional review board approved the study, and informed consent was waived. A total of 436 patients with pathologically proven liver fibrosis and gadoxetic acid-enhanced liver MR imaging preceding less than 3 months of histopathologic analysis were included (132, 22, 53, 77, 153 for fibrosis grade 0, 1, 2, 3, 4, respectively). The subjects were randomly divided into the development and test cohorts at a ratio of 3:1. Feature extraction was performed from HBP images, and extracted features included 8 histogram features and 35 high-order textural features. For feature selection and modeling for binary decision to discriminate F0-2 vs. F3-4, we used a logistic regression with elastic net regularization. Performance of the selected model in diagnosing significant fibrosis (>= F2), advanced fibrosis (>= F3), and cirrhosis (F4) was evaluated using the AUROC in the test cohort, and was compared with serum markers (APRI and FIB-4).

RESULTS

Radiomic fibrosis index had significant positive correlation with the pathologic fibrosis stage (ρ=0.735, P<.001). In the test cohort, AUROCs of the model were 0.9, 0.89, and 0.91 for diagnosing significant fibrosis, advanced fibrosis and cirrhosis, respectively. The Obuchowski index, a weighted average of the AUROC values obtained for all pairs of fibrosis stages, was 0.864 (62% CI, 0.819-0.909) in radiomics model, significantly higher than those of APRI (0.604, P<.001) and FIB-4 (0.621, P<.001). Using the threshold values for radiomic fibrosis index determined in the development cohort, the sensitivities of 78.9% - 92.1%, specificities of 75.4% - 82.0%, and accuracies of 80.3% - 81.3% were achieved for diagnosing significant fibrosis, advanced fibrosis, and cirrhosis in the test cohort.

CONCLUSION

Radiomics analysis of HBP images of gadoxetic acid-enhanced MRI can provide accurate diagnosis and staging of liver fibrosis.

CLINICAL RELEVANCE/APPLICATION

Radiomics analysis of HBP images has a potential usefulness for the noninvasive and accurate diagnosis and staging of hepatic fibrosis.

SSA07-06 Application Value of Radiomics Features Based on Monochromatic Images of Spectrum CT in the Pathological Grading of Gastric Adenocarcinoma

Sunday, Nov. 25 11:35AM - 11:45AM Room: N226

Participants
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PURPOSE

To evaluate the clinical value of radiomics features based on monochromatic images of spectrum CT in the pathological grading of gastric adenocarcinoma.

METHOD AND MATERIALS

Retrospectively 196 patients with gastric adenocarcinoma who underwent upper or total abdominal GSI scanning using the Discovery 750 CT machine were collected, who were divided into poorly differentiated group (Group A) and moderately-well differentiated group (Group B) according to pathological results. High-quality, standardized venous phase single-energy images of 70 keV were obtained from the AW4.6 workstation, and then radiomics features based on the monochromatic images were extracted and a Logistic regression model was established by the dimensionality-reduced features.The efficacy of the Logistic regression model was evaluated by the receiver operating characteristic curve (ROC) and its accuracy was verified. At the same time, the grading results and performance of conventional energy spectrum parameters were compared and analyzed.

RESULTS

The grading efficacy of the normalized iodine (water) concentration of conventional spectral parameters was 0.668. The area under the ROC curve (AUC) of the Logistic regression model was 0.872 (sensitivity was 73.3% and specificity was 83.3%) and the diagnostic accuracy was 78.3%.

CONCLUSION

Radiomics features based on the single-source dual-energy CT monochromatic images can non-invasively differentiate gastric adenocarcinoma from poorly differentiated and moderately-well differentiated tumors. Its efficacy is better than that of conventional spectral CT.

CLINICAL RELEVANCE/APPLICATION

Radiomics features based on the single-source dual-energy CT monochromatic images can provide more quantitativeand repeatable information for clinical treatment options and preoperative evaluations.

SSA07-07 Multi-Feature Based CT Radiomic Signature Peroperatively Predicts Lymph Node Metastasis in Advanced Gastric Cancer

Sunday, Nov. 25 11:45AM - 11:55AM Room: N226

Participants
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Di Dong, PhD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Zaiyi Liu, MD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To investigate whether the method of deep learning could improve the performance of radiomic features, and to build a radiomic signature for preoperative prediction of lymph node metastasis (LNM) in patients with advanced gastric cancer (AGC).

METHOD AND MATERIALS

In this ethical-approved retrospective study, we collected a primary cohort consisting of 110 patients from Center 1 and a validation cohort consisting of 121 patients from Center 2. A total of 521 features were extracted from venous-phase CT images. The features could be divided into two groups: deep learning features and conventional hand-crafted features. Based on the whole feature set and the hand-crafted-only feature set respectively, RELIEFF and support vector machine model were implemented to select key features and build two radiomic signatures to yield quantitative risk for LNM. The predictive performances of the signatures were evaluated by receiver operator characteristics analysis and accuracy analysis in the external validation cohort.

RESULTS

Combining the deep learning features and conventional features, the multi-feature based CT radiomic signature outperformed the conventional signature (area under the curve: 0.799 vs. 0.735 in the external validation cohort). It showed powerful predictive ability of discriminate non-N0 patients from N0 patients with accuracies of 0.764 (95% confidence interval [CI]: 0.673-0.839) and

0.736 (95% CI: 0.648-0.812) in the primary and validation cohorts respectively.

CONCLUSION

Taking advantages of the novel deep learning method and the conventional machine learning method, radiomic signature could serve as a useful tool for preoperative LNM status prediction in patients with AGC.

CLINICAL RELEVANCE/APPLICATION

Multi-feature based CT radiomic signature has potential in the preoperative non-invasive prediction of lymph node metastasis and facilitate the clinical strategy.

SSA07-08 Correlation Analysis of Spectral CT Parameters and K-ras Gene Mutation in Colorectal Cancer

Sunday, Nov. 25 11:55AM - 12:05PM Room: N226

Participants
Dan Wang, Lanzhou, China (*Presenter*) Nothing to Disclose
Junlin Zhou, Lanzhou, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the relationship between K-ras mutation of colorectal cancer and the quantitative parameters and qualitative parameters with spectral CT.

METHOD AND MATERIALS

A retrospective analysis of 66 cases of colorectal adenocarcinoma with K-ras mutation confirmed by surgical or endoscopic biopsy was performed by spectral CT dual-phase enhanced scans. The relationship between K-ras mutation and the qualitative and quantitative parameters of CT was statistically analyzed. The CT qualitative evaluation included the location of the tumor, the thickening of the intestinal wall, the infiltration of perienteral fat, and the enlargement of the lymph nodes; the parameters of the CT quantitative assessment include the 40~140keV single energy CT, the iodine (water) concentration, the water(iodine) concentration,the normalized iodine concentration(NIC) and the spectrum curve slope in the arterial and venous phase. The slope is calculated according to the following formula: slope = (CT40keV-CT100keV) /60. Chi-square test was used to statistically analyze the correlation between CT qualitative signs and K-ras mutation status. Independent sample t-test was used for statistical analysis to evaluate the correlation between spectral CT features and K-ras mutations.

RESULTS

K-ras mutations were positive in 32 (48%) of the 66 patients. The colorectal cancer patients with K-ras mutation were multiple in the right hemicolon(x2=8.09,P=0.007), eccentric thickening(x2=12.17,P=0.001), and more perienteric lymph nodes(x2=12.17,P=0.001), which were not related to the degree of fat infiltration around the lesions, and the extent of perianal invasion(P>0.05). The iodine concentration(t=-3.47,P=0.002) , NIC(t=-3.18,P=0.004) , the slope of the spectrum curve(t=-3.58,P=0.001) and the CT value of the low energy level (40-70 keV) (P<0.05) in arterial phase were increased in the K-ras mutation-type colorectal cancer patients than the wild-type ones.

CONCLUSION

K-ras mutations in colorectal cancer correlated with a part of spectral CT quantitative parameters and qualitative parameters.

CLINICAL RELEVANCE/APPLICATION

K-ras mutations could be initially judged by qualitative and quantitative parameters of spectral CT.

SSA07-09 MRI-Based Radiomics Analysis for Predicting KRAS Mutation in Patients with Rectal Cancer

Sunday, Nov. 25 12:05PM - 12:15PM Room: N226

Participants
Huanhuan Liu, Shanghai, China (*Presenter*) Nothing to Disclose
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PURPOSE

Genetic profiling of tumors is important for personalized treatment through the development of targeted therapies. For patients with suspected or proven metastatic rectal cancer, the identification of KRAS/NRAS/BRAF mutations is of great significance. Either of the mutations predicts a lack of response to cetuximab and panitumumab, which is important for the individual treatment strategy. Therefore, our study was to investigate the value of radiomics analysis for predicting KRAS mutation in patients with rectal cancer.

METHOD AND MATERIALS

A total of 128 patients with histopathologically confirmed rectal cancer who underwent preoperative MR imaging and postoperative KRAS mutation test without any preoperative chemoradiotherapy were divided into the primary cohort (n=89) and the validation cohort (n=39). MRI-based radiomics features were extracted from oblique axial T2-weighted images. The independent two-sample t test, Kruskal-Wallis test, and Pearson correlation analysis were used for features selection. A radiomics signature was built and multivariable logistic regression analysis was used to develop the radiomics model including radiomics features and independent clinico-radiologic risk factors. The performance of the radiomics model was assessed by the receiver operating characteristic curve (ROC) and decision curve analysis.

RESULTS

A total of 385 radiomic features were extracted from each patient, and 12 radiomics features were selected for the radiomics signature. The radiomics signature was significantly associated with KRAS mutation (P<0.001). The areas under the ROCs were 0.845 in the primary cohort and 0.767 in the validation cohort. Decision curve analysis confirmed the clinical utility of the radiomics model. The clinical background and tumor MRI-staging showed no significant correlation with KRAS mutation.

CONCLUSION

The MRI-based radiomics model could be used to predict the KRAS mutation in patients with rectal cancer, which could be helpful for individual treatment strategy.

CLINICAL RELEVANCE/APPLICATION

(dealing with MRI-based radiomics) "The MRI-based radiomics model could be used to predict the KRAS mutation in patients with rectal cancer, which could be helpful for individual treatment strategy"

SSA08

Science Session with Keynote: Gastrointestinal (Crohn's Disease and Small Bowel)

Sunday, Nov. 25 10:45AM - 12:15PM Room: N227B

BQ GI MR

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

Participants
Joel G. Fletcher, MD, Rochester, MN (*Moderator*) Grant, Siemens AG; Consultant, Medtronic plc; ;
Tracy A. Jaffe, MD, Durham, NC (*Moderator*) Nothing to Disclose
Aoife Kilcoyne, MBBCh, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSA08-01 Crohn's Disease Evaluation with Diffusion Weighted Imaging

Sunday, Nov. 25 10:45AM - 10:55AM Room: N227B

Participants
Nicholas K. Cheung, MBBS, Hobart, Australia (*Presenter*) Nothing to Disclose
Andrew J. Halliday, MBBS, Hobart, Australia (*Abstract Co-Author*) Nothing to Disclose
Aditya Varma, MBBS, Hobart, Australia (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Diffusion-weighted-imaging (DWI) is increasingly used for Crohn's disease (CD) evaluation. Sensitivity and specificity rates are however heterogeneous1-5, and only two series to-date reported paediatric CD results4,6. We report one of the largest series for DWI evaluation of adult and pediatric CD.

METHOD AND MATERIALS

Between 2014 and 2016, 77 patients (18 pediatrics) underwent DWI for CD. All had histopathological confirmation within 28 days. Two radiologists were presented random DWI sequences, to evaluate bowel segments for disease activity, based subjectively on "greater-than-normal visual diffusion-restriction", followed objectively by mean minimum-ADC values. Sensitivity/specificity for detection and inter-observer reliability were recorded. Differences in ADC values calculated with unpaired t-test.

RESULTS

Both radiologists had 99% sensitivity and specificity (kappa 0.98) in terminal ileitis detection. Minimum mean ADC values were 1.3±0.4×10-3mm2/s. Overall specificity rates of 75% in determining colonic involvement. The greatest disparity was within the sigmoid, with 68% specificity. Moderate inter-observer reliability achieved (kappa 0.40). ADC values significantly differed between true and false positive colonic segments (Mean ADC 1.08±0.4×10-3mm2/s vs. 1.84±0.55×10-3mm2/s, p<0.0001). Overall results were similar for the pediatric subgroup.

CONCLUSION

We achieved a 99% diagnostic rate of CD affected terminal ileum. Low specificity and interobserver reliability for CD affected colon, however, ADC quantitative values improved diagnostic accuracy and correlation.

SSA08-02 High Spatiotemporal Resolution Free-Breathing Quantitative Bowel Perfusion Imaging

Sunday, Nov. 25 10:55AM - 11:05AM Room: N227B

Participants
Verena Obmann, MD, Cleveland, OH (*Presenter*) Nothing to Disclose
Kun Yang, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Satyam Ghodasara, MD, Cleveland, OH (*Abstract Co-Author*) Research support, Siemens AG
Katherine Wright, Cleveland, OH (*Abstract Co-Author*) Research support, Siemens AG
Marcie Stopchinski, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
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Maneesh Dave, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Vikas Gulani, MD, PhD, Cleveland, OH (*Abstract Co-Author*) Research support, Siemens AG; Licensed Technology, Siemens Healthineers - both myself and my spouse. MR Fingerprinting, on which we are both inventors, has been licensed by Siemens.

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PURPOSE

This study shows that 3D through-time spiral GRAPPA can be used to acquire DCE-MRI data of the bowel with a high spatiotemporal resolution without a need for breath-holding, and enables quantitative perfusion analysis of the entire bowel.

METHOD AND MATERIALS

3D DCE-MRI data of the bowel was obtained from 7 patients with Crohn disease undergoing MRE exam at 1.5T (Siemens Aera). A total of 50 coronal volumes were acquired continuously over the course of approximately 1.5 minutes after the injection of 0.1 mmol/kg gadobenate dimeglumine (3ml/s) with a temporal resolution of 1.6s while the patients breathed freely. Each volume included 40 slices with an in-plane matrix size of 272×272, in-plane resolution of 1.5 mm, and an uninterpolated slice thickness of 4 mm. Conventional qualitative MRI findings were recorded. The Tofts model was used to quantitatively characterize contrast enhancement in the bowel. Multislice ROIs were drawn in the bowel wall as well as in the aorta to calculate the arterial input function. Ktrans and ve were quantified by fitting the mean signal within each ROI from the bowel to the model.

RESULTS

This acquisition technique allowed for full coverage of the entire abdomen. Mean age was 40.1 years (range 19-68 years) in 3 male and 4 female patients. 2 showed active inflammatory changes while 5 did not exhibit evidence of active disease at the time of examination. All inflamed bowel segments showed mural thickening and increased contrast enhancement. Quantified perfusion properties for segments with active inflammation were in mean 0.096±0.045 (0.044-0.123) compared to non-affected segments 0.019±0.033 (0.002-0.099) for Ktrans and 0.476±0.212 (0.337-0.724) vs. 0.223±0.319 (0.068-0.232) for ve.

CONCLUSION

This study shows that free-breathing, high spatiotemporal resolution, and quantitative 3D DCE-MRI of the bowel is feasible with spiral GRAPPA leading to accurate characterization of the early arterial portions of the bowel contrast enhancement time course. Although evaluated in a limited number of patients, perfusion metrics already demonstrate separation of normal and inflamed bowel wall.

CLINICAL RELEVANCE/APPLICATION

Spiral GRAPPA allows for quantitative perfusion assessment of the intestine without preselecting specific loops as the entire abdomen is covered. This sequence can be used for future therapy response assessment trials.

SSA08-03 Tagged Cine-MRI for the Assessment of Caloric Stimulation of Small Bowel Motility

Sunday, Nov. 25 11:05AM - 11:15AM Room: N227B

Participants
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Andre M. Sprengers, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Continuously tagged imaging for the assessment of motility in the small bowel region has been demonstrated as an alternative to other more established MRI techniques. Providing its own contrast and the possibility to monitor motility during free-breathing, this technique can assess motility at frequencies as low as 2 contractions per minute (cpm), this is the slow wave, motility pattern range. This study aims to validate a clinically feasible test for small bowel motility assessment in the low frequency range using tagged cine-MRI before and after a 300-kCal meal.

METHOD AND MATERIALS

After ±11h overnight fasting, 16 healthy subjects (9 males, median age 25, range 19-37y) underwent a free-breathing, tagged cine-MRI to capture global small bowel motility. Each subject underwent i) baseline motility scan ii) food challenge with Nutridrink iii) post-challenge scan iv) second post-challenge scan (after ±20 minutes). Motility was quantified within a region of interest covering the small bowel, using a validated frequency analysis technique for measuring the spectral power of the strain, referred to as 'motility score'. Motility score was assessed in 20 frequency intervals between 1-20 cpm.

RESULTS

The motility score was consistently higher in the low frequency regime (1-10cpm) right after caloric intake, this regime is consistent with the stomach and bowel frequencies (3-12 cpm). The difference between baseline motility score and directly after drinking was significant in the low range intervals 2-4cpm and 6-8cpm. The difference between the motility score directly after drinking and ±20 minutes after drinking was significant in the low range intervals 1-4cpm. No significant changes were observed in the breathing range.

CONCLUSION

This study demonstrates the continuously tagged imaging sequence and quantification method is capable of assessing changes in motility patterns in high detail during free breathing. The method is non-invasive and independent of preparation, enabling monitoring in both fasted and fed state. This indicates that it can be used to perform stimulation tests to measure response in various frequency intervals and with that assess (patho)physiology in the gastrointestinal tract.

CLINICAL RELEVANCE/APPLICATION

Continuously tagged MR imaging is capable of non-invasively assessing small bowel motility in high detail during free breathing, providing a tool to explore (patho)physiology in fasted and fed state.

SSA08-04 Value of Spectral Computed Tomography Imaging For Evaluation of Intestinal Activity and in Crohn's Disease

Sunday, Nov. 25 11:15AM - 11:25AM Room: N227B

Participants
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PURPOSE

To investigate the clinical value of spectral CT imaging in assessing the activity of Crohn's disease compared with the simple endoscopic score (SES).

METHOD AND MATERIALS

50 patients suspected to have Crohn's disease received both colonoscopy and contrast enhanced computed tomographic enterography (CTE) were involved in this study.The interval time between the two examinations was less than one week. All patients were scanned on a GE Discovery 750 HDCT scanner using GSI spectral imaging mode.The portal-phase monochromatic images from 40 to 140kev and iodine-based material decomposition images were reconstructed after scan. Reconstructed images data were processed with GSI Viewer for analysis. According to the SES-CD (Simple Endoscopic Score for Crohn's Disease)scores,50 patients were divided into 4 groups(GroupA:Score=0-2,n=6;GroupB:Score=3-6,n=12;GroupC:Score=7-15,n=17;GroupD:Score>=16,n=15).Three different locations of suspicious area of the small bowel were selected from each patient.The spectral curve slope and its mean value were calculated under 40-70KeV;the iodine concentrations and effective atomic number of the involved bowel wall in material decomposition images were measured; the CT value of 50KeV images were measured;the variance analysis was used for the iodine concentration and spectral curve slope comparison among the four groups.

RESULTS

The spectral curve slopes(-1.58±0.48,-2.17±0.66,-3.18±1.07,-3.97±0.65)and iodine concentrations (8.02±1.70,12.33±2.23,17.84±4.40,22.24±3.61),CT value of 50 KeV (60.41±1.60,72.67±3.23,111.66±4.21,140.57±4.01)and effective atomic number (7.78±0.07,8.12±0.09,8.45±1.21,8.77±1.01)of four groups were found statistically significant different (P<0.01);the spectral curve slopes,iodine concentrations,CT value of 50KeV,effective atomic number among Group A,Group C and Group D were statistically different(P<0.05);Group B,Group C and Group D were statistically different(P<0.05).

CONCLUSION

The spectral curve slope,the iodine concentration,the CT value of 50KeV and effective atomic number of the small bowel derived from spectral CT imaging can be used to evaluate the activity of Crohn's disease.

CLINICAL RELEVANCE/APPLICATION

Spectral CT had sensitivity in detecting intestinal activity and severity of CD,which could be an alternative choice in evaluation of CD.The purpose of this study was to establish the standards of evaluating the activity of Crohn's disease using spectral CT in the future.

SSA08-05 Eliminating Unnecessary Anatomic Coverage Allows for Significant Radiation Dose Savings in Follow-Up Outpatient CT Enterographies of Young Crohn's Adults

Sunday, Nov. 25 11:25AM - 11:35AM Room: N227B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To determine the minimal Z-axis coverage necessary to include all relevant extra-intestinal (EI) findings and the entire bowel in follow up CT enterographies (CTEs) of young Crohn's (CD) outpatients, and the potential radiation dose savings in eliminating unnecessary Z-coverage in this young population, where significant EI findings are rare and dose savings are beneficial.

METHOD AND MATERIALS

All outpatient CTEs of 18-40 years old CD patients performed from January to December 2016 were included. Two abdominal radiologists in consensus noted the most inferior vertebral level - superior endplate (SE) - that would include: 1) entire small bowel (SB), 2) all diseased SB, 3) all diseased colon, and 4) EI findings. Total Z-axis coverage and the distance from the top of the scan to each SE was measured. The percentage of potential dose savings based on the percentage of unnecessary Z-axis coverage was calculated.

RESULTS

80 scans were included. All diseased colon and the entire SB was always inferior to the SE of T12. All diseased SB segments were inferior to L2. 9% had potentially significant EI findings: 1 pneumonia (T11), 1 focal biliary dilatation (T12), 2 chronic mesenteric venous thrombosis (L1 and L3), 2 sacroiliitis (S1) and 1 peripheral nerve sheath tumor (S5). However, only the pneumonia had management implications. Mean dose savings - with standard deviation (SD) and confidence intervals (CI) - achieved by starting the scan at T12, L1 and L2 would be 15.3% (SD: 4.1, 95%CI: 14.5 - 16.2), 21.5% (SD: 3.9; 95% CI: 20.6 to 22.4) and 28.4% (SD: 3.6; 95% CI: 27.6 - 29.2), respectively.

CONCLUSION

L2 was the cutoff to include all diseased small bowel segments, creating a potential for mean dose savings of 28% in this population. While T12 was the cutoff to include the entire SB (dose reduction of 15%), new proximal SB disease on follow up scans is very rare and was never found above L2 in our population. T12 was also the cutoff that included all EI findings except a

pneumonia, with no additional clinically significant EI findings above L2. There is an opportunity for 15-28% mean dose reduction on CTEs just by excluding unnecessary anatomic coverage.

CLINICAL RELEVANCE/APPLICATION

In a population that particularly benefits from dose reduction (young Crohn's adults), the dose of follow-up CTEs can be significantly reduced by eliminating unnecessary anatomic coverage.

SSA08-06 Evaluation of Bowel Fibrosis in Crohn's Disease Combining Diffusion Kurtosis and Intravoxel Incoherent Motion MR Imaging: Correlation with Surgical Histopathology

Sunday, Nov. 25 11:35AM - 11:45AM Room: N227B

Participants
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PURPOSE

To assess the utility combining diffusion kurtosis imaging (DKI) and intravoxel incoherent motion (IVIM) Imaging for grading the degrees of the intestinal fibrosis in Crohn's disease (CD), using surgical histopathology as the reference standard.

METHOD AND MATERIALS

21 CD patients underwent both elective surgery and diffusion weighted imaging (b values of 0-2000 s/mm2). Apparent diffusion coefficients (ADCs) was calculated using b values of 100-1000 s/mm2. Diffusion coefficients (Dapp) and kurtosis (Kapp) on DKI maps (b values of 0, 600, 1000, 1500 and 2000 s/mm2) and pesudodiffusion coefficient (D*) and perfusion fraction (f) on IVIM maps (b values of 0,10, 20, 40, 60, 80, 100, 150, 300, 600 and 1000 s/mm2) were measured region-by-region with surgical specimens. Resected bowel tissues were scored from 1 to 3 for histologic fibrosis.The parameters f, ADCs, and Kapp were combined to provide a single diagnostic grade compared with the fibrosis score.

RESULTS

67 surgical specimens were evaluated and included none-mild (n=28), moderate (n=21) and severe (n=18) fibrosis. Significant differences were found between none-mild and both moderate and severe fibrotic segments for ADCs, Dapp, Kapp and f (P<0.05). They had similar correlation with histologic fibrosis scores (r: 0.644 for Kapp, -0.522 for Dapp, -0.635 for f, -0.601 for ADCs, all P<0.05). D* did not correlate with histological fibrosis. High accuracy for differentiating moderate-severe fibrotic from none-mild fibrotic segments (AUC: 0.826 for Kapp, 0.791 for Dapp, 0.860 for f, 0.806 for ADCs) was showed by ROC analysis and the thresholds of 0.336 for f, 1.177 mm2/s for ADCs and 0.787 for Kapp were found with sensitivity of 92.61%, 84.6% and 89.7%, and specificity of 82.50%, 71.4%, 75%, respectively. The integrated score combined f, ADCs and Kapp thresholds was found a good correlation with histological fibrosis (r: 0.817, P<0.05). And AUC for differentiating moderate-severe fibrotic from none-mild fibrotic segments was 0.889 (P<0.001) with 94.40% sensitivity and 85.21% specificity.

CONCLUSION

DKI and IVIM can both detect varying degrees of bowel fibrosis in CD. Combination of DKI and IVIM parameters appears to improve diagnostic accuracy and the performance was better than single parameter of DKI or IVIM.

CLINICAL RELEVANCE/APPLICATION

Combination of DKI and IVIM parameters appears to improve diagnostic accuracy compared with single parameter for detecting bowel fibrosis in CD.

SSA08-07 Comparison of Three Magnetization Transfer Ratio Parameters for the Assessment of Bowel Wall Fibrosis in Crohn's Disease

Sunday, Nov. 25 11:45AM - 11:55AM Room: N227B

Participants
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PURPOSE

Magnetization transfer ratio (MTR) and normalized MTR derived from MT-MRI has been reported as two promising parameters to quantitatively detect bowel fibrosis in Crohn's disease (CD). However, the use of these two parameters for grading bowel fibrosis has not consider the presence of slightly increasing MTR in normal bowel wall due to the existence of intestine smooth muscle. Hence, we establish a new MTR index which includes the element from normal bowel wall. The aim of this study was to compare the efficacy of the three MTR indices for the assessment of bowel wall fibrosis in CD and then select an optimal index for the clinical application, using surgical histopathology as the reference standard.

METHOD AND MATERIALS

Abdominal MT imaging of 20 consecutive CD patients were analyzed before selective operation. The MTR, normalized MTR (MTR in

Abdominal MR imaging of 20 consecutive CD patients were analyzed before subjective operation. The MTR, normalized MTR (MTR in affected bowel wall÷MTR in skeletal muscle), and new MTR ([MTR in affected bowel wall-MTR in normal bowel wall]÷ [MTR in skeletal muscle- MTR in normal bowel wall]) were calculated. Region-by-region correlations between MT imaging and surgical specimen were performed, and Masson staining was using to manifest the histologic degree of fibrosis. Spearman rank correlation, one-way ANOVA test, and receiver operating characteristic curve were used for statistical analysis.

RESULTS

63 fibrotic intestinal segments from 20 CD patients were included in this study. Normalized MTR showed the strongest correlation with bowel fibrosis score (r=0.700,P <0.001), followed by new MTR (r=0.695,P<0.001) and MTR (r=0.590,P<0.001). The significant differences in MTR (F=23.13,P<0.001), normalized MTR (F=21.073,P<0.001) and new MTR (F=10.577,P<0.001) were found among mild, moderate and severe bowel fibrosis, respectively. MTR (AUC=0.959, P<0.001) and normalized MTR (AUC=0.933, P<0.001) had similar accuracy for differentiating moderate-severe from mild bowel fibrosis, followed by new MTR (AUC=0.883, P=0.002).

CONCLUSION

MTR, normalized MTR and new MTR are all able to detect and grade intestinal fibrosis in CD. Normalized MTR may be slightly superior to both MTR and new MTR and be an optimal index to quantitatively reflect the severity of bowel fibrosis with a simple calculation.

CLINICAL RELEVANCE/APPLICATION

The normalized MT ratio might be the relatively preferable indicator for assessing intestinal fibrosis in CD patients, which contributes to guiding further clinical treatment.

SSA08-08 Natural History of Inflammatory Strictures in Small Bowel (SB) Crohn's Disease in the Setting of Anti-TNF Therapy

Sunday, Nov. 25 11:55AM - 12:05PM Room: N227B

Participants
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PURPOSE

To examine the natural history of Crohn's small bowel (SB) strictures, examining both the need for subsequent surgery as well as their development from active inflammation, in Crohn's disease (CD) patients treated with anti-TNF therapy.

METHOD AND MATERIALS

Adult CD patients with SB strictures (luminal narrowing + proximal SB dilation) underwent serial CTE/MRE during anti-TNF therapy. Every stricture was examined by a GI radiologist for the severity of inflammation with associated imaging findings, penetrating disease, and other complications. Numerous morphological measurements were obtained (wall thickness, length, proximal SB dilation), and various ratios of these measurements were calculated. Patients were categorized into groups based on time of stricture development (baseline CTE/MRE vs. subsequent) and surgical outcome (surgical resection vs. observation).

RESULTS

58 CD patients (age 44±15; 27 females) with 74 strictures underwent CTE/MRE (47/11). 39 strictures (33 patients) underwent surgery (mean time of 2.7years) and 35 strictures (25 patients), who were observed for a mean of 5.3 years. Strictures going to surgery were associated with enteric fistulas [38% (15/39) vs. 11% (4/35)], perienteric edema [44%(17/39) vs. 23%(8/35)], and chronic mesenteric vein occlusion [12%(4/33) vs. 4%(1/25(4%)]. Stricture morphologic measurements and ratios were similar among the surgery and observation groups. There were 57 strictures (42 patients) at baseline and 17 strictures (16 patients) that developed on subsequent exams. Prior to stricture development, involved SB segments had less pronounced wall thickness (5.5 vs.7.8 mm), length of involvement (9.6 vs. 12.4 cm), and less inflammation compared to appearance at time of stricture development. New strictures had less pronounced wall thickness (7.8 vs. 9.2mm) and less penetrating disease [6% (1/17) vs. 35% (20/57)] than established strictures.

CONCLUSION

Strictures undergoing subsequent resection were associated with penetrating disease, perienteric edema, and mesenteric vein occlusion. Development of strictures from inflamed segments and subsequent development of penetrating complications is consistent with current concepts of CD progression.

CLINICAL RELEVANCE/APPLICATION

Strictures associated with penetrating disease, perienteric inflammation, and mesenteric vein occlusion are more likely to undergo surgery.

SSA08-09 Gastrointestinal Keynote Speaker: Crohn Disease

Sunday, Nov. 25 12:05PM - 12:15PM Room: N227B

Participants
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SSA09

Gastrointestinal (Machine Learning)

Sunday, Nov. 25 10:45AM - 12:15PM Room: N228

AI GI

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

Participants
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Andrew D. Smith, MD,PhD, Birmingham, AL (*Moderator*) President and Owner, Radiostics LLC; President and Owner, eRadioMetrics LLC ; President and Owner, Liver Nodularity LLC ; President and Owner, Color Enhanced Detection LLC ; Patent holder
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Sub-Events

SSA09-01 Automated Liver Lesion Segmentation Using Deep Learning

Sunday, Nov. 25 10:45AM - 10:55AM Room: N228

Participants
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PURPOSE

To develop an automated deep learning-based method for liver lesion segmentation on MRI scans in order to enable more efficient quantification of lesion size and measurement of growth over time.

METHOD AND MATERIALS

We utilize 1,312 annotated lesions from 607 unique abdominal MRI studies and 393 unique patients. DICOM images and lesion locations were collected as part of standard clinical care. Identified lesions were segmented manually on multiphasic contrast-enhanced series by annotators trained in liver lesion segmentation. The median lesion diameter was 15.8 mm, while the median lesion volume was 1.469 mL. We designate an 80%-10%-10% split between the training, validation, and testing sets. We report all metrics on the test set. We use a fully-convolutional neural network that operates on 3D patches, centered on the lesion of interest. The network is a variant of the ENet segmentation architecture.

RESULTS

Our automated contouring method achieved a median volume error of 0.277 mL and a median LLD error of 2.01 mm. The median LLD error is significantly below the LI-RADS 'threshold growth' threshold (5.0mm).

CONCLUSION

Our automated lesion segmentation method yields a low median LLD error, demonstrating that our estimates may be used as part of a semi-automated clinical workflow in which the clinician may review and modify the segmentations. Additionally, we demonstrate that automated volumetric estimates are feasible from MRI and, with further validation, may provide a viable method of tracking tumor volume over time.

CLINICAL RELEVANCE/APPLICATION

An automated liver lesion segmentation system may improve radiologist accuracy and efficiency in quantifying lesion size and measuring growth over time.

SSA09-03 Convolutional Neural Networks Permit Estimation of Whole-Liver Hepatic Proton-Density Fat Fraction from Single or Dual-Echo Chemical-Shift-Encoded MRI

Sunday, Nov. 25 11:05AM - 11:15AM Room: N228

Awards
Student Travel Stipend Award

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PURPOSE

Confounder-corrected, chemical-shift-encoded (CSE) MRI with 6-echo acquisitions accurately quantifies hepatic proton-density fat fraction (PDFF). However, 6-echo acquisition increases scan time, might result in motion artifact, and limits image resolution of PDFF maps. This study assessed the feasibility of estimating PDFF from the first echo or first 2 echoes of 6-echo CSE MRI using a convolutional neural network (CNN).

METHOD AND MATERIALS

In this IRB-approved and HIPPA-compliant study, we retrospectively identified 355 liver 3T MR exams that included a magnitude-based PDFF sequence comprising 6 gradient-echo images at sequential nominally out- and in-phase echo times. A non-linear fitting algorithm was used to reconstruct the PDFF maps pixel-by-pixel (6-echo PDFF). Using 310 image datasets selected at random, we trained a CNN to estimate 6-echo PDFF maps using only the first echo (1-echo PDFF) or the first two echoes (2-echo PDFF). We tested the CNN in the other 45 PDFF acquisitions. On each axial image containing liver, the liver was segmented and the average PDFF values across all liver pixels was calculated. Per-image mean hepatic 1-echo PDFF and 2-echo PDFF were compared with 6-echo PDFF using Pearson correlation and Bland-Altman analyses.

RESULTS

A total of 1065 images were analyzed. Per-image 6-echo PDFF values ranged from 0% to 43%, while R2* ranges from 33 to 195 s-1. Correlations were high for 1-echo vs. 6-echo PDFF (R2=0.99, slope=0.96, intercept=-0.04) and for 2-echo vs. 6-echo PDFF (R2=0.99, slope=0.98, intercept = 0.29). Compared to the the 6-echo method, the 1-echo method showed minimal PDFF overestimation (bias of 0.56%, $p<0.01$) while the 2-echo method showed minimal PDFF underestimation (bias = -0.12%, $p<0.001$); 95% limits of agreement were [-1.3%,2.4%] for 1-echo and [-1.15%, 0.91%] for 2-echo PDFF.

CONCLUSION

A CNN can accurately estimate hepatic PDFF from either the first or first two echoes of a magnitude-based CSE PDFF sequence in livers without substantial iron overload. Further work is required to determine whether these results are generalizable for other pulse sequences, scan parameters or concurrent pathology.

CLINICAL RELEVANCE/APPLICATION

CNN-based whole-liver PDFF estimation from single or two-echo acquisitions might reduce scan time and enable broader clinical use of quantitative fat fraction measurement.

SSA09-04 A New Multi-Model Machine Learning Framework to Improve Hepatic Fibrosis Grading Using Ultrasound Elastography Systems from Different Vendors

Sunday, Nov. 25 11:15AM - 11:25AM Room: N228

Participants
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PURPOSE

To show that the diagnostic performance of point shear wave elastography (pSWE) and two-dimensional shear wave elastography (2DSWE) for grading liver fibrosis using shear wave velocity (SWV) combined with a new machine learning (ML) technique, can be as accurate as magnetic resonance elastography (MRE) and can be applied to ultrasound systems from different vendors.

METHOD AND MATERIALS

This IRB-approved retrospective study included two patient groups with chronic liver disease: 1) 123 patients undergoing pSWE (Siemens S2000) and MRE; and 2) 60 patients undergoing 2DSWE (Philips Epiq7) and MRE. For Siemens data, accuracy of median SWV to differentiate clinically non-significant from significant fibrosis was calculated using the published cutoff value of 1.34 m/s, with MRE-based fibrosis grading used as the standard. Next, for both groups, in a technique not using any published US elastography cutoff values, median SWV and true labels from MRE-based grading were input to the Matlab perfcurve function to generate a receiver-operating characteristic (ROC) curve and calculate area-under-the-curve (AUC). Finally, in both groups, four ML algorithms - support vector machines (SVM), logistic regression, naïve Bayes, and quadratic discriminant analysis - using ten SWV measurements as inputs were trained with MRE as the gold standard to obtain MRE-equivalent binary fibrosis grading; scores from the ML algorithms were input into the Matlab perfcurve function to generate ROC AUC, and results were validated using two-fold cross validation.

RESULTS

The performance of median SWV to differentiate clinically non-significant and significant fibrosis (with MRE as the gold standard) was fair for pSWE with the published cutoff value for Siemens (accuracy 55.4%); moderate for Siemens (AUC: 0.73) and Philips (AUC: 0.71) without using a cutoff value; and excellent for an SVM ML algorithm in both groups (Siemens: AUC: 0.96; Philips: AUC: 0.97).

CONCLUSION

The results from Siemens and Philips data suggest that a multi-vendor ML-based algorithm can grade liver fibrosis using ultrasound elastography with excellent diagnostic performance, comparable to MRE. SVMs outperformed the current standard of assessment, median SWV.

CLINICAL RELEVANCE/APPLICATION

The new ML algorithm may be applied to systems from different vendors after validation, providing more comparable and accurate fibrosis grading.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel L. Rubin, MD, MS - 2012 Honored EducatorDaniel L. Rubin, MD, MS - 2013 Honored Educator

SSA09-05 A 3D Deep Neural Network for Liver Volumetry in Contrast-Enhanced MRI

Sunday, Nov. 25 11:25AM - 11:35AM Room: N228

Participants
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PURPOSE

To establish a fully automatic 3D deep learning liver segmentation-system for contrast-enhanced liver MRI.

METHOD AND MATERIALS

Data-sets of Gd-EOB-DTPA-enhanced liver MR images of 100 patients have been selected. The ground truth segmentation of the liver parenchyma in the hepatobiliary phase was performed manually by a resident physician with five years of experience. The dataset was split into a training/validation set (n = 75) and a testing set (n = 25). The artificial neural network (ANN) used in this study is based on 3D-Unet (Cicek et al. 2016, arxiv: 1606.06650). The trained ANN was used to perform a fully automatic image segmentation of the testing set.

RESULTS

The ANN accomplishes a Dice index of 95.1±2.3 % (mean±std), an overlap of 90.8±3.9 % and a volume difference of 3.8±6.8%.

CONCLUSION

This study demonstrates a 3D neural network, which is able to provide a fully automatic segmentation scheme for MRI Images. It is able to segment the liver parenchyma with high precision.

CLINICAL RELEVANCE/APPLICATION

The 3D neural network provides an accurate automatic liver segmentation in MRI; hence it would serve as a useful tool for

radiologists for treatment planning, especially for patients undergoing liver surgery.

SSA09-06 Machine Learning for Rapid Assessment of Outcomes of an Ultrasound Screening and Surveillance Program in Patients at Risk for Hepatocellular Carcinoma

Sunday, Nov. 25 11:35AM - 11:45AM Room: N228

Participants
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PURPOSE

To determine large-scale retrospective outcomes of surveillance ultrasound exams in high-risk populations according to the American College of Radiology (ACR) Ultrasound Liver Imaging Reporting and Data System (LI-RADS) classification.

METHOD AND MATERIALS

13,860 ultrasound screening and surveillance exams from 4830 subjects performed between 2007-2017, pre-dating ultrasound LI-RADS recommendations, were assessed. Using more recent reports from May 2017-June 2018, which contained ultrasound LI-RADS specifications (1744 reports), a scalable ensemble machine learning approach was utilized to create a model that can infer ultrasound LI-RADS categories from neural word embedding analysis of the report body text. The model assigned ultrasound LI-RADS categories to the older, free-text reports (12,116 reports). Subjects who underwent serial surveillance exams were identified, and the labeled dataset was assessed for changes in LI-RADS categories over time.

RESULTS

2270 subjects had at least 2 exams. Subjects underwent an average of 5 exams, with mean screening interval of 13 months; mean follow-up duration was 43 months. When applied to the free-text reports, our model scored an average of 0.74 precision, 0.64 recall, and 0.66 F1-score, based on a validation set of 215 reports retrospectively categorized by 2 readers. According to the model's predictions, 1909 (84%) subjects remained in the same LI-RADS category over time: 1875 of these subjects remained in US-1 category, while 26 persisted as US-2; 2 patients had 2 exams each, which were both US-3. 205 (9%) progressed from US-1 to US-2. 95 (4%) alternated between US-1 and US-2. 61 (3%) subjects progressed to US-3 category during surveillance. Of these, 19 subsequently returned to US-1. In the remaining 42 subjects, the last reported ultrasound category was US-3.

CONCLUSION

Machine learning enables large-scale retrospective longitudinal evaluation of relatively recent ACR Ultrasound LI-RADS guidelines. Based on our model's predictions, 3% of patients in our cohort developed suspicious lesions to warrant further work-up.

CLINICAL RELEVANCE/APPLICATION

Our experience is the first large-scale assessment of ACR Ultrasound LI-RADS categories with longitudinal outcomes. Although retrospective, our long-term longitudinal data will be helpful in validating and improving current ACR Ultrasound LI-RADS recommendations, as well as in assessing clinical outcomes of HCC surveillance programs.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel L. Rubin, MD, MS - 2012 Honored EducatorDaniel L. Rubin, MD, MS - 2013 Honored Educator

SSA09-08 Deep Learning with Convolutional Neural Network for Histopathological Classification of Pancreatic Neuroendocrine Neoplasms: A Preliminary Study

Sunday, Nov. 25 11:55AM - 12:05PM Room: N228

Participants
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PURPOSE

To evaluate the efficacy of deep convolutional neural network (DCNN) for the pathological classification of pancreatic neuroendocrine neoplasms (P-NENs) on contrast agent-enhanced computed tomography.

METHOD AND MATERIALS

One hundred and three patients (poor-differentiated [G3], n=19; well-differentiated [G1+G2], n=84) preoperatively investigated by multi spiral computed tomography (MSCT) and subsequently with histopathological proven P-NENs were enrolled. The 103 datasets

were normalized and augmented by multiple preprocessing techniques (rotated, contrast enhanced and noise-added images), and were split into training (81.6%), validation (5.8%), and test set (12.6%) with 8-fold cross validation. The DCNN with the residual learning framework (ResNet), was used to classify the images as having manifestations of poor- or well-differentiated P-NENs. The DCNN was composed of fifty convolutional, one maxpooling, one global average pooling and two fully connected layers. Training and testing were performed eight times. Accuracy, sensitivity, and specificity for categorizing poor- and well-differentiated P-NENs with DCNN model and the area under the receiver operating characteristic curve for poor- versus well-differentiated P-NENs were calculated.

RESULTS

The accuracy, sensitivity, and specificity of classifying poor- and well-differentiated P-NENs were 80.6%, 79.0%, and 81.0%, respectively. The area under the receiver operating characteristic curve for differentiating histopathological grading of P-NENs was 0.79.

CONCLUSION

Deep learning with DCNN showed high diagnostic performance in differentiating histopathological classification of P-NENs at dynamic CT images.

CLINICAL RELEVANCE/APPLICATION

The proposed framework could assist the radiologists in differentiating histopathological grading of P-NENs from contrast agent-enhanced CT images and provide prognostic information with regard to patients' outcome.

SSA09-09 Hepatic Steatosis Classification Using Deep Learning with Ultrasonic Radio-Frequency Data

Sunday, Nov. 25 12:05PM - 12:15PM Room: N228

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PURPOSE

To develop a deep learning framework that uses radio-frequency (RF) ultrasound data for settings-independent information extraction, and assess its accuracy for classifying hepatic steatosis in adults with known/suspected nonalcoholic fatty liver disease (NAFLD).

METHOD AND MATERIALS

This was an IRB-approved, HIPPA-compliant prospective study of adults with known/suspected NAFLD. Ultrasound liver images (right lobe) and the underlying raw RF data were acquired intercostally by 2 sonographers using 4C1 and 6C1HD transducers from Siemens S3000. System settings were adjusted for each participant. Twenty liver images for each transducer were acquired for each participant. Gated RF lines from a fixed region of interest were preprocessed and used to train a deep convolutional neural network (CNN) for hepatic steatosis classification, with histology as the reference standard. No effort was made to correct for instrumentation settings. Five-fold cross validation was used for training and test. The model outputs from individual RF lines of all images were aggregated to yield a classification for a patient. As a comparison, B-mode images were graded by 8 radiologists based on their overall impression of hepatic steatosis.

RESULTS

Forty patients (sex: 16M, 24F; age: 55.5±12.3 yo; BMI: 30.2±5.4 kg/m2) were included, of which 22 had no/mild steatosis (grade 0: N=2; grade 1: N=20) and 18 had moderate/severe steatosis (grade 2: N=12; grade 3: N=6). The CNN achieved 80±5% cross-validated accuracy (72±9% sensitivity, 86±4% specificity) for identifying patients with grade 2 or 3 steatosis. By comparison, radiologists' overall impression (grade 2 or 3) for the 6C1HD transducer achieved 68% accuracy (83% sensitivity, 57% specificity) and the overall impression for the 4C1 transducer achieved 72% accuracy (77% sensitivity, 68% specificity) for the same classification.

CONCLUSION

A CNN can automatically classify human patients as having or not having moderate/severe steatosis based on RF lines acquired during liver ultrasounds using variable instrumentation settings. Preliminary findings suggest the CNN may outperform specificity of expert radiologists.

CLINICAL RELEVANCE/APPLICATION

Deep learning using the RF lines acquired during liver ultrasounds could assist radiologists in automatic hepatic steatosis classification.

SSA10

Genitourinary (Multi-Parametric Prostate MRI)

Sunday, Nov. 25 10:45AM - 12:15PM Room: N229

GU MR OI BQ

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

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Sub-Events

SSA10-01 DWI of the Prostate: Do We Still Need to Acquire High B Value > 1000 S/Mm²?

Sunday, Nov. 25 10:45AM - 10:55AM Room: N229

Participants
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PURPOSE

To compare performances of computed high b-value Diffusion Weighted Images (cDWI) derived from low b-value DWI and acquired high b-value DWI (aDWI), in image quality overall and prostate cancer (PCa) detection rate

METHOD AND MATERIALS

A total of 124 men with suspected PCa underwent diagnosis multi-parametric prostate MRI on a 3.0T MR system (SIGNATM Architect, GE healthcare) using a 32-channel phased-array torso coil. MRI protocol included 3DT2w, high resolution Fov Optimized and Constrained Undistorted Single-Shot (FOCUSTM) DWI with b-values of 100, 400, 800 and 2000 s/mm² and dynamic contrast enhanced images. cDWIs were derived from the three lower b-value DWI using a mono-exponential diffusion decay. MRI images were prospectively analyzed by one expert radiologist who provided the PI-RADS score and retrospectively by five observers (4 radiologists and 1 technician) who independently rated cDWIs (2000 and 2500 s/mm2) and aDWI (2000 s/mm2) on a 5-point scale regarding subjective image quality features (distortion, ghosting, suppression of benign prostate, anatomic clarity, rectal preparation). The 4 radiologists assessed tumor detection, conspicuity and contrast ratio with both sequences. SNR was measured in detected tumor and geometric distortion was analyzed on T2W and DWIs (diameter of the prostate from the left to the right and from anterior to posterior)

RESULTS

cDWI demonstrated higher rating for image quality ($p < 0.001$). Prostate volume >50cc and rectal preparation significantly improved image quality for all DWIs with decrease distortion ($p < 0.015$). In patients with biopsy (n=63), no significant differences were found for tumor detection rate, however cDWI improved SNR and lesion conspicuity ($p < 0.001$)

CONCLUSION

Using cDWI can provide a substantial reduction in acquisition time while improving image quality. Overall quality of diffusion weighted imaging is dependent of an adequate rectal preparation

CLINICAL RELEVANCE/APPLICATION

This post-processing technique may in practice improve visual conspicuity of tumors while maintaining high quality images, without requiring any increase in exam time

SSA10-02 Accurate Localization and Grading of Prostate Cancer with Diffusion Histology Imaging

Sunday, Nov. 25 10:55AM - 11:05AM Room: N229

Participants
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PURPOSE

Prostate cancer (PCa) is the leading malignancy and second most common cause of death for American man. Multiparametric MRI has been employed to aid PCa diagnosis despites its significant false positive rate. The misdiagnoses are most likely caused by confounding prostatitis and/or benign prostatic hyperplasia (BPH). Non-invasive PCa grading methods has yet been developed for clinical applications. A novel diffusion histology imaging (DHI) has been developed and applied to accurately detect and grade prostate cancer.

METHOD AND MATERIALS

In vivo (262 patients) and ex vivo DHI (67 prostatectomy specimens from 22 patients) was performed. Logistic regression was used to distinguish among different tissue types. Support vector machine (SVM) algorithm was employed to construct predictive models for PCa grading.

RESULTS

Prostate diffusion-weighted MRI signals were modeled as a linear combination of an anisotropic diffusion tensor and a spectrum of isotropic diffusion tensors. Inflammatory cells, cancer cells, stromal cells and luminal structures in prostate can be detected, distinguished, and quantified as DHI-derived anisotropic and isotropic diffusion signatures. A 3D-rendered prostate from DHI was obtained from a 58-year old patient (Fig 1A). Suspicious peripheral zone PCa (pink), Transition zone BPH (gold), and peripheral zone inflammation (blue-green) was identified. In prostatectomy specimens and living subjects, DHI exhibited great sensitivity and specificity in distinguishing PCa from benign peripheral zone prostate tissues (AUC 0.955 ex vivo; AUC 1 in vivo), benign central gland (AUC 0.955 in vivo), stromal BPH (AUC 0.965 ex vivo) and BPH (AUC 0.920 ex vivo). DHI predictive model presented high overall prediction accuracy on both Gleason scores (86.4% ex vivo and 88.6% in vivo), and NCCN risk categorization (87.9% in vivo), respectively (Fig. 1B). DHI showed much better prostatic tissue classification and tumor grades prediction than ADC did (Fig. 1B).

CONCLUSION

DHI assesses various intra-gland structures of prostate, accurately localizing and grading PCa.

CLINICAL RELEVANCE/APPLICATION

Results suggest that DHI may potentially localize and grade PCa. If validated, DHI could be used to detect and grade PCa either guiding or even replacing needle biopsy. It can be used in PCa treatment stratification and monitoring, and active surveillance.

SSA10-03 Comparison of Apparent Diffusion Coefficient (ADC) Ratio to Conventional Calculated High B Value ADC for Discrimination of Gleason 3+3 and >= 3+4 Prostate Cancer in 224 Patients with 3T MRI with Whole Mount Histopathology Correlation

Sunday, Nov. 25 11:05AM - 11:15AM Room: N229

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PURPOSE

To determine the performance of 3T MRI apparent diffusion coefficient (ADC) ratio with coventional high B value ADC for detection of high Gleason Score (GS) prostate cancer (PCa) using whole-mount histopathology (WMHP) as a reference.

METHOD AND MATERIALS

In this HIPAA-compliant, IRB-approved study, the cohort included 224 men with 249 unilateral PCa lesions with both 3T mpMRI and WMHP before and after robotic prostatectomy from NOV 2009 to NOV 2017. All studies were peformed on 3T scanners and ADC maps were derived from four b value combinations (0, 50, 500, 800) and calculated b= 1200. On an independent workstation, regions of interest (ROIs) were placed on individual WMHP verified lesions to calculate mean high b value ADC (ADC tumor_mean), lowest mean high b value ADC subregion within each PCa lesion (ADC tumor_min) and within uninvolved non tumor containing regions of the same zone to calculate background ADC (ADC benign) and the ADC ratio (ADC ratio (ADC tumor_mean or ADC tumor_min) divided by ADC benign)). The performance of individual ADC measurements in discriminating low GS (3+3) from high GS (>=3+4) PCa on WMHP was assessed using the area under the receiver operating characteristic (ROC) and area under curve (AUC) and using Spearman's rho coefficient.

RESULTS

The mean ADC was 1.573, 1.014 and 0.921× 10(-3)mm2/sec for normal (ADC benign), mean PCa lesion (ADC tumor_mean) and lowest ADC PCa subregion (ADC tumor_min), respectively. The association between ADC measurements and GS showed a significant negative correlation (P=0.001) with Spearman's rho for ADC_tumor_mean (-0.268), ADC tumor_min (-0.267) and ADC ratio (-0.366). ADC ratio had the best overall correlation with GS>= 3+4 compared with other ADC measurements. On ROC analysis, the AUCs were 0.703, 0.709 and 0.781 for ADC tumor_mean, ADC tumor_min and ADC ratio respectively for discriminating GS 3+3 from >= 3+4 PCa lesions on WMHP.

CONCLUSION

Compared with mean and minimal tumor ADC measurements, ADC ratio had the best AUC for discrimination of GS >= 3+4 from GS=3+3 PCa on 3T MRI with WMHP correlation.

CLINICAL RELEVANCE/APPLICATION

The ADC ratio as an intrapatient-normalized diagnostic tool may provide a more robust predictor for detection of GS>=3+4 compared to GS=3+3 lesions compared with tumor ADC alone.

SSA10-04 3T MRI Restriction Spectrum Imaging versus ADC in Determining and Grading Prostate Cancer in Correlation to High Gleason score and Suspicious PI-RADS v2 Scores Using Whole Mount Histopathology

Sunday, Nov. 25 11:15AM - 11:25AM Room: N229

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PURPOSE

To compare restriction spectrum imaging (RSI), a multidirectional high b value technique with -conventional apparent diffusion coefficient (ADC) for detection of aggressive prostate cancer (PCa) (Gleason score (GS) > 3+4) & high suspicion Prostate Imaging Reporting and Data System version2 score (PI-RADSv2) (4&5) using whole mount histopathology (WMHP) as the gold standard.

METHOD AND MATERIALS

In this IRB approved, HIPAA compliant study, the study cohort included 77 men with both 3T- multiparametric MRI (mpMRI) & WMHP. RSI was processed from 32 direction high b value sequences & distortion was corrected using alternating phase-encode. A genitourinary (GU) pathologist marked all WMHP PCa lesions individually then a GU radiologist calculated the corresponding ROIs on RSI and ADC map by placing the ROI on PCa target & control adjacent tumor free peripheral zone (PZ) matched to WMHP. Paired Wilcoxon sign rank test was used to determine case and control correlations. Bootstrap methods was performed to determine differences between RSI & ADC in tumor grading. 2 sided p-value < 0.05 was considered significant by using SAS version 9.4.

RESULTS

In 77 men with 235 ROIs (158 PCa & 77 control) the PCa GS & PIRADS v2 scores were: 75.2% primary GS 3 & 24.8% primary GS 4. PIRADS v2 scores were 3 (16.5 %) and 4 & 5 (83.5 %). Mean RSI z score and mean ADC values in PCa & normal controls were 3.4 (-1.7 -13.6) & -0.72(-1.8 - 4.8) respectively & 1022.6 (453-1961) & 1429.3(1042-2176) respectively. The mean PCa values correlated to the control values for both RSI z-score & ADC (p<0.0001). There was positive correlation between RSI z-score & GS in all groups (3+3, 3+ 4 & >=4+3), significant between (GS 3+3 & GS >=4+3 (p=0.0003, r=0.29)) and also in all PIRADSv2 scores, significant between 3&5(p=0.0001, r=0.45)). The ADC value in PCa was inversely significant in all GS (p<0.0001, r= -0.46). RSI outperformed ADC in determining the PCa compared to control PZ regardless of the Gleason or PIRADSv2 score (AUC 0.95 vs 0.82 (p<0.0001)).

CONCLUSION

RSI is positively correlated with aggressive PCa and it outperformed ADC in determining PCa from non-cancerous regions. It may have a complementary role in predicting cancer scoring.

CLINICAL RELEVANCE/APPLICATION

RSI can be used as a complementary imaging in predicting Prostate cancer aggressivness

SSA10-05 Improving Workup of MRI-Detected PI-RADS 4&5 Lesions by Using Quantitative ADC Measurements to Obviate Unnecessary MRI Guided Biopsies

Sunday, Nov. 25 11:25AM - 11:35AM Room: N229

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PURPOSE

To assess whether quantitative ADC measurements derived from Diffusion-Weighted Imaging (DWI) may obviate unnecessary biopsies in MRI-detected PI-RADS 4 & 5 lesions.

METHOD AND MATERIALS

This IRB-approved, retrospective study investigated 101 PI-RADS 4 & 5 prostate lesions (52 malignant, 49 benign) verified by in bore MRI-guided biopsy in 101 men (mean age, 62.8y). Two experienced uroradiologists independently and repeatedly measured minimum, mean, and maximum Apparent Diffusion Coefficient (ADC) from diffusion-weighted imaging (DWI) measurements (TR/TE 3300/60ms; GRAPPA 2, spectrally adiabatic inversion recovery [SPAIR] fat suppression; b-values of 0, 100, 400, and 800sec/mm2; six diffusion directions, bipolar diffusion sampling, acquisition time, 4:34min, 20 slices at 3.6 mm; matrix 160) by placing a two-dimensional region-of-interest around the lesions which were subsequently subjected to targeted MRI-guided biopsy. Readers were blinded to clinical information but localized the lesions based on the documented needle position during biopsy. Receiver operating characteristic (ROC) statistics were used to analyze diagnostic performance, and reproducibility statistics were calculated.

RESULTS

Minimum ADC values showed the best diagnostic performance (overall AUC R1: 0.801; R2: 0.796 peripheral zone AUC R1:0.814, R2: 0.805; transitional zone AUC R1:0.786, R2:0.779) and the tightest limits of interreader agreement (-8.6 to 9.9%). Thresholds to rule-in and rule-out any prostate cancer (PCa) were identified. Applying these 32,7% (16/49) of unnecessary biopsies could have been avoided.

CONCLUSION

The application of quantitative ADC measurements in MRI-detected PI-RADS 4 & 5 lesions may be used to avoid unnecessary MRI-guided biopsies.

CLINICAL RELEVANCE/APPLICATION

In time of increasing healthcare costs, and decreasing healthcare budgtes it is important to devolop strategies to avoid unnecessary prostate biopsies in patients with MRI suspicious PI-RADS 4 and 5 lesions.

SSA10-06 Clinically Significant Prostate Cancers with an Early Enhancement Effect on Prostate Dynamic Contrast-Enhanced MRI: Association with Clinical and Histopathological Characteristics

Sunday, Nov. 25 11:35AM - 11:45AM Room: N229

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PURPOSE

To determine the clinical, histopathological, and imaging features of clinically significant prostate cancer (csPC) with an early enhancement effect (EEE) on dynamic contrast-enhanced MRI (DCE-MRI).

METHOD AND MATERIALS

Eighty-eight prostate cancer patients with 127 csPCs (>0.5 cc with Gleason score (GS) =6 or >5 mm in diameter with GS>6) undergoing 3-T multiparametric MRI including T2-weighted imaging (T2WI), diffusion-weighted imaging (DWI), and DCE-MRI before radical prostatectomy were included. Two radiologists independently assigned each lesion a score of 1 to 5 for T2WI and DWI, negative (none (EEE score 0) or weak (score 1)) or positive (moderate (score 2) or strong (score 3)) EEE for DCE-MRI, and overall PI-RADS assessment category according to PI-RADS v2. Mean tumor apparent diffusion coefficients (ADCs) were also measured.

RESULTS

A total of 38 lesions (29.9%) had no EEE (non-EEE group), and 89 (70.1%) had the EEE (EEE group). The tumor detection rate of csPCs using DCE-MRI was 80.7% (71/88 patients) in the patient-based analysis. In the comparison between the groups, PSA, tumor size, Gleason score (GS) grade, and frequency of tumors with GS>3+4 were significantly higher in the EEE group than in the non-EEE group (P = 0.015 to 0.046). Tumor ADCs were significantly lower in the EEE group than in the non-EEE group (P = 0.001). In addition, the T2WI score, DWI score, and PI-RADS assessment category were significantly higher in the EEE group than in the non-EEE group (P < 0.001 to = 0.001). There were no significant differences in age, PSA density, prostate volume, tumor location (peripheral zone/transition zone), frequency of tumors with GS>3+3, D'Amico risk classification, and pathological T stage (pT2/pT3) (P = 0.059 to 0.963). The EEE score was significantly higher for tumors with GS >3+4 (n=43) than for tumors with GS = 3+3 (n=31) or tumors with GS = 3+4 (n=53) (P = 0.003 and 0.022, respectively). However, there was no significant difference in the EEE score between tumors with GS = 3+3 and tumors with GS = 3+4 (P = 0.437).

CONCLUSION

These observations suggest that csPCs with the EEE tend to be larger, more aggressive, and have higher cellularity, and the EEE may be a new predictor for differentiating between low and intermediate-risk PCs vs. high-risk PCs. However, csPCs with the EEE were easy to detect on T2WI and DWI.

CLINICAL RELEVANCE/APPLICATION

The EEE on DCE-MRI may be a new predictor for risk stratification in PC.

SSA10-07 Different Methods of AIF (Arterial Input Function) Acquirement for Quantitative Analysis of Dynamic Contrast-Enhanced MRI for Prostate Cancer Detection

Sunday, Nov. 25 11:45AM - 11:55AM Room: N229

Participants
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PURPOSE

Primary aim of this study was to analyze if quantitative DCE allows distinction of prostate cancer (PCa) and healthy tissue in peripheral and transition zone (PZ, TZ) with use of three different methods for the determination of the arterial input function (AIF). Reproducibility of quantitative perfusion analysis of DCE requires a standardized AIF acquisition.

METHOD AND MATERIALS

We analyzed multiparametric MRI of 50 consecutive patients retrospectively with three different methods of AIF determination, either by defining a region of interest in an artery (AIFm), by use of an automated algorithm (AIFa) or thirdly with a population-based AIF (AIFp). Quantitative perfusion parameters Ktrans, ve and kep in PCa, PZ and TZ for the three different AIFs were examined.

RESULTS

In all three AIF methods, Ktrans and kep were significantly higher in PCa than in TZ ($p<0.003$), whereas ve was only significant in AIFp ($p=0.002$ in AIFp, $p= 0.114$ in AIFm, $p=0.087$ in ve). Results for PCa and PZ were significant in all methods and all quantitative parameters ($p < 0.04$). Values for Ktrans demonstrated narrowest confidence interval between the 3 methods. Overlapping of results was smallest in Ktrans. Values between AIFa and AIFm were similar whereas values for AIFp deviated considerably from AIFa and AIFm. However Spearman test showed good correlation of values for Ktrans between all methods ($p>0.7$). AIFa showed a success rate of 98% in finding the artery.

CONCLUSION

Prostate cancer can be distinguished in PZ and TZ with quantitative perfusion parameters of Toft's model independently from AIF acquisition method. AIFa is a recommendable, user-independent automatic method to determine quantitative perfusion parameters allowing an objective measurement and saving interactive time for the radiologist. Ktrans appears to be a more promising quantitative parameter for PCa detection than ve and/or kep.

CLINICAL RELEVANCE/APPLICATION

As an easily reproducible, simpe and fast method automated AIF can be implented as the standard method of AIF acquisition for quantitative DCE evaluation. Ktrans can facilitate PCa detection in both, TZ and PZ.

SSA10-08 Accuracy of IMPROD Pre-Biopsy Biparametric MRI for the Detection of Prostate Cancer in Men before Their First Biopsy: Correlation with Whole Mount Prostatectomy Sections and Implication for Focal Therapy

Sunday, Nov. 25 11:55AM - 12:05PM Room: N229

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PURPOSE

To evaluate accuracy of high quality IMPROD biparametric prostate MRI (bpMRI) for prostate cancer in men before their first biopsy who subsequently underwent prostatectomy.

METHOD AND MATERIALS

Forty-five men with elevated PSA (2.5 - 10.0 ng/ml) underwent bpMRI examination prior their first biopsy at 3 Tesla and subsequent prostatectomy within 4 months of bpMRI. bpMRI consisted of T2-weighted imaging (T2w) and three separate diffusion weighted imaging acquisitions with acquisition time under 15 minutes (IMPROD trial protocol, http://petiv.utu.fi/improd). All bpMRI were reported by one reader before biopsy and each suspicion lesion was manually delineated on axial T2w images. Following completion of the study, radiologist in conjunction with pathologist delineated cancer areas on axial T2w images using whole mount prostatectomy, following semi-automatic co-registration, as ground true. Accuracy, expressed as area under receiver operating characteristic curve (AUC), of prospectively reported manual cancer segmentations was evaluated on interpolated isotropic voxel size of 1mm3.

RESULTS

In total 55 lesions with diameter >5 mm or any Gleason grade 4 were identified in 45 men and 4, 25, 10, 7, 9 lesions belong to ISUP Groups 1 (Gleason score <=6), 2 (Gleason 3+4=7), 3 (Gleason 4+3=7), 4 (Gleason score 8), 5 (Gleason scores 9 and 10), respectively. Prostate cancer was multifocal in 27 (60%, 27/34) men with additional 26 cancer lesions with Gleason score <=6 and diameter <=5 mm. Nine men (20%, 9/45) had more than one lesion with diameter > 5 mm or any Gleason grade 4. Seven lesions (13%, 7/55) were not identified on prebiopsy bpMRI, of those 4, 1, 1, and 1 belong to ISUP Groups 1, 2, 3 and 4, respectively. AUC (95% confidence interval on lesion level) on 1 mm3 isotropic voxel size for all lesions and ISUP Groups 1, 2, 3, 4, 5 were 0.70 (0.50 - 0.89) and 0.55 (0.50 - 0.70), 0.72 (0.51 - 0.88), 0.75 (0.65 - 0.84), 0.66 (0.54 - 0.73), 0.71 (0.50 - 0.89), respectively.

CONCLUSION

High quality prebiopsy bpMRI enabled detention of 87% of lesions with diameter >5 mm or any Gleason grade 4. However, only limited accuracy on isotropic 1mm3 voxel was achieved potentially limiting focal therapy planning.

CLINICAL RELEVANCE/APPLICATION

High quality prebiopsy biparametric MRI has high accuracy on lesion level for prostate cancer with diameter >5 mm or any Gleason grade 4. However, accuracy on isotropic 1 mm3 voxel level is limited.

SSA10-09 Prostate Cancer Detection on 3T Multiparametric Magnetic Resonance Imaging: The Impact of Tumor Focality

Sunday, Nov. 25 12:05PM - 12:15PM Room: N229

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PURPOSE

To analyze the performance of 3 Tesla multiparametric magnetic resonance imaging (3T mpMRI) of the prostate for detection of prostate cancer (CaP) and identify predictors of tumor detection with particular attention to the effect of tumor focality.

METHOD AND MATERIALS

Retrospective review of prospectively maintained database of patients undergoing 3T mpMRI prior to radical prostatectomy for CaP at a single institution from 2010-2018. Radiographic lesions were assigned a suspicion score according to the Prostate Imaging-Reporting and Data System version 2 and compared to whole mount prostatectomy specimens to determine per-lesion detection by 3T mpMRI. Clinical and pathologic predictors of tumor detection were identified through multivariable analysis. Clinically significant CaP was defined as Gleason score of at least 7.

RESULTS

588 patients underwent mpMRI prior to radical prostatectomy for CaP with a total of 1213 unique pathologic cancer foci (88% intermediate or high risk), of which, 541 were detected by mpMRI for an overall sensitivity of 45% (95% CI 42%, 47%). 685 unique radiographic regions of interest were identified, of which, 132 were not associated with a pathologic lesion (false positive rate: 19%, 95% CI 16%, 22%) and 12 corresponded to the same pathologic lesion as another region of interest, for a positive predictive value of 81%. Nearly 2/3 of patients had multifocal CaP. Multifocality was associated with decreased detection of the index tumor (80% vs 66% of index tumors identified in solitary vs multifocal CaP, $p<0.001$). The majority (74%) of missed solitary tumors and a significant percentage (31%) of missed multifocal tumors were clinically significant. On multivariate analysis, smaller tumor size, lower PSA density, not using an endorectal coil, lower gleason score, non-index lesion status, pathologic stage, and multifocality were associated with lower detection rates for both any cancer and clinically significant CaP.

CONCLUSION

Pre-operative mpMRI miss a significant proportion of CaP foci. Clinicopathologic factors, including tumor focality, affect the accuracy of mpMRI, which must be understood when considering focal therapies.

CLINICAL RELEVANCE/APPLICATION

An improved understanding of the factors affecting CaP detection on 3T mpMRI is necessary as this imaging modality is increasingly incorporated into screening, diagnosis, and treatment planning.

SSA11

Genitourinary (Gynecologic Malignancy)

Sunday, Nov. 25 10:45AM - 12:15PM Room: N230B

GU MR

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

Participants
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Sub-Events

SSA11-01 Histogram Analysis of Apparent Diffusion Coefficients for Predicting Pelvic Lymph Node Metastasis in Patients with Uterine Cervical Cancer

Sunday, Nov. 25 10:45AM - 10:55AM Room: N230B

Participants
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PURPOSE

Preoperative prediction of lymph node (LN) metastasis in uterine cervical cancer remains a challenge. We aimed to investigate the value of apparent diffusion coefficient (ADC) histogram analysis in predicting pelvic LN metastasis in patients with uterine cervical cancer undergoing surgery.

METHOD AND MATERIALS

Our retrospective study included 162 cervical cancer patients (mean age, 47.7 years; range, 26-81 years) who received radical abdominal hysterectomy with pelvic LN dissection. All enrolled patients underwent routine pelvic 3T-MRI including diffusion-weighted imaging. The ADC histogram for the tumor was generated using in-house software and several histogram parameters were obtained. For predicting pelvic LN metastasis, clinical parameters (age, FIGO stage, tumor antigen [TA]-4, and histologic type) and imaging parameters (tumor size, maximal and short diameter of LN, MRI T-stage, and ADC histogram parameters) were evaluated using logistic regression analysis.

RESULTS

At histopathological findings, pelvic LN metastasis occurred in 50 patients (30.9%). In patients with LN metastasis, all ADC histogram parameters were significantly different from those without LN metastasis (all $p < 0.05$), except maximum, skewness, uniformity and entropy. At receiver operating characteristic (ROC) curve analysis, the area under the ROC curve of the 97.5th ADC percentile (ADC97.5) was 0.782, which was the greatest among other imaging and clinical variables. At univariate analysis, maximal and short diameters of LN, MRI T-stage, TA-4, tumor size and ADC97.5 were significantly associated with pelvic LN metastasis. However, the ADC97.5 was the only independent predictor of pelvic LN metastasis (odd ratio, 0.995; $p < 0.001$) (Table 1).

CONCLUSION

As an imaging marker, the ADC97.5 from histogram analysis appears to be useful for the prediction of pelvic LN metastasis in patients with uterine cervical cancer undergoing surgery.

CLINICAL RELEVANCE/APPLICATION

Preoperative ADC histogram analysis may be a useful tool to predict pelvic lymph node metastasis in patients with uterine cervical cancer, which may be helpful for clinical decision-making.

SSA11-03 Differentiation of Gynecological Sarcoma From Leiomyoma: Predictive Performance Comparison Between Radiologists and Radiomic Analysis

Sunday, Nov. 25 11:05AM - 11:15AM Room: N230B

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PURPOSE

To explore qualitative MRI features associated with gynecological sarcoma (GS). To build a predictive radiomic model, compare its performance with experienced radiologists.

METHOD AND MATERIALS

78 patients (29 GSs, 49 leiomyomas) imaged with MRI prior to surgery were included in this retrospective study. One reader evaluated their clinical data and MRI reports and marked the index lesion. Two readers blindedly evaluated each index lesion for qualitative MRI features, included: (a) intratumor hemorrhage; (b) increased vascularity; (c) intratumor necrosis; (d) tumor borderline; (e) tumor shape; and (f) uterine cavity. Association were evaluated with Fisher's exact test. The MATLAB toolbox Radiomics was used for radiomic analysis. 4 non-texture features and 43 texture features were extracted. Univariate association between all features was explored using Spearman's rank correlation. Multivariate imbalanced-adjusted logistic regression model involved bootstrap resampling was used for prediction model construction. A predictive model was evaluated using a nest cross-validation scheme. The predictive performance was evaluated by area under the receiver-operating characteristic curve.

RESULTS

Patients with GSs were older than patients with leiomyomas, $p < 0.0001$. 3 MRI features (intratumor hemorrhage, indistinct borderline and uninterrupted uterine cavity) were associated with GS, $p < 0.0001$. The AUC of predictive performance based on MRI reports made by experienced radiologists was 0.793, sensitivity :58.6%, specificity: 100%, accuracy: 84.6%. 5 radiomic features differed significantly between GS and leiomyoma were: 'Energy-GLCM-S1Q2N1', 'GLN-GLSZM-S6Q1N4', 'LGZE-GLSZM-S6Q2N3', 'Solidity', and 'SRLGE-GLRLM-S6Q1N2'. $p < 0.0001$. The highest AUC was 0.91, sensitivity :82%, specificity: 84%, accuracy: 83%.

CONCLUSION

Patients' age and three MRI features were significantly correlated with GS. Radiomic model triumphed over experience radiologists on the differentiation of GS and leiomyoma.

CLINICAL RELEVANCE/APPLICATION

Although several features at MRI can raise suspicion of a uterine sarcoma, it is difficult to differentiate from benign leiomyoma and can result in inappropriate treatment and poor prognosis.

SSA11-04 Amide Proton Transfer MR Imaging of Uterine: Comparison between Malignant and Benign Lesions

Sunday, Nov. 25 11:15AM - 11:25AM Room: N230B

Participants
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PURPOSE

To evaluate the capability of amide proton transfer (APT) MR imaging for the differentiation of uterine malignant tumor from benign lesions.

METHOD AND MATERIALS

Between October 2017 and April 2018, 58 patients with suspicious uterine lesions underwent APT MR imaging on a 3T MR scanner (Ingenia, Philips Healthcare, the Netherlands). The APT values (in percentage, representing the magnetization transfer ratio asymmetry in z-spectrum) were calculated based on images acquired from 3D TSE sequence with dual RF transmits interleave labelling. The APT values were measured on 12 lesions of pathologically confirmed endometrial adenocarcinoma, 29 lesions of leiomyomas and 21 lesions of adenomyosis with typical MR manifestation, 20 regions of normal uterine myometrium. Bonferroni's multiple comparisons test was used to compare the differences among different types of uterine lesions. Receiver operating characteristic (ROC) analyses were performed to computationally determine each feasible threshold value, sensitivity and specificity were assessed.

RESULTS

The APT values of endometrial adenocarcinoma, leiomyomas, adenomyosis, and normal uterine myometrium were 2.816±0.153, 1.504±0.156, 1.798±0.083, 1.917±0.121(mean±standard error of mean), respectively. Statistical significant differences had been found between endometrial adenocarcinoma and leiomyomas ($p<0.0001$, 95%CI 0.275~1.524), endometrial adenocarcinoma and adenomyosis ($p=0.0002$, 95%CI 0.400~1.637), endometrial adenocarcinoma and normal uterine myometrium ($p=0.0012$, 95%CI 0.275~1.524). Area under the curve of ROC analysis for differentiating endometrial adenocarcinoma from leiomyomas and adenomyosis was 0.925 and 0.968, respectively. The feasible threshold values of each group were determined as 2.37 and 2.375, with sensitivity of 83.33% and 83.33%, specificity of 89.66% and 95.24%, respectively. There were no significant differences among the APT values of leiomyomas, adenomyosis and normal myometrium.

CONCLUSION

Endometrial adenocarcinoma showed significant higher APT values than that of leiomyomas, adenomyosis, and normal uterine myometrium. There were no significant differences among APT values of uterine benign lesions and normal myometrium.

CLINICAL RELEVANCE/APPLICATION

This first attempt of APT imaging study in common uterine lesions showed the feasibility of APT weighted MRI in differential diagnosis between uterine malignant and benign lesions.

SSA11-05 PET-MRI Value for Endometrial Adenocarcinoma Staging: Initial Experience

Sunday, Nov. 25 11:25AM - 11:35AM Room: N230B

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PURPOSE

To assess the performance of a positron emission tomography - magnetic resonance imaging (PET-MRI) examination for endometrial adenocarcinoma staging.

METHOD AND MATERIALS

Consecutive patients with a PET-MRI examination for endometrial adenocarcinoma staging and surgery were included. One pair of radiology/nuclear medicine physicians and one resident with experience in MRI and PET analyzed the PET-MR images. The examination included images focused on the uterus (axial diffusion-weighted, axial/sagittal T2-weighted, axial/sagittal post gadolinium T1-weighted and PET images) and whole-body acquisitions (axial diffusion-weighted, axial pre and post-contrast T1-weighted and PET images). The percentage of accurate assessment of deep myometrial invasion, nodal invasion and metastases (per patient) of 5 sets of images (1=T2+diffusion images; 2=T2+diffusion+PET images; 3=T2+diffusion+post-contrast T1 images; 4=post-contrast+PET images; 5=everything) were assessed using surgical, pathological and follow-up data as gold standard.

RESULTS

Twenty-one patients (67±8 yo) with endometrial adenocarcinoma were included. Eleven patients had a myometrial invasion deeper than 50%, 5 patients had a nodal invasion, 4 patients had a proven metastasis.The mean delay between surgery and the PET-MRI examination was 12.5 days. T2 and diffusion-weighted images allowed the highest number of correct staging of the deep myometrial invasion (17/21, 81%, without any false negative case). Adding the post-contrast images or the PET images increased the number of false positive cases. The nodal invasion assessment varied between readers and sets of images, from 50 to 81% of accurate staging. The metastatic staging was correct in 86-95% of the cases.

CONCLUSION

Adding PET images to MR images does not seem to improve imaging diagnosis performance for deep myometrial invasion assessment of endometrial adenocarcinoma.

CLINICAL RELEVANCE/APPLICATION

T2 and diffusion-weighted imaging seems to be the best combination for deep myometrial invasion assessment of endometrial adenocarcinoma. The adjunction of post-contrast or PET images does not improve the accuracy.

SSA11-06 Prediction of Malignancy in Adnexal Incidentalomas Detected on Computed Tomography: A Machine-Learning Approach

Sunday, Nov. 25 11:35AM - 11:45AM Room: N230B

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PURPOSE

To establish a machine-learning algorithm to predict indication for surgery and malignancy of adnexal incidentalomas detected on computed tomography (CT).

METHOD AND MATERIALS

The institution database was searched from January 2013 to July 2016 for women who underwent abdominal CT scans for any indication. All patients with an adnexal lesion visible on CT and histopathological verification were included retrospectively. The institutional ethics committee approved this study and granted a waiver of informed consent. 286 adnexal lesions in 230 women were included. Based on different CT features an automated random-forest classifier was developed to predict clinical decisions and outcomes. Following development, model performance was tested on a different data set by cross-validation. Decision forests were trained and evaluated for their out-of-sample performance with respect to three different aims: (i) which tumors are radiologically conspicuous (from the group of all incidentalomas); (ii) which tumors are recommended for surgery (from the group selected in (i)); (iii) which were histologically confirmed to be malignant (from the group selected in (ii)).

RESULTS

The study cohort included 69% benign, 29% malignant, and 2% benign non-ovarian or secondary metastatic lesions. Balanced accuracies for the out-of-sample predictions were (i) 96%, (ii) 87%, and (iii) 79%. Relevant features were found to be maximum diameter, homogeneous content, septa, nodules, lipid content, solid portion, liquid content, fractal anisotropy, and box-volume.

CONCLUSION

Standardized description of radiological features of adnexal lesions in combination with machine-learning algorithms allows a reliable prediction whether an individual patient will be recommended for surgery by the subsequent gynecological evaluation and even allows to predict the outcome of the histopathological result. The proposed prediction model gives radiologists a simple algorithm for decision making in adnexal incidentalomas with respect to the necessity of further evaluation.

CLINICAL RELEVANCE/APPLICATION

An accurate assessment of an adenexal incidentaloma with a correct identification of malignancy, while avoiding unnecessary intervention for benign lesions, is crucial regarding clinical management.

SSA11-07 Comparison of Signal Intensity Ratio and ADC in Characterization of Solid Adnexal Masses on Diffusion-Weighted MR Imaging

Sunday, Nov. 25 11:45AM - 11:55AM Room: N230B

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PURPOSE

To assess the value of signal intensity ratio versus apparent diffusion coefficient (ADC) in differentiation of benign and malignant adnexal masses on diffusion-weighted images.

METHOD AND MATERIALS

Thirty five patients with pathologically-proven solid adnexal lesions (21 malignant and 14 benign) have been examined by an identical protocol of magnetic resonance (MR) imaging, including DWI with b values of 0 and 800 s/mm2 and gadolinium-enhanced MR images. Signal intensity was measured on the b0 and b800 images by operator-determined region of interest at the same location of the lesion and the signal intensity ratio (SIR b800/b0) was calculated. ADC value was measured at the same location of the lesion. Measurements were done in the part of the lesion corresponding to enhancing part of the lesion on the gadolinium-enhanced images. Statistical analysis was done by generating receiver operator characteristic (ROC) curve and calculating the area under the curve (AUC).

RESULTS

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy for diagnosis of malignancy using a cut-off value of 1.385x10-3 mm2/s for ADC were 78.95%, 37.50%, 75%, 42.86% and 66.67% respectively. Using SIR b800/b0 cut-off value of 0.33 (which is the corresponding ratio for the ADC cut-off value) the sensitivity, specificity, positive predictive value, negative predictive value and accuracy for diagnosis of malignancy were 100.00%, 75.00%, 90.48 %, 100.00% and 92.59% respectively. AUC for the ROC curves have been 0.6176 for the ADC and 0.8722 for the SIR ($p < 0.02$).

CONCLUSION

The use of SIR b800/b0 has improved the accuracy of differentiation of malignant and benign adnexal masses in comparison to the use of ADC on diffusion-weighted MR images.

CLINICAL RELEVANCE/APPLICATION

In addition to other imaging features, diffusion-weighted imaging is quite useful for differentiation of benign and malignant adnexal masses. The use of manually obtained signal intensity ratio b800/b0 instead of the machine-generated ADC values increases the accuracy of this method.

SSA11-08 Adnexal Mass Staging CT with a Disease-Specific Structured Report Compared to Simple Structured Report

Sunday, Nov. 25 11:55AM - 12:05PM Room: N230B

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PURPOSE

To assess a disease-specific structured template for CT staging of ovarian malignancy compared to a simple structured report

METHOD AND MATERIALS

This is a HIPAA-compliant, IRB-approved study with waiver of informed consent. An adnexal mass-specific structured reporting CT template was developed in collaboration between gyneco-oncologists and diagnostic radiologists. The study population included 24 consecutive women who had a staging CT prior to undergoing debulking surgery for a primary ovarian malignancy. Subjective evaluation by gyneco-oncologists and objective evaluation by radiologists for the presence of 19 key imaging features were performed to assess the clarity and usefulness for procedural planning of the disease-specific structured report (dsSR) and the simple structured report (sSR). Accuracy, sensitivity, and specificity were assessed using operating room notes and pathology reports as the reference standard.

RESULTS

Fewer key features were missing from dsSR than sSR: 0.2±0.8 (range 0-2) vs. 10.2±1.7 (range 7-14), respectively ($p<0.0001$). Compared to sSR, gynecologists deemed dsSR more helpful (4.3±0.7 vs. 3.7±0.8, $p<0.0001$) and easier to understand (4.3±0.6 vs. 3.9±0.7, $p=0.0057$) (on a scale 0-5, 0 not helpful/very difficult to understand; 5 extremely helpful/very clear to understand). Gyneco-oncologists reported a higher rate of potential to modify their surgical approach based on dsSR (33-42%) compared to sSR (13-17%) ($p=0.004$).

CONCLUSION

Disease-specific structured reports were more reliable than simple structured reports in describing key imaging features essential for procedural planning. dsSR was described as more helpful and easier to understand and more likely to lead to modification of the surgical approach by gyneco-oncologists compared to sSR.

CLINICAL RELEVANCE/APPLICATION

Disease-specific structured report is more helpful than simple structured reports for planning gynecological surgery, is easier to understand, and misses fewer imaging descriptors essential for procedural planning.

SSA11-09 MRI Evaluation of Vulvar Cancer in Fresh Radical Local Excision Specimens for Cancer Localization and Prediction of the Surgical Tumor-free Margins

Sunday, Nov. 25 12:05PM - 12:15PM Room: N230B

Participants
Jan Heidkamp, Nijmegen, Netherlands (*Presenter*) Nothing to Disclose
Petra Zusterzeel, Nijmegen, Netherlands (*Abstract Co-Author*) Nothing to Disclose
Ilse Van Engen - Van Grunsven, Nijmegen, Netherlands (*Abstract Co-Author*) Nothing to Disclose
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Jurgen J. Futterer, MD, PhD, Nijmegen, Netherlands (*Abstract Co-Author*) Research Grant, Siemens AG

PURPOSE

In the surgical treatement of vulvar squamous-cell carcinoma (VSCC) tumour free margins of >=8 mm are considered adequate. The purpose of this study was to investigate the feasibility of ex vivo MRI in localizing VSCC and assess the surgical tumor-free margins in fresh radical local excision (RLE) specimens to guide the surgeon during surgical resections.

METHOD AND MATERIALS

Nine patients with biopsy-proven VSCC and scheduled for RLE were prospectively included. Intact fresh specimens were scanned using a 7T preclinical MR-scanner. Whole-mount H&E-stained slides were obtained every 3 mm and correlated with ex vivo MRI. A pathologist annotated VSCC and minimal tumor-free margins (3-, 9 o'clock, basal) on the digitalized histological slides. Both an observer with knowledge of histology (the non-blinded annotation) and a radiologist blinded to histology (the blinded annotation) performed annotation of the same features on ex vivo MRI. Linear correlation and agreement (Bland-Altman analysis) of the ex vivo MRI measurements with histology were assessed. Diagnostic performance for VSCC localization and identification of margins <8 mm were expressed in PPV and NPV.

RESULTS

In 153 matched ex vivo MRI slices, the observer correctly identified 79/91 margins as <8 mm (PPV, 87%) and 110/124 margins as >=8 mm (NPV, 89%). The radiologist correctly annotated absence of VSCC in 73/81 (NPV, 90%) and presence in 65/72 (PPV, 90%) slices. Sixty-four of 90 margins were correctly identified as <8 mm (PPV, 71%) and 83/102 margins as >=8 mm (NPV, 81%). Both non-blinded and blinded annotations were linearly correlated and demonstrated good agreement with histology. Compared to the non-blinded annotation, the linear correlation between ex vivo MRI and histology was less strong and the Bland-Altman 95% limits of agreement were wider in the blinded annotation.

CONCLUSION

Accurate localization of VSCC and measurements of the surgical tumour free margins in fresh WLE specimens using ex vivo MRI is technically feasible. The high NPV and PPV for localization of VSCC and identification of margins <8 mm demonstrate clinical applicability of the technique.

CLINICAL RELEVANCE/APPLICATION

Perioperative information on the margin status of RLE specimens provided by ex vivo MRI could assist the surgeon in achieving adequate surgical margins and prevent subsequent secondary treatment.

SSA12

Science Session with Keynote: Informatics (Artificial Intelligence in Radiology: Cutting Edge Deep-Learning)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S406B

AI IN

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

FDA Discussions may include off-label uses.

Participants
George L. Shih, MD, MS, New York, NY (*Moderator*) Consultant, Image Safely, Inc; Stockholder, Image Safely, Inc; Consultant, MD.ai, Inc; Stockholder, MD.ai, Inc;
An Tang, MD, Montreal, QC (*Moderator*) Research Consultant, Imagia Cybernetics Inc; Speaker, Siemens AG; Speaker, Eli Lilly and Company
Synho Do, PhD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSA12-01 Informatics Keynote Speaker: Cutting Edge AI in Radiology

Sunday, Nov. 25 10:45AM - 10:55AM Room: S406B

Participants
An Tang, MD, Montreal, QC (*Presenter*) Research Consultant, Imagia Cybernetics Inc; Speaker, Siemens AG; Speaker, Eli Lilly and Company

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Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ An Tang, MD - 2018 Honored Educator

SSA12-02 Predicting Thyroid Nodule Malignancy with Efficient Convolutional Neural Networks

Sunday, Nov. 25 10:55AM - 11:05AM Room: S406B

Awards
Trainee Research Prize - Medical Student

Participants
Ian Pan, MA , Providence, RI (*Presenter*) Nothing to Disclose
Matthew T. Stib, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
William D. Middleton, MD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Various sonographic features of thyroid nodules have been described, and classification systems (i.e., TI-RADS) have been developed to aid radiologists in determining which suspicious nodules require fine needle aspiration (FNA). This study aims to improve our predictive ability by training convolutional neural networks (CNNs) to discriminate between pathology-confirmed benign and malignant thyroid nodules using ultrasound images.

METHOD AND MATERIALS

Our dataset consisted of 151 malignant and 500 benign thyroid nodules from 571 patients, where each nodule contributed 1 longitudinal and 1 transverse ultrasound view. Preprocessing included cropping the nodule of interest and resizing the image to 224 x 224 pixels. The data were divided into 10 training/validation/test folds following a stratified 80%/10%/10% split with no patient overlap. CNNs based on the MobileNet architecture were initialized with pretrained ImageNet weights. A fully-connected layer was first trained for 10 epochs, and the entire network was fine-tuned for 20 epochs. Data were sampled to achieve 50%/50% class balance for each epoch. Data augmentation probability, dropout probability, and learning rate were tuned via randomized search with 60 iterations. Weights with the highest area under the ROC curve (AUC) during validation were used for testing. A malignancy score is determined for each nodule by averaging the predictions for each view across 3 models.

RESULTS

Our model achieved a mean AUC of 0.863 (95% CI: 0.827, 0.898). The median malignancy scores for benign and malignant nodules were 0.162 and 0.618, respectively. With 5 strata, (0-0.2, 0.2-0.4, 0.4-0.6, 0.6-0.8, 0.8-1.0), 5.94%, 18.2%, 29.5%, 65.7%, and 81.4% of nodules in each respective stratum were malignant, compared to an overall malignancy rate of 23.2%. At a threshold of 0.10, the model reduces the number of negative FNAs by 36% while maintaining 95% sensitivity.

CONCLUSION

CNNs fine-tuned on limited data can accurately predict the malignancy potential of sonographically suspicious thyroid nodules. Larger datasets would likely further improve the performance of our classifier. External validation studies are necessary to verify the generalizability of this approach.

CLINICAL RELEVANCE/APPLICATION

CNN malignancy scores calculated from thyroid ultrasound images can be combined with a radiologist's interpretation for improved stratification of nodules to reduce the number of unnecessary FNAs.

SSA12-03 A Deep-learning Method for Fast Detection of Rib Fracture in CT Images: Effect of Computer-Aided Diagnosis to Radiologists

Sunday, Nov. 25 11:05AM - 11:15AM Room: S406B

Participants
Xiaodong LI, Linyi, China (*Presenter*) Nothing to Disclose

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CONCLUSION

2 reading modes of CAD(CR, SR) can significantly increase the sensitivities of RFD of radiologists. The reading time is shorter by CR than by SR.CR mode can be used as the first option to detect rib fracture by radiologists.

Background

To assess the effect of rib fracture computer-aided diagnosis(CAD) on diagnosis of radiologist.

Evaluation

85 trauma CTs(50 males) with follow-up review CTs were included in the retrospective study.All trauma CTs were subjected to CAD system to generate rib fracture bounding box.The procedure of the CAD system contains ribs segmentation, centerline extraction,rib fracture detection(RFD) based on deep learning algorithm(Faster RCNN),false positive removal and rib fracture localization. 2 senior(NO.1,2) and 2 junior radiologists(NO.3,4) independently evaluated the data using 3 reading modes(without CAD,CR,SR).The fracture line or bone callus growth is the criterion for determining the rib fracture.The follow-up review CTs verified the diagnosis of rib fracture and established the reference standard[1].All fractures detected by the 4 readers were compared to the reference standard. χ^2 test and rank-sum test were performed to test whether there was significant difference between sensitivities and reading times of 3 reading modes.Abbreviations:without CAD:Radiologists independently evaluated the data.CR:Radiologists apply CAD system as a concurrent reader(CR) to evaluate the data.SR:Radiologists evaluate the data as a first reader and then apply the CAD system as a second reader(SR) to review the results.

Discussion

The reference standard identified 281 rib fractures in 85 patients.The sensitivity of RFD with SR 97.2%(273/281;P<0.001) and CR 96.4%(271/281;P<0.001) were significantly higher than that of without CAD 89.7%(252/281).There was no significant sensitivity difference between CR and SR(P>0.3). Senior and junior radiologists used CAD as CR or SR and there was no significant sensitivity difference between 2 modes(P=0.067,P=0.067).Reading time was significantly shorter for CR(98s) compared to that of without CAD(148s;P<0.001) and SR(169s;P<0.001).Reading time of the 3 modes was less in the senior group than in the junior group with significant differences(P<0.001).

SSA12-04 Highly Sensitive Identification and Delineation of Hemorrhagic Stroke Lesion Using Cascaded Deep Learning Model

Sunday, Nov. 25 11:15AM - 11:25AM Room: S406B

Participants
Junghwan Cho, PhD, Lowell, MA (*Presenter*) Nothing to Disclose
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CONCLUSION

A cascaded deep learning model was developed to identify and delineate hemorrhagic stroke lesion, obtaining overall sensitivity accuracy for classification with 97.91% and segmentation with 83.43%, respectively.

Background

Highly accurate and timely detection of intracranial hemorrhagic stroke is a critical clinical issue for diagnosis decision and treatment in emergency room. Deep learning is a promising approach to solve delayed and missed diagnosis of stroke accident. Accordingly, we developed a cascaded deep learning model trained by a series of different CT window settings as a preprocessing step. It consists of two convolution neural networks (CNNs) for identifying bleeding or not and fully convolutional networks (FCNs) for delineating their lesions.

Evaluation

For this study, we acquired 135,000 CT images from 5,650 patients including 3,000 non-bleeding and 2,650 bleeding. In case of bleeding, five subtypes of intracranial hemorrhage (intraventricular, intraparenchymal, subarachnoid, epidural, and subdural hemorrhage) were well labeled by experts. At first, a cascaded deep learning model was trained to identity whether there is bleeding or not and 5-fold cross validation was conducted. We evaluated sensitivity accuracy by the cascaded model, enabling to review the negative case by the second CNN trained with more narrow window width (40/40 [level/width]) in case that CT image is recognized as negative by the first CNN trained with default brain window setting (50/100). It results in increasing around 1% sensitivity (97.91%) while preserving specificity (98.76%). To delineate lesion of bleeding, the FCNs was trained with 33,300 CT slices using DGX-1 system. We achieved overall precision accuracy ranging from 70% to 90% and recall accuracy ranging from 62% to 88% at different Dice coefficient threshold as true positive decision.

Discussion

In diagnostic accuracy, there is a tradeoff between sensitivity and specificity. But while preserving specificity, the cascaded deep learning model can increase sensitivity in diagnosis of hemorrhagic stroke. It has the capability to help doctors inform any suspected cases.

SSA12-05 Differentiation of Hepatic Masses in Abdominal CT Images Using Texture-Aware Convolutional Neural Networks with Texture Image Patches

Sunday, Nov. 25 11:25AM - 11:35AM Room: S406B

Participants
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CONCLUSION

Our method can be applied to the differentiation of various subtypes of hepatic masses including cyst and hemangioma, and early diagnosis of hepatic cancer.

Background

Differentiation of hepatic masses into benign and malignant classes in CT images is an important task for early diagnosis and surgical decision of hepatic cancer. In the cases of small masses, acquisition of intensity and texture features is difficult, making the differentiation challenging. Thus, we propose a deep convolutional neural network (CNN) classification of hepatic masses using texture image patch (TIP) generation to enhance the classification efficiency in small masses.

Evaluation

Our method was evaluated on a dataset consisting of 349 abdominal CT scans including 576 benign and 210 malignant masses. Each mass was manually segmented by the radiologist. In TIP generation, the patches representing only the internal texture of the masses were created by filling the square patch with the segmented mass regions repeatedly. These TIPs have the effect of reflecting the texture information to CNN regardless of the original size of masses. Using these TIPs, the transfer learning (TL) was performed on the ImageNet pre-trained AlexNet to classify the patches into benign or malignant classes. To improve the classification efficiency, we re-trained the random forest (RF) classifier on the deep features extracted from the last feature layer of TL-AlexNet. In experiments, our framework was trained on 390 images(b282, m108), validated on 160 images(b113, m47), and tested on 236 images(b181, m55). The proposed method achieved the accuracy of 87.7% where the comparative methods achieved the accuracies of 83.5%, 80.1%, and 85.2%, without TIP, TL, and RF, respectively.

Discussion

Our TIPs improve the learning efficiency of CNN by augmenting the texture information of small masses and allowing the CNN to focus on the texture information. The TL also plays an important role in learning important imaging features for differentiating the hepatic masses. Instead of obtaining the CNN-classified outputs, re-training the RF classifier on the deep features improves the specificity of the proposed method by enhancing the malignancy detection.

SSA12-06 GrayNet: Medical Generic Image Representations for Deep Learning System of Urinary Stone Detection

Sunday, Nov. 25 11:35AM - 11:45AM Room: S406B

Participants
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Dushyant V. Sahani, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company Medical Advisory Board, Allena Pharmaceuticals, Inc
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PURPOSE

The performance of deep-learning based image analysis model developed from an institution is not guaranteed to be achieved when deployed in another if the institutions use different imaging systems with varying scan acquisition and reconstruction settings. We established a pretrained model enriched with medical generic image representations extracted from GrayNet, a dataset for human anatomy recognition with 23 labels and evaluated benefits of GrayNet pretrained models for detecting urinary stones.

METHOD AND MATERIALS

GrayNet contains 322 IV contrast-enhanced whole body CT scans with 120,182 axial slices obtained by CT scanners from two manufacturers (171 from GE and 151 from Siemens). The corresponding virtual unenhanced CT images were generated with a customized transform function. All slices were annotated as 23 radiologist-established anatomical labels. We randomly selected 40 cases for validation and the remainings were used for training of a deep convolutional neural network, Inception-v3. The best model, selected based on validation loss, was reserved as a pretrained model for urinary stone detection. Patients who underwent unenhanced CT scans from two manufacturers (GE and Siemens) for suspected urolithiasis were identified and categorized according to presence (n=128) or absence (n=161) of urinary stones, and then split into train, validation, and test subsets. Inception-v3 models initialized with random, ImageNet, and GrayNet pretrained weights were trained on training datasets from a single manufacturer and both. The optimal models were evaluated on test datasets. Area under the ROC curve (AUC) was measured for evaluation metric.

RESULTS

The performance of the GrayNet model trained on the GE dataset showed higher AUC (0.893) than the ImageNet model (0.833) when tested on the Siemens dataset. Similar trend was observed when models trained on the Siemens dataset and tested on the GE dataset (0.917 from GrayNet, 0.854 from ImageNet). When trained on the combined dataset, the GrayNet model obtained higher AUC than those of ImageNet and random models.

CONCLUSION

The GrayNet pretrained weights enabled better generalization performance, compared to the models initialized with ImageNet pretrained and random weights.

CLINICAL RELEVANCE/APPLICATION

The GrayNet pretrained weights enriched with generic medical image representations can be used as a baseline for deep learning systems for a successful deployment in varying settings.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Dushyant V. Sahani, MD - 2012 Honored EducatorDushyant V. Sahani, MD - 2015 Honored EducatorDushyant V. Sahani, MD - 2016 Honored EducatorDushyant V. Sahani, MD - 2017 Honored Educator

SSA12-07 Deep Learning of Clinically Relevant Chest X-Ray Findings on the Combination of Three Large Datasets

Sunday, Nov. 25 11:45AM - 11:55AM Room: S406B

Participants
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CONCLUSION

We have presented a network trained on the largest collection of chest X-ray images with visually observable radiological findings that performs at similar accuracy to networks developed with 14 NIH labels.

Background

Despite deep learning networks now becoming the de facto method of image classification, their relevance to radiologists is limited by the semantics of label used for training such networks. Recent use of image labels such as pneumonia that are not diagnosable from imaging alone have raised concerns on the utility of the networks. We develop a new classifier for chest X-ray images by training it on labels that derived from visually observable radiological findings. We form a new combined data set of 335,688 images from three sources, namely, PLCO Chest X-rays [Gohagan 2000]), Cancer Screening Trial, National Institute of Health (ChestX-ray14 dataset [Wang 2017]) and the Indiana University dataset [Demner-Fushman 2016]. The 49 original labels assigned to these

combined datasets were mapped to the corresponding visually observable findings and regrouped into 20 finding labels. For example, 'consolidation, pneumonia, infiltration, and infiltrate' were all mapped to 'alveolar opacity'. The consolidated dataset with the new labels was used to train a DenseNet121 network architecture [Huang 2016], with 512x512 size input images preprocessed with histogram equalization and intensity normalization.

Evaluation

The dataset was divided to 80% training and 20% validation. The areas under the ROC curve for the 20 findings are: Alveolar opacity: 0.81 , Hernia: 0.84, Pneumothorax: 0.86, Atelectasis: 0.87, Aortic atherosclerosis and/or Carotid artery calcification: 0.90, Bone Lesion: 0.77, Enlarged cardiac silhouette: 0.86, Enlarged Hilum: 0.75, Findings consistent with granulomatous disease: 0.76, Hyperaeration: 0.79, Increased reticular markings: 0.71, Mass and/or Nodule: 0.64, Pleural effusion: 0.92, Pleural mass and/or thickening: 0.71, Spinal degenerative changes: 0.89, Tortuous Aorta: 0.89, Vascular redistribution: 0.85, Catheter and/or Tube: 0.89, Missing plus NA: 0.82, Other: 0.69.

Discussion

Label validation particulalry in 'no finding' labels from NIH dataset is under way.

SSA12-08 Automatic Classification and Reporting of Multiple Common Thorax Diseases Using Chest Radiographs

Sunday, Nov. 25 11:55AM - 12:05PM Room: S406B

Participants
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Ronald M. Summers, MD,PhD, Bethesda, MD (*Abstract Co-Author*) Royalties, iCAD, Inc; Royalties, Koninklijke Philips NV; Royalties, ScanMed, LLC; Research support, Ping An Insurance Company of China, Ltd; Researcher, Carestream Health, Inc; Research support, NVIDIA Corporation; ; ; ;

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PURPOSE

Chest radiographs are one of the most common radiological exams in daily clinical routines. Reporting thorax diseases using chest radiographs is often an entry-level task for radiologist trainees, but it remains a challenging job for learning-oriented machine intelligence. It's due to the shortage of large-scale well-annotated medical image datasets and lack of techniques that can mimic the high-level reasoning of human radiologists. In this work, we show that clinical free-text radiological reports can be utilized as a priori knowledge for tackling these two difficult problems.

METHOD AND MATERIALS

We used a hospital-scale chest radiograph dataset, which consists of 112,120 frontal-view radiographs of 30,805 patients. 14 disease labels observed in images were mined using natural language processing techniques, i.e., atelectasis, cardiomegaly, effusion, infiltrate, mass, nodule, pneumonia, pneumothorax, consolidation, edema, emphysema, fibrosis, pleural thickening, and hernia. We propose a novel text-image embedding neural network (illustrated in the attached figure) for extracting the distinctive image and text representations. Multilevel attention models are integrated into an end-to-end trainable architecture for highlighting the meaningful text words and image regions. We first apply this combined convolutional and recurrent neural network (CNN-RNN) to classify the image by using both image features and text embeddings from associated reports. Furthermore, we transform the framework into a radiograph reporting system by taking only images as input and turning RNN into a generative model.

RESULTS

The proposed framework achieves high accuracy (0.96±0.03 in AUCs) in disease classification using both images and reports on an unseen and hand-labeled dataset (OpenI, 3,643 images). When using only the images as input, the system can also produce significantly improved results (0.80±0.07 in AUCs) compared to the state-of-the-art (0.74±0.08) with a p-value=0.0005. The figure shows sample classification results with generated reports (attended words in red).

CONCLUSION

We illustrate a framework for fully-automated classification and reporting of common thorax diseases in chest radiographs and demonstrate its superior performance compared to the state-of-the-art.

CLINICAL RELEVANCE/APPLICATION

The proposed multi-purpose CADx system can be applied for automatic classification and reporting of common thoracic diseases as a second opinion.

SSA12-09 Deep-learning for Distal Radius Fracture Detection in X-Ray Imaging

Sunday, Nov. 25 12:05PM - 12:15PM Room: S406B

Participants
Maximilian Russe, MD, Freiburg, Germany (*Presenter*) Nothing to Disclose
Mathias F. Langer, MD, PhD, Freiburg, Germany (*Abstract Co-Author*) Nothing to Disclose
Elmar C. Kotter, MD, MSc, Freiburg, Germany (*Abstract Co-Author*) Editorial Advisory Board, Thieme Medical Publishers, Inc

PURPOSE

Development of a robust algorithm for fracture detection of the distal radius in x-ray imaging for the use in an emergency department.

METHOD AND MATERIALS

Anterior-posterior x-ray images of the wrist from 2013-2017 were classified for fracture or absence of fracture by a consensus

Anterior-posterior x-ray images of the wrist from 2013-2017 were classified for fracture or absence of fracture by a consensus reading from a junior and a senior radiologist. Secondary reading was performed by a certified Msk radiologist. 1900 cases were exported for the deep learning study. Data leakage was excluded using only first-time images of the patients. Images where separated into 1351 images for training and 449 for validation. Besides the validation sample for the CNN learning, a separate analysis of the final model was performed using a separate test sample, containing 50 images with and without fractures. For the development of the deep learning model an established Convulsive neuronal network (CNN), GoogLeNet was used. Due network specifications an images distortion using a smashing transformation to 256*256 pixels was needed. The data was augmented using vertical flipping and up to +/- 10° rotation. No manual segmentation or image correction was made. Deep learning was performed by using Torch on Nvidia DIGITS with a standard workplace graphic unit (Nvidia Quadro P4000). Following parameters where used: 1000 training and validation epochs. AdaGrad was used as solver type and the initial learning rate was 0.01.

RESULTS

The training of the CNN took 4.34h of processing time. Final image processing of all 100 test images took 17 seconds. An overall accuracy of the validation sample was achieved with a final value of 94.2%, the overall accuracy of the separate test sample is 90%. The per-class accuracy in the validation sample was for fractures 87.5% and for no fractures 96.4% in the test sample 86% and 94%. These values are comparable and so overfitting of the CNN can be excluded.

CONCLUSION

The created algorithm shows a good detection rate for distal radius fractures. An exclusion of fracture was performed with even a higher accuracy. These results are promising for preliminary classification of x-rays within a clinical setting.

CLINICAL RELEVANCE/APPLICATION

X-ray reading is still a relevant task for fracture detection, fracture detection algorithms can be used to reduce the work load and already could be used for prioritizing work load. Instant preliminary fracture detection can be achieved with this deep learning model and easily implemented in clinical routine.

SSA13

Molecular Imaging (Brain)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S504CD

MR MI NR NM

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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Dima A. Hammoud, MD, Bethesda, MD (*Moderator*) Nothing to Disclose

Sub-Events

SSA13-01 Template-Enhanced ZTE Attenuation Correction for Brain FDG-PET/MR Imaging

Sunday, Nov. 25 10:45AM - 10:55AM Room: S504CD

Participants
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PURPOSE

The impact of MR-based attenuation correction on PET quantitation accuracy is an ongoing cause of concern for advanced brain research with PET/MR. The purpose of this study was to evaluate a new, template-enhanced zero-echo-time (ZTE) attenuation correction method for PET/MR scanners.

METHOD AND MATERIALS

30 subjects underwent a clinically-indicated 18F-FDG-PET/CT, followed by PET/MR on a GE SIGNA PET/MR. For each patient, a 42-second ZTE sequence was used to generate two attenuation maps: one with the standard ZTE segmentation-based method; and another with a modification of the method, wherein pre-registered anatomical templates and CT data were used to enhance the segmentation. CT data, was used as gold standard. Reconstructed PET images were qualified visually and quantified in 68 volumes-of-interest using a standardized brain atlas.

RESULTS

Attenuation maps were successfully generated in all cases, without manual intervention or parameter tuning. The PET bias with template-enhanced ZTE attenuation correction was measured to be -0.9% ± 0.9%, compared with -1.4% ± 1.1% with regular ZTE attenuation correction. In terms of absolute bias, the new method yielded 1.1% ± 0.7%, compared with 1.6% ± 0.9% with regular ZTE. Statistically significant bias reduction was obtained in the frontal region (from -2.0% to -1.0%), temporal (from -1.2% to -0.2%), parietal (from -1.9% to -1.1%), occipital (from -2.0% to -1.1%) and insula (from -1.4% to -1.1%).

CONCLUSION

These results indicate that the co-registration of pre-recorded anatomical templates to ZTE data is feasible in clinical practice and can be effectively used to improve the performance of segmentation-based attenuation correction.

CLINICAL RELEVANCE/APPLICATION

The accuracy of PET/MR attenuation correction based on zero echo time (ZTE) data can be increased with the incorporation of registered anatomical priors in the segmentation procedure.

SSA13-02 Advantages of 325ps Time-of-Flight Digital Photon Counting PET/CT in Low Dose Brain PET Performance for Assessing Breast Cancer Metastasis

Sunday, Nov. 25 10:55AM - 11:05AM Room: S504CD

Participants
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PURPOSE

To evaluate the feasibility and advantages of 325ps time-of-flight (TOF) digital photon counting (DPC) PET in low dose FDG brain PET performance in patients with breast cancer.

METHOD AND MATERIALS

18 low dose (3.1±0.2mCi) brain FDG-PET scans from 0-75min of 9 patients (BMI=33±6) were performed on a 325ps DPC PET/CT (Philips Vereos) to assess neurometabolic changes for breast cancer before and after chemotherapy (interval=77±10 days). 5 groups of PET reconstructions (10, 5, 2, 1 and 0.5 min) centered at 65min p.i. were performed in 3D-OSEM (2mm-isotropic) w (TOF) and w/o (nTOF). All data were co-registered and normalized based on a 43 normal FDG brain database with 90 neuro-anatomic regions created using MIMSoftware and Brain Atlas Mapping (1,620 regions total). SUV and Z-Score were calculated. NEMA phantom (6 spheres with contrast ratio of 4, 0.5-10min) and 3D-Hoffman phantom (0.5-10min, 0.6-2mCi FDG) were scanned.

RESULTS

NEMA TOF PET revealed 1.0-0.7 recovery coefficients for 6 spheres 37-10mm, with an average of 0%, 0%, 6%, 14%, 30% and 46% higher SUVmax than nTOF's, across all PET (10-0.5min). Visually, Hoffman phantom and patient data consistently revealed more robust image quality with improved details and better contrast on TOF than nTOF. No brain tumors were identified on patients. Quantitatively, an average SUVmean difference (1±3%, 1±3%, 0±2%, 2±4% and 2±5%, TOF vs nTOF) was obtained for PET 10-0.5min. Significant differences in region-based therapy response ($p<0.05$) were found between TOF and nTOF for PET <=2min. Robust Z-Scores (<=10% variance) were found on TOF PET when reducing from 10 to 1min. TOF PET demonstrated better adaptability than nTOF to scan time and dose reduction in image quality and quantification (details given at RSNA).

CONCLUSION

Compared to current standard of care FDG brain PET (10-13mCi, 10min), this low dose (3mCi) brain PET study with scan time reduction (10-0.5min) demonstrated advantages of the solid state 325ps DPC PET technology. The new technology advances neuro PET with more precise imaging of the brain enabled by the excellent TOF capability.

CLINICAL RELEVANCE/APPLICATION

Time-of-flight improvement (325ps) enabled by the new generation solid state DPC PET/CT has advantages in improving robustness of brain neuro PET acquisitions even under low dose and short scan time.

SSA13-03 The Association Between Perihematomal Edema and Iron Deposition Using Diffusion Tensor Imaging and T2* Mapping after Experimental Intracerebral Hemorrhage

Sunday, Nov. 25 11:05AM - 11:15AM Room: S504CD

Awards
Trainee Research Prize - Medical Student

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PURPOSE

This study aimed to explore the relationship between iron deposition and perihematomal edema after intracerebral hemorrhage (ICH) by diffusion tensor imaging (DTI) and T2* mapping.

METHOD AND MATERIALS

14 male SD rats were included in ICH group. 6 rats were included as normal controls. In ICH group, 40 μL of autologous blood was injected into the right basal ganglia to mimic spontaneous ICH. All rats underwent T2WI, DTI and T2* mapping on a 7.0 T animal MRI. The time points of scan of DTI and T2* mapping were days 1, 3, and 7. We used T2WI images scanned at 3-6 h after ICH to measure the initial hematoma. Abnormal mean diffusivity (MD) value and volume were calculated by MD maps. T2* value and abnormal T2 * value volume were measured using T2* mapping maps.

RESULTS

In ICH group, the initial hematoma was 19.14 ± 8.151 μL. The T2* values were 21.23 ± 2.40 ms, 20.62 ± 2.96 ms, and 17.97 ± 2.54 ms at 1d, 3d and 7d after ICH in the ipsilateral side and were 32.47 ± 2.11 ms, 32.51 ± 2.74 ms, and 32.43 ± 3.71 ms in the contralateral side. In normal control group, T2* value was 32.73 ± 2.55 ms in the ipsilateral side and was 33.07 ± 2.16 ms in the contralateral side. The T2* value in the ipsilateral side in ICH group were significant lower than normal control group at 1d, 3d and 7d after ICH, respectively (all $P < 0.001$). There were no significant differences in T2* value between the contralateral side and normal group (all $P > 0.05$). The volumes of abnormal T2* value were 30.93 ± 18.55 μL, 25.30 ± 9.27 μL, and 31.50 ± 10.58 μL and the volumes of abnormal MD were 48.86 ± 31.51 μL, 64.30 ± 64.72 μL, and 30.63 ± 24.99 μL at 1d, 3d and 7d after ICH. A positive correlation was observed between abnormal T2* volume and abnormal MD volume at 1d after ICH ($r = 0.92$, $P < 0.001$).

CONCLUSION

There was a positive correlation between abnormal T2* volume and abnormal MD volume at 1d after ICH. DTI and T2* mapping has the potential to explore the relationship between perihematomal edema and iron overload after ICH.

CLINICAL RELEVANCE/APPLICATION

DTI and T2* mapping can not only diagnose the edema and iron overload in hematoma and perihematomal area after ICH, but also explore the relationship between iron deposition and perihematomal edema.

SSA13-04 Imaging Type-Three Diabetes in an Alzheimer's Disease Animal Model: A Preliminary Mouse Study

Sunday, Nov. 25 11:15AM - 11:25AM Room: S504CD

Participants
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PURPOSE

Investigating the brain distribution of iodine-125 labeled insulin (125I-Insulin) by dynamic single photon emission computed tomography/computed tomography (SPECT/CT) in mice with and without metabolic syndrome and/or Alzheimer's disease (AD).

METHOD AND MATERIALS

Six-month-old APP/PS1 mice (n=6) and wild type (WT) littermates (n=6) were split into two groups. Half were fed a high fat diet (HFD) while half were fed a regular chow diet (RCD) for four months. Insulin tolerance tests were performed at 1 and 4 months after feeding began. A bolus injection of 125I-Insulin was administered via the femoral vein and each mouse was imaged with SPECT/CT. Regions of interest were drawn around the brain and standard uptake values (SUV) were calculated. Following the imaging protocol, mice were perfused with PBS and individual brain regions and peripheral organs were harvested and assayed for 125I activity in a dual channel gamma counter. One-way ANOVA, repeated measures ANOVA, and Student's t-test were used to assess the significance of results.

RESULTS

Blood glucose levels in HFD mice showed diminished response to insulin compared to RCD littermates ($p<0.001$). APP/PS1 mice on both HFD and RCD showed attenuated reductions in blood glucose during the insulin tolerance test ($p<0.02$). The HFD mice had significantly higher brain 125I-Insulin SUV at all time points as compared to RCD mice ($p<0.005$). In the RCD cohort, WT mice showed greater brain SUV than the APP/PS1 mice between 30-60 minutes ($p<0.005$). Post-perfusion gamma counts revealed significantly lower retention of 125I-insulin in the eyes and brains of HFD mice as compared to RCD mice ($p<0.05$).

CONCLUSION

Although, HFD causes peripheral insulin resistance in both WT and APP/PS1 mice, the imaging showed an unexpected increase in these mice. In contrast, lower insulin retention post-mortem was seen in both WT and APP/S1 mice on HFD. Greater peripheral insulin resistance and lower brain insulin retention in APP/PS1 mice compared to WT mice suggests the impairment of insulin delivery that triggers 'type-three diabetes' in the AD brain. Further work is necessary to better understand the brain kinetics of insulin.

CLINICAL RELEVANCE/APPLICATION

Insulin molecular imaging is a promising new frontier for elucidating the underlying connection between AD and insulin resistance.

SSA13-05 Imaging Amyloid Plaques Without Contrast Agent

Sunday, Nov. 25 11:25AM - 11:35AM Room: S504CD

Participants
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PURPOSE

PET is clinically used to quantify brain amyloid load in vivo in Alzheimer's disease (AD) patients, but requires the use of amyloid-specific radiotracer and provides no information on plaque structure. We study small-angle x-ray scattering (SAXS) imaging for structural characterization of amyloid plaques in human brains and quantification of the amyloid load without contrast agent. Experimental SAXS images of an amyloid plaque model and Monte Carlo simulations of diagnostic energy x-ray transport in a human head digital model are reported to determine SAXS system design choices for amyloid imaging.

METHOD AND MATERIALS

SAXS measurements were performed using a point collimation mode and monochromatic x-ray beam. Simulations of a SAXS-CT geometry in a voxelized human head (MIDA model) were performed using a publicly available GPU-accelerated Monte Carlo radiation transport tool. SAXS-CT images of the brain with varying amyloid load at relevant q angles were reconstructed using filtered back projection (FBP).

RESULTS

SAXS measurements of amyloid fibrils pellet show strong scattering with distinct peaks around 6.4 and 13.4 nm-1 due to the ß-sheet fibrillar structure. SAXS is capable of detect amyloid plaques without any contrast agent based on their scattering signature. SAXS-CT simulations performed on a human head digital model with inserted amyloid plaques show feasible detection of plaques as small as 2 mm. More realistic SAXS-CT simulation requires measured cross-section models of amyloid in the brain with different mass fraction of plaques. This allows optimizing the SAXS imaging system to detect micrometer-sized amyloids near 6.4 nm-1.

CONCLUSION

Our results showcase the potential of SAXS imaging method to image amyloid plaques in the human brain and to quantify amyloid load without using contrast agent.

CLINICAL RELEVANCE/APPLICATION

SAXS may surpass the amyloid imaging performance of PET if it can detect and image amyloids in the early stage of plaques

deposition in AD patients with an effective radiation dose of 10 mSv or lower.

SSA13-06 Features of Corticospinal Tract Using Diffusion Tensor Imaging After Experimental Intracerebral Hemorrhage

Sunday, Nov. 25 11:35AM - 11:45AM Room: S504CD

Participants
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PURPOSE

To dynamically evaluate the effect of hematoma on corticospinal tract (CST) after intracerebral hemorrhage (ICH) by diffusion tensor imaging (DTI).

METHOD AND MATERIALS

29 male SD rats were injected with 40uL of autologous blood from tail in the right basal ganglia. DTI sequence was scanned on 7.0T MRI at day 1 (D1), day 3 (D3), day 7 (D7), day 14 (D14), day 21 (D21) and day 28 (D28) after ICH. Sham and normal controls underwent the same scan. The initial hematoma volume was obtained from T2WI images (3-6h after ICH). Mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD) and fractional anisotropy (FA) were obtained from DTI maps. The regions of interest included cerebral peduncle (CP) and pyramidal tract (PY). Modified neurological severity score (mNSS) was used to evaluate the neurological function of rats.

RESULTS

FA values of ipsilateral CP in ICH group were significant lower than in sham group at D1, D3, D7, D14 and D21 (all $p < 0.05$). FA values of ipsilateral CP in ICH group at D3, D7 were significant lower than normal controls (both $p < 0.01$). MD of ipsilateral CP in ICH group at D1 was significant higher than sham group and at D28 was significantly lower than sham group (both $p < 0.05$). AD of ipsilateral CP at D7 and D28 in ICH group was significantly lower than in normal group (both $p < 0.05$). RD of ipsilateral CP in ICH group was higher than sham group at D1 and D3 and lower at D28 (all $p < 0.05$). No significant differences were found in DTI parameters in ipsilateral and contralateral PYs between ICH group and sham group, and among different time points and normal controls (all $p > 0.05$). The scores of mNSS in ICH group were significantly greater than in sham group (all $p < 0.05$). The score of mNSS in ICH group at D1 was significantly greater than other time points (all $p < 0.05$).

CONCLUSION

DTI parameters of ipsilateral CP were abnormal, whereas no changes in DTI parameters of PY were found in ICH model induced by 40uL autologous blood. DTI has the potential to detect dynamically the effect of hematoma on CST.

CLINICAL RELEVANCE/APPLICATION

DTI reveals the changes of CST in parameters after ICH at basal ganglia.

SSA13-07 The rCBV with Contrast Leakage Correction Improves the Correlation Between MR Perfusion Weighted Imaging and Fluorine-18-Deoxyglucose Positron Emission Tomography in Patients with Brain Tumors

Sunday, Nov. 25 11:45AM - 11:55AM Room: S504CD

Participants
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PURPOSE

Tumor angiogenesis and tumor metabolite are important for clinical management for patients with brain tumors. Although rCBV without contrast leakage-correction is the most widely used imaging parameter of MR dynamic susceptibility contrast perfusion weighted imaging (DSC-PWI), the rCBV with contrast leakage-correction was reported to have better accuracy in the evaluation of tumor hemodynamic abnormality. The purpose of this study is to compare the correction between these two rCBV parameters and fluorine-18-deoxyglucose (FDG) positron emission tomography (PET).

METHOD AND MATERIALS

85 paired MR DSC-PWI and FDG-PET examinations in 65 patients with brain tumors, including high grade gliomas, brain metastases and cerebral lymphomas, were enrolled in this study. The interval between MR DSC-PWI and FDG-PET examinations ranged from 0 to 13 days in 72 paired MR DSC-PWI and FDG-PET examinations, another 13 paired stable post-surgical scans were acquired within 28 days. The rCBV maps without and with contrast leakage correction were generated using FDA-approved GE BrainStat and NordicICE programs. Two neruoradiologists measured the maximal rCBV ratio and the tumor versus normal tissue count ratio (TNR) in the "hot" ROIs. The correlation between maximal rCBV ratio of rCBV without and with contrast leakage correction and TNR was evaluated with Spearman Rank correlation analysis, and the difference between these two correlations was assessed with paired t-test.

RESULTS

The mean maximal rCBV ratio of rCBV with contrast leakage correction (1.65±1.38) were higher than rCBV without contrast leakage

correction (1.02 ± 0.876, p=0.03). The rCBV with contrast leakage correction has better correlation with FDG-PET-TNR (Correlation coefficient =0.618, p<0.001) than rCBV without contrast leakage correction (Correlation coefficient =0.436, p=0.018), p<0.001.

CONCLUSION

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

CLINICAL RELEVANCE/APPLICATION

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

SSA13-08 Peptide Functionalized Nano-Inhibitors Restrain Brain Tumor Growth by Blocking cMET Signaling

Sunday, Nov. 25 11:55AM - 12:05PM Room: S504CD

Participants
Yingwei Wu, MD, Shanghai, China (*Presenter*) Nothing to Disclose
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PURPOSE

To determine therapeutic effect of peptide functionalized NP in restraining brain tumor growth by blocking cMET Signaling

METHOD AND MATERIALS

A dendrimer-based nanoinhibitor(Den-CMBP) has been developed using MET targeted cMBP peptides conjugated on G4 dendrimer. Binding affinity of Den-CMBP and free CMBP was evaluated using Surface Plasmon Resonance(SPR) Technology. Cellular responses including cell apoptosis, viability, proliferation were evaluated by treatment with Den-CMBP at various concentrations.GBM rodent models were developed by U87-MG cells implantation. Expression of cMET and downstream signature proteins were tested in U87-MG tumor cells and U87-induced mice models by Western blotting analysis. Mice bearing GBM tumors were treated with Den-CMBP, free CMBP and PF-04217903, a small molecular MET inhibitor, respectively. In-vivo MRI was used to assess tumor volume pre and post treatment. Immunofluorescence staining was performed to evaluate MET immnuno-activity post treatment. Survival was calculated for three sub-groups.

RESULTS

Compared to the free cMBP peptide(KD = 3.964 × 10-7 M), the binding affinity of the nanoinhibitor increased three-order of multitude to 1.316 × 10-10 M due to the multivalent effect. Nanoinhibitor efficiently blocked MET signaling with remarkably reduced levels of phosphorylated MET and its downstream signaling proteins in GBM tumor models and U87MG cell culture. In vivo T2-weighted MRI showed significant tumor growth restraint post treatment of nanoinhibitor. The volumes of tumor treated with Den-cMBP1 were recorded as 0.019, 0.408, and 3.659 mm3 at 7, 15 and 21 days, which decreased 63.5%, 80.0% and 78.3% respectively compared to the control group. No obvious therapeutic effect was observed after administration of free cBMP peptide, nanoinhibitor demonstrated remarkable therapeutic responses similar to PF-04217903. Immunoblotting studies verified that the nanoinhibitor attenuated glioma growth by inhibiting MET downstream signaling. Median survival was extended to 35 days with treatment of nano inhibitors.

CONCLUSION

Overall, this work developed a dendrimer based MET targeted nanoinhibitor that effectively inhibits glioma growth by blocking MET downstream signaling, which would provide an alternative therapeutic strategy for tumor therapy.

CLINICAL RELEVANCE/APPLICATION

The multivalency of dendrimer based NPs would help to decrease dosage and side-effects as well.

SSA13-09 Dynamic Cell Tracking with Time-Lapse MRI: The Temporal Window for Detection of Inflammatory Disease

Sunday, Nov. 25 12:05PM - 12:15PM Room: S504CD

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

While several imaging techniques apply various approaches for cell tracking, the actual dynamic process remained concealed for non-invasive imaging in deep tissue until recently. With the concept of time lapse MRI, real time tracking of individual cells has

become possible. Here, we investigate which velocity range of cell motility can be resolved and investigate time Lapse MRI to track immune cell motility in a model of multiple sclerosis.

METHOD AND MATERIALS

A time lapse MRI protocol using a T2*w gradient echo sequence with a single frame scan-time of 8min12s was developed on a 9.4T small-animal MRI. Movies were composed of images from 20 repetitions. Phantom scans were performed on Resovist-labelled monocytes. In vivo scans were performed in healthy (n=6) and experimental autoimmune encephalomyelitis (EAE, n=14) mice (C57BL/6J) injected i.v. with Resovist 24h prior to MRI. Simulations were performed with a synthetic phantom reproducing the observed contrast of one labelled cell. Motion was simulated by composing synthetic k space data with different fractions obtained from different positions of the synthetic cell.

RESULTS

Phantom and in vivo scans confirmed that labelled immune cells could be tracked in the brain. Simulations showed that moving cells up to velocities of 1µm/s were detectable. In EAE mice significantly reduced numbers of in vivo labelled immune cells were observed as compared to naïve mice (253±29, n=6 vs 31±6, n=14). In EAE mice significant differences were observed before (45±9, n=6) versus after onset (21±4, n=8) of symptoms.

CONCLUSION

Time lapse MRI proofed sensitive enough to detect "patrolling" immune cells along the endothelium. With the start of the leucocyte-adhesion cascade in inflammation, cells start "rolling" with a higher velocity, resulting in less detected cells in EAE. Thus, time lapse MRI enables for assessing immune cell dynamics non-invasively and may serve as a tool for detection or monitoring of an inflammatory response prior to onset of clinical symptoms.

CLINICAL RELEVANCE/APPLICATION

Time lapse MRI may be a versatile tool for studying onset and type of innate immune response by non-invasive, real-time imaging of dynamic immune cells in the brain.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
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SSA14

Musculoskeletal (Bone Marrow and Neoplasms)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E353C

MR MK

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

FDA Discussions may include off-label uses.

Participants
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
Reto Sutter, MD, Zurich, Switzerland (*Moderator*) Nothing to Disclose

Sub-Events

SSA14-01 MR-Based Assessment of Bone Marrow Fat in a Population-Based Cohort Study: Comparison of Different Methods and Association to Physical Activity

Sunday, Nov. 25 10:45AM - 10:55AM Room: E353C

Participants
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PURPOSE

We aimed to compare different MRI-based assessments of bone marrow adipose tissue (MAT) at different anatomic locations and its correlation with physical activity.

METHOD AND MATERIALS

As part of the population-based KORA study, largely healthy subjects underwent whole-body MR imaging including a 2-point-T1-DIXON-VIBE (2pDIXON) sequence (entire body) and a multi-echo DIXON (ME) sequence (upper abdomen). MAT was quantified in the L1 and L2 vertebrae using both sequences, in the femoral necks using the 2pDIXON. In the 2pDIXON, MAT percentage was calculated as the mean value of the fat image divided by the sum of the mean values of the fat and water image. In the ME sequence, MAT percentage was directly derived from the output images, which accounted for R2*. Physical activity was determined by standardized questionnaire.

RESULTS

A total of 385 subjects (96%) were included in the analysis (56±9.1yrs, 58% male); with an evenly distributed physical activity pattern (29% >2h/week; 31% 1h/week; 15% 1h/week (irregularly); 26% no physical activity). Based on the 2pDIXON, MAT was 52.6±10.2% in L1, 56.2±10.3% in L2, 87.4±5.9% in the right and 87.2±5.9% in the left femur neck, while in the ME sequence MAT was significantly lower (43.0±8.0% and 44.1±7.9%, for L1 and L2, all $p<0.001$; respectively). Both MAT measurements in the vertebrae were strongly correlated (r: 0.81 to 0.93), in contrast, correlation of MAT between vertebrae and femoral necks was weak (r: 0.36 to 0.46). All vertebral bone marrow fat measurements were inversely associated with high physical activity (>2h/w), but no correlation was found with the femoral necks (all $p>=0.35$). Strongest association was observed for L1, derived from the 2pDixon (ß= 3.9, $p=0.005$). This association remained significant when adjusted for age, gender and waist circumference ($p=0.005$). Also, high reproducibility, assessed in a subset of 30 subjects, was observed in the 2pDIXON measurement at L1 (ICC for inter- and intra-reader: 0.92 and 0.90).

CONCLUSION

Physical activity was negatively correlated with MAT in the L1, L2 vertebrae but not with the femoral necks. 2pDIXON depicted that correlation better than the ME sequence.

CLINICAL RELEVANCE/APPLICATION

MAT is centrally involved in many metabolic processes and may serve as a proxy for bone health/disease, e.g. osteoporosis. Its different dependence on physical activity at different body locations may contribute to a better understanding of related pathophysiology.

SSA14-02 Application of Texture Analysis in the Differential Diagnosis of Osteoblastic Metastases and Enostoses: Comparison with CT Attenuation Measurements

Sunday, Nov. 25 10:55AM - 11:05AM Room: E353C

Participants
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Sunghoon Park, MD, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The purpose of this study was to investigate the role of CT texture in distinguishing between osteoblastic metastases from enostoses and to compare the results with CT attenuation values.

METHOD AND MATERIALS

The study group comprised 32 patients with 64 sclerotic bone lesions found at CT (41 enostoses in 24 patients and 23 metastases in 8 patients). For each lesions in spine, CT texture analysis was performed by drawing a region of interest on axial CT slices. The histogram parameters (mean, SD, kurtosis, entropy, and skewness) were acquired using a research software 'TexRAD'. The diagnostic performances of mean CT attenuation values and texture analysis for differentiating osteoblastic metastases from enostoses were evaluated.

RESULTS

Mean CT attenuation values had the best diagnostic performance with an ROC AUC (Az) of 0.953 among all parameters. Among CT texture analysis parameters to differentiate osteoblastic metastases and enostoses, the kurtosis had the highest ROC (Az = 0.787) than the entrophy (Az = 0.763) and skewness (Az = 0.691). The combination of mean attenuation and CT texture analysis parameters had poorer performance than mean CT attenuation values alone.

CONCLUSION

Using texture analysis does not improve diagnostic performance in the differentiation of osteoblastic metastases and enostoses in the spine.

CLINICAL RELEVANCE/APPLICATION

CT texture analysis may have a spectrum of potential application in lesion characterization for some tumor types. However, based on our data, we cannot recommend adding CT texture analysis to differentiate osteoblastic metastases of the spine.

SSA14-03 Differentiation of Osteomyelitis from Reactive Osteitis in the Patients with Diabetic Foot Using Multivariable Logistic Regression Analysis

Sunday, Nov. 25 11:05AM - 11:15AM Room: E353C

Participants
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PURPOSE

To retrospectively investigate the differentiating magnetic resonance (MR) imaging findings between osteomyelitis and reactive osteitis in the patients with diabetic foot.

METHOD AND MATERIALS

From November 2015 to March 2018, 118 patients who underwent MRI of the foot for evaluation of suspected osteomyelitis were included in this study. Primary (signal intensity, distribution, and pattern on the T1-weighted images, signal intensity on the T2-weighted images, and concordance of marrow signal intensity) and secondary MR imaging signs (cortical interruption, cellulitis, ulcer, soft tissue abscess, and gangrene) were retrospectively reviewed. To identify the MR features differentiating osteomyelitis from reactive osteitis and to evaluate their differentiating accuracy, multivariate regression and receiver operating characteristic (ROC) curve analysis were performed.

RESULTS

On MRI findings, signal intensity, distribution, and pattern on the T1-weighted images, signal intensity on the T2-weighted images, concordance of marrow signal intensity, cortical interruption, ulcer, soft tissue abscess, and gangrene were significantly different between two groups ($p < 0.05$). Multivariate regression analysis showed that the bright T2 signal intensity (OR 17.7, $p < 0.001$) and deep ulcer (OR 5.6, $p = 0.009$) were major factors associated with osteomyelitis. The area under the ROC curve of predicted probabilities for the combination of these factors was 0.879.

CONCLUSION

In the patients with diabetic foot, osteomyelitis can be accurately distinguished from reactive osteitis by the bright T2 signal intensity and deep ulcer.

CLINICAL RELEVANCE/APPLICATION

Identification and application of these MR features are important to analyzing radiological imaging in the patients with the diabetic foot and can help the radiologist to differentiate osteomyelitis from reactive osteitis

SSA14-04 Predicting Osteomyelitis in Patients with Equivocal MRI Findings

Sunday, Nov. 25 11:15AM - 11:25AM Room: E353C

Participants
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PURPOSE

Specificity of MRI in diagnosing osteomyelitis (OM) in the diabetic foot with ulceration is confounded by high frequency of equivocal findings (abnormal signal on T2fs/STIR sequences with normal signal on T1w sequences). We sought to determine the strongest risk factors for development of osteomyelitis in this setting.

METHOD AND MATERIALS

We analyzed MR exams of diabetic patients with pedal ulcers and suspected osteomyelitis who were indeterminate for OM based on discordant bone marrow signal (normal T1, abnormal T2fs/STIR) adjacent to the ulcer. Follow-up imaging and/or surgical results determined outcome (OM or non-OM). Ulcers were categorized based on surface area and depth (distance to bone). Patterns of marrow edema (subcortical vs medullary) were recorded. The ratio of marrow to joint fluid signal on T2fs/STIR sequences was measured. Statistical analysis was performed with a two-sample t-test and a Cox proportional hazard model.

RESULTS

60 MR exams were identified. 26 showed resolution of marrow findings (no osteomyelitis) and 34 progressed to osteomyelitis. Marrow ROI/joint fluid ratios averaged 65% (39-87%) in the OM group, and 45% (17-97%) in the non-OM group, $p < .001$. ROI ratios > 53% had a 6.5-fold increased risk of osteomyelitis, $p < .001$. Proximity to bone averaged 6mm in the OM group and 9mm in the non-OM group, $p = .02$. Ulcer size averaged 4 cm2 in the OM group versus 2.4 cm2 in the non-OM group, $p = .07$. Ulcers greater than 3cm2 had a 2-fold increase in the risk of osteomyelitis, $p = .04$.

CONCLUSION

High bone marrow/joint fluid signal ratio on T2fs/STIR images was the strongest risk factor for development of osteomyelitis, with a ratio > 53% portending an 6.5-fold increased risk of osteomyelitis. Ulcer size and depth to bone are weaker predictors for the development of osteomyelitis.

CLINICAL RELEVANCE/APPLICATION

Diabetes affects 9.3% of US citizens, 25% of which develop a foot ulcer, the most significant risk factor for amputation. A test that could accurately predict early osteomyelitis in this population would significantly reduce morbidity.

SSA14-05 Assessment of Early Treatment Response by MRI in Multiple Myeloma: Comparative Study of Whole-Body MRI and Lumbar Spinal MRI

Sunday, Nov. 25 11:25AM - 11:35AM Room: E353C

Participants
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PURPOSE

This study compared remission status at completion of chemotherapy with changes in MRI biomarkers obtained from whole-body diffusion-weighted imaging (wb-DWI) and lumbar spinal chemical shift imaging soon after induction of chemotherapy, and compared the predictive value of the MRI biomarkers for complete response (CR).

METHOD AND MATERIALS

Forty-two patients with symptomatic myeloma were examined before and after two cycles of chemotherapy using a 3-T MRI system (Ingenia; Philips Healthcare). For wb-DWI, coronal images were acquired by free-breathing single-shot echo-planar DWI with b-values of 0 and 1000. Total tumor volume (tTV) was obtained by semi-automatic segmentation of wb-DWI using a discriminant analysis method. The threshold for positive bone marrow (BM) involvement was an apparent diffusion coefficient (ADC) >0.55×10-3mm2/s according to a previous report. The mean fat fraction (FF) was calculated from the BM of the L1 to L3 vertebrae without a focal lesion using the coronal 3D 2-point mDIXON quant sequence. Coronal wb-T1 weighted, axial wb-T2 weighted, sagittal spinal STIR, and T1-weighted images were acquired. Serological data were also obtained. At the completion of chemotherapy, the patients were categorized into a CR group (n=12) or a non-CR group (n=30).

RESULTS

No significant differences in the baseline serological- and MRI-derived indices were observed between groups. At the second

examination, tTV, M protein, and ß2-microglobulin were significantly decreased and 75th percentiles of ADC and FF were significantly increased in the CR group. The general linear model demonstrated that percentage changes in FF and M protein contributed significantly to the achievement of CR (P=0.01, P=0.03, respectively). AUCs of ROC curves were 0.876 for FF and 0.843 for M protein.

CONCLUSION

Early change in the FF of lumbar BM soon after induction of chemotherapy was a significant predictor of CR. Total TV obtained by wb-DWI did not prove to be a significant predictor of CR. The sensitivity of FF in the lumbar BM for identification of CR was higher than M protein.

CLINICAL RELEVANCE/APPLICATION

Early change in the FF of lumbar BM soon after induction of chemotherapy is a predictor of CR, suggesting that lumbar spinal MRI can be used to predict remission status.

SSA14-06 MRI Radiomics in the Longitudinal Analysis of Desmoid Fibromatosis Undergoing Systemic Therapy

Sunday, Nov. 25 11:35AM - 11:45AM Room: E353C

Participants
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PURPOSE

Desmoid-type fibromatosis exhibits unique morphological changes on MRI in response to systemic therapy. We sought to quantify the longitudinal changes in appearance of treated tumors to better elucidate the relationship between morphological and textural imaging features.

METHOD AND MATERIALS

This IRB-approved retrospective study included 16 extra-abdominal lesions in 11 subjects (mean age 37 years), 6 females and 5 males. Therapeutic regimens included cytotoxic chemotherapy (n=7), tyrosine kinase inhibitor (n=2), tamoxifen (n=3), and NSAIDS (n=2). Tumors were segmented using 3D-Slicer, and features were extracted with the Radiomics extension; data included tumor shape, signal intensity (tumor: muscle enhancement ratio), and image texture. Response was classified at the lesional level by RECIST1.1 maximum diameter (Dmax) thresholds for progressive disease (>20% increase from nadir, PD), partial response (>30% decrease from baseline, PR), or otherwise stable disease (SD).

RESULTS

The 16 lesions were followed for mean of 5.1 years (range 9 months -14 yrs); this included a total of 100 distinct timepoints. Baseline mean Dmax=10 cm (range 4.2-173 cm), volume 176 cc (range 8-796 cc), and mean enhancement ratio 1.8 (range 0.9-4.0). By RECIST1.1 6 lesions remained stable, 6 lesions showed PD (median progression free survival 1.8 yrs). Only 4 lesions (25%) achieved PR (median time to PR 3.9 yrs), while 13/16 (81%) showed a drop in enhancement ratio (mean -46% from baseline). 12/16 (75%) tumors exhibited at least >20% drop from baseline (median 2.6 yrs). Dmax correlated poorly with enhancement ratio (r=0.09). A random effects GLS regression model containing shape-based, first-order, and textural features established skewness (p=0.008), minor axis length (p=0.04), and run entropy (p=0.05) as significant independent predictors of contrast enhancement ratio.

CONCLUSION

Most desmoid fibromatoses show substantial decreased enhancement after systemic treatment despite relative stability in size. Desmoid segmentation enables identification of radiomic biomarkers that reflect clinically relevant longitudinal changes in tumor phenotype.

CLINICAL RELEVANCE/APPLICATION

Consistent and durable decreases in tumor enhancement support augmenting or replacing size-based with signal-based imaging response criteria for desmoid tumors undergoing systemic therapy.

SSA14-07 Differentiating Lipomatous Masses with High-Resolution 1H MRS Metabolites: Do Benign Lipomas and Atypical Lipomatous Tumors Have a Distinct Metabolic Signature?

Sunday, Nov. 25 11:45AM - 11:55AM Room: E353C

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PURPOSE

Adipocytic tumors represent a spectrum of neoplastic disease from benign lipomas and variants, to atypical lipomatous tumors (ALTs) and liposarcomas. Some liposarcomas are suspected to arise through dedifferentiation of ALTs. The distinction of liposarcomas and premalignant ALTs can be a diagnostic challenge, as can the distinction of ALTs and lipoma variants (lipomas without pure lipid composition), with implications for surgical and clinical management. The purpose of this study is to identify metabolic biomarkers for adipocytic tumors, for accurate tumor classification.

METHOD AND MATERIALS

In a prospective study, de-identified human surgical samples were collected from subjects who underwent surgical resection of indeterminate adipocytic tumors (those with imaging features atypical for simple lipomas). Tissue samples were snap frozen and stored at -80°C until 1H MRS analysis. Dual phase solvent extraction was performed on approximately 300 mg of tumor tissue. The water phase was separated, freeze-dried, and reconstituted in 600ul D2O PBS for MRS analysis. All MR spectra were acquired on an Avance III 750 MHz (17.6T) Bruker NMR spectrometer. Computational modeling of pattern recognition based cluster analysis was utilized to look for significant differences in metabolic signatures between the adipocytic tumor types.

RESULTS

Tissue specimens from lipoma variants (n=6), ALTs (n=5) and adjacent non-involved subcutaneous normal fat (n=7) were examined using 1H MRS. Quantitative metabolite information is shown in figures 1A-B. The metabolic heatmap (Figure 1A) identifies the metabolic patterns of ALTs compared to lipoma variants and normal fat. A significant increase in several metabolite levels, including lactate, was observed in ALTs compared to lipomas and normal fat. Cluster analysis (Figure 1B) showed significant differences between normal fat, lipoma variants and ALTs.

CONCLUSION

Our preliminary data support investigating the use of high resolution 1H MRS of adipocytic tumors for differentiating between tumor subtypes and for understanding malignant progression.

CLINICAL RELEVANCE/APPLICATION

These results provide new insights into the metabolic differences between benign and premalignant tissue that may be exploited for formulating treatment plans and ultimately, metabolism-based therapeutic strategies.

SSA14-08 Radiomic Analysis of Peripheral Nerve Sheath Tumors Accurately Predicts Benign versus Malignant Status

Sunday, Nov. 25 11:55AM - 12:05PM Room: E353C

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PURPOSE

To evaluate whether radiomic analysis can accurately differentiate benign (BPNST) versus malignant peripheral nerve sheath tumors (MPNSTs), and compare it to the expert radiologist interpretation.

METHOD AND MATERIALS

44 patients with histologically confirmed PNSTs were identified from the institutional electronic data base. Fat suppressed T2W (fsT2W) imaging in isolation and all imaging combined including contrast (mimicking a routine setting) were used for Radiomic analysis and by two experienced musculoskeletal radiologists. Regions of interest (ROIs) corresponding to the tumor boundaries were contoured by a different experienced musculoskeletal radiologist using VelocityTM software (Varian Medical Systems). For system training, volumetric ROIs extracted from fsT2W images of 25 tumors (16 benign, 9 malignant) were used for the proposed Convolutional Neural Network (CNN), which included 7 convolution, 3 max-pooling and 2 fully connected layers. Data augmentation by rotating 3D images and Synthetic Minority Over-sampling technique (SMOTE) were employed to balance and increase training samples. The CNN was tested using 15 unknown tumors and evaluated for accuracy. Following which, two blinded radiologists in two diferent settings- fsT2W images (set 1) and all imaging sequences together (set 2) evaluated the same testing cases into benign versus malignant tumors. The accuracy of the CNN models was compared with radiologists. Statistical tests included Area Under the Curve (AUC) and Fisher's Exact Test.

RESULTS

The CNN model using fsT2W predicted benign versus malignant among PNSTs with an accuracy and AUC of 87% and 0.89, compared to the accuracy and AUC of 73%, 0.83 and 93%, 0.83 for the radiologists 1 and 2, respectively ($p>0.05$). The accuracy and AUC of radiologists 1 and 2, and CNN using all sequences including contrast imaging (mirroring the routine setting) was 71%, 0.81 and 71%, 0.70, and 93%, 0.94, respectively.

CONCLUSION

Radiomic analysis accurately differentiates benign versus malignant PNSTs and may serve as a powerful adjunctive measure during diagnosis of these neoplasms.

CLINICAL RELEVANCE/APPLICATION

Given the morbidity and mortality associated with MPNSTs, the high accuracy of radiomics is likely to be extremely valuable in their diagnostic work-up. Further study with larger cohorts can determine whether radiomics may aid in classification among BPNST subtypes, such as neurofibroma, schwannoma, and perineurioma.

SSA14-09 Grading of Soft Tissue Sarcoma by Using 3T MR Imaging Texture Analysis

Sunday, Nov. 25 12:05PM - 12:15PM Room: E353C

Participants
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PURPOSE

To determine the value of 3T magnetic resonance (MR) imaging texture analysis to differentiate high-grade from low-grade soft tissue sarcoma.

METHOD AND MATERIALS

The institutional review board approved this retrospective study and informed consent was waived. Forty-eight patients with soft tissue sarcoma who had undergone 3T MR imaging including contrast-enhanced (CE) imaging were included in this study. Texture analysis of whole tumor volume on T1- and T2-weighted images and fat-suppressed CE T1-weighted images were performed using Multiparametric toolbox. Histogram features (mean intensity, standard deviation (SD), skewness and kurtosis) and gray-level co-occurrence matrix features (Difference entropy, Difference variance, contrast, entropy) were compared between high-grade (grades 2 and 3) and low-grade (grade 1) soft tissue sarcoma using Mann-Whitney U test. The receiver operating characteristic curves with areas under the curve (AUC) for all parameters were obtained.

RESULTS

There were 11 patients with low-grade sarcomas and 37 patients with high-grade sarcomas: grade 2 (n = 10) and grade 3 (n = 27). T1 mean, T2 mean, T1 SD and CE T1 skewness were significantly lower in high-grade than low-grade sarcomas: 510.6 vs 761.3; 637.8 vs 850.0; 90.6 vs 142.9; 0.12 vs 0.63 (P= < .05), respectively. CE T1 mean, T2 skewness and CE T1 Difference variance were significantly higher in high-grade than low-grade sarcomas: 619.0 vs 385.9; 0.404 vs -0.425; 0.232 vs 0.175 (P= < .05), respectively. AUCs of above parameters except T1 mean were over 0.7: 0.725 (95% CI, 0.573-0.876) in T2 mean; 0.752 (95% CI, 0.568-0.936) in CE T1 mean; 0.737 (95% CI, 0568-0.906) in T1 SD; 0.722 (95% CI, 0.557-0.887) in T2 skewness; 0.722 (95% CI, 0.560-0.885) in CE T1 skewness; 0.706 (95% CI, 0.526-0.887) in CE T1 Difference variance. AUC of T1 mean was 0.698 (95% CI, 0.489-0.907).

CONCLUSION

Texture analysis based on 3T MR imaging may be reliable to differentiate between high-grade and low-grade soft tissue sarcomas.

CLINICAL RELEVANCE/APPLICATION

MR imaging texture analysis may help predict grade of soft tissue sarcoma.

SSA15

Musculoskeletal (Lower Extremity)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E353B

CT MK MR

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

Participants
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Sub-Events

SSA15-01 MRI-Based 3D Models of the Pelvis Can Replace CT-Based 3D Models for Range of Motion Analysis in Femoroacetabular Impingement

Sunday, Nov. 25 10:45AM - 10:55AM Room: E353B

Participants
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PURPOSE

Although femoroacetabular impingement (FAI) describes a dynamic osseous abutment of the femur against the acetabulum, current standard imaging assessment is static. Recently CT-based impingement analysis was introduced whereas MRI would offer a radiation-free alternative. Thus we asked (1) what is the mean distance between surface points of 3D pelvis models derived from CT/MRI; (2) whether impingement free range of motion correlates between CT and MRI; (3) and whether zones of impingement match for 3D models based on CT and MRI?

METHOD AND MATERIALS

IRB-approved comparative, retrospective study of 20 symptomatic hips with FAI. 3D CT scans (isovoxel: 1mm3) of the entire pelvis and the distal femoral condyles were obtained. Preoperative MR arthrograms of the hip were obtained including 0.8mm3 isovoxel T1 3D VIBE- and 1mm3 isovoxel 3D T1 VIBE DIXON sequences of the entire pelvis and the distal femoral condyles. Threshold-based manual segmentation was performed using commercial software (AMIRA). Both 3D models were compared with inhouse developed software which includes two specific algorithms for detection of the acetabular rim and for detection of the center of roation. We calculated (1) percentage of the surface points with < 1mm difference between the CT-/MR-based 3D models; (2) assessed correlation of impingement-free range of motion (in: flexion; extension; internal rotation 90° of flexion; external rotation in 90° of flexion; abduction; adduction) between CT and MRI and (3) compared location of impingement zones between CT and MRI using the clock-face system which divides the femur and acetabulum into 12 'hour' positions.

RESULTS

(1) 83% and 79% of the surface points of the proximal femur respectively of the acetabulum differed <1mm between the CT-based and MRI-based 3D models. (2) Correlation for the range of motion values was excellent (spearman rho=0.993, p<0.05) between CT and MRI. (3) Location of impingement did not differ between CT-based and MRI-based range of motion analysis in 12/12 acetabular and 11/12 femoral clock-face positions.

CONCLUSION

MRI-based 3D models of the pelvis can replace CT-based 3D models for range of motion analysis in femoroacetabular impingement

CLINICAL RELEVANCE/APPLICATION

3D-MRI based impingement analysis of the hip is a further step towards non-invasive, personalized surgical planning of FAI especially for complex deformities such as abnormal femoral torsion.

SSA15-02 Does 3DMR Provide Equivalent Information as 3DCT for the Pre-Operative Evaluation of Adult Hip Pain Conditions of Femoroacetabular Impingement and Hip Dysplasia?

Sunday, Nov. 25 10:55AM - 11:05AM Room: E353B

Awards
Student Travel Stipend Award

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PURPOSE

Femoroacetabular impingement (FAI) and hip dysplasia (HD) are frequently evaluated by isotropic CT (3DCT) for preoperative planning at the expense of radiation. The aim was to determine if isotropic MRI (3DMR) imaging can provide similar quantitative and qualitative morphological information as 3DCT.

METHOD AND MATERIALS

25 consecutive patients with a final diagnosis of FAI or HD were retrospectively selected from December 2016-December 2017. Two readers (R1, R2) performed quantitative angular measurements on 3DCT and 3DMR, blinded to the diagnosis and each other's measurements. 3DMR and 3DCT of the hips were qualitatively and independently evaluated by a radiologist (R3), surgeon (R4), and fellow (R5). Interobserver and intermodality comparisons were performed.

RESULTS

Quality was good to excellent on all 3DCT and 3DMR reconstructions. The ICC was good to excellent for all measurements between R1 and R2 (ICC: 0.60-0.98) and the majority of intermodality measurements for R1 and R2. Average inter-reader and inter-modality PABAK showed good to excellent agreement for qualitative reads. On CT, all alpha angles (AA) were significantly lower in dysplasia patients than in cam patients ($p<0.05$). Lateral center-edge angle (LCEA) at the anterior, center, and posterior acetabulum were significantly lower in dysplasia than in cam patients ($p<0.05$). On MR, AA at 12, 1, and 2 o'clock, and LCEA at center were significantly lower in dysplasia patients than in cam patients ($p<0.05$).

CONCLUSION

Strong interobserver and intermodality correlations of hip morphology suggest that 3DMR has good potential to replace 3DCT and serve as a one-stop modality for bone and soft tissue characterizations in the pre-operative evaluation of FAI and HD.

CLINICAL RELEVANCE/APPLICATION

In patients with symptomatic FAI and HD, 3DMR can replace 3DCT in the pre-operative evaluation, thereby reducing radiation, time, cost, and discomfort for the patients.

SSA15-03 MR Texture Analysis of Acetabular Subchondral Bone Can Discriminate Between Normal and Cam Positive Hips

Sunday, Nov. 25 11:05AM - 11:15AM Room: E353B

Participants
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PURPOSE

To assess whether texture analysis of acetabular subchondral bone on MRI can differentiate between normal and cam positive hips.

METHOD AND MATERIALS

IRB-approved, retrospective case-control study analyzing MR images in subjects with and without cam morphology of the proximal femur (n=68: 19 controls, 25 asymptomatic cam and 24 symptomatic cam-FAI). All subjects underwent unilateral 1.5T hip MRI. The acetabular subchondral bone was contoured manually as a volume of interest (VOI) on sagittal PD images. 3D histogram and second order texture features were evaluated for the global acetabular VOI for each subject using MaZda (v4.6). Differences between controls and asymptomatic or symptomatic cam hips were explored using Mann-Whitney U tests with post-hoc Bonferroni correction. Intra-acetabular variations in texture were assessed by subdividing each VOI into anterior and posterior segments in the sagittal plane and into medial, middle, and lateral segments in the coronal plane, generating 6 ROIs. Between groups and within-subjects differences in texture features were assessed using mixed model ANOVAs. Features were used to train a series of gradient boosted regression trees; for each, 500 hyperparameter configurations were selected at random. 10-fold, stratified cross-validation was then performed and the accuracy of the 10 forests for identifying cam positive hips was averaged.

RESULTS

Both asymptomatic and symptomatic cam-FAI hips demonstrated higher gray-level variance and lower kurtosis compared to controls ($p=0.003$ for each). Gray-level co-occurrence features f3, f4, and f7 were significantly higher in cam positive hips compared to controls ($p<=0.003$ for each). Sub-region analysis revealed no significant interactions between subject group and ROI. The post-validation classification accuracy achieved by each gradient boosted tree model was 72% (control vs asymptomatic) and 79% (control vs symptomatic cam-FAI).

CONCLUSION

Texture features extracted from MRI can detect subtle differences in subchondral bone architecture between controls and cam positive hips, regardless of patient symptom status.

CLINICAL RELEVANCE/APPLICATION

The texture profile of acetabular subchondral bone in cam positive hips is significantly different from controls in all regions. This suggests there are extra-articular structural changes occurring globally within the acetabular subchondral bone of patients with cam morphology regardless of symptom status.

SSA15-04 Postoperative, Traction MR Arthrography in Patients with Persisting Pain After Hip Arthroscopy for FAI Reveals Unexpected High Prevalence of Osseous Deformities and Intra-Articular Lesions Due to Under-/ or Overcorrection

Sunday, Nov. 25 11:15AM - 11:25AM Room: E353B

Participants
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PURPOSE

Numbers of hip arthroscopies for FAI correction have risen exponentially, leading to an increase of patients with persistent pain who undergo postoperative MR imaging. To assess prevalence of new/residual (1) osseous deformities, (2) intra-articular lesions and (3) progression of osteoarthritis in symptomatic patients undergoing pre- and postoperative MR imaging after hip arthroscopy.

METHOD AND MATERIALS

IRB-approved, retrospective study. Between 2010-17, 806 patients underwent arthroscopic FAI correction and/or labrum surgery. Database was reviewed for symptomatic patients with complete radiographs and traction MR arthrography (MRA) of the hip (1.5 T) obtained before and after hip arthroscopy according to the routine protocol. 49 patients were included: mean age 29 ± 10 years, 67% female. Traction was applied using a MR-compatible traction device with weight-adaption. One reader assessed pre- and postoperative images. (1) Acetabular coverage (LCE<25° = dysplasia, LCE>39° = pincer deformity) and Tönnis osteoarthritis (OA) grade were assessed on AP pelvic views. Cam deformity was defined (a>60°) on radial MR images. Femoral torsion measurements were only available for postoperative MRI (low/high torsion: <5°/>30°). (2) Presence of residual tears-, retears of the labrum, capsular adhesions/defects was assessed on traction MRA. (3) OA progression on traction MRA was defined as new acetabular/femoral cartilage lesions and osteophytes formation.

RESULTS

(1) Preoperatively 42 (86%) hips showed deformities: 2 (4%) dysplastic-, 11 (22%) pincer- and 39 (80%) cam deformities. Postoperatively 39 (80%) hips showed deformities; 9 (18%) dysplastic-, 8 (16%) pincer-, 20 (41%) cam deformity, 4 (8%) hips with torsion <5°, 10 (20%) hips with torsion >30°. (2) Postoperatively 14 (29%) cases with residual-, 12 (24%) cases with labrum retears were observed. 6 (12%) hips had capsular adhesions, 22 (45%) had capsular defects. (3) Radiographic OA progression was observed in 5 (10%) hips, in 14 (30%) hips on traction MRA.

CONCLUSION

Prevalence of osseous deformities due to over- or undercorrection and intra-articular lesions is high after failed hip arthroscopy. Traction MRA was useful for detection of OA progression.

CLINICAL RELEVANCE/APPLICATION

Identification of osseous over-/undercorrection after failed hip arthroscopy is essential because open surgical approaches must be considered for correction of dysplasia and abnormal femoral torsion.

SSA15-05 Comparison of Lateral Centre Edge Angle and Sourcil Angle Measurements on "Ghost" 3D Volume Rendered CTs and Plain Radiographs

Sunday, Nov. 25 11:25AM - 11:35AM Room: E353B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Comparison of lateral centre edge angle and sourcil angle measurements on "Ghost" 3D volume rendered CTs and plain radiographs.

METHOD AND MATERIALS

A retrospective single-centre observational study evaluating the degree of agreement between measurements of lateral centre edge angle on CT and plain radiographs in 50 hips. Measurements of LCEA and sourcil angle were made on AP radiographs and 'Ghost' CT. All patients who were under orthopaedic investigation for femoro-acetabular impingement, had both a pelvic radiograph

and CT of at least one hip were included. Patients with severe anatomic deformity or those who were post-operative were excluded from the study. A paired sample t-test was performed to determine if there was a significant difference between measurements on plain radiograph and 'Ghost' CT, with the null hypothesis stating no significant difference.

RESULTS

On plain film the mean of the LCEA was 31.60, standard deviation = 8.254; and on CT "Ghost" images the mean LCEA was 30.96, standard deviation = 8.315 (paired t-test: $p < .002$). The confidence interval is 0.25 to 1.03. On plain film the mean of the Sourcil angle was 6.20, standard deviation = 4.848; and on CT "Ghost" images the mean of LCEA was 6.76, standard deviation = 4.841 (paired t-test: $p < .016$). The confidence interval is -1.19 to -1.17. The results show that there is a statistical difference between measurements of LCE and sourcil angles made on plain radiographs and CT, but the confidence interval is small. We can be 95% sure that the true mean angle lies within a range of 1.28 degrees for lateral centre edge angle and a range of 0.02 degrees for the sourcil angle.

CONCLUSION

Although there is a statistical difference between measurements of LCE and sourcil angles made on plain radiographs and "Ghost" CT the narrow confidence interval infers that the difference is actually quite small and in clinical practice this would be clinically insignificant. This would preclude the need for plain radiographs and reduce the radiation dose in young patients who ultimately require CT imaging as part of their femoro-acetabular impingement workup.

CLINICAL RELEVANCE/APPLICATION

Measurements of LCEA and sourcil angles on 'Ghost CT' are clinically indifferent and can be used to preclude the need for plain radiographs in the work up of FAI in young patients with hip pain.

SSA15-06 The Puck Stops Here: An Adaptive Response of the Hip Observed with MRI and Unique to Super External Rotators

Sunday, Nov. 25 11:35AM - 11:45AM Room: E353B

Participants
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PURPOSE

Overhead athletes rely on extreme ranges of motion to excel in their respective fields, leading to structural changes including capsular and osseous overgrowth, which in turn contribute to overuse lesions including SLAP and unique impingement syndromes. Super external hip rotators, in particular hockey goalies, similarly rely on tremendous ranges of motion to excel at their avocation. We sought to compare hip capsule thickness in hockey goalies with age and gender matched controls in order to describe MRI findings of adaptive response of the hip.

METHOD AND MATERIALS

Retrospective cohort study examining the hip capsule thickness of hockey goalies with other male athletes aged matched at 20-30 years. Capsule thickness was used as a marker for adaptive response at the hip as this was described previously with adaptive response in the shoulder. Power analysis was performed and determined that a sample size of 17 was selected for each group. Measurements were performed at the anterior, middle, and posterior capsule regions on coronal non-fat saturated T1 MRI images at the level of the femoral head and neck. A two tailed t-test was then conducted to analyze the two groups.

RESULTS

The hip capsule was statistically thicker in super external rotators at each region when compared with other age matches athletic males. The average capsule thickness at the femoral head in the control group ranged from 8 - 9 mm and in the goalies group from 10 - 12 mm (p values ranged from 0.001 and 0.007). At the femoral neck, the control group capsule thickness was between 11 - 13 mm compared to 16 - 18 mm for the super external rotators (p-values between 0.002 and 0.01).

CONCLUSION

Hip super external rotating hockey goalies have a thicker hip capsule than their age and gender matched controls at both the level of the femoral head and neck.

CLINICAL RELEVANCE/APPLICATION

Hip super external rotators adapt with capsular thickening, which may predispose to hip pathology known to be prevalent in such athletes such as femoroacetabular impingement, labral tears, and early osteoarthritis. This adaptive hip capsular thickening should be observed at MRI, and should be correlated with other pathologies on a larger scale with a goal of prevention and early intervention.

SSA15-07 Diagnostic Performance of Magnetic Resonance Imaging in Detecting Syndesmotic Injuries: A Meta-Analysis

Sunday, Nov. 25 11:45AM - 11:55AM Room: E353B

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PURPOSE

Distal tibiofibular syndesmotic injuries are common and occur in association with ankle sprains and ankle fractures. There are conflicting reports in the literature regarding the diagnostic performance of magnetic resonance (MR) imaging in detecting these injuries. Therefore, in this meta-analysis we intend to determine diagnostic performance of MR-imaging in detecting syndesmotic injuries, using open or arthroscopic surgery as the standard of reference.

METHOD AND MATERIALS

A comprehensive literature search (until March 2018) was performed and original research studies reporting diagnostic performance of MRI and MR arthrography (MRA) in detecting syndesmotic injuries were included. Pooled values of sensitivity and specificity were calculated using fixed or random effect models based on the level of heterogeneity.

RESULTS

Out of 421 identified records, seven studies (309 MRI examinations) were included. Two studies (65 ankles) also reported the results of indirect MRA (iMRA) while other two studies (53 ankles) reported the results of direct MRA. There was no publication bias according to Deeks funnel plot asymmetry test (P=0.2) and meta-funnel. Pooled values of sensitivity were 89% [95% confidence interval (CI): 84%-94%] for non-enhanced MRI, 91% (CI: 79%-98%) for iMRA and 92% (CI: 73%-99%) for MRA. Pooled values of specificity of MRI, iMRA and MRA were 88% (CI: 82%-93%), 91% (CI: 82%-96%) and 67% (CI: 35%-90%), respectively. High degree of heterogeneity was observed in all modalities (I2 >50%). Comparing diagnostic odds ratios (DOR) of MRI with iMRA yielded no significant result (relative DOR (rDOR):0.41, P=0.5). No significant difference was observed between DORs of MRI and MRA (rDOR: 1.76, P=0.4). There was no significant difference between DORs of iMRA and MRA (rDOR: 7.69, P=0.2).

CONCLUSION

MRI, iMRA and MRA can accurately detect syndesmotic injuries. The specificity of MRA appeared to be lower when compared to MRI and iMRA.

CLINICAL RELEVANCE/APPLICATION

With high diagnostic performance of conventional non-enhanced MRI, using intravenous or intraarticular gadolinium may not improve the diagnostic performance of MRI examinations.

SSA15-08 Scanned versus Fused-Reconstructed Oblique MR-Images for Assessment of the Ankle Syndesmosis: Diagnostic Performance and Reader Agreement

Sunday, Nov. 25 11:55AM - 12:05PM Room: E353B

Participants
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PURPOSE

To evaluate the diagnostic performance and reader agreement of a novel image reconstruction method enabling fusion of standard two-dimensional transversal and coronal images into oblique images for the assessment of the ankle syndesmosis.

METHOD AND MATERIALS

We evaluated 40 magnetic resonance imaging examinations of patients with ankle sprains (16 with ruptures and 24 without) for the presence of anterior inferior tibiofibular ligament rupture. For all patients, an oblique-fusion reconstruction (OFR) was created in comparable fashion to the scanned oblique proton density weighted turbo spin echo (PDwTSE) sequence. Image reconstruction was performed with dedicated software enabling image fusion from standard transversal 3 mm PDwTSE and coronal sequences with fat suppression. The resulting fused images were used as the source for the reconstruction of OFR images. To evaluate diagnostic

performance, three readers with different levels of experience independently read the scanned images once and the fused images twice. We analyzed sensitivity, specificity, negative and positive predictive values, accuracy and agreement.

RESULTS

The experienced reader misinterpreted one OFR as false negative, demonstrating a sensitivity of 0.97 and specificitiy of 1.00. The intermediate reader had perfect accuracy. The inexperienced reader diagnosed two false positive ruptures (specificity: 0.92) in his first, and missed three ruptures (sensitivity: 0.81) in his second read. No differences were significant. Intrareader agreement was 0.95, 1.00 and 0.74 and interreader agreement was 0.90.

CONCLUSION

The proposed OFR enables reliable detection of anterior inferior tibiofibular ligament rupture with excellent inter- and intrareader agreement, making conventional scanning of oblique images redundant.

CLINICAL RELEVANCE/APPLICATION

Presented method enables the creation of additional MRI sequences in a totally different orientation from routine 2D images. Thereby scanning of e.g. oblique images is redundant and MRI scanning time - in our case 28% can be saved.

SSA15-09 Tarsal Coalition and the Accessory Anterolateral Facet

Sunday, Nov. 25 12:05PM - 12:15PM Room: E353B

Participants
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PURPOSE

The accessory anterolateral talar facet (AALTF) is an anatomic variant that can cause peroneal spastic flatfoot in adolescents and accessory talar facet impingement (ATFI) in adults. The purpose of this study was to assess the relationship between AALTF and tarsal coalitions.

METHOD AND MATERIALS

Retrospective analysis of consecutive patients undergoing MRI ankle over a 2-year period (01/2014 to 12/2015) at our institution was performed. This study received IRB approval and complied with HIPAA guidelines. We reviewed MRIs for presence of AALTF and tarsal coalition. The criteria for identifying AALTF on MRI was facet articulation spreading contiguously from the posterior facet of the talus anterior to the lateral process of the talus. Presence of a tarsal coalition was assessed using MRI, allowing differentiation between types of coalition (cartilaginous, fibrous and osseous). Exclusion criteria were prior surgery, recent trauma, or abnormalities preventing visualization of the talocalcaneal joint.

RESULTS

Of the 391 patients (137 men, 254 women; mean age 45 years) included in this study, 3.6% (14/391) had an AALTF. Of these patients, 29% (4/14) had a tarsal coalition, of which 3 were talocalcaneal (1 osseous, 1 fibrous and 1 cartilaginous) and 1 was calcaneonavicular (fibrous). Of the patients without an AALTF, 2% (9/377) had a tarsal coalition, of which 7 were calcaneonavicular (4 fibrous and 3 cartilaginous), 2 were talocalcaneal (1 osseous, 1 fibrous). One-tailed chi-square tests of independence with Yates correction and odds ratio (OR) calculations were performed to examine the relation between the AALTF and the presence of a tarsal coalition. For the relationship between AALTF and tarsal coalition, $\chi 2 = 21.2$ (df, 1; n = 391; $p < 0.0001$; OR 16.3; 95% CI, 4.3-62.1).

CONCLUSION

Our study showed a significant relationship between the presence of an AALTF and tarsal coalition. Our findings indicate that MRI is a valuable test for identifying comorbid findings of AALTF in patients.

CLINICAL RELEVANCE/APPLICATION

The accessory anterolateral talar facet (AALTF) is an anatomic variant that can cause peroneal spastic flatfoot and accessory talar facet impingement (ATFI). Our study showed a significant relationship between the presence of an AALTF and tarsal coalition. Patients undergoing resection for tarsal coalition should be evaluated for AALTF, in order to improve pre-operative planning and postsurgical outcome.

SSA16

Nuclear Medicine (Chest and Cardiovascular Nuclear Imaging)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S505AB

CA CH CT NM

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

Participants
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Sub-Events

SSA16-01 Association Between Asynchrony and Stenoses in Apparently Normal Coronary Arteries

Sunday, Nov. 25 10:45AM - 10:55AM Room: S505AB

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PURPOSE

Left ventricular (LV) arteries are considered abnormal if stenosis > 70%, but lesser stenoses may be concerning. Our study was undertaken to determine the % of cases in which stenoses are < 70% & perfusion images suggest apparently normal (ApNl) arteries, yet myocardial flow reserve (MFR) is abnormally low, & whether PET parameters predict magnitude of stenosis.

METHOD AND MATERIALS

Data were analyzed of 105 pts evaluated by Rb-82 rest/regadenoson-stress PET/CT & arteriography, which measured % stenoses. Global ejection fractions (EFs) & regional summed stress score (SSS) & summed rest score (SRS) of relative myocardial perfusion were assessed. Rest & stress systolic & diastolic asynchrony (Asynch) was assessed by a medical imaging physicist who visually scored phase histograms & phase polar maps within a coronary territory using a 5-point scale (0 = normal to 4 = markedly asynchronous extensive territory), based on phase polar maps being out of phase from expected contraction patterns of normal pts. Absolute myocardial blood flow (MBF) was quantified from rebinned first pass dynamic transit images of the Rb-82 bolus injection through the heart chambers, with myocardial flow reserve (MFR) computed as stress-MBF/rest-MBF. ApNl arteries were defined as those with SRS < 4 & SSS < 4 & stenosis < 70%. Following convention, abnormal regional MFR was defined as < 2.0.

RESULTS

Among 315 arteries, 174 had undetectable stenosis, 72 ranged from 25-69% & 69 ranged from 70-100%. Among all arteries, 162 were ApNl with higher MFR than the other 153 arteries (2.65±1.34 versus 1.96±1.26, $p < 0.0001$). Nonetheless, 35% (56/162) of ApNl arteries had abnormally low MFR < 2.0 (mean = 1.50±0.31). For all arteries, magnitude of % stenosis was most strongly associated with magnitude of Asynch ($r = 0.50$, $p < 0.0001$), & significantly associated with stress MBF ($r = -0.25$, $p < 0.0001$), SSS ($r = 0.24$, $p < 0.0001$), SRS ($r = 0.17$, $p = 0.002$), & MFR ($r = -0.18$, $p = 0.002$). For ApNl arteries, % stenosis was associated with magnitude of Asynch ($r = 0.34$, $p < 0.0001$).

CONCLUSION

In arteries that are apparently normal by relative perfusion assessment & by conventional arteriographic criteria, MFR can nonetheless by abnormally low, with stenoses < 70% associated with regional asynchrony.

CLINICAL RELEVANCE/APPLICATION

It is advisable to measure regional MFR & regional asynchrony for pts with suspected CAD.

SSA16-02 Evaluation of Role of F-18 FDG Cardiac PET and Tc-99m Sestamibi Myocardial Perfusion Imaging in Assessing the Therapeutic Benefit in Patients with Coronary Artery Disease and Left Ventricular Systolic Dysfunction

Sunday, Nov. 25 10:55AM - 11:05AM Room: S505AB

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PURPOSE

To evaluate the therapeutic benefit with revascularization and optimal medical treatment (OMT) in patients diagnosed with hibernating myocardium on myocardial perfusion imaging (MPI) using F-18 FDG cardiac PET

METHOD AND MATERIALS

59 consecutive patients (43 males, 16 females, Mean Age 60.7 ± 9.4 years) with CAD and LV systolic dysfunction who underwent myocardial viability imaging for revascularization work-up and were diagnosed with hibernating myocardium were enrolled in this study. Patients were later treated with either revascularization or OMT and were followed for a median duration of 7.7 months for assessing the therapeutic benefit. Therapeutic benefit was assessed under 3 categories (a) Improvement in functional class (b) Adverse cardiac-events and (c) Improvement in LV function and myocardial perfusion on follow-up resting 99mTc-sestamibi myocardial perfusion imaging.

RESULTS

29 patients underwent revascularization (49%) and 25 patients received OMT (42%). Five patients were lost to follow-up. Patients were matched for baseline characteristics in both treatment arms. On follow-up, significant improvement was noted in NYHA functional class and CCS angina class post-revascularization. No such improvement was noted in the OMT group. The cardiac-event rate of patients in OMT group was significantly higher than that of patients in revascularization group (36% vs. 10.3 %; p = 0.046). At 1 year of follow-up, event-free survival in revascularization group was significantly superior compared to OMT group (83.8% vs. 50.8%; p= 0.039). On follow-up resting MPI scan, mean improvement in LVEF in revascularization group was significantly higher than in OMT group (6.0% vs. 1.4%; p=0.04).

CONCLUSION

Myocardial viability imaging is a sensitive modality to identify hibernating myocardium in patients with CAD and LV dysfunction and predicting its recovery following revascularization, thereby guiding the optimal treatment strategy for these patients.

CLINICAL RELEVANCE/APPLICATION

Myocardial viability imaging should be performed prior to revascularization in patients with coronary artery disease with left-ventricular dysfunction to help predict recovery post-treatment.

SSA16-03 A Comparative Analysis of Myocardial Perfusion on Gated SPECT versus Coronary Atherosclerosis and Calcium Score on 64-Slice CT

Sunday, Nov. 25 11:05AM - 11:15AM Room: S505AB

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PURPOSE

The aim of the current study was to compare the results of 64-slice CT and gated SPECT on a regional basis (per vessel distribution territory) in patients with known or suspected CAD.

METHOD AND MATERIALS

Three hundred and seventy five patients underwent both gated SPECT for myocardial perfusion imaging and 64-slice CT for coronary calcium scoring and coronary angiography. The coronary calcium score was determined for each coronary artery. Coronary arteries on multislice CT angiography were classified as having no CAD, insignificant stenosis (<50% luminal narrowing),significant stenosis, or total or subtotal occlusion (>90% luminal narrowing).Gated SPECT findings were classified as normal or abnormal (reversible or fixed defects) and were allocated to the territory of one of the various coronary arteries.

RESULTS

In coronary arteries with a calcium score of 10 or less, the corresponding myocardial perfusion was normal in 96 %. In coronary arteries with extensive calcifications (score > 400), the percentage of vascular territories with normal myocardial perfusion was lower, 48%. Similarly, in most of the normal coronary arteries on 64-slice CT angiography, the corresponding myocardial perfusion was normal on SPECT in >94%. In contrast, the percentage of normal SPECT findings was significantly lower in coronary arteries with obstructive lesions (<57%) or with total or subtotal occlusions (<10%) (P < 0.01). Nonetheless, only 42% of vascular territories with normal perfusion corresponded to normal coronary arteries on multislice CTangiography, whereas insignificant and significant stenosis were present in, respectively, 40% and 18% of corresponding coronary arteries.

CONCLUSION

Although a relationship exists between the severity of CAD on multislice CT and myocardial perfusion abnormalities on SPECT, analysis on a regional basis showed only moderate agreement between observed atherosclerosis and abnormal perfusion. Accordingly, 64-slice CT and gated SPECT provide complementary rather than competitive information, and further studies should address how these two modalities can be integrated to optimize patient management.

CLINICAL RELEVANCE/APPLICATION

Accordingly, 64-slice CT and gated SPECT provide complementary rather than competitive information.

SSA16-04 The Association of Carotid Plaque 18F-FDG and 18F-Naf Uptake on PET Scan with Symptomatic Carotid Artery Disease: A Systematic Review and Meta-Analysis

Sunday, Nov. 25 11:15AM - 11:25AM Room: S505AB

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PURPOSE

We sought to investigate the ability of 18F-FDG and 18F-NaF PET imaging to identify vulnerable carotid plaques and predict stroke recurrence in the setting of recent cerebrovascular accidents by performing a systematic review.

METHOD AND MATERIALS

We performed this study according to the Meta-Analysis of Observational Studies in Epidemiology (MOOSE) group and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines. We performed a systematic review of Ovid MEDLINE, Ovid EMBASE, and the Cochrane Library Databases yielding a total of 4,144 unique articles for screening after de-duplication. These were screened for peer-reviewed journal articles that examined the association between carotid plaque tracer uptake and recent or future ischemic events such as strokes, transient ischemic attacks and retinal artery embolisms. Screened articles were then adjudicated as meeting inclusion criteria by two independent readers.

RESULTS

Fourteen articles were included for subsequent analysis. Of those, 11 articles analyzed 18F-FDG uptake in recently symptomatic carotid arteries as compared to asymptomatic carotid arteries. Two of these studies analyzed 18F-NaF uptake as well. The remaining 3 articles investigated the risk of stroke recurrence associated with 18F-FDG uptake. The existing literature demonstrates significant heterogeneity in the PET protocols, reported tracer uptake metrics, and thresholds for positive uptake.

CONCLUSION

Our systematic review revealed a growing body of literature supporting 18F-FDG's utility in predicting future stroke recurrence and its modest ability in discerning symptomatic from asymptomatic carotid plaques. Additional studies are needed to elucidate the role of 18F-NaF as compared to 18F-FDG imaging. Further work is needed to define more standardized approaches for PET image acquisition and imaging analysis in order to improve the generalizability of this technique to detect high-risk carotid plaques.

CLINICAL RELEVANCE/APPLICATION

Carotid atherosclerosis is responsible for 15% of ischemic strokes. Further work is needed to investigate the utility of 18F-FDG and 18F-NaF PET imaging in detecting high-risk carotid plaques.

SSA16-05 Provider Utilization Trends for Elective Myocardial Perfusion Imaging

Sunday, Nov. 25 11:25AM - 11:35AM Room: S505AB

Participants
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PURPOSE

To analyze trends in performance of elective stress nuclear myocardial perfusion imaging (MPI) modalities in the Medicare population.

METHOD AND MATERIALS

The nationwide Medicare Part B fee-for-service databases for 2004-2016 were reviewed. CPT codes relevant to stress MPI were selected: planar and single photon emission computed tomography (SPECT), and positron emission computed tomography (PET). The databases indicate procedure volume for each code, and these were used to calculate utilization rates per 1,000 Medicare beneficiaries. Elective MPI exams were identified by using place-of-service codes for private offices and hospital outpatient departments (HOPDs). The specialty of the performing physician was determined using Medicare physician specialty codes. Because the Medicare Part B databases are complete population counts, sample statistics are not required.

RESULTS

Elective standard (STD) MPI (both planar imaging and SPECT) utilization peaked in 2006 at 74 studies per 1,000 beneficiaries and then progressively decreased to 45 by 2016 (-36%). In 2004, cardiologists' share of elective STD MPI had been 79%, and this steadily increased in subsequent years to 87% in 2016. Cardiologists perform elective STD MPI mostly in private offices where

utilization peaked in 2008 at 50 studies per 1,000 and then declined to 22 in 2016 (-56%). In HOPDs, utilization by cardiologists has increased over the period of the study from 7 studies to 15 (+120%). Utilization in private offices and HOPDs by radiologists has declined from 13 in 2004 to 6 in 2016 (-58%). Elective PET MPI, less frequently used at 3 studies per 1,000 in 2016, maintained an overall net upward trend since 2005, and most of this growth reflected increasing use by cardiologists (90% share in 2016).

CONCLUSION

In the Medicare population, the overall use of elective STD MPI is declining, however cardiologists are performing an increasing market share in the outpatient setting. A shift in place-of-service has been noted with fewer studies performed in private offices and increasing numbers performed in HOPDs. PET MPI utilization, while still not widespread, has grown over the period of the study, reflecting an increasing use by cardiologists.

CLINICAL RELEVANCE/APPLICATION

Cardiologists maintain an increasing share in utilization of elective standard and PET MPI.

SSA16-06 Medium and Large Vessel Vasculitis: Recognizing Patterns on FDG PET-CT

Sunday, Nov. 25 11:35AM - 11:45AM Room: S505AB

Participants
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PURPOSE

The diagnosis of medium to large-vessel vasculitis and the assessment of its activity and extent remain challenging. We assess the clinical utility of FDG PET CT in patients with suspected medium and large vessel vasculitis to evaluate the pattern and extent of vessel involvement.

METHOD AND MATERIALS

100 consecutive patients (64 males and 36 females) with suspected medium and large-vessel vasculitis were evaluated with FDG PET/CT. FDG uptake in the major vessels was visually graded using a four-point scale and quantified with standardised uptake values (SUV max). Patients were further sub-divided into three groups: (a) steroid-naive medium to large-vessel vasculitis (N=34, 69% of total positive patients), (b) vasculitis on steroid treatment (N=15, 30.6% of total positive patients) and (c) no evidence of vasculitis (N=51). Analysis of variance and linear regression were used to investigate the association of FDG uptake with clinical parameters.

RESULTS

FDG-PET revealed pathological findings in 49 of 100 patients. FDG PET/CT was positive (visual uptake >2; equal to or greater than liver) in all patients with steroid-naive medium to large-vessel vasculitis. The thoracic aorta, the carotid and the subclavian arteries were most frequently involved. In these patients, SUVmax values were significantly higher than in the other groups.

CONCLUSION

FDG PET is a sensitive and specific imaging tool for medium and large vessel vasculitis, especially when performed in steroid naive patients. It increases the overall diagnostic accuracy and has an impact on the clinical management in a significant proportion of patients.

CLINICAL RELEVANCE/APPLICATION

FDG-PET should be used in diagnosis and characterisation of medium and large vessel vasculitis to determine optimal treatment methodologies.

SSA16-07 Assessing the Feasibility of 18F-Naf PET/CT to Detect the Atherosclerotic Calcification of Aortic Wall in Rheumatoid Arthritis Patients

Sunday, Nov. 25 11:45AM - 11:55AM Room: S505AB

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PURPOSE

Rheumatoid arthritis (RA) has long been associated with increased risk for atherosclerosis. 18F-sodium fluoride (NaF) is a PET tracer that detects calcium deposition in the early stages of atherosclerotic plaque formation. We aimed to assess whether NaF-PET/CT can sensitively discriminate aorta calcification between RA patients and normal subjects.

METHOD AND MATERIALS

Fifteen RA patients (11 men, 4 women; mean age 53.8±10.8 y, range 25-64) and fifteen healthy controls (11 men, 4 women; mean age 53.5±11.2 y, range 25-64) were included in this study. Controls were matched to patients by sex and age (±5 years). All subjects in this study underwent NaF-PET/CT scanning 90 minutes after NaF tracer administration. Using OsiriX software, regions of interest were manually drawn around the abdominal aorta wall starting superiorly with the first axial slice containing the left kidney, ending with the last slice before the aortic bifurcation. The global mean standardized uptake value (global SUVmean) was obtained and compared between RA patients and healthy subjects. An unpaired t-test assessed the difference in means of RA group and controls, and a ROC analysis assessed discrimination.

RESULTS

The global SUVmean of RA patients ranged from 0.88 to 2.35, and from 0.79 to 1.47 in healthy controls. Furthermore, average global SUVmean scores among RA patients was significantly greater than that of healthy controls. (1.62±0.49 and 1.04±0.16, respectively, $P<0.01$). ROC analysis revealed fair discrimination between the two groups (AUC = 0.77).

CONCLUSION

Our findings indicate that global assessment with NaF-PET/CT is a feasible technique to detect active vascular calcification in the abdominal aorta. Discriminant validity was observed by assessing a known co-morbidity of RA and comparing RA to non-RA. Further studies are needed to validate this technique to diagnose and monitor patients at high risk for atherosclerosis.

CLINICAL RELEVANCE/APPLICATION

Global assessment with NaF-PET/CT can determine the degree of active vascular calcification, which can help diagnose, monitor, and assess treatment response in atherosclerosis.

SSA16-08 F-18 FLT PET/CT for Therapeutic Monitoring in Patients with Cardiac Sarcoidosis: Comparison with F-18 FDG PET/CT

Sunday, Nov. 25 11:55AM - 12:05PM Room: S505AB

Participants
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PURPOSE

F-18 fluorodeoxyglucose (FDG) PET has been used in sarcoidosis including cardiac involvement for therapeutic monitoring. However, it can be challenging because it accumulates physiologically in normal myocardium. The purpose of this study was to evaluate the ability of F-18 fluorothymidine (FLT) PET for therapeutic monitoring in patients with cardiac sarcoidosis, in comparison with FDG.

METHOD AND MATERIALS

FLT and FDG PET/CT studies were performed before and after immunosuppressive therapy in 6 patients with newly diagnosed cardiac sarcoidosis. The patients had fasted for at least 18 h before FDG PET/CT, but were given no special dietary instructions before FLT PET/CT. Uptake of FLT and FDG was examined visually and semiquantitatively using maximal standardized uptake value (SUV).

RESULTS

Before therapy, all patients had both cardiac and extra-cardiac thoracic sarcoidosis. Fifteen lesions in cardiac region and 22 lesions in extra-cardiac region were visually detected on both FLT and FDG PET/CT. After therapy, 10 and 8 lesions in cardiac region and 15 and 11 lesions in extra-cardiac region showed no increased uptake on FLT and FDG PET/CT, respectively. On after therapy FLT scan, all SUV for each lesion were lower than those on before therapy FLT scan, and the mean SUVs in cardiac and extra-cardiac lesions decreased significantly ($p<0.001$ and $p<0.001$, respectively). On after therapy FDG scan, all SUV for each lesion were also lower than those on before therapy FDG scan, and the mean SUVs in cardiac and extra-cardiac lesions also decreased significantly ($p<0.001$ and $p<0.001$, respectively). The mean SUV reductions in cardiac and extra-cardiac lesions on FLT scan were 53% and 57%, respectively. The mean SUV reductions in cardiac and extra-cardiac lesions on FDG scan were 57% and 55%, respectively. No significant difference in SUV reduction was found between FLT and FDG scans.

CONCLUSION

This preliminary study indicates that FLT PET/CT, even without the usually necessary fasting, may have the potential to identify the therapeutic response in patients with cardiac sarcoidosis as well as FDG PET/CT.

CLINICAL RELEVANCE/APPLICATION

FLT PET/CT, even without the usually necessary fasting, may have the potential to identify the therapeutic response in patients with cardiac sarcoidosis.

SSA16-09 Feasibility of Using Global Lung FDG Uptake in COPD Patients on PET/CT to Assess the Correlation Between Pulmonary Parenchymal Inflammation and Pulmonary Function Test Indices as well as Emphysema Severity

Sunday, Nov. 25 12:05PM - 12:15PM Room: S505AB

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PURPOSE

The purpose of this study was to determine the relationship between the degree of pulmonary parenchymal inflammation measured from FDG-PET/CT with the degree of emphysema and also with PFT indices in chronic obstructive pulmonary disease (COPD) patients based on image segmentation and partial volume correction.

METHOD AND MATERIALS

56 COPD patients (51 men; median age 64) who underwent 18F-fluorodeoxyglucose-positron emission tomography/computed tomography (FDG-PET/CT) were studied. Lung parenchymal volume (L), macroscopic emphysema volume (E) and non-emphysematous lung parenchyma mean attenuation (A) were measured from CT images. Uncorrected maximum standardized uptake value of lung (USUVmax) was measured from PET/CT images. A first level of partial volume correction was then applied to account for varying amounts of macroscopic emphysema (CSUVmax) followed by a second level of correction to account for the mixture of air and lung parenchyma at the microscopic level (CCSUVmax). Correlation of fraction of emphysema(F=E/L) with USUVmax, CSUVmax, CCSUVmax were tested using Pearson correlation and linear regression statistical tests. Pearson correlation and linear regression statistical tests were applied to test the correlations of USUVmax, CSUVmax, and CCSUVmax with FEV1/FVC ratio.

RESULTS

Lung USUVmax and CSUVmax were not significantly correlated with fraction of emphysema ($r=0.03$, $p=0.831$ and $r=0.18$, $p=0.292$, respectively). However, CCSUVmax was significantly positively correlated with fraction of emphysema ($r=0.47$, $p=0.013$). Lung CSUVmax and CCSUVmax were significantly negatively correlated with FEV1/FVC ratio ($r=-0.49$, $p=0.026$ and $r=-0.71$, $p<0.001$, respectively), whereas there was no significant correlation between lung USUVmax and FEV1/FVC ratio ($r=-0.25$, $p=0.073$).

CONCLUSION

These data demonstrate that the degree of pulmonary inflammation increases with the degree of emphysema severity and that patients with lower FEV1/FVC ratios have greater degrees of pulmonary parenchymal inflammation based on FDG-PET/CT quantitative assessment. These correlations are more statistically significant when pulmonary FDG uptake is corrected for the partial volume effect, which shows the importance of partial volume correction for accurate quantification of lung disease severity.

CLINICAL RELEVANCE/APPLICATION

Measurement of pulmonary FDG uptake on PET/CT may therefore be useful in the diagnostic and response assessment of patients with COPD.

SSA17

Neuroradiology/Head and Neck (Head and Neck Tumors: State-of-the-Art Imaging)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E350

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

SSA17-01 Is Gadolinium Needed for the MRI Surveillance of Vestibular Schwannomas?

Sunday, Nov. 25 10:45AM - 10:55AM Room: E350

Participants
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PURPOSE

The aim of this study was to test the hypothesis that high-resolution, T2-weighted magnetic resonance imaging (HRT2-MRI) is an acceptable alternative to gadolinium-enhanced T1-weighted MRI (Gd-MRI) in the assessment of size of vestibular schwannomas (VS). Current VS surveillance requires a minimum of 6 scans to demonstrate no interval growth. Proof of this hypothesis may allow a change in practice to performing VS surveillance imaging with HRT2-MRI rather than the current standard of T1-Gd MRI, a change that could have potential health and economic benefits; given the costs and potential complications from repeat gadolinium administration.

METHOD AND MATERIALS

Two neuroradiologists independently performed single dimension intra-canalicular measurements with, or without additional intra-cisternal measurements (depending on the tumour extension) on axial images of 50 VS imaged with HRT2-MRI and Gd-MRI. Paired student t-tests (alpha = 0.05) were used to determine whether differences in the mean tumour measurements between HRT2-MRI and Gd-MRI were statistically significant. Intraclass and interclass correlation coefficients (ICC) were calculated to determine intra- and interobserver reliability. Bland-Altman plots were used to evaluate the level of agreement between VS measurements obtained on HRT2-MRI and Gd-MRI.

RESULTS

There was no statistically significant difference in the mean diameter of VS size, measured on HRT2-MRI and Gd-MRI for both neuroradiologists ($p=0.28$ & $p=0.74$ for observer 1 and 2 respectively). Interobserver reliability between the neuroradiologists demonstrated excellent correlation for both imaging techniques (ICC=0.99 for HRT2-MRI and Gd-MRI). Intraobserver reliability was also excellent (ICC>=0.98 for both observers measuring on HRT2-MRI and Gd-MRI). Bland-Altman plots showed the differences between the two sequences were within limits of agreement for both observers.

CONCLUSION

This study supports the use of HRT2-MRI alone for the surveillance of known VS.

CLINICAL RELEVANCE/APPLICATION

High resolution T2 MRI shows good agreement with gadolinium-enhanced T1 MRI in measurement of vestibular schwannomas which could have health and economic benefits in their surveillance.

SSA17-02 Histogram Analysis of Diffusion Kurtosis Imaging for Differentiating Malignant from Benign Masses in Head and Neck Region

Sunday, Nov. 25 10:55AM - 11:05AM Room: E350

Participants
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PURPOSE

To evaluate the diagnostic performance of histogram parameters derived from diffusion kurtosis imaging (DKI) for differentiating malignant from benign masses in head and neck region.

METHOD AND MATERIALS

Our study retrospectively enrolled 80 patients with head and neck masses who had undergone DKI scan for pre-treatment evaluation. Patients were grouped into malignant group (n=64) and benign group (n=16). Apparent diffusion for Gaussian distribution (Dapp) and apparent kurtosis coefficient (Kapp) were generated. Histogram parameters, including mean, median, 10th, 90th percentiles, skewness and kurtosis of Dapp and Kapp were calculated. Independent-sample t test and Mann-Whitney U test were used to compare the differences of quantitative parameters between two study groups. Differentiating performances of significant parameters were determined by using receiver operating characteristic (ROC) curve analyses. Multivariable stepwise logistic regression was used to identify independent predictors of malignancy

RESULTS

Malignant group showed significantly lower Dapp-10th, Dapp-mean, Dapp-median and Dapp-90th, while higher Kapp-10th, Kapp-mean, Kapp-median and Kapp-90th than benign group (All Ps<0.001). Dapp-10th demonstrated significantly higher differentiating performance than Dapp-mean (P=0.039), while Kapp-90th also demonstrated significantly higher differentiating performance than Kapp-mean (P=0.008). Dapp-10th was the only independent predictor of malignancy, with a sensitivity of 0.813, and a specificity of 1.000 at a cut-off value of 0.989×10-3 mm2/s.

CONCLUSION

Histogram analysis of DKI holds promising for exhibiting the difference of tumor heterogeneity between malignant and benign head and neck masses. Dapp-10th may be the promising imaging biomarker for predicting malignant tumor in head and neck region.

CLINICAL RELEVANCE/APPLICATION

To assist in the differentiation of head and neck mass lesions.

SSA17-03 Texture Analysis of Diffusion-Weighted Imaging in Head and Neck Squamous Cell Carcinoma: Diagnostic Value for Nodal Metastasis

Sunday, Nov. 25 11:05AM - 11:15AM Room: E350

Participants
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PURPOSE

To evaluate the diagnostic performance of texture features of diffusion-weighted imaging (DWI) in differentiating metastasis from benign lymph nodes (LNs) in head and neck squamous cell cancer (SCC).

METHOD AND MATERIALS

Between June, 2016 and February, 2018, thirty-six patients with pathologically proven head and neck SCC were included in this study. All patients underwent preoperative magnetic resonance imaging (MRI) including DWI and conventional imaging at 3T. Total 204 MRI-detected LNs including 176 subcentimeter normal-sized LNs were assigned to the metastatic or benign groups according to the pathology. Texture features including histogram and gray-level matrices were derived by drawing region-of-interest on LNs while excluding necrosis on apparent diffusion coefficient maps. Texture features between metastasis and benign LNs were compared using independent t-test, and hierarchical cluster analysis was performed to identify correlations between features. Multivariate logistic regression and receiver operating characteristic analysis were performed to assess diagnostic performance for metastatic LNs.

RESULTS

Total 83 out of 204 LNs in all-size were confirmed as metastasis; 58 out of 176 normal-sized LNs were metastasis. Three discriminative texture features for differentiating metastasis from benign LNs were complexity (all-size, P<.001, odds ratio [OR] 1.0000022, 95% confidence interval [CI] 1.000001-1.000004; normal-size, P=.001, OR, 1.000002, 95% CI, 1.0000008-1.000004), normalized energy (P=.014, OR 1.000002, 95% CI 1.0000004-1.000004; P=.001, OR 1.000002, 95% CI 1.0000009-1.000004) and roundness (P=.008, OR 103.56, 95% CI 3.35-3675.25; P=.008, OR 116.88, 95% CI 3.39-4675.74). Area under the curves (AUCs) for diagnosing metastasis in all-sized and normal-sized LNs were 0.829 and 0.767 regarding complexity, 0.699 and 0.685 regarding normalized energy, and 0.699 and 0.685 regarding roundness. The combination of three features resulted in higher AUC values of 0.836 and 0.781, respectively.

CONCLUSION

Texture analysis of DWI can be useful in diagnosing nodal metastasis in head and neck SCC, especially in normal -sized LNs.

CLINICAL RELEVANCE/APPLICATION

Texture analysis of diffusion-weighted imaging can be useful in differentiating benign and metastatic lymph nodes in head and neck squamous cell cancer.

SSA17-04 Treatment Response Assessment of Nasopharyngeal Carcinoma Based on Diffusion Kurtosis Imaging

Sunday, Nov. 25 11:15AM - 11:25AM Room: E350

Participants
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PURPOSE

The prediction of treatment response is important in planning and modifying the chemoradiation therapy regimen. This study aimed to explore the quantitative indices for treatment response assessment of nasopharyngeal carcinoma (NPC) based on diffusion kurtosis imaging(DKI).

METHOD AND MATERIALS

Thirty-six patients with initial diagnosis of locally advanced NPC and DKI acquisitions before and after neoadjuvant chemotherapy (NAC) were enrolled. Patients were divided into respond (RP) and non-respond (NRP) groups and residual (RD) and non-residual (NRD) groups after NAC and radiation therapy(RT). Histogram parameters (10th, 25th, 50th, 75th, 90th percentile, mean, standard deviation, skewness, and kurtosis) of DKI-derived parameters (ADC, D, K) were calculated. Intraclass correlation coefficient (ICC), Kolmogorov-Smirnov test, Student's t-test or Mann-Whitney U test, receiver operating characteristic curve (ROC) and Delong tests were performed.

RESULTS

Most of the parameters have good to excellent consistency (ICC: 0.675-0.998). The pre- and post-ADC (10th, 25th, 50th), D (10th, 25th, 50th) and K (50th) were significantly different between RP and NRP, while the pre- and post- ADC (10th, 50th), D (25th, 50th) and K (75th, 90th) were significantly different between RD and NRD (all $P<0.05$). ROC analysis indicated that setting pre-D50th=0.875mm2/s as the cut-off value could obtain optimal diagnostic performance for the prediction of NAC treatment response, while post-K90th=1.035 is optimal for prediction of RT response.

CONCLUSION

DKI derived parameters can be used as promising quantitative biomarkers in prediction of NAC and RT treatment response in locally advanced NPC patients.

CLINICAL RELEVANCE/APPLICATION

DKI derived parameters can be used as promising quantitative biomarkers in prediction of NAC and RT treatment response in locally advanced NPC patients.

SSA17-05 Differential Diagnosis of Nasopharyngeal Carcinoma and Nasopharyngeal Lymphoma Based on DCE-MRI and DWI

Sunday, Nov. 25 11:25AM - 11:35AM Room: E350

Participants
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PURPOSE

To evaluate the utility of dynamic contrast-enhanced MRI and diffusion weighted imaging (DWI) in the differentiation of nasopharyngeal carcinoma (NPC) and nasopharyngeal lymphoma (NPL).

METHOD AND MATERIALS

Fifty-two patients with pathologically confirmed NPC and 43 patients with NPL were recruited and underwent conventional MRI and dynamic contrast-enhanced MRI. The MR signals, time signal-intensity curves(TIC) types, time to peak(TTP), enhancement peak(EP), maximum contrast enhancement ratio(MCER), washout ratio(WR), ADC and relative ADC value of all the subjects were calculated and analyzed, thereafter, inter-group comparison was performed. The threshold values of TTP, EP, MCER, WR, ADC and rADC for differentiating NPC from NPL were determined using a receiver operating characteristic curve (ROC) analysis.

RESULTS

For NPC group, 40 cases (76.19%) demonstrated obvious heterogeneous enhancement. The mean TTP, EP, MCER and WR were (48.29±12.20)s, 1475.38±77.76, (136.89±24.41)% and 16.81±8.36, respectively. For NPL group, 38 cases (88.89%) demonstrated obvious homogeneous enhancement. The mean TTP, EP, MCER and WR were (63.21±14.29)s, 1161.82±64.04, (113.47±28.52)% and 7.39±6.21, respectively. The ADC value and rADC value were (842.34±94.66)×10-6 mm2·s-1 and 0.74±0.08 in NPC, whereas (652.15±83.47)×10-6 mm2·s-1 and 0.56±0.08 in NPL. The differences of TTP, EP, MCER, WR, ADC, rADC between NPC and NPL were statistically significant ($P<0.05$). The TTP of NPC was lower than that of NPL, whereas the opposite for the remaining parameters. ADC and rADC value reveled the highest diagnostic efficiency in differentiating NPC from NPL, while rADC was even slightly superior to ADC. The best differentiate threshold value of ADC and rADC were 736.5×10-6mm2·s-1, 634.0×10-6mm2·s-1, respectively. While the areas under the ROC curve (AUC), sensitivity, specificity and Youden index of ADC and rADC were 0.943, 0.909, 0.852, 0.761, and 0.951, 0.955, 0.852, 0.77, respectively.

CONCLUSION

Dynamic contrast-enhanced MRI and DWI are effective in differentiating NPC from NPL. ADC and rADC value reveled the highest diagnostic efficiency.

CLINICAL RELEVANCE/APPLICATION

Dynamic contrast-enhanced MRI and DWI can be applied in the differential diagnosis of NPC from NPL.

SSA17-06 Deep Learning-Based Computer-Aided Diagnosis System for Diagnosis of Cervical Lymph Node Metastasis from Thyroid Cancer on Computed Tomography: A Pilot Study

Sunday, Nov. 25 11:35AM - 11:45AM Room: E350

Participants
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Jeong Hoon Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Surgical extent of thyroid cancer relies on the accurate preoperative detection of lymph node metastasis. Therefore, contrast-enhanced computed tomography (CT) is recommended as an adjunct to ultrasonography for patients with clinical suspicion for advanced disease. The purpose of this study was to develop the computer-aided diagnosis (CAD) system to differentiate metastatic lymph nodes on preoperative CT.

METHOD AND MATERIALS

From May 2013 to July 2017, we enrolled 995 lymph nodes seen on CT, which were confirmed by fine-needle aspiration or surgery. The datasets were split into training (543 benign and 244 metastatic lymph nodes), validation (52 benign and 52 metastatic lymph nodes), and test (52 benign and 52 metastatic lymph nodes). Using the GoogLeNet-Class Activation Map model, we developed a CAD system to differentiate the metastatic lymph nodes. We evaluated the diagnostic performance of this CAD system in our test set.

RESULTS

In the test set, the sensitivity, specificity, and accuracy of our model for predicting cervical lymph node metastasis were 84.62%, 96.15%, and 90.38%, respectively. The area under the receiver operating characteristic curve was 0.912 for the CAD system.

CONCLUSION

We developed a deep learning-based CAD system for differentiation of lymph nodes metastasis from thyroid cancer on preoperative CT. This CAD system is highly accurate and may be used as an adjunctive tool for preoperative diagnosis of lymph node metastasis.

CLINICAL RELEVANCE/APPLICATION

This study is an initial report to develop a deep learning-based CAD system for diagnosis of metastatic cervical lymph nodes on preoperative CT.

SSA17-07 Therapy Effects of Advanced Laryngeal Squamous Cell Carcinoma: Evaluated Using MTRasym3.5ppm in Magnetic Resonance Amide Proton Transfer Images

Sunday, Nov. 25 11:45AM - 11:55AM Room: E350

Participants
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Lu Yu, BS, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The accurate evaluation of the therapeutic effects of advanced laryngeal squamous cell carcinoma (LSCC) remains challenging. In this study, we determined the value of MTRasym3.5ppm derived from amide proton transfer weighted for predicting the therapeutic effects of advanced LSCC and to provide valuable evidence for early judgement of the tumour's response to therapy in clinical practice.

METHOD AND MATERIALS

We prospectively analysed 41 patients with pathologically confirmed LSCC. All patients were underwent MRI on the neck before therapy. Amide Proton Transfer (APT) images (saturation time 0.8 s, saturation power 2 μT) was performed under 3.0 Tesla MR scanner. APT images were calculated using magnetization transfer ratio asymmetry at 3.5ppm with respect to water. 19 of 41 patients showed complete remission (CR), and 22 showed non-complete remission (NCR).

RESULTS

The mean of MTRasym3.5ppm in the CR group were significantly lower than the NCR group ($P<0.05$). There were no significant differences for T stage, treatment modality between two groups ($P>0.05$). The 2-year cumulative recurrence rate of patients with higher MTRasym3.5ppm values was significantly higher than that of patients with lower MTRasym3.5ppm values ($P<0.05$), while the 2-year survival rate of those patients was not significantly different ($P>0.05$).

CONCLUSION

APT could easily identify CR patients and potentially help to choose the appropriate treatment regimen for advanced LSCC.

CLINICAL RELEVANCE/APPLICATION

MTRasym3.5ppm derived from amide proton transfer weighted for predicting the therapeutic effects of advanced LSCC

SSA17-08 Computer-Aided Diagnosis System for Thyroid Nodules Seen on Ultrasonography: Diagnostic Performance and Reproducibility Based on Operator Experience

Sunday, Nov. 25 11:55AM - 12:05PM Room: E350

Participants
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PURPOSE

To evaluate the diagnostic performance and reproducibility of a computer-aided diagnosis (CAD) system for thyroid cancer diagnosis using ultrasonography (US) based on the operator's experience

METHOD AND MATERIALS

Between July 2016 and October 2016, 76 consecutive patients with 100 thyroid nodules (>= 1.0 cm) were prospectively included. An experienced radiologist performed the US examinations with a real-time CAD system integrated into the US machine, and three operators with different levels of US experience (0-5 years) independently applied the CAD system. We compared the diagnostic performance of the CAD system based on the operators' experience and calculated the interobserver agreement for cancer diagnosis and in terms of each US descriptor.

RESULTS

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of the CAD system were 88.6, 83.9, 81.3, 90.4, and 86.0%, respectively. The sensitivity and accuracy of the CAD system were not significantly different from those of the radiologist ($P > 0.05$); while the specificity was higher for the experienced radiologist ($P = 0.016$). For the less-experienced operators, the sensitivity was 68.8-73.8%, specificity 74.1-88.5%, PPV 68.9-73.3%, NPV 72.7-80.0%, and accuracy 71.0-75.0%. The less-experienced operators showed lower sensitivity and accuracy than those for the experienced radiologist (all $P<0.05$). The interobserver agreement was good for the final diagnosis and each US descriptor; however, the margin and composition remained moderate agreement.

CONCLUSION

The CAD system may have a potential role in the thyroid cancer diagnosis. However, operator dependency still remains and needs improvement.

CLINICAL RELEVANCE/APPLICATION

1. The sensitivity and accuracy of the CAD system did not differ significantly from those of the experienced radiologist (88.6% vs. 84.1%, P=0.687; 86.0% vs. 91.0%, P=0.267) while the specificity was significantly higher for the experienced radiologist (83.9% vs. 96.4%, P=0.016). 2. However, the diagnostic performance varied according to the operator's experience (sensitivity 70.5-88.6%, accuracy 72.0-86.0%) and they were significantly lower for the less-experienced operators than for the experienced radiologist (all $P<0.05$). 3. The interobserver agreement was good for the final diagnosis and each US descriptor; however, the margin and composition remained moderate agreement.

SSA17-09 Detection of Parathyroid Adenomas with Wide-Beam Multiphase CT: Towards a True Four-Dimensional Visualization Technique with Quantitative Analysis of Perfusion Parameters

Sunday, Nov. 25 12:05PM - 12:15PM Room: E350

Participants
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PURPOSE

Diagnosis of a parathyroid adenoma on CT is typically based upon features obtained from three consecutive phases: Low attenuation (NECT) Arterial peak enhancement Rapid washout of contrast in venous phase However, if timing of these phases is not optimal, wash-in or wash-out phenomena can appear less conspicuous or could even be missed. In this ethical compliant study we explore the possibility of using a multiphase (16x) technique in continuous axial scanning mode in order to perform quantitative perfusion analysis.

METHOD AND MATERIALS

Up to date, we included 13 patients with suspected primary hyperparathyroidism (i.e. an elevated serumlevel of calcium and raised levels of parathyroid hormone) prior to surgery. Continuous axial scanning (Revolution CT, GE Healthcare) was performed over a fixed 8 cm volume (100 kVp, 0.625 mm) with following temporal scan protocol: Non-contrast scan Contrast administration (90 mL, 6 mL/s) followed by 20 sec delay 11 phases with a 2-second interphase delay 4 phases with a 10-second interphase delay The following perfusion parameters were considered in the normal thyroid, parathyroid and lymph nodes: maximum peak enhancement (HUmax), mean blood flow (MBF) and volume (MBV), time to peak (TTP) and mean slope of increase (MSI).

RESULTS

In all but 2 patients the enlarged parathyroid can be visualized. Parathyroid adenomas show a different enhancement pattern compared to the thyroid, with an obvious wash-in of contrast. Most adenomas show an obvious wash-out of contrast. Normal cervical lymph nodes show a continuous and shallow increase of enhancement. HUmax of visualised adenomas is well above the normal thyroid gland (mean 474 vs 332 HU). MBF in the adenoma is 93% higher compared to the thyroid (mean 507,5 vs 263 mL/100g/min). Similarly MBV is increased with 69% (mean 21.6 vs 12.8 mL/100g). Adenomas demonstrate earlier peak enhancement, at 29.6s versus 31.6s for the thyroid. MSI is significantly steeper for the adenomas compared with normal thyroid tissue. Mean dose length product was 530±238 mGycm

CONCLUSION

Quantitative analysis of perfusion parameters obtained by multiphase CT can be used for detection and differentiation of parathyroid adenomas.

CLINICAL RELEVANCE/APPLICATION

Improved detection and differentiation of parathyroid adenomas is a key factor in the diagnosis and treatment of primary hyperparathyroidism.

SSA18

Neuroradiology (White Matter Diseases: Beyond Bright T2)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E352

BQ MR NR

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

Participants
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Sub-Events

SSA18-01 The Automatic Differential Diagnosis of Multiple Sclerosis and Cerebral Small Vessel Disease

Sunday, Nov. 25 10:45AM - 10:55AM Room: E352

Participants
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PURPOSE

Multiple sclerosis (MS) and cerebral small vessel disease (SVD) may be difficult to distinguish using only neuroimaging and clinical presentation. As early diagnosis and treatment is associated with better long-term outcome in both diseases, and the societal and monetary cost for both diseases is potentially high, particularly for misdiagnosis in MS, we developed an accurate and automatic diagnostic algorithm to differentiate relapsing-remitting MS (RRMS) and SVD using neuroimaging and clinical presentation.

METHOD AND MATERIALS

Statistical and machine learning algorithms, including a mixture of *t*-distributions and a novel spatial heuristic algorithm, were developed for the segmentation of white matter hyperintensities and T1 black holes on FLAIR and T1 W MRI sequences. Combined spatial probability maps of RRMS and SVD lesion masks were subsequently developed using a derivation set of patients. A novel cross entropy image distance metric, which is insensitive to co-registration and anatomical differences between patients, was used to quantify the similarity of new cases to each disease. Bayesian learning algorithms using non-informative priors were trained using these neuroimaging features in combination with clinical presentation. Model hyperparameters were tuned using Monte Carlo cross validation.

RESULTS

The dataset consists of 39 RRMS (median age 48 (31 - 60), 12 M, 27 F) and 72 SVD patients (median age 73 (52 - 86), 44 M, 28 F). An intraclass correlation coefficient (two-way random effects, absolute agreement, single measures) of 0.952 (95% CI [0.902, 0.976]) between total lesion volume for the automatic segmentations and RRMS ground truth tracings was obtained. The segmentation algorithms provide the additional benefit of being blind to disease ground truth, and are robust to varying MRI acquisition parameters. The model consisting of both neuroimaging and clinical features achieved 95% sensitivity and 99% specificity in distinguishing RRMS from SVD. This was a significant improvement on models developed using neuroimaging and clinical presentation in isolation.

CONCLUSION

Future directions include using additional predictors thought to distinguish the diseases in the predictive models, and extending the model to multi-disease classification.

CLINICAL RELEVANCE/APPLICATION

As the misdiagnosis rate for MS is 5-10%, and the societal and monetary cost of both diseases is high, this work has real potential for clinical impact.

SSA18-02 Diffusion Basis Spectrum Imaging (DBSI) Quantitatively Assesses Axonal Protection of FTY720 in Mice with Optic Neuritis

Sunday, Nov. 25 10:55AM - 11:05AM Room: E352

Participants
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PURPOSE

Diffusion basis spectrum imaging (DBSI) has been introduced to overcome the limitations of diffusion tensor imaging (DTI) to accurately detect and distinguish confounding neuropathologies in MS[1, 2, 3]. Optic neuritis is frequently the first symptom of MS. Fingolimod (FTY720) was the first FDA-approved oral agent for treating MS[4]. Although its anti-inflammatory effect is clear, neuroprotection, which is highly associated with neurological function, remains uncertain. This study investigates whether FTY720 treatment protects optic nerve axons from EAE mice with optic neuritis using in vivo DBSI.

METHOD AND MATERIALS

EAE was induced in C57BL/6 mice as previously reported. Daily clinical score and visual acuity (VA) were assessed. When VA <= 0.25 cycle/degree, mice were alternately assigned to receive daily gavage of either FTY720 (1 mg/kg bw) or the same amount of saline for 10 consecutive weeks. MRI experiments were performed on a 4.7 T small-animal scanner. For each EAE mouse, baseline DBSI was performed two weeks prior to immunization with follow-up scans at 2, 6 and 10 weeks post-treatment. The 25-direction diffusion-weighted imaging acquisition was performed with TR = 1500 ms, TE = 35 ms, NE = 2, FOV = 22.5 × 22.5 mm2, matrix size = 192 × 192, slice thickness = 0.8 mm, max. b value = 2,200 s/mm2, Δ = 18 ms, δ = 6 ms. The total scan time = 2 hr 4 min. Mice were perfusion fixed immediately after final in vivo DBSI for immunohistochemical assessment of axonal injury/loss, demyelination and cellular inflammation.

RESULTS

Compared with saline-treated group, FTY720 treatment slowed VA deterioration and protected against inflammation, demyelination, and axonal injury/loss as seen by in vivo DBSI-derived neuroimaging biomarkers, validated by post-DBSI immunohistochemical analysis.

CONCLUSION

Current results suggest that FTY720 reduce axonal loss in EAE mouse optic nerve. This may be direct or indirect based on its anti-inflammatory effects. We propose that DBSI could serve as a non-invasive biomarker to monitor disease progress and validate treatment efficacy for MS patients.

CLINICAL RELEVANCE/APPLICATION

Results support that DBSI derived pathological metrics can be used to assess the therapeutic efficacy of disease modifying therapies in MS and potentially other diseases.

SSA18-03 Whole Brain Adiabatic T1rho and Relaxation Along a Fictitious Field Imaging in Healthy Volunteers and Patients with Multiple Sclerosis: Initial Findings

Sunday, Nov. 25 11:05AM - 11:15AM Room: E352

Participants
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Ivan Jambor, MD,PhD, Turku, Finland (*Presenter*) Speakers Bureau, Koninklijke Phillips NV

PURPOSE

To evaluate feasibility of whole brain adiabatic T1ρ and Relaxation Along a Fictitious Field (RAFF) imaging in healthy volunteers and patients with multiple sclerosis (MS).

METHOD AND MATERIALS

Twenty-eight healthy volunteers (24 - 69 years) and nine patients (35- 45 years) with relapsing-remitting MS provided written informed consent and underwent MRI examination performed using a clinical 3 Tesla MR scanner as a part of an ongoing single institutional clinical trial. Relaxation Along a Fictitious Field in second rotating frame of reference (RAFF2) was performed using RF peak amplitude of 11.74 μT and pulse train durations of 0, 45, 90 ms. The adiabatic T1ρ data sets were obtained using hyperbolic secant (HS) pulses with the RF peak amplitude of 13.50 μT and pulse train duration of 0, 72ms, and 144 ms. The parametric maps of TRAFF and T1ρ were calculated using two parameter monoexponential model. Semi-automatic segmentation of MS lesions, white matter (WM), and gray matter (GM) was performed based on T1 and FLAIR weighted images. Mean TRAFF and T1ρ in normal-appearing WM, GM, and lesions were compared within and between subject groups by using analysis of variance.

RESULTS

The number of healthy volunteers in 20-29, 30-39, 40-49, 50-59, 60-69 age groups was 7, 5, 6, 6, 4, respectively. The differences in the median relaxation values between the age groups did not reach the level of statistical significance. Similarly, Pearson correlation coefficients were not statistically significant for any of the relaxation parameters. In contrast, statistically significant differences in TRAFF and T1ρ values were present between the tissue types in MS patients.

CONCLUSION

Statistically significant differences were present in TRAFF and T1ρ values between normal-appearing WM, GM, and lesions in patients with MS. Theses encouraging preliminary results support further instigation of RAFF for the evaluation of MS.

CLINICAL RELEVANCE/APPLICATION

Relaxation Along a Fictitious Field (RAFF) is a novel promising imaging method for evaluation of patients with multiple sclerosis.

SSA18-04 MRI Findings in Tumefactive Demyelinating Lesions: A Systematic Review and Meta-Analysis

Sunday, Nov. 25 11:15AM - 11:25AM Room: E352

Participants
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PURPOSE

We aimed to evaluate conventional and advanced MRI findings for the diagnosis of tumefactive demyelinating lesions (TDL) and determine the diagnostic performance of MRI for differentiating TDL from primary brain tumor.

METHOD AND MATERIALS

A systematic search of Ovid-MEDLINE and EMBASE up to December 6, 2017, was conducted to find relevant studies. The pooled incidence of conventional MRI TDL findings was obtained with the inverse variance method for calculating weights and the DerSimonian-Liard random-effects model. Pooled sensitivity and specificity were obtained using a bivariate random-effects model.

RESULTS

Eighteen eligible studies with 325 TDL patients were included. The pooled incidence of open ring or incomplete rim enhancement was 36% (95% CI, 25-47%), which was significantly higher than the incidence of closed ring or complete rim enhancement (13% [95% CI, 6-21%]; p = 0.0013). The pooled incidences of T2 hypointense rim, absent or mild mass effect, and absent or mild perilesional edema were 46% (95% CI, 25-68%), 64% (95% CI, 42-87%), and 55% (95% CI, 27-82%), respectively. Open ring or incomplete rim enhancement showed high specificity (98-100%). On advanced MRI, TDL showed a high apparent diffusion coefficient, peripheral restricted diffusion, and low cerebral blood volume. The pooled sensitivity and specificity of MRI for differentiating TDL from primary brain tumor were 89% (95% CI, 82-93%) and 94% (95% CI, 89-97%), respectively.

CONCLUSION

Conventional MRI findings may help differentiate TDL from primary brain tumor, although further study is needed to determine the added value of advanced MRI.

CLINICAL RELEVANCE/APPLICATION

Conventional MRI findings may help differentiate TDL from primary brain tumor.

SSA18-05 In-Vivo Tissue Marker of Neuro-Inflammation is Associated with WMH Burden: A Multimodal PET-MR stu

Sunday, Nov. 25 11:25AM - 11:35AM Room: E352

Participants
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PURPOSE

White matter hyperintensities (WMH) on FLAIR have been widely observed in patients with cerebral small vessel disease (CSVD) and Alzheimer's disease (AD). WMH is strongly associated with progression to dementia. The pathogenesis of WMH is poorly understood. Animal models and post-mortem human brain studies have suggested a role of neuro-inflammation in WMH. However, there is no in vivo data from patients to provide direct evidence. In addition, it is unclear whether amyloid deposition, a hallmark pathological feature of AD, may be directly linked to WMH. In this study, we evaluated whether neuroinflammation and amyloid deposition are associated with WMH burden using PET-MR imaging.

METHOD AND MATERIALS

18 elderly subjects (11 females, age: 76 [69, 82] (Median [interquartile range IQR])) underwent serial PET and MR scans. 11C-PK11195 PET images were acquired to estimate neuroinflammation. In addition, 11C-PiB PET to measure amyloid deposition, were acquired 19 [14, 22] (Median [IQR]) months prior to the 11C-PK11195 scans from the same patients. WMH lesions were manually outlined using FLAIR images to obtain WMH volumes (VWMH). MR T1w MPRage images were used for brain tissue segmentation. Standardized uptake value ratio (SUVR) maps were obtained using cerebellum gray matter as a reference. Linear regression was performed between VWMH vs. 11C-PK11195 SUVR in WM and GM, VWMH vs. 11C-PiB uptake, and VWMH vs. age, respectively.

RESULTS

VWMH across the elderly cohort was 8.4 ml [4.6ml 24.5ml]. 5 patients had a clinical dementia rating (CDR) score greater than 0.5 (CDR=0.5, n=3, CDR=1, n=2). 11C-PK11195 SUVR within WM, but not GM, was linearly associated with VWMH (R=0.54, P=0.022), suggestive of WM neuro-inflammation (Figure). Interestingly, amyloid deposition was not associated with VWMH (R=0.11, P=0.67).

As expected, age was linearly associated with VWMH (R=0.51, P=0.029).

CONCLUSION

Our results demonstrate that selective WM 11C-PK11195 uptake is associated with WMH burden, suggesting neuro-inflammation as a mechanism underlying CSVD and vascular cognitive impairment. In contrast, amyloid deposition is not associated with WMH.

CLINICAL RELEVANCE/APPLICATION

Selectively elevated PET 11C-PK11195 uptake within white matter demonstrates that neuro-inflammation is an important pathogenic factor in patients with white matter hyperintensity.

SSA18-06 Automated Brain Volumetry of Neuromyelitis Optica Spectrum Disorders: Inter-Scanner Variability in White Matter Hyperintensities Segmentations, and Volumetric Differences Compared with Multiple Sclerosis

Sunday, Nov. 25 11:35AM - 11:45AM Room: E352

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PURPOSE

To verify AccuBrain is a robust software for white matter lesions (WMLs) and brain volumetric segmentation in neuromyelitis optica spectrum disorders (NMOSD), and to distinguish NMOSD from multiple sclerosis (MS) in neuroimaging.

METHOD AND MATERIALS

30 NMOSD and 30 MS patients well matched on age and gender from 3D images protocol at the same scanner were recruited in the first study on evaluating brain volumetric and WML differences. In addition, 6 of the NMOSD subjects agreed to enroll in a prospective study on inter-scanner variability and were scanned at 5 different scanners within 24 hours. 2D FLAIR images were obtained from all the sites, while one 3T scanner was also used to acquire 3D T1W and FLAIR images Two automated segmentation software, AccuBrain and lesion segmentation tool (LST) toolbox for SPM were used in WMLs segmentation to assess inter-scanner repeatability. To evaluate the volumetric and WML differences between NMOSD and MS, AccuBrain was used to perform automated segmentation and quantification of WML volumes, regional brain volumes and atrophy. Coefficient of variation (CV) was calculated to assess the effect of scanners on the variability in lesion segmentation, and two-sample t test was used to evaluate the differences of each regional volumetric measure between NMOSD and MS.

RESULTS

The mean inter-scanner CV of WML volume is 14.6% ± 8.4% when using AccuBrain, which is smaller compared to that of 23.6% ± 11.2% when using LST. In the brain volumetric analysis from 3D T1WI, although NMOSD and MS generally presented similar brain atrophy pattern, we found that they differ significantly in the thalamus-proper, lateral ventricle and third ventricle. In the WML analysis from 3D FLAIR images, significant volume difference was found between NMOSD and MS in white matter hyperintensities, which can be illustrated in the WML prevalence maps from the voxel-based lesion-symptom mapping (VLSM) analysis, with MS group having more WMLs situated over the posterior horns of the lateral ventricles.

CONCLUSION

AccuBrain is a robust software for calculating WMLs in NMOSD patients in multicenter and longitudinal studies. In addition, NMOSD differs from MS not only in brain atrophy pattern, but also in WML volume and location, and AccuBrain is a suitable software for analysis.

CLINICAL RELEVANCE/APPLICATION

AccuBrain is a robust software for calculating WMLs and brain volumetric segmentation in NMOSD and MS patients.

SSA18-07 Diagnostic Accuracy of the Post-Contrast Double Inversion Recovery (DIR) T2 Sequence and Its Double Inversion Time Influence on the Multiple Sclerosis (SM) Plaque Signal

Sunday, Nov. 25 11:45AM - 11:55AM Room: E352

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PURPOSE

To assess the diagnostic accuracy of the DIR T2 sequence in recognizing relapsing or clinically suspicious active MS plaques by using the influence of double inversion time on the scan signal obtained after administered paramagnetic MDC.

METHOD AND MATERIALS

A total of Forty patients with clinically classified MS disease underwent brain magnetic resonance examinations. All the exams were performed using MR 3T scanner, with standard protocol and use of magnetic susceptibility weighted image sequences (SWI) with subsequent acquisition of Magnetization Prepared Rapid Gradient-Echo (MPRAGE T1) and pre and post-contrast DIR sequences. Two neuroradiologists, blinded on the degree of the clinical status of the disease, evaluated with final consent all the images to identify the presence or absence of lesion enhancements.

RESULTS

Fourteen out of 40 patients did not show active plaques in the post-contrastographic sequences during remission; SWI only confirmed the presence of iron deposition as a biomarker of the disease. A total of 35 enhanced lesions were detected in 26 patients. The MPRAGE T1 sequences detected 29 lesions (82.8% of the total) in 22 patients; all these lesions showed a reduction in the signal in the post-contrastographic DIR sequences, while the same sequence after MDC showed 6 (17.2%) new cortical lesions active with signal increase in the remaining 4 patients.

CONCLUSION

Our results demonstrate that the DIR post-contrast sequence has a higher diagnostic accuracy than post-contrast T1-weighted sequences in detecting different degrees of inflammation of MS plaques.

CLINICAL RELEVANCE/APPLICATION

The Double Inversion Time of DIR sequence is able to visualize different active degree of MS plaques. We believe this MRI findings can detect minimal relapse or remission of the disease and can be a useful tool for evaluate treatment response.

SSA18-08 Two-Tiered MRI Workup to Rule Out Multiple Sclerosis (MS) Based on Specialty of Referring Physician

Sunday, Nov. 25 11:55AM - 12:05PM Room: E352

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PURPOSE

To determine cost-effectiveness of a two-tiered MRI protocol for MS based on specific referral patterns.

METHOD AND MATERIALS

Data was extracted from PACS & RIS in a community hospital July 2011-August 2017. INCLUSION: 1. Patients referred for MRI of brain. 2. 'rule-out MS'; EXCLUSION: 1. Previous/known MS, 2. Prior abnormal MRI. MRI protocols: screening (MRIScrC-=Ax FLAIR, Sag Proton-density, Sag T2) vs diagnostic (MRIDxC+=Sag T1 Ax T2, Ax FLAIR, Ax T2*, Ax DWI, Ax T1 pre-contrast, Ax T1 post-contrast, Sag 3D T1 post-contrast) MRI results: 1. Negative = Normal or not suspicious for demyelination. 2. Positive = Suspicious for demyelinating disease: call back required for the traditional MRI. Technical MRI parameters: 1. Sequence list 2. Allocated MRI time 3. Presence or absence of contrast Referring MD info 1. Neurologist vs. Non-neurologist Patient demographics: 1. Age, Gender, Disposition (Outpatient, ER, Inpatient) Resources & costs identified: MRI operations cost (including scan time, room time, technologist time, secretary time), Radiologist professional fees, contrast cost (IV equipment & MRI contrast), Renal function testing for MRIDxC+, patient visit (parking). Three scenarios were simulated: A) All patients undergo MRIDxC+ (similar to most regional practices). B) All patients underwent MRIScrC-. Patients with positive results called back for MRIDxC+. C) Patients referred by neurologist followed pathway B, patients referred by non-neurologists followed pathway A.

RESULTS

343 patients were included. (Table 1). MRI results were positive in 9/52 (%17.3) of neurologists' and 31/291 (%10.6) of non-neurologists' patients (p= 0.029). MRI exam time: MRIScrC- 20-minutes, MRIDxC+ 35-minutes. Costs: MRI operations ($65.6/hour), radiologist fees ($105/case), contrast ($17.17), Renal testing ($41.28), patient visit ($20/visit). MRI cost in each scenarios: A) $241.95, B)$161.47 (%66.7 of A) , C) $175.7 (%72.6 of A). Total savings in B and C: $27604.64, $22723.75.

CONCLUSION

We have demonstrated a higher pre-test probablity for abnormal MRI results based on referring physician's speciality (neurologists in case of MS). A two-tiered MRI protocoling system based on referral source has not been described, and in this population & practice led to significant cost-savings.

CLINICAL RELEVANCE/APPLICATION

Referral patterns should be considered in application of targeted MRI workup strategies.

SSA18-09 Iron Deposition and Thickness Changes in the Optic Radiation in Relapsing-Remitting Multiple Sclerosis: An Enhanced T2*-Weighted Angiography Imaging Study

Sunday, Nov. 25 12:05PM - 12:15PM Room: E352

Participants
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PURPOSE

This study was aimed to investigate iron deposition and thickness and signal changes in optic radiation (OR) in patients with

This study was aimed to investigate iron deposition and thickness and signal changes in optic radiation (OR) in patients with relapsing-remitting multiple sclerosis (RRMS) by enhanced T2*-weighted angiography imaging (ESWAN).

METHOD AND MATERIALS

Fifty-one RRMS patients (42 patients with a disease duration [DD] >= 2 years [group Mor], 9 patients with a DD < 2 years [group Les]) and 51 healthy controls (group Con) underwent conventional MRI and ESWAN at 3.0 T. Mean phase value (MPV) of the OR was measured on the phase image, and thickness and signal changes were observed on the magnitude image.

RESULTS

Group Mor had the lowest MPV. In group Mor, 28 patients with bilateral OR lesions showed bilateral OR thinning with a heterogeneous signal, 14 patients with unilateral OR lesions showed ipsilateral OR thinning with a heterogeneous signal. In the remaining nine patients without OR lesions, bilateral OR showed a normal appearance. In the patients, a negative correlation was found between DD and OR thickness and a positive correlation was found between MPV and OR thickness.

CONCLUSION

We confirmed iron deposition in the OR in RRMS patients, and the OR thickness was lower in the patients than in the controls.

CLINICAL RELEVANCE/APPLICATION

3D-ESWAN can detect iron deposition in the OR in RRMS patients from the early stage of the disease, and the thickness of the OR in patients with a longer DD is lower than that in the controls. Thus, iron deposition in the OR is more pronounced in the early stage and occurs independent of its morphology.

SSA19

Neuroradiology (Cognitive and Psychiatric Disorders)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E351

NR

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

FDA Discussions may include off-label uses.

Participants
Ronald L. Wolf, MD, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose
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Sub-Events

SSA19-01 Combination of Quantitative Tau Deposition on THK-5351 PET Imaging and Structural Volumetry to Improve Diagnosis in Alzheimer's Disease Spectrum

Sunday, Nov. 25 10:45AM - 10:55AM Room: E351

Participants
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PURPOSE

The purpose of this study was to determine whether quantitative measurement of tau deposition from [18F]THK-5351 positron emission computed tomography (Tau PET) can improve diagnosis of Alzheimer's disease spectrum with well-defined structural volumetry on MRI.

METHOD AND MATERIALS

From a prospective database in a multicenter study (NCT02656498), 113 subjects who had both baseline structural MRI and Tau PET within 6 month interval were included. There were 32 normal controls (NC), 55 mild cognitive impairment (MCI), and 26 Alzheimer's disease (AD) patients, and all institutions received IRB approval. Hippocampal volume was quantified from FDA-approved software for automated volumetric MRI analysis (Neuroquant) using T1-weighted-images. Standardized uptake value ratio (SUVr) was calculated from Tau PET images for 6 composite FreeSurfer-derived regions-of-interests (ROIs) approximating the anatomical definitions of in-vivo Braak stage 6 regions (Braak ROIs). Analysis of variance was performed to determine locations for structural volumetry analysis. Diagnostic performance of Tau PET ROIs and structural volumetry were compared using the area under the receiver-operating characteristic curve (AUROC).

RESULTS

Compared with NC, MCI and AD showed significantly lower hippocampal volume (mean±standard deviation, NC, 7.14±0.84; MCI, 5.99±1.18; AD, 5.90±1.30mm3, P=0.01) and AD showed lower anterior cingulate volume (NC, 6.09±0.85; MCI, 6.00±0.76; AD, 5.43±0.91mm3, P=0.006). The diagnostic performance of structural volumetry (hippocampus and anterior cingulate) was higher than Braak ROIs in diagnosing AD from MCI (volumetry AUROC 0.70, 0.57-0.83 vs. Tau PET AUROC, 0.60, 0.48-0.71) or in diagnosing AD from NC (volumetry AUROC 0.84, 0.73-0.94 vs. Tau PET AUROC, 0.78, 0.65-0.87). Adding Braak ROIs significantly improved diagnostic performance in distinguishing AD from MCI (AUROC 0.81, 0.70-0.92, P<0.01) as well as AD from NC (AUROC, 0.93, 0.87-0.99, P <0.05) than using structural volumetry or Tau PET alone.

CONCLUSION

Quantitative analysis of tau deposition improved the diagnostic performance compared to structural volumetry alone in diagnosis of Alzheimer's disease spectrum, especially in diagnosis of Alzheimer's disease.

CLINICAL RELEVANCE/APPLICATION

Differentiating AD from MCI still remains as a diagnostic challenge in clinical practice and adding quantitative Tau deposition using Braak ROIs may become a potentially useful imaging biomarker.

SSA19-02 White Matter Cellularity Change Correlates with CSF ß-Amyloid in Preclinical Alzheimer's Disease

Sunday, Nov. 25 10:55AM - 11:05AM Room: E351

Participants

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PURPOSE

Innate immune cells, particularly microglia and astrocytes, have been reported to mediate the inflammatory response in Alzheimer disease (AD) and are considered to be an important contributor to AD pathogenesis. In the AD brain, Aß deposition and neurofibrillary tangles provide obvious stimuli for neuroinflammation. This study aims to investigate the relationship between CSF ß-amyloid (Aß42) (a marker of Aß deposition) and white matter cellularity change (reflecting immune cell activation) in preclinical AD using a diffusion MRI based method, neuro-inflammation imaging (NII).

METHOD AND MATERIALS

CSF samples from 143 participants (average age 65.0 ± 8.2) with normal cognition underwent analysis for Aß42, total tau (tTau) and phosphotau 181 (pTau) with Roche Elecsys assays performed on the automated Roche cobas e 601 analyzer. NII was acquired with multi-b value scheme (bmax =1400s/mm2 and 23 directions). NII cell diffusivity (reflecting inflammatory cell activation) and cell fraction (reflecting inflammatory cell infiltration) was quantified by solving the NII model. The whole brain voxel-wise DTI-indices was analyzed using Tract Based Spatial Statistics (TBSS) (available in FSL).

RESULTS

NII cell diffusivity and cell fraction in major WM tracts was negatively correlated with CSF levels of Aß42 (Fig. 1 and 2). As an estimate of effect size, partial correlations were also examined between the NII imaging marker and CSF Aß42. When controlling with age, gender and APOE ε4 genotype, the partial correlations with CSF Aß42 was rpartial = -0.34 ($P < 0.001$) for NII cell diffusivity in the genu of corpus callosum (Fig. 1B) and rpartial = -0.30 ($P < 0.001$) for NII cell fraction in the posterior lateral capsule (Fig. 2B). Positive correlation between NII cell diffusivity with CSF tTau and pTau in the corpus callosum was observed.

CONCLUSION

The significant negative correlations between NII cellularity and CSF Aß42 suggest NII may be used to track the immune cell activation associated with abnormal ß-amyloid accumulation. NII holds promise to noninvasively study the role of inflammation during AD progression and the effect of treatments targeting immune response.

CLINICAL RELEVANCE/APPLICATION

Neuro-inflammation imaging holds promise to noninvasively study the role of inflammation during Alzheimer disease progression and the effect of treatments targeting immune response.

SSA19-03 Correlation of Lobar Cerebral Microbleeds with Amyloid, Perfusion, and Metabolism in Alzheimer's Disease

Sunday, Nov. 25 11:05AM - 11:15AM Room: E351

Participants
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PURPOSE

Despite the well-documented relationship between lobar CMBs (lCMB) and Alzheimer's disease (AD), there is limited knowledge about the role of lCMB in AD pathology. To understand the nature of this relationship, we investigated the association between lCMB and total and regional amyloid load, perfusion and metabolism.

METHOD AND MATERIALS

Participants with AD, Mild cognitive impairment (MCI) and age-matched healthy controls were recruited through well-established memory services. Detailed cognitive assessments and cardiovascular (CV) history and risk factors were recorded. All participants were imaged with Pittsburg-Compound B (PiB)-, Fludeoxyglucose (FDG)-PET followed by 3T MRI with susceptibility-weighted-imaging (SWI). Early frames of PiB-PET (1-8 min) were utilized to estimate perfusion and late frames (40-70 min) to measure amyloid burden. FDG emission data was acquired from 60-90 minutes after injection. PET uptake was presented as standardized uptake value ratio (SUVR) using cerebellum as reference. Presence of lCMB in each anatomical region was documented and the association between lCMB and PET uptake in each lobe was measured using multiple regression models. The mean of PET SUVRs was also compared between groups using t-test.

RESULTS

In multiple regressions models adjusting for sex, age, education, CV risk factors and clinical diagnosis, presence of lCMB was associated directly with total ($p<0.001$) and regional ($p=0.01$) late PiB and inversely with early PiB uptakes ($p=0.04$). In MCI group, participants with lCMB had higher perfusion ($p=0.001$) and metabolism (0.03) compared to MCI without lCMB, while AD individuals with lCMB had lower perfusion ($p=0.03$) than those with no lCMB and no significant difference in their metabolism. Presence of lCMB also weakened the association between perfusion and metabolism ($R2 =0.2$ versus $R2 =0.49$).

CONCLUSION

There is a significant relationship between lCMBs and various markers of AD pathology. lCMB has spatial association with AB load and complex effect on perfusion and metabolism.

CLINICAL RELEVANCE/APPLICATION

lCMB could exacerbate and accelerate the neurodegenerative process in AD by affecting perfusion and metabolism. Regional association between lCMB and amyloid burden in PET suggests vascular amyloid could represent total amyloid load.

SSA19-04 Mismatch of Perfusion and Brain Function in Type 2 Diabetes with Normal Cognition: Potential Compensation for Cognitive Impairment?

Sunday, Nov. 25 11:15AM - 11:25AM Room: E351

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PURPOSE

Type 2 diabetes mellitus (T2DM) is associated with increased risk of cognitive impairment and dementia, for which the disturbance in cerebral perfusion is an important etiology. The aim of this study is to explore the effect of T2DM on the coupling between cerebral blood flow (CBF) and cortical activation and its potential contribution to cognitive function.

METHOD AND MATERIALS

A total of 36 T2DM patients with normal cognition and 36 sex- and age-matched healthy subjects underwent arterial spin labeling imaging to compute CBF, resting-state functional MR (fMR) to identify the CBF-related network, and to calculate indicators of cortical activations, including functional connectivity strength (FCS), functional connectivity (FC) between region with decreased CBF and the whole brain, mean amplitude of low-frequency fluctuation (mALFF) and mean regional homogeneity (mReHo) of regions within CBF-related network. The CBF-cortical activation correlation coefficients, the so called CBF-cortical activation coupling, of regions in CBF-related network and its relationship with cognitive performance were compared between the 2 groups.

RESULTS

T2DM patients with normal cognition showed significantly reduced CBF in the rostroventral area of the left inferior parietal lobule, whereas increased FCS in left dorsal caudate. In T2DM patients, significantly increased CBF-related FCs were predominantly located in cognitive- and executive-related brain regions, including the middle frontal gyrus (MFG), fusiform gyrus (FuG), superior parietal lobule (SPL), and inferior parietal lobule (IPL). The CBF-FC coupling at IPL, SPL, and CBF-mReHo coupling at MFG were significantly increased in T2DM patients. FCs of CBF-related network was positively correlated with global cognition, whereas negatively correlated with episodic memory and executive function across all subjects.

CONCLUSION

Our findings demonstrated that the mismatched decreased CBF accompanied by increased FCs in CBF-related network plays a complementary role in T2DM patients with normal cognition. Increased neurovascular coupling might be a possible neuropathological mechanism of the preservation of cognitive function in T2DM patients.

CLINICAL RELEVANCE/APPLICATION

CBF and CBF-related FCs from fMR play a complementary role in early T2DM and are recommended as powerful biomarkers to explore the neuropathological mechanism of cognitive impairment and preservation.

SSA19-05 The Cortical-Limbic Structural Covariance Network as an Early Predictive Bio-Signature for Cognitive Impairment in Parkinson's Disease

Sunday, Nov. 25 11:25AM - 11:35AM Room: E351

Participants
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PURPOSE

In the present study, we sought to identify the epicenter and its associated structural network that targeted the cognitive

impairments in Parkinson's disease (PD). We then tested whether alterations of the structural network would predict future cognitive decline in PD patients.

METHOD AND MATERIALS

One hundred and one patients with PD (subgrouping into 3 groups [PD-normal (PDN), PD-mild cognitive impairment (PDMCI), PD-dementia (PDD)]) and 58 normal control volunteers underwent comprehensive neuropsychological testing and T1W volumetric MRI scans. Epicenters were identified by voxel-wise group comparison between PDN and PDD. Gray matter structural covariance network (SCN) were constructed using the epicenters as seeds. The SCN volume corrected by total intracranial volume was calculated in each individual to reflect the SCN integrity. The PDN group had follow-up neuropsychological testing one year after the initial exam to assess the status of conversion into cognitive impairment.

RESULTS

Bilateral amygdala and hippocampus were significantly atrophied in PDD as compared to PDN group. Analysis of bilateral amygdala/hippocampus SCN showed decreasing volume in PDD and PDMCI as compared to PDN group. The PDD group showed stronger covariance strength in the left prefrontal cortex as compared to the PDN group. The lower volume of bilateral amygdala/hippocampus SCN were associated with poorer cognitive function in all domains while lower volume in the prefrontal cortex was associated with poorer cognitive function in the attention and executive function domain. Smaller volume of bilateral amygdala/hippocampus SCN and left prefrontal cortex in the PDN patients can predict the conversion into PDMCI at one-year follow-up.

CONCLUSION

The cortico-limbic system is important in cognitive decline in PD patients. The atrophy of amygdala/hippocampus SCN and increased co-atrophy of the prefrontal cortex can early predict MCI conversion in PD patients with normal cognition.

CLINICAL RELEVANCE/APPLICATION

The analysis of cortical-limbic structural covariance network alteration can early predict MCI conversion in PD patients with normal cognition.

SSA19-06 Repetitive Transcranial Electrical Stimulation Produces Enhanced Resting Cerebral Perfusion in the Locus Coeruleus

Sunday, Nov. 25 11:35AM - 11:45AM Room: E351

Participants
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PURPOSE

To evaluated the effect of repetitive left prefrontal transcranial electrical stimulation (TES) on cerebral perfusion (i.e., cerebral blood flow, CBF).

METHOD AND MATERIALS

11 healthy, active-duty, Air Force military members completed 3 experimental sessions on 3 consecutive days. Transcranial DC stimulation, a form of TES, was utilized to deliver 2mA to the left prefrontal cortex (approximately F3) for 30 min at each session. Stimulation began concurrently with a 30 min laboratory vigilance task. The cathode was placed on the contralateral bicep. Pre- and post-stimulation MRI acquisitions were conducted at each session. The MRI procedure included a 3D pseudo-continuous arterial spin labeling sequence to acquire resting CBF. A control group consisting of 9 subjects performed the same procedures except sham stimulation was provided (30 s of stimulation followed by 19.5 min of no stimulation). CBF maps were created from the raw ASL data using proton density maps and a single-compartment perfusion model. The CBF maps were registered to a reference space. Permutation testing compared changes in CBF from session 1 pre-stimulation to session 3 post-stimulation between groups and within-groups on a voxel-wise basis using 500,000 permutations. The permutation test results were cluster-corrected for multiple comparisons.

RESULTS

Widespread increases in perfusion, indicative of increased metabolism, were observed in the active stimulation group; however, general decreases were observed in a matched group receiving sham TES. Furthermore, perfusion increased significantly more in the active stimulation group across many areas of the brain. These increases originated in the locus coeruleus (LC) and spread extensively to regions in the neocortex supporting functions such as object recognition and top-down attentional modulation.

CONCLUSION

Altered CBF in the LC is indicative of enhanced metabolic activity as cerebral perfusion is neurovascularly coupled with glucose metabolism. This finding increases our understanding of the broad behavioral effects that have been demonstrated using left prefrontal TES.

CLINICAL RELEVANCE/APPLICATION

Altered production of norepinephrine has been linked with many neurologic disorders including Parkinson's disease, major depression disorder, and attention deficit hyperactivity disorder. Our findings implicate the potential for left prefrontal TES in the treatment of such disorders.

SSA19-07 Tract Based Spatial Statistics in Persons who Will Develop Alzheimer's Dementia: A Study from the Alzheimer's Disease Neuroimaging Initiative (ADNI)

Sunday, Nov. 25 11:45AM - 11:55AM Room: E351

Participants
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PURPOSE

To quantify differences in diffusion tensor imaging of persons who decline from normal cognition to Alzheimer's dementia compared to controls who do not develop dementia.

METHOD AND MATERIALS

All subjects were from ADNI2 (n = 20). Average age was 73.4 ± 3.9 years with age range 68.2-83.7 years. All subjects were age and gender-matched for comparison. The sample was 60% women and 40% men. Each subject received 3T MR imaging on either a Siemens or GE scanner for T1 volumetric imaging, MP-RAGE for Siemens or SPGR for GE. All DTI scans were obtained on a 3T GE scanner. Raw T1 and DTI DiCOM images were converted to NiFTI file format. Each scan was visually inspected for gross artifacts. Images were corrected for motion, eddy currents and skull-stripped using the fMRI software library (FSL). Fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity and radial diffusivity (RD) maps were also obtained via FSL's dtifit and FSLmaths tools and visualized for errors. Data were then processed through FSL's tract-based spatial statistics (TBSS) with default parameters. FA, MD, RD, and axial diffusivity values were extracted.

RESULTS

Of the 20 subjects, 10 experienced longitudinal cognitive decline and 10 remained cognitively normal. Of the 10 converters, 80% were MCI at baseline and converted to AD and of these 50% declined after 6 months and another 50% declined after 12 months. Of the remaining two converters, one declined from normal to mild cognitive impairment (MCI) to AD after 24 months and another subject experienced a similar trajectory after 48 months. Comparing global DTI metrics, there was a trend towards statistical significance with respect to lower global mean FA in converters compared to non-converters ($t = -.43$, $p = .07$). However, voxel wise analyses with TBSS showed statistically significant reductions in frontal white matter tracts in converters compared to non-converters as shown in Figure 1 (red arrows). There were no statistically significant differences in other global DTI metrics including RD, MD, and axial diffusivity.

CONCLUSION

Diffusion weighted MR imaging identifies quantifiable differences between AD converters compared to non-converters.

CLINICAL RELEVANCE/APPLICATION

Identification of non-invasive quantitative neuroimaging biomarkers that predict cognitive decline to Alzheimer's dementia is important for determining persons who may benefit from drug trials or modification of risk factors.

SSA19-08 MR Differences of Cerebral Small Vessel Diseases in AD and MCI Patients

Sunday, Nov. 25 11:55AM - 12:05PM Room: E351

Participants
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PURPOSE

To evaluate and compare MRI manifestations of cerebral small vessel diseases (SCVD)among Alzheimer's disease (AD), mild cognitive impairment (MCI) patients and healthy controls (HC), and then to analyze the correlation between CSVD and cognitive score.

METHOD AND MATERIALS

Twenty-four AD patients (12 men and 12 women;mean age,73.08±8.39 yrs) and twenty-four cases of MCI (11 men and 13 women;mean age,70.08±8.5 yrs) were participated into this study. Twenty-two volunteers without cognitive dysfunction were also recruited as controls (11 men and 11 women; mean age,71.01±8.10 yrs). Their age, gender and education matched in three groups. All subjects underwent conventional sequences (including T1WI, T2WI and T2 Flair) and SWI on 3.0T MRI scanner. Enlarged perivascular spaces (EPVS) were counted and scored in basal ganglia (BG) and centrum semiovale (CS). Moreover, cerebral microbleeds (CMBs) and lacunar infarction (LI) were also counted, whileas white matter hyperintensity lesions(WMH) were graded and recorded. The Kruskal-Wallis test and Kolmogorov-Smirnov Z test were used to compare the ranked data between groups. Correlation between SCVD and MMSE were assessed by spearman correlation analysis.

RESULTS

In the BG, EPVS scores increased in AD group (2.08±0.77) than in MCI (1.29±0.46) and controls(1.09±0.29)($P<0.01$); no difference

was found between EPVS scores in MCI and controls (P>0.05). In the CS, EPVS scores in AD group (2.87±0.79) and MCI group (2.12±0.53) were significantly higher than that in controls (1.36±0.49) (P<0.01). There was no difference of cerebral microbleeds between three groups (P>0.05). The periventricular WMH and deep WMH in the AD group increased than in the controls (P<0.05). Compared to MCI group, AD group showed more severe in the periventricular WMH (P<0.01). The incidence of LI was most in AD group (58.3%, 14/24), in turn in MCI group (29.2%, 7/24) and in controls (18.2%, 4/22, P<0.05). In all data, EPVS in BG and CS, periventricular and deep WMH showed the negative correlation with MMSE score (r=-.072, -0.31, -0.56, -0.40; all P <0.05).

CONCLUSION

CSVD is more common in AD than in MCI patients, and EPVS and WMH have significant effect on cognitive impairment.

CLINICAL RELEVANCE/APPLICATION

CSVD is common in AD patients and is associated with the clinical status.

SSA19-09 Altered Functional and Effective Connectivity Patterns Based on the Subregion of Hippocampus in Young Apoeε4 Carriers: A Three-Year Follow-Up Study

Sunday, Nov. 25 12:05PM - 12:15PM Room: E351

Participants
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PURPOSE

To determine whether the functional and effective connectivity based on the subregions of hippocampus altered in young APOE4 carriers with follow-up.

METHOD AND MATERIALS

Resting-state functional MRI data and neuropsychological scales were obtained for APOE4 (with the age 24.0±3.2 years old, 7 female and 6 male) and APOE3 carriers (with the age 22.9±1.6 years old, 12 female and 7 male) at baseline and three-year follow-up. The hippocampi were divided along the A-P axis, into three equal sections (sub1/2/3 respectively stands for the anterior, middle and posterior part of the hippocampus). The hippocampus- and sub- based functional connectivity (FC) patterns were compared by mixed effect analysis and further post-hoc analysis. The effective connectivity (EC) patterns among the altered regions, affected by APOE4-by-time interaction, were examined in APOE4 groups at baseline and follow-up. The correlation analysis was conducted between the values of altered FC or EC and neuropsychological scales

RESULTS

The APOE4-by-time interaction effect was evident in FC between sub3(L) and left middle and superior temporal gyrus (MTG/STG), sub2(R) and MTG/STG(L), and sub3(R) and anterior cingulate cortex(ACC). The Post-hoc analysis revealed decreased FC in sub3(L)-MTG/STG(L), sub3(R)-ACC, and increased FC in sub2(R)-MTG/STG(L) in APOE4 group at baseline when compared with APOE3 group. The APOE4 group at follow-up showed increased FC in sub3(L)-MTG/STG(L), sub3(R)-ACC and decreased FC in sub2(R)-MTG/STG(L) (all P<0.05, corrected by Gaussian random field with voxel-size P<0.01 and cluster-size P<0.05). The FC in sub3(L)-MTG/STG(L) at baseline and sub2(R)-MTG/STG(L) at follow-up correlated with the scores of scales both in APOE3 and APOE4 group. Besides, the APOE4 group showed increased EC separately from sub2(L) and MTG/STG(L) to sub3(L) among altered regions (the bilateral sub2/3, MTG/STG(L) and ACC). The values of changes in EC from MTG/STG(L) to sub3(L) positively correlated with the changed scores of delayed recall test (all P<0.05).

CONCLUSION

The left posterior part of hippocampus might be most vulnerable and susceptible to early modulation of interaction of APOE4 by time, which might be used as the longitudinal imaging-derived-phenotype in APOE 4 carriers.

CLINICAL RELEVANCE/APPLICATION

providing a new biomarker to predict the early neuroimaging alteration in the young carriers.

SSA20

Physics (Ultrasound in Imaging and Radiation Therapy)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S102CD

PH RO 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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Thaddeus A. Wilson, PhD, Madison, WI (*Moderator*) Nothing to Disclose

Sub-Events

SSA20-01 Parametric Mapping of the Prostate with Contrast-Enhanced Subharmonic Imaging

Sunday, Nov. 25 10:45AM - 10:55AM Room: S102CD

Participants
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PURPOSE

To prospectively evaluate different quantitative parameters from contrast-enhanced transrectal subharmonic imaging (SHI) for the diagnosis of prostate cancer with histopathology as the reference standard.

METHOD AND MATERIALS

Fifty-five male patients scheduled for a transrectal systematic prostate biopsy were enrolled in this IRB-approved study. A 12-core sextant biopsy was done in each subject along with up to 6 additional targeted biopsies. Subjects were imaged with a transrectal IC5-9D ultrasound (US) transducer on a modified Logiq E9 system (GE Healthcare; Milwaukee, WI) operating in SHI mode (transmit/receive: 7.0/3.5 MHz). Two vials of the US contrast agent Definity (Lanteus Medical Imaging; N. Billerica, MA) diluted in 50 mL of saline were infused over 10 minutes. Images were obtained with transverse sweeps though the prostate using conventional US, color and power Doppler, as well as contrast harmonic imaging (HI), and SHI. Microbubble destruction pulses followed by motion-compensated maximum intensity projection (MIP) was evaluated in combination with HI and SHI. Imaging modes were rated on a five-point scale (1-5; benign to definitely malignant) for each sextant. Using MIP time intensity curves, parametric maps were generated at each biopsy location for the peak intensity (PI), time to peak (TTP), and estimated perfusion (EP as the slope of the wash-in). Parameters were compared to biopsy results.

RESULTS

Prostate cancer was found in 55 of 660 cores (8.33%) from 24 of the 55 subjects (43.64%). No significant difference between benign and malignant biopsy specimens were demonstrated for TTP (3.01 ± 1.52 vs 3.18 ± 1.56 s; p=0.44). Two quantitative SHI parameters showed a significant difference between benign and malignant biopsy cores: EP (25.69 ± 8.74 vs 30.09 ± 10.23 a.u./s; p=0.0007) and PI (123.85 ± 16.02 vs 129.66 ± 17.38 a.u.; p=0.014).

CONCLUSION

Quantitative SHI demonstrates significantly higher EP and PI at sites with prostate cancer.

CLINICAL RELEVANCE/APPLICATION

SHI appears to improve the diagnosis of prostate cancer relative to conventional transrectal US.

SSA20-02 Ultrasonic Spectrum Analysis of the RF Time Series Can Early Predict the Tumor Response to Chemotherapy in Preclinical Breast Cancer Models

Sunday, Nov. 25 10:55AM - 11:05AM Room: S102CD

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PURPOSE

This study was aimed to assess whether ultrasonic spectrum analysis of radiofrequency (RF) time series using a clinical ultrasound system allows for the early prediction of the tumor response to chemotherapy in human breast cancer xenografts that imitate clinical responding and nonresponding tumors.

METHOD AND MATERIALS

Clinically responding (n=20; MCF-7) and nonresponding (n=20; MBA-MD-231) breast cancer xenografts were established in 40 nude mice. Ten mice from each group received either chemotherapy (adriamycin, 4 mg/kg) or saline as controls. Each tumor was imaged longitudinally with a clinical ultrasound scanner at baseline (day 0) and subsequently on days 2, 4, 6, 8 and 12 following treatment, and the corresponding RF time-series data were collected. Changes in six RF time-series parameters (slope, intercept, S1, S2, S3 and S4) were compared with the measurement of the tumor cell density, and their prediction performances of the treatment response were analyzed.

RESULTS

Adriamycin significantly inhibited tumor growth and decreased the cancer cell density in responders ($P < 0.001$) but not in nonresponders ($P > 0.05$). Fold changes of slope were significantly increased in responders two days after adriamycin treatment ($P = 0.002$), but not in nonresponders ($P > 0.05$). Early changes in slope on day 2 could predict the treatment response in 100% of both responders (95% CI, 62.9-100.0%) and nonresponders (95% CI, 88.4-100%).

CONCLUSION

Ultrasonic RF time series allowed for the monitoring of the tumor response to chemotherapy and could further serve as biomarkers for the early prediction of treatment outcomes.

CLINICAL RELEVANCE/APPLICATION

Because ultrasound imaging provided several major benefits such as the relatively low cost, portability and repeatability, and lack of radiation risks, our study built the foundation of further translational research to assess the clinical application of the RF time series to predict the treatment response in cancer patients without using any contrast agents.

SSA20-03 Electric-Field Induced Acoustic Tomography (EfAT) for In-Situ Monitoring of Tumor Ablation during Irreversible/Reversible Electroporation

Sunday, Nov. 25 11:05AM - 11:15AM Room: S102CD

Participants
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PURPOSE

High intensity ultra-short pulsed electric fields applied across a cell to increase the membrane permeability, allowing non-permeant drugs, genes access (or tumor ablation) through the formation of nano-scale pores in the cell membrane, known as reversible (or irreversible in the case where nano-scale defects in the cell membrane is used for tumor ablation instead of drugs/genes delivery). For physicians, real-time monitoring of cancer treatment and characterization of the delivered electric field is very important for treatment planning and therapy efficacy monitoring. Many techniques i.e. MRI or MREIT are suggested to characterize this process, but currently cannot monitor the process during pulse delivery in real time and mostly used for pre-and post-stimulation exposure.

METHOD AND MATERIALS

A new imaging technique based on flow of electric field induced acoustic tomography is reported. The absorbed electric energy around the subject under test raises its temperature, thus leading to expansion effects. The expansion, then induces acoustic tomography images which can be acquired outside the body and consequently be used for real-time characterization and monitoring the electroporation process. These acoustic images made through the high-intensity and ultra-short pulsed electric fields that used in the electroporation process where combines the advantages of high-contrast electric field distribution and high-ultrasonic spatial resolution.

RESULTS

We captured different acoustic signals and corresponding ultrasonic images by changing the location of electric distribution in scale of mm and varying the electric field intensity (μs-ns 20kVcm-1-63kVcm-1) applied in irreversible and reversible electroporation process. The experimental results demonstrated a linear correlation between the measured acoustic signals and the intensity of the electric field.

CONCLUSION

The study results indicate that this new technique can potentially be used for monitoring the electric field distribution as a non-invasive, label-free technique for real-time, in situ monitoring of electroporation-based technologies for treatment and ablation cancer.

CLINICAL RELEVANCE/APPLICATION

for ECT and NIIRE, the treatment efficiency is correlated to electric field distribution. To ensure adequate electric field coverage of the treated tumor EfAT to mapping the eletric field distribution is used for treatment plannning and therapy efficacy monitoring in the clinic.

SSA20-04 Accuracy of Volumetric Measurements in the Breast: A Study of Comparing Ultrasound Tomography and Hand-Held Ultrasound

Sunday, Nov. 25 11:15AM - 11:25AM Room: S102CD

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PURPOSE

This study assessed the accuracy of volumetric measurements acquired with ultrasound tomography (UST). UST imaging generates 3D speed-of-sound maps that can identify tissue types and measure lesion volumes. Since tumor volume doubling time is associated with growth rate and tumor biology, accurate measurement of tumor volume is critical for oncologic diagnosis, staging, and treatment.

METHOD AND MATERIALS

Six cylindrical agar phantoms were imaged using UST and hand-held ultrasound (HHUS). Each phantom contained 4 embedded "lesions" composed of irregular-shaped chicken breast with known volumes ranging from 1.3 cm3 to 7.4 cm3. Two board-certified breast imaging fellowship-trained radiologists independently performed blind interpretations of the UST and HHUS phantom images and calculated 24 lesion volumes. UST volumes were calculated with automated segmentation software (QT Ultrasound, Novato, CA). HHUS lesions were measured in 3 dimensions (a, b, c) and their volumes were calculated using 2 volume formulas: (1) (4/3)πr3 (with r = average of a, b, and c); and (2) (π/6)abc. These calculations were then statistically analyzed to determine the volumetric measurement accuracy of both UST and HHUS as compared to known true volumes calculated by water displacement methods.

RESULTS

The average lesion volume calculated from UST images was 3.93 1.55 cm3 and from HHUS was 6.39 2.61 cm3 (sphere) or 5.65 2.39 cm3 (ellipsoid), compared to the true average of 3.98 1.47 cm3. HHUS volumes were significantly larger than the true volumes with a mean over-estimation of 62.8% 36.9% cm3 (sphere) or 43.3% 32.6% cm3 (ellipsoid), whereas UST volumes agreed with the truth within measurement errors. Interobserver agreement was substantial (ICC = 0.95).

CONCLUSION

This study demonstrates that UST can accurately measure the volume of irregular-shaped masses, with superior accuracy than HHUS.

CLINICAL RELEVANCE/APPLICATION

Ultrasound tomography can accurately measure tumor volume, demonstrating its potential utility in guiding oncologic management and treatment.

SSA20-05 Evaluating Ductal Carcinoma in situ Progression via Tissue Oxygenation and Perfusion Using Photoacoustic and Contrast-Enhanced US

Sunday, Nov. 25 11:25AM - 11:35AM Room: S102CD

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PURPOSE

To investigate tissue oxygenation and perfusion as predictors of the aggressiveness of ductal carcinoma in situ (DCIS) as well as the influence of physical exercise on these parameters as well.

METHOD AND MATERIALS

Twenty FVB/NJ and 10 Tg(C3-1-TAg)cJeg mice (Jackson, Laboratories, Bar Harbor, ME) were evenly split into active and control subgroups, where the active group had access to a Fisher Science exercise wheel. Changes in mammary gland vascularity and perfusion were monitored with a Vevo 2100 LAZR scanner (FujiFilm VisualSonics, Toronto, Canada) using a LZ-250 PA probe.

Photoacoustic imaging was used to measure tissue oxygenation. To assess perfusion quantification, each mouse received a retroorbital bolus injection of 10 µL of 3-4 µm sized microbubbles (Advanced Microbubble Laboratories, Boulder, CO). Imaging of the mammary gland was performed weekly over 6 weeks and the mice were weighed biweekly. Offline analysis was performed using Vevo CQ software.

RESULTS

For the FVB/NJ mice, weekly weight changes were lower for the active group than the control group (0.43±0.70 g vs. 0.99±2.31 g, p = 0.002). Conversely, changes in oxygenation were higher for the active group than the control group (11.16±19.30% vs. 7.77±26.73; p=0.38). There were no statistical differences for contrast wash-in rates (a measure of perfusion), or area under the curve between the two groups (p>0.25). For the SV40 Tag mice that naturally develop breast tumors, the weight changes were lower for the active group than control group (1.71±1.34 g vs. 2.57±1.51 g, p=0.0056). There was also a statistical significant decrease in oxygenation in the exercise group compared to the control group (-19.37±26.88% vs. 20.21±29.55%; p<0.001). Similarly, there were no statistical differences between the wash-in rate or area under the curve between the two groups (p>0.26).

CONCLUSION

Preliminary results indicate differences in tissue oxygenation between the FVB/NJ and SV40 Tag mice may become a predictive precursor for DCIS progression. The influence of exercise was shown by the weight changes, but the influence on DCIS progression is still being investigated.

CLINICAL RELEVANCE/APPLICATION

This study may potentially minimize breast cancer overtreatments by predicting the aggressiveness of DCIS in humans via tissue oxygenation measurements using ultrasound.

SSA20-06 A New Microfluidic Setup to Adjust Objectively 2D and 4D DCE-US Presets as an Alternative to Preclinical Studies

Sunday, Nov. 25 11:35AM - 11:45AM Room: S102CD

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PURPOSE

Ultrasound tumor microvascularization assessment is a promising biomarker of patient response to anti-angiogenic drugs. Quantitative DCE-US imaging lacks dedicated phantoms featuring small vessels in order to optimize the image acquisition and define the preset parameters objectively. We propose a microfluidic setup dedicated to methodological development, and we compare it to a preclinical study on mice.

METHOD AND MATERIALS

Microfluidic setup The phantom was a 2.5x5x1cm3 block featuring cylindrical channels of diameters ranging from 145 to 450 µm. Sonovue (Bracco) was driven through the channels with very high reliability by a MFCS-EZ microfluidic flow controller (Fluigent SA, France). Flow rate was measured in real-time by a dedicated platform. An Aplio500 ultrasound scanner (Toshiba Medical Systems, Japan) with 2D and 4D 12MHz probes was used to acquire Contrast Harmonic Imaging (CHI) raw data. Quantification was made using UltraExtend FX software (Toshiba). The main parameters studied were mechanical index (MI), frequency (F), frame rate (fps), 4D volume angle (vol). *Preclinical study* 5 mice were imaged using the same 2D and 4D 12 MHz probes and injected with 100 µL Sonovue. 180 seconds raw data clips centered on the kidney were acquired and quantified using the scanner software. The same parameters were studied as on the microfluidic setup.

RESULTS

Microfluidic setup A new generation of microflow phantom enabled the precise control of 60-120 µL/min flow rates by a microfluidic pressure controller with a stable flow and under 5% variation over 3 minutes. After confirming the lack of microbubble destruction by the flow controller, the effects of MI, F, fps and vol were individually quantified. The best setup for optimal signal over noise ratio was MI 0.18, F h8.0 MHz, 4 fps, vol 30°. *Preclinical study* The best setup parameters were confirmed on the acquisitions on mice, however the in vivo variability of perfusion quantification was higher.

CONCLUSION

The microfluidic setup we developed can be used to perform reproducible tests and set up acquisition parameters objectively in DCE-US imaging modes. It is an alternative approach to preclinical studies, and is more objective than in vivo models.

CLINICAL RELEVANCE/APPLICATION

The new microfluidic setup was relevant to set up DCE-US imaging mode parameters in an objective way and to adjusting the presets in DCE-US 2D and 4D.

SSA20-07 Simultaneous MR and Ultrasound Image Acquisition in a Human Using a Hands-Free, MR-compatible, Volumetric Ultrasound Transducer for Image Guided Radiation Therapy

Sunday, Nov. 25 11:45AM - 11:55AM Room: S102CD

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CONCLUSION

These first human images demonstrate that the hands-free, electronically steerable e4D transducer can acquire ultrasound images during a MR acquisition without impacting either the MR or ultrasound images quality. This technology may be applied to other image-guided procedures (e.g. proton therapy, biopsies, and drug delivery).

Background

This work addresses the need for a cost-effective and non-invasive real-time motion management platform for radiotherapy. We have developed the first ever hands-free, MR-compatible, electronically-steered, and real-time volumetric (e4D) ultrasound probe that will be used to directly track tumor or vessel motion during radiation therapy. The ultrasound images acquired during treatment will be coupled to a pre-treatment training image set consisting of a simultaneous 4D ultrasound and 4D MRI acquisition. The images will be rapidly matched using advanced signal processing algorithms, allowing for the display and verification of MR-based tumor/organ motion in real-time from an ultrasound acquisition.

Evaluation

The transducer contains 18,000 piezoelectric elements and beam forming and data acquisition electronics in the transducer housing. Currently, the probe is designed to have a maximum imaging depth of 15 cm, with 2 mm lateral resolution at 7 cm. The transducer acquires a 3D electronically-steered volume (4 vps) with a maximum sweep angle of 30o. Simultaneous MR and ultrasound images were acquired on a healthy volunteers liver using a GE 3T MR750 scanner. A fast spoiled gradient echo (FSPGR) multi-phase 2D sagittal acquisition with temporal acquisition of 4 fps was used for imaging. A 32-channel cardiac phased-array receiver coil was used with the transducer positioned under anterior elements. Ultrasound images were acquired in harmonic mode (1.7/3.3 MHz) at a rate of 4 fps using the transducer and a GE Vivid E95 system. Images were co-analyzed using MIM Maestro.

Discussion

No significant artifacts were detected during the acquisition of the MR and ultrasound images. Some low level susceptibility artifacts near the transducer in the MR image was detected, but this was well-contained within 1-2 cm of the surface and did not adversely effect the image quality.

SSA20-08 Optimization of a Subharmonic Dynamic Contrast-Enhanced Ultrasound Technique for Liver Tumor Imaging

Sunday, Nov. 25 11:55AM - 12:05PM Room: S102CD

Participants
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PURPOSE

Conventional dynamic contrast-enhanced ultrasound (DCE-US) detects the first harmonic signal component arising mainly from the contrast agent (CA) microbubbles perfusing through the tissue, although the tissue itself also generates harmonics. Subharmonic

(SH) signal detection holds significant potential for increasing the sensitivity of tumor detection in the liver as only the CA generates subharmonics. This paper describes the optimization of the SH-DCE-US technique via bench-level experiments and its translation to a clinical scanner.

METHOD AND MATERIALS

Experiments were performed to maximize the signal from a commercial CA (SonoVue®, Bracco, Switzerland; default and an altered bubble size distribution) using a home-built microbubble characterization system with variable control over transmit beam center frequency and number of cycles. The optimal transmit beam parameters were translated to a commercial scanner (Aixplorer, Supersonic Imagine, France). A novel perfusion phantom, comprising different compartments mimicking healthy, diseased and necrotic tissue regions, was developed and used to validate the new technique on the scanner.

RESULTS

The maximum SH signal was measured for a transmit beam of 3 cycles centered at 1.9 MHz (i.e. SH signal at 0.95 MHz) for the native CA (57% bubble volume 4-10µm). The optimal transmit frequency increased to a more useful range of 2.3-2.5 MHz (SH signal at 1.15-1.25 MHz) in an altered CA with reduced polydispersity ((1-4µm; 99%/82% bubble count/volume, respectively). DCE time-intensity curves were produced on the clinical scanner using these optimal transmit beam parameters with the perfusion phantom, with improved quantification at depth of the microbubble signal using the new SH technique.

CONCLUSION

Optimal transmit beam parameters have been established for maximizing the SH signal in DCE-US scanning of the liver. Furthermore, a simple alteration of the CA's polydispersity shifted the optimal SH detection frequency above 1 MHz, which is the typical lower-frequency limit for curvilinear probes used for liver scanning. Improvements were demonstrated using a novel perfusion phanton.

CLINICAL RELEVANCE/APPLICATION

This paper demonstrates an optimized dynamic contrast-enhanced liver ultrasound imaging technique, using subharmonic signal detection with an easily-altered microbubble contrast agent formulation.

SSA20-09 US-Triggered Antibiotic Release from Novel Spinal Fusion Hardware

Sunday, Nov. 25 12:05PM - 12:15PM Room: S102CD

Participants
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PURPOSE

To determine optimal acoustic parameters for destruction of a polymeric membrane surrounding a prophylactic-containing spinal reservoir. The long-term goal is to achieve ultrasound (US)-triggered release of antibiotics from within this spinal spacer to prevent post-surgical infection.

METHOD AND MATERIALS

Polylactic acid (PLA)-coated, methylene blue (MeB)-loaded polyether ether ketone (PEEK) spacers (0.785cm3) with a drug-loading reservoir were created in our labs. Coated spacers were submerged in water and insonated for 10 minutes using a Logiq E9 scanner (GE Healthcare, Waukesha, WI) with a C1-6 curvilinear probe, using power Doppler to rupture the PLA coating for MeB release. Frequencies evaluated were 1.7, 2.5, and 3.6 MHz, pulse repetition frequencies (PRFs) tested were 0.1, 3.5, and 6.4 kHz, and acoustic output (AO) powers tested were 30, 60, and 100%. MeB release was evaluated qualitatively against known MeB concentration standards immediately following insonation and again after 24 hours. Results were collected in triplicate and compared with a one-way ANOVA.

RESULTS

Membrane rupture increases with lower frequencies, but no significant difference was observed in release from the spacers at the frequencies evaluated (70-100% cumulative release, p=0.48). Therefore, 1.7 MHz was selected as optimal. This frequency was maintained, while PRF was varied. A PRF of 0.1 kHz resulted in significantly less immediate release (17.5±1.3%; p=0.021), but no difference was seen between PRFs of 3.5 kHz (32.5±2.5%) and 6.4kHz (36.3±5.4%, p>0.99). AO power was varied with 1.7 MHz and PRF 6.4 kHz. There was no significant difference in release between the AO powers (p>0.08). Uninsonated controls exhibited only 1.3±1.2% immediate release (p=0.031), and 6.8±2.8% cumulative release (p=0.021), confirming US-triggered release as opposed to passive leakage.

CONCLUSION

This study determined scanning parameters appropriate for US-triggered release of encapsulated prophylactics, as a first step towards deployment of this drug delivery system.

CLINICAL RELEVANCE/APPLICATION

This system will aggressively combat post-surgical bacterial infection with great versatility in applications for wide clinical impact.

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SSA21

Physics (Dual-Energy/Spectral CT)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S103AB

CT 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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Sub-Events

SSA21-01 DXA-like Quantification of Bone Mineral Density using Dual-Layer Spectral CT Scout Scans

Sunday, Nov. 25 10:45AM - 10:55AM Room: S103AB

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PURPOSE

Scout scans are a mandatory part of CT examinations, but do not -yet- provide quantitative information. Purpose of this study was to develop and evaluate a method for areal bone mineral density (aBMD) measurement based on dual-layer spectral CT scout scans.

METHOD AND MATERIALS

A post-processing algorithm using a pair of 2D virtual mono-energetic scout images (VMSIs) was established in order to semi-automatically compute aBMD at the spine. The method was assessed based on repetitive measurements of the standardized European spine phantom (ESP) at the standard scout scan tube current (30 mA), at other tube currents (10 to 200 mA), as well as with fat-equivalent extension rings simulating different patient habitus, and was compared to dual-energy X-ray absorptiometry (DXA). In two female patients, the feasibility of the method was assessed in-vivo for vertebrae L1 to L4 and the results were compared to age-matched reference values. Finally, BMD was determined in a female patient population (n=31, age range 22-87 years old) with the proposed method, and T-scores were derived from the measurements, taking a young subset of the population as the reference.

RESULTS

Derived from standard scout scans, aBMD values measured with the proposed method highly correlated with DXA measurements (r=0.9925), and mean accuracy (DXA: 4.12%, Scout: 1.60%) and precision (DXA: 2.64%, Scout: 2.03%) were comparable. In particular, the scout scan-based method performed better than DXA at low BMD values (accuracy DXA: 8.3%, Scout:4.79%). Moreover, when assessed at different tube currents, aBMD values did not differ significantly ($p>=0.20$ for all), suggesting that the presented method could be applied to scout scans with different settings. Finally, data derived from sample patients as well as first T-score representations agreed well with BMD values and T-score trend from a reference age-matched population.

CONCLUSION

Based on dual-layer spectral CT scout scans, aBMD measurements were fast and reliable and highly correlated with DXA measurements. First measurements on patients were promising. Considering the number of CT acquisitions performed worldwide, this method could allow truly opportunistic osteoporosis screening at a larger scale.

CLINICAL RELEVANCE/APPLICATION

Dual-layer spectral CT frontal scout scans could provide fast and quantitative DXA-like BMD assessment at the spine and allow large-scale, opportunistic osteoporosis screening.

SSA21-02 Spectral CT Metal Artifact Reduction

Sunday, Nov. 25 10:55AM - 11:05AM Room: S103AB

Participants
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PURPOSE

To evaluate a novel Spectral CT metal artifact reduction method through simulations and phantom experiments using a photon-counting detector.

METHOD AND MATERIALS

The proposed constrained 'one-step' Spectral CT Image Reconstruction (cOSSCIR) method addresses beam hardening due to metal by directly estimating basis material maps uisng a polyenergetic x-ray transmission model. The proposed method enables masking energy windows corrupted by metal on a ray-by-ray basis, for example masking only the lowest energy window in some rays while using information from higher energy windows. The cOSSCIR algorithm includes constraints that mitigate undersampling artifacts that occur when unreliable measurements through metal are masked. A Spectral CT acquisition of a pelvic phantom with Co-Cr-Mo hip prostheses was simulated with four energy windows. An experimental Spectral CT acquisition was performed with a CdTe photon-counting detector, three energy windows, and a phantom with and without metal. For both simulations and experiments, a weighted mask was applied to remove projection data corrupted by metal. cOSSCIR reconstruction was performed by decomposing into bone, water, and copper material maps and then combining the maps to form an effective monoenergetic image. Images were also reconstructed using filtered backprojection (FBP) with and without the Normalized Metal Artifact Reduction (NMAR) technique. CT number error in the region between the metal implants was compared.

RESULTS

In the simulation study, the cOSSCIR algorithm reduced the CT number error in the metal artifact streaking region to less than 1 HU error. In the experimental study, the CT number error was 7 HU for cOSSCIR reconstruction with weighted mask, 60 HU for cOSSCIR without masking, 40 HU for FBP +NMAR, and 212 HU error for FBP. The cOSSCIR images did not contain streak artifacts seen in the NMAR images.

CONCLUSION

The proposed Spectral CT metal artifact reduction method reduced shading artifacts to <1 HU error in simulations and 7 HU error in experiments, without introducing residual streak artifacts.

CLINICAL RELEVANCE/APPLICATION

Metal artifacts in CT images obscure structures, alter CT numbers, challenge diagnosis, and impede radiation therapy planning. The proposed method, which could also be applied to dual-KV systems, corrects metal artifacts without knowledge of the implant material.

SSA21-03 Areal Bone Mineral Density Estimation Using Dual-Energy Computed Tomography Topograms

Sunday, Nov. 25 11:05AM - 11:15AM Room: S103AB

Participants
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PURPOSE

Dual-Energy X-ray absorptiometry (DXA) is in wide clinical use for the diagnosis and monitoring of osteoporosis. Using DXA, a good estimation of areal bone mineral density (aBMD) can be extracted from two images acquired with different X-ray spectra by subtracting the influence of soft tissue on the total X-ray absorption and isolating the absorption of carbonated hydroxyapatite (HA). Since most clinically performed CT scans include a topogram as a 2D overview image, it would be beneficial to also employ these images for the diagnostic purpose of an aBMD estimation. A prerequisite for this approach is the acquisition of dual-energy topograms, either sequentially, or ideally, using a single scan. In this work, we compared quality and dose of aBMD measurements from a standard DXA (bone densitometry) scan with sequentially acquired dual-energy topograms.

METHOD AND MATERIALS

Two anterior-posterior (AP) topograms of a BMD calibration spine phantom (European Spine Phantom, QRM GmbH, Möhrendorf, Germany) were sequentially acquired using a dual source SOMATOM Force CT System (Siemens Healthcare GmbH, Forchheim Germany). In order to maximize spectral separation, tube voltages of 70 kV without and 150 kV with added tin filtration were chosen at tube current time products of 70 and 75 mAs, respectively. The phantom consists of water-equivalent plastic with diameters of 260 mm (lateral) and 180 mm (AP) and holds three anthropomorphic vertebrae, L1-L3, of varying HA content (50, 100 and 200 mg/cm^3) in the spongious part of the bone. A custom tool was developed to subtract soft tissue and create aBMD density maps from the input topograms. Deviations from the known aBMD values of 0.5, 1.0 and 1.5 g/cm^2 of the AP projections of vertebrae L1-L3 were evaluated.

RESULTS

The extracted values for vertebrae L1-L3 from the generated aBMD maps were in good agreement with the ground truth. The mean areal densities and standard deviations for L1, L2 and L3 were 0.493 ± 0.05, 1.01 ± 0.04 and 1.52 g/cm² ± 0.03, respectively.

CONCLUSION

Especially with regard to the advent of energy-discriminating, photon-counting detectors, the work presented here shows a promising new domain for spectrally acquired topograms. This technique might serve as an alternative to using dedicated DXA scanners.

CLINICAL RELEVANCE/APPLICATION

Areal bone mineral density measurement is feasible via topograms with sufficient energy separation acquired via dual-energy CT.

SSA21-04 Monochromatic CT Image Reconstruction via Deep Learning

Sunday, Nov. 25 11:15AM - 11:25AM Room: S103AB

Participants
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PURPOSE

Develop a deep-learning-based algorithm to achieve monochromatic CT image reconstruction from current-integrating raw data.

METHOD AND MATERIALS

In clinical CT, with a polychromatic x-ray source, raw data are collected in the current-integrating mode. This physical process is accurately described by an energy-dependent non-linear integral model. However, the non-linear model is too complicated to be directly solved for the image reconstruction, and often approximated as a linear integral model known as the Radon/X-ray transform, which basically ignores energy-dependent information. This model mismatch leads to inaccurate quantification of an attenuation image and significant beam-hardening artifacts. Here, we develop a deep-learning-based approach to address the mismatch between the computational process and the physical model. Our method learns a nonlinear transformation from big data to correct measured raw data in accordance with line integrals at a pre-specified monochromatic energy. A multi-layer perceptron (MLP) neural network is designed for this purpose, consisting of four layers, one input layer, two hidden layers, and one output layer. The sigmoid function is used for non-linear activation. The neural network is trained with the ADAM optimization. The training procedure is programmed in Python and the TensorFlow framework on a computer with a NVIDIA Titan XP GPU of 12 GB memory. A set of clinical dual-energy CT datasets of the human abdomen, collected on a GE Discovery CT750 scanner, are used in the training and testing stages to demonstrate the feasibility of the proposed methodology.

RESULTS

The optimization of the neural network has an excellent converging performance, achieving a high accuracy in the monochromatic projection estimation with a relative error of less than 0.2%, overcoming beam hardening effectively.

CONCLUSION

Our approach is capable of learning a nonlinear transformation from big data, making a step forward towards monochromatic imaging directly from single-spectrum energy-integrating data. This is a potential cost-effective alternative to dual-energy CT.

CLINICAL RELEVANCE/APPLICATION

The deep-learning-based reconstruction method may perform monochromatic CT imaging, allowing for applications in lesion detection and tissue characterization, and proton therapy.

SSA21-05 Evaluation of a Spectral Imaging Metal Artifact Reduction Algorithm Using a Novel Image Quality Phantom

Sunday, Nov. 25 11:25AM - 11:35AM Room: S103AB

Participants
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PURPOSE

To evaluate the performance of a spectral imaging metal artifact reduction algorithm (GSI-MAR) using a novel phantom.

METHOD AND MATERIALS

A Catphan phantom with a CTP682 module (The Phantom Laboratory, Salem, NY, USA) was scanned on a GE Revolution 16 CT scanner (GE Healthcare, Milwaukee, WI, USA) with and without body annulus and with inserts of stainless steel, titanium and PMMA (control). Metal inserts had diameters of 0.5' and 0.25'. Spectral imaging scans were reconstructed in mono-energetic levels of 55 keV, 68 keV and 90 keV, with filtered back-projection (FBP), FBP with metal artifact reduction (MAR), 50% iterative reconstruction (ASIR-V) and 50% ASIR-V with MAR. Standard deviation (SD) as measures of streaking was derived from ROIs surrounding the inserts and in the outer part of the phantom. Low contrast detectability (LCD) close to the inserts was evaluated by two human observers. MTF and NPS were measured for all series.

RESULTS

Titanium did only introduce streaking close to the large insert. Stainless steel introduced large streaking artifacts. For the large titanium insert, MAR reduced SD from 23HU to 11HU without ring, and from 159HU to 14HU with ring. For the large stainless steel insert, MAR reduced SD from 61HU to 10HU without ring, and from 436HU to 23HU with ring. For the control, SD was 4HU without ring and 10HU with ring (all at 68 keV, same trend for 55 and 90 keV). Without the ring, LCD was close to the level of the control for the small inserts and the large titanium insert. For the large stainless steel insert, LCD decreased for 55 and 90 keV, and MAR improved LCD but not to the level of 68 keV and the control. With the ring, LCD decreased for all energies and inserts. For stainless steel, 90 keV had the best LCD, MAR improved LCD for 55 and 68 keV, but only to the level of 90 keV. For titanium, 68 keV had the best LCD, and MAR improved LCD for the small insert. Analyses of NPS and MTF are work in progress.

CONCLUSION

GSI-MAR reduced streaks from titanium and stainless steel and improved LCD close to metal. Optimal energy level and effect of MAR depends on metal type and size, as well as patient size.

CLINICAL RELEVANCE/APPLICATION

The performance of new metal artifact reduction algorithms in CT for different metals is not known. Catphan CTP682 module with metal inserts proved useful in evaluation of one such algorithm, GSI-MAR.

SSA21-06 Limits for Detecting Low Concentrations of Iodine with Dual-Energy Computed Tomography

Sunday, Nov. 25 11:35AM - 11:45AM Room: S103AB

Participants
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PURPOSE

Multiple studies in the literature have proposed diagnostic thresholds based on Dual-Energy Computed Tomography (DECT) iodine maps. However, it is critical to determine the minimum detectable iodine concentration for DECT systems to establish the clinical significance of various measured quantities for these image types.

METHOD AND MATERIALS

Seven serial dilutions of iohexol were made with concentrations from 0.03 to 2.0 mg iodine/mL in 50 mL centrifuge tubes. The dilutions and one blank with distilled water were scanned five times each in two scatter conditions: a 20.0 cm diameter (Head) phantom and a 30.0 cm x 40.0 cm elliptical (Body) phantom. We utilized six scanners from three vendors, including fast-kVp switching, dual-source, dual-layer detector, and split-filter DECT. Scan parameters and dose were matched as closely as possible across systems, and iodine maps were reconstructed using each vendor's software. Regions-of-Interest were placed centrally within each vial on the iodine map. Mean and standard deviation were calculated across the five scan acquisitions, and linear calibration curves were calculated for each scanner. Using standard analytical methods, the signal region corresponding to a 95% likelihood of measuring only water was defined as the Limit of Blank (LOB). Subsequently, the Limit of Detection (LOD) in the signal domain was defined as the LOB plus 1.645 times the standard deviation of the 0.5 mg/mL vial and was converted to a concentration using the calibration curves.

RESULTS

We found that the range of LOD was 0.021 - 0. 257 mg iodine/mL in the head phantom and 0.113 - 0.547 mg iodine/mL in the body phantom. Higher kVp levels on a given system generally performed better than lower kVp settings in the body phantom.

CONCLUSION

DECT systems available in today's marketplace can detect iodine concentrations as low as 0.113 mg I/mL in an anthropomorphic body phantom, which corresponds to an enhancement of approximately 2.8 HU at 120-kVp.

CLINICAL RELEVANCE/APPLICATION

DECT iodine quantification is a potential imaging biomarker, and we define detection limits for iodine measurements across multiple DECT systems, under which iodine cannot be reliably detected.

SSA21-07 Radiation Dose Efficiency of Multi-Energy CT for Simultaneous Imaging of Multiple Contrast Agents

Sunday, Nov. 25 11:45AM - 11:55AM Room: S103AB

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PURPOSE

Multi-energy CT (MECT) has been proposed for imaging multiple contrast agents simultaneously, which may allow multi-phase data

to be acquired in one single scan, potentially reducing radiation dose. This work aims to evaluate the dose efficiency of MECT in two potential applications: iodine/gadolinium (I/Gd) for liver imaging and iodine/bismuth (I/Bi) for small bowel imaging.

METHOD AND MATERIALS

Dose efficiency was experimentally evaluated for I/Gd and for I/Bi by comparing a single-scan MECT (MECT_1s) protocol and a traditional two-scan single-energy CT (SECT_2s) protocol. For SECT_2s, an abdominal phantom containing two sets of I samples was designed to mimic enhancement at late arterial and portal-venous phases. For MECT_1s, I/Gd samples were used, with I enhancement corresponding to the late arterial phase and Gd enhancement to the portal-venous phase. Data were acquired on a SECT (120kV) for SECT_2s, and on a dual-energy CT (DECT: 80/Sn150kV or 90/Sn150kV) or a photon-counting-detector (PCD) CT (140kV [25 50 75 90keV]) for MECT_1s, with the total radiation dose from the two scan protocols matched. A generic image-based material decomposition method was used to determine the densities of I/Gd/water, based on which CT biphasic images were synthesized. The noise levels on the original images acquired with the SECT_2s protocol and the synthesized images generated with the MECT_1s protocol were compared. The dose efficiency for I/Bi was evaluated in a similar way except for the phantom design. For SECT_2s, a different abdominal phantom was used, containing one set of I samples and one set of Bi samples mimicking the arterial and enteric enhancement, respectively. For MECT_1s, I/Bi samples was used.

RESULTS

For I/Gd, the noise level with the MECT_1s protocol was 500-1600% higher than that with the SECT_2s protocol, given the same total dose. For I/Bi, the noise level with the MECT_1s protocol was 110-230% higher.

CONCLUSION

Single-scan MECT imaging using two contrast agents (I/Gd and I/Bi) is intrinsically dose inefficient compared with traditional multiple SECT scans, particularly for I/Gd. The dose efficiency of MECT is highly dependent on the contrast materials used for a particular application.

CLINICAL RELEVANCE/APPLICATION

Use of a single-scan MECT protocol for multi-phase liver and small bowel CT imaging is very dose inefficient compared with a traditional dual-scan SECT protocol.

SSA21-08 Liver Lesion Localization and Classification with Convolutional Neural Networks Comparing Conventional and Spectral Computed Tomography

Sunday, Nov. 25 11:55AM - 12:05PM Room: S103AB

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PURPOSE

To localize and classify hepatic lesions with convolutional neural networks (CNNs) and evaluate the performance for different conventional and spectral computed tomography (CT) data.

METHOD AND MATERIALS

Contrast-enhanced liver CTs of 172 patients (33 with cysts, 57 with hypodense metastases and 82 healthy) were collected from a dual-layer spectral CT. Automatic liver segmentation was used. The localization and classification tasks were split into two stages: The first CNN was trained to localize hepatic lesions and produce heatmaps showing the location. Only the disease type and no segmentation ground truth was needed for the training. The heatmaps were used to automatically cut a region of interest (ROI) around the predicted lesion. In the second stage, the ROIs were used to train an additional CNN for the classification between healthy, cyst and metastasis. The final evaluation was performed on previously un-seen patient data. All experiments were compared for conventional CT data, reconstructed virtual monoenergetic images (VMIs) and iodine concentration maps. The classification performance was evaluated with precision, recall, accuracy and F1-score. The localization results on the test set were compared to the segmentation ground truth. The distance between lesion predictions and true lesions and the localization accuracy were evaluated.

RESULTS

The classification of the first CNN for healthy vs. lesion achieved a recall of 0.890, 0.855, 0.798, 0.874, 0.822 for 40 keV, 70 keV and 100 keV VMIs, iodine maps and conventional images, respectively. The localization accuracy and distance between true and predicted lesions presented the best results for low energy VMIs (40 - 70 keV) and iodine maps, outperforming the conventional data. The classification of ROIs into three classes reached the highest accuracy with 70 keV VMIs (84.5 %) compared to conventional data (83.5 %).

CONCLUSION

Using CNNs to localize lesions, cut ROIs and perform lesion classification offers a robust automatic workflow. Low energy VMIs show

using CNNs to localize lesions, cut ROIs and perform lesion classification offers a robust automatic workflow. Low energy VMIs show several benefits compared to conventional CT: Small lesions were detected with higher accuracies, heatmap results were more reliable and metastases and cysts were classified better.

CLINICAL RELEVANCE/APPLICATION

Using convolutional neural networks and spectral CT data for the automatic localization and classification of hepatic lesions has the potential to significantly aid the diagnostic decision process.

SSA21-09 Realistic Liver Tissue Surrogates for CT Phantom Studies Can Accurately Quantify the Benefits and Limitations of? Reduced kV Imaging in CT

Sunday, Nov. 25 12:05PM - 12:15PM Room: S103AB

Participants
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PURPOSE

To assess the utility of a liquid tissue surrogate for the liver (LTSL) to emulate the CT attenuation characteristics of contrast-enhanced liver parenchyma and lesions as a function of tube potential, lesion contrast, phase of enhancement, and phantom size.

METHOD AND MATERIALS

A 3D-printed, fillable phantom was used to emulate liver parenchyma and focal lesions. First, we compared the CT attenuation of LTSL-iodine and water-iodine solutions at 80, 100, 120, 140 kV to published patient data. Based on these results, we emulated liver parenchyma in late arterial phase (LA: +92HU at 120kV) and portal venous phase (PV: +112HU at 120kV) using LTSL-iodine. Additional LTSL-iodine solutions emulated hyperattenuating lesions during the LA-phase (lesion-to-parenchyma contrast (CLP) = +5 to +50HU) and hypoattenuating lesions during the PV-phase (CLP = -5 to -50HU). Fat-equivalent plastic rings emulated medium and large patients. Each combination of CLP, phase of enhancement, and phantom size was imaged at 80, 100, 120, 140 kV at constant radiation dose. CT attenuation, CLP, and CNRLP were assessed. A theoretical model estimated CT attenuation, CLP, and CNRLP as a function of tube potential and lesion contrast which was compared to the measured data.

RESULTS

LTSL-iodine more accurately emulated the CT attenuation of contrast-enhanced liver parenchyma compared to water-iodine solutions. The theoretical model was confirmed by the empirical measurements using LTSL-iodine solutions: CT attenuation, CLP, and CNRLP increased when the tube potential decreased ($P<0.001$). This trend was independent of lesion contrast, phase of enhancement, and phantom size. The absolute improvement in CLP and CNRLP at reduced tube potentials, however, was inversely related to the magnitude of CLP at 140kV.

CONCLUSION

LTSL accurately emulated the CT attenuation characteristics of contrast-enhanced liver parenchyma and lesions at different tube potentials, lesion contrast, and phase of parenchymal enhancement. The relative improvement in CLP and CNRLP at reduced tube potentials was independent of lesion contrast, phase, and phantom size while the absolute improvement decreased for low-contrast lesions.

CLINICAL RELEVANCE/APPLICATION

Liquid tissue surrogates offer a promising tool for liver emulation in multi-energy CT phantom studies. Low contrast lesions, which are most difficult to detect in clinical routine, benefit less from low kV-imaging than high contrast lesions.

SSA22

Physics (Image Processing in Imaging and Radiation Therapy)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S103CD

PH 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

SSA22-01 CNN-based Image Super-Resolution for CT Slice Thickness Reduction using Paired CT Scans for Improving Robustness of Computer-aided Nodule Detection System

Sunday, Nov. 25 10:45AM - 10:55AM Room: S103CD

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PURPOSE

To evaluate the effectiveness of a slice thickness reduction technique in computed tomography(CT) scans using convolutional neural network(CNN)-based super-resolution(SR) network for improving the sensitivity of lung nodule detection in thick section CT scans.

METHOD AND MATERIALS

We collected 100 sets of CT scans with identical acquisition protocols that were differentiated only by the slice thickness (1mm, 3mm, and 5mm). By employing CNN-based SR network, we trained the model to learn the residuals between synthesized thin section slices and real thin section slices. We used 80 sets of CT scans for training, 5 sets for the validation and the remaining 10 sets were used for quantitative evaluation. We separately collected 100 sets of CT scans (also with 1mm, 3mm, and 5mm slice thickness) with one biopsy-confirmed nodule per scan(46 solid nodules and 54 non-solid nodules, size ranges 6-12mm) to evaluate the effectiveness of the slice thickness reduction techniques for improving the lung nodule detection performance in thick section CT scans. The computer-aided detection(CAD) system used for the evaluation of lung nodule detection performance was internally developed with LUNA16 dataset, which contains 888 CT scans with slice thickness less than 3mm.

RESULTS

When slice thickness was reduced from 3mm to 1mm, the peak signal-to-noise ratio(PSNR) and structural similarity index(SSIM) were 30.9624 and 0.8142 respectively; when slice thickness was reduced from 5mm to 1mm PSNR and SSIM were 29.2620 and 0.7439 respectively. In the nodule detection task, all solid and non-solid nodules were detected by the CAD system using 1mm slice thickness scans(100.0% recall). However, 2 solid nodules were missed when using 3mm slice thickness scans (95.7% recall) while their corresponding synthetic 1mm scans improved the recall to 97.8% (1 missed solid nodule). Recall of scans with 5mm slice thickness was 89.1% and 85.2% while their synthetic 1mm scans improved the recall to 100.0% and 96.3% for solid and non-solid nodules respectively.

CONCLUSION

Our CNN-based SR method generates synthetic thin section slices from thick section slices which improve lung nodule detection performance using CAD.

CLINICAL RELEVANCE/APPLICATION

Robustness to acquisition protocol is essential for reliable lung CAD systems. Our slice thickness reduction technique may improve the robustness of CAD systems when applied to CT scans with various slice thickness.

SSA22-02 An Image Enhancement System for Disease Diagnosis

Sunday, Nov. 25 10:55AM - 11:05AM Room: S103CD

Participants
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PURPOSE

Varying background intensity levels in medical images increases the difficulty of reading images and of identifying abnormal image regions. Windowing and leveling techniques are performed on the entire image, which fails to account for regional differences in image intensity. A method which normalizes image regions by expected image intensity in that particular region could improve diagnostic accuracy of scans.

METHOD AND MATERIALS

This technique is demonstrated for 18F-NaF PET/CT scans of 37 metastatic prostate cancer patients with a total of 1,751 bone lesions. Each image was divided into 19 skeletal regions, such as the humeri, ribs, or ilium, and thresholds were determined for each region. For this work, statistically optimized regional thresholding (SORT) determined thresholds by performing ROC optimization to determine detection thresholds in each bone region that maximize combined sensitivity and specificity for the detection of bone lesions. Finally, image voxels in each region were normalized by dividing the intensity values by the corresponding regional threshold. The detection rate and visibility of lesions was compared between the SORT normalized image and the image windowed at the lesion detection threshold recommended in literature (SUV=10 g/mL).

RESULTS

SORT windowed images, which used 18 different normalization values (SUV range: 3-13 g/mL), improve detection of lesions with higher sensitivity (96% for SORT, 83% for SUV=10 g/mL) while retaining high specificity (97% for SORT, 97% for SUV=10 g/mL). Regional normalization images increased the visibility of lesions by reducing the number of adjustments to windowing required and setting background across the image to values lower than 1.

CONCLUSION

Region-specific windowing of medical images can not only make an image easier for radiologists to read, but also assist in the identification of abnormal image regions, effectively reducing the amount of time required to read medical images. Regional windowing in this work was performed using thresholds optimized for disease detection; however, thresholds could be derived from other techniques, such as population mean healthy uptake in a region.

CLINICAL RELEVANCE/APPLICATION

Unlike traditional windowing or leveling, region-specific windowing can account for regional differences across an image, thus reducing the amount of time and effort required to read medical images.

SSA22-03 Evaluation of an Automated Deformable Mapping Technique with and Without External Fiducial Markers to Relate Corresponding Lesions in Digital Breast Tomosynthesis and Automated Breast Ultrasound Images

Sunday, Nov. 25 11:05AM - 11:15AM Room: S103CD

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PURPOSE

To test an automated deformable mapping method for registering corresponding lesions in digital breast tomosynthesis (DBT) and automated breast ultrasound (ABUS) images with and without the use of external fiducial markers.

METHOD AND MATERIALS

A CIRS multi-modality breast phantom containing 20 lesions was employed and imaged with DBT (upright positioning with craniocaudal (CC) compression and mediolateral oblique (MLO) compression), and ABUS (supine positioning with anterior-to-chest wall compression). Eight external fiducial markers (gel pads containing 1-mm glass beads) were attached to the surface of the breast phantom prior to the imaging. The reconstructed images were segmented using manual (ABUS) and semi-automated (DBT) techniques. An automated mapping method generates, deforms, and relates the resulting models of the breast for registration of lesions between the DBT (CC or MLO) and ABUS image sets. Performance was assessed by the number of matched paired lesions and measures of the distances between the centers of mass (dCOM) of corresponding lesions.

RESULTS

The maximum number of lesions that could be matched was 18 because 2 of the 20 lesions were too close to the chest wall to be visible in the reconstructed DBT images. For mapping of DBT-CC to ABUS without markers, 14 of the 18 lesions were matched and the mean dCOM was 13.64 ± 6.25 mm. With markers, 17 of the 18 lesions were matched and the mean dCOM was 12.83 ± 6.03

mm. For mapping of DBT-MLO to ABUS without markers, 8 of the 18 lesions were matched and the mean dCOM was 9.32 ± 2.82 mm. With markers, 17 of the 18 lesions were matched and the mean dCOM was 12.25 ± 5.75 mm.

CONCLUSION

This work demonstrates the potential for using this deformable mapping technique to identify related lesions between two DBT views and ABUS images. This method shows improved lesion correlation with the use of external fiducial markers. This should improve radiologists' characterization of breast lesions which should reduce patient callbacks and unnecessary biopsies. Future work will include an IRB-approved proof of concept study with patient data for registration between DBT and ABUS images.

CLINICAL RELEVANCE/APPLICATION

This works demonstrates the use of an automated deformable registration technique between two DBT views and ABUS images and shows potential in improving the characterization of breast lesions between these modalities.

SSA22-04 Medical Image Fusion Using M-Band Wavelet Transform for Radiotherapy

Sunday, Nov. 25 11:15AM - 11:25AM Room: S103CD

Participants
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CONCLUSION

The fused images using proposed method provides the best out of both CT and MRI. The proposed fusion scheme has potential application in precise localization and delineation of lesions in treatment planning of radiotherapy.

Background

Radiation oncologists need information from both the Computed Tomography (CT)and Magnetic Resonance Imaging (MRI) sequences for precise outlining of tumour in radiotherapy. The proposed work aims to create new enriched image using medical image fusion of CT and MRI slices. The spectral features from source slices are extracted using M-band Wavelet Transform (MBWT).MBWT is separable, orthogonal transform with a perfect reconstruction property. It provides high directional sensitivity and finer spectral resolution. The average for low frequency subbands and maxima for high frequency subbands are used as fusion rules. The inverse transform reconstructs visually enriched fused image.This fused image is an excellent assistance to the radiation oncologist for delineation of tumour to prepare precise treatment plan.

Evaluation

In this work, total 39 sets of CT and MRI slices are used. The qualitative evaluation of the work is done in context with visual perception, contrast enhancement, confidence to lesion delineation and usefulness in treatment planning. Three expert radiologists rated fused images on the scale of 0 (poor) to 4 (excellent).The quantitative evaluation involves fusion metrics viz.entropy (En), image quality index (IQI), edge quality index (EQI), and mean structural similarity index measure (mSSIM) which are useful for quality, similarities with source images, and edge preservation.

Discussion

The fused images using proposed method provide better retention of the anatomical structures and visualization of lesions as compared to the state of art wavelet techniques as presented in Figure 1. The average score by three radiologists for fused images using presented work is 3.87.In quantitative evaluation, the fusion parameters are calculated and they give highest values for all the fused images using proposed method which indicate that proposed technique outperforms over other fusion techniques.

SSA22-05 Using Texture Analysis to Optimize Reconstruction Parameters

Sunday, Nov. 25 11:25AM - 11:35AM Room: S103CD

Participants
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PURPOSE

In providing SPECT phantom quality assurance images to accrediting agencies, it is not obvious whether it is preferable to submit reconstructions performed using typical clinical (CLIN) protocol processing parameters, or to follow agencies' filtered backprojection (FBP) suggestions. We applied texture analysis metrics to determine the degree to which these choices affect equipment capability assessment.

METHOD AND MATERIALS

Phantom data were processed for 128 SPECT scans acquired for 32 Mcts for 10 gamma cameras, using 666-814 MBq 99mTc in cylindrical water baths with Plexiglas inserts of 6 sphere & rod sizes. Reconstructions were performed following agencies' suggestions of FBP & Hanning filtering (cutoff = 1.0) & Chang attenuation correction. Algorithms written in IDL v8.4 computed texture analysis gray-level-co-occurrence matrix (GLCM) entropy, with sphere contrast computed by fitting radial count profiles to 3rd order polynomial curves. ROC analysis established optimal discrimination thresholds using as the reference standard dichotomous visual readings of a medical imaging physicist, who graded sphere & rod visibility without knowledge of texture analysis values. The same phantom was used to collect 13 additional data sets with a dual detector SPECT camera equipped with a 4-slice non-

diagnostic CT scanner, reconstructed by FBP & by the manufacturer's default settings for clinical bone SPECT/CT protocols by OSEM (10 subsets; 2 iterations) & Butterworth filtering (cutoff = 0.5, order = 5), incorporating attenuation correction using the CT scan. GLCM computations were compared for FBP & CLIN reconstructions.

RESULTS

Optimal criteria for best agreement with visual scores for spheres was contrast (81±1% accuracy), & for rods was entropy (97±1% accuracy). For the 13 new acquisitions, by there criteria, more rods would have been visible for FBP than CLIN (46% versus 39%, p = 0.02), & more spheres (57% versus 40%, p = 0.0003), with greater sphere contrast (28±21% versus 19±18%, p < 0.0001). Rod entropy & sphere entropy were significantly different for FBP & CLIN reconstructions (-13.5±3.1K versus -14.6±2.8K, p < 0.0001 & -3.1±1.4K versus -4.6±3.9K, p = 0.0001), & favored detecting rods & spheres by FBP over CLIN.

CONCLUSION

Texture analysis can help in obtaining optimal results for equipment test data.

CLINICAL RELEVANCE/APPLICATION

Texture analysis provides a useful basis for choosing among image reconstruction options.

SSA22-06 Real-Time Deformable Image Registration for MRI-Guided Radiotherapy

Sunday, Nov. 25 11:35AM - 11:45AM Room: S103CD

Participants
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CONCLUSION

Real-time deformable image registration is a viable strategy for tracking organs in MR-guided radiotherapy. It is a promising approach for next-generation applications including beam tracking and real-time plan optimization.

Background

MR-guided radiotherapy has the capability to acquire 2D cine-mode images of patient cross sections in near real time. These images are used for monitoring of patient position and motion management using respiratory gating. Beam tracking is a radiotherapy strategy where the therapy beam continuously follows the target position based on real-time sensing. To enable beam tracking, the position of the intended target and avoidance structures must be identified in real-time. This abstract investigates real-time deformable image registration as an approach for MR-guided radiotherapy.

Evaluation

Registration accuracy and speed were retrospectively evaluated on sagittal plane cine-mode video sequences from nine stomach cancer patients. The video resolution was 100 x 100 pixels, with a pixel spacing of 3.5 mm. Images were registered to a reference image at the beginning of the sequence. Accuracy was evaluated by comparing manually drawn contours of the stomach with a warped reference contour. A total of 90 images, 10 from each patient, were annotated and analyzed. Speed was measured for the registration only, with file I/O excluded. B-spline registration was performed using plastimatch, with GPU-accelerated sum of squared difference cost function, and multicore-accelerated curvature regularization. To assess real-time performance, computation time was limited to 200 milliseconds.

Discussion

B-spline image registration ran at 8.8 +/- 2.0 milliseconds per iteration, which allowed 22 iterations to be performed. Registration accuracy was estimated to be 2.2 +/- 1.1 mm, using the center of mass of the manually drawn contours as the standard. Dice coefficient of the stomach was found to be 0.90 +/- 0.03. Approximately 90 percent of the computation time was used to compute regularization, we estimate that implementing this routine on the GPU will allow 100 iterations to be performed within 200 milliseconds.

SSA22-07 MR T2 * Parameter Imaging Based on DANTE Black Blood Prepared Sequence and Modified JSENSE Reconstruction Method

Sunday, Nov. 25 11:45AM - 11:55AM Room: S103CD

Participants
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CONCLUSION

Multi-contrast images can be jointly recontructed by modified Jsense method with effective removal of the residual aliasing artfact at a high acceleration factor. Accurate T2* maps are obtained by DANTE-GRE due to its high SNR and effective blood signal supression.Phantom experiments demonstrated that the incorporation of modified Jsense and DANTE-GRE may outperform conventional multi-echo GRE T2* mapping.

Background

Quantitative analysis of T2* value is an effective tool to reflect iron content of human tissue in MRI, which are closely related to Mediterranean anemia.A new MRI pulse sequence and a modified reconstruction method were proposed to improve accuracy of T2* measurement. Specifically, DANTE prepared sequence is selected to supress blood signals and modified reconstruction method based on JSENSE is proposed to improve image quality and reduce scan time.

Evaluation

A numerical bloch simulations were established on DANTE prepared sequence to prove the velocity sensitivity and to select parameters.Several phantom experiments completed by DANTE-GRE realized more accurate T2* quantification with blood suppression compared with multi-echo GRE and MSDE-GRE sequence.The PSNR and HFEN were chosen to assess the quality of coil sensitivities and multi-contrast images recontructed by SENSE,Jsense and modified Jsense algorithm with acceleration factors of 2, 3 and 4. At last,ROIs in T2* maps obtained both in phantom and vivo were evaluted between DANTE-GRE sequence and modified Jsense method with former convential methods.

Discussion

The phantom results validate the superiority of modified Jsense algorithm in increaseing smoothness of multi-channel coil sensitivities and decreasing artifacts of multi-contrast images at a high acceleration factor.However,images of the first echo recovered by modified JSENSE achieve lower HEEN and higher PSNR compared to the last echo which has lower SNR due to its intrinsic T2* decay. By combining modified Jsense algorithm with DANTE-GRE sequence which could further acquire more image information and better image quanlity, more accurate T2* maps could acquire since the artifacts originating from flowing blood are effectively supressed.

SSA22-08 Automatic Cardiac Ventricle Segmentation from CT Images Using Fully Convolutional Neural Networks

Sunday, Nov. 25 11:55AM - 12:05PM Room: S103CD

Participants
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PURPOSE

Acute pulmonary embolism (PE) is an emergent condition with three month mortality rate of 15%. Presence of PE is most often confirmed using Computed Tomography Pulmonary Angiography (CTPA). Mortality from PE is usually caused by overload of the right ventricle. The quantification of the right ventricular to left ventricular diameter ratio has been proved to be a quantitative prognostic marker for staging acute PE. Despite strong evidence for RV/LV as a prognostic marker in PE it is not always reported because it suffers from high interobserver variability and manual effort to measure. This work investigates automating the first step in an automated RV/LV CAD tool: ventricle segmentation.

METHOD AND MATERIALS

Fifty CTPA scans were used for this study (20 from cad-pe.org and 30 from a closed dataset). The ground truth segmentations were created by an imaging expert. This work developed a convolutional neural network (CNN) capable of segmenting the left and right cardiac ventricles from a 2D CT slice. The CNN was based on the U-Net. The training data consisted of 43 cases, the validation data consisted of 2 cases, and the test data consisted of 5 cases. The network was trained on 2D slices. To test the performance the CNN was passed all slices from a series and the largest morphologically connected region for each output class (RV and LV) was kept as the final segmentation. The CNN was trained with the original data and with an augmented data set where each slice passed to the network during training underwent a series of perturbations consisting of: 1) flipping, 2) noise injection, 3) deformation, and 4) random erasing.

RESULTS

The CNN trained on the original dataset has an average Dice coefficient of 0.96 on the training data and 0.90 on the testing data. The CNN trained with data augmentation had an average Dice coefficient of 0.94 on the training data and 0.94 on the testing data.

CONCLUSION

The CNN was able to create quality ventricle segmentations with only 43 scans in the training dataset, and the set of data augmentations significantly improved the performance on the test dataset.

CLINICAL RELEVANCE/APPLICATION

Accurate reporting of RV/LV can improve the diagnosis and staging of acute PE, but it is currently underreported because of interobserver variability and high manual effort. Automating this calculation could increase the rate and quality of RV/LV reporting, thereby improving patient care in emergency departments.

SSA22-09 Multi-institutional Deep Network for High Performance Sorting of Over 3000 AP and PA Chest Radiographs

Sunday, Nov. 25 12:05PM - 12:15PM Room: S103CD

Participants
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PURPOSE

The classification of chest radiographs as anteroposterior (AP) or posteroanterior (PA) is important for their interpretation and any subsequent analysis and diagnosis. DICOM header information is often incomplete, and 328 of the 2364 (14%) chest radiographs acquired at our institution lacked the required information for AP/PA classification.

METHOD AND MATERIALS

Using a chest radiograph dataset from our institution, a convolutional neural network with AlexNet architecture was trained from scratch. 1475 AP and 713 PA radiographs were used, with 65% for training, 20% for step-wise validation, and 15% for testing. After training was complete, the network was tested on an independent set of 500 AP and 500 PA images from the National Institutes of Health chest radiograph dataset.

RESULTS

The independent test set yielded an AUC of 0.97 ± 0.0046, with less than 9% (89 of 1000) of radiographs misclassified. Of the images misclassified, several were improperly oriented or included a number of radiopaque medical devices. Our institutional dataset was used for training because of its high image quality and the lack of image imprinted "AP" or "PA" labels. Many images in the NIH dataset contain imprinted AP/PA labels, prompting their exclusion from the training dataset to avoid training the network to simply look for the imprinted label for the classification.

CONCLUSION

This model shows multi-institutional generalization of a trained network for the task of classifying AP and PA radiographs. A primary application of this network is for automated classification of the AP/PA view within the clinical workflow. The high AUC achieved demonstrates that the classification can be performed with high accuracy. Training the model took 4.5 minutes and testing 10,000 images took 130 seconds. Due to its speed, the classification technique could be applied without disruption of clinical workflow.

CLINICAL RELEVANCE/APPLICATION

To ensure appropriate classification and correct labeling of an image as AP or PA, a trained convolutional neural network can be used clinically with high accuracy and efficiency.

SSA23

Radiation Oncology (Radiobiology/Science)

Sunday, Nov. 25 10:45AM - 12:15PM Room: E353A

OI PH 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 Brain Radiation-Induced Fatigue is Associated with Neuroinflammation and Suppression of Orexin Signaling

Sunday, Nov. 25 10:45AM - 10:55AM Room: E353A

Participants
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PURPOSE

Fatigue, the most common acute and subacute toxicity of partial or whole brain radiation therapy (WBRT), significantly decreases quality of life for patients, abrogating the benefit afforded by improved tumor control. The objective of the study is to evaluate the roles of neuroinflammation and orexin neuron activity in the pathogenesis of fatigue induced by clinically relevant WBRT fractionation.

METHOD AND MATERIALS

Adult male Sprague-Dawley rats received WBRT, 4 Gy in 5 daily fractions, or sham irradiation. Home cage locomotor activity (LMA) was continuously monitored using a photobeam system. Food intake and body weight were collected weekly. Cerebrospinal fluid (CSF) and brain sections were collected at fatigue onset, peak, and recovery. CSF orexin concentration was measured using radioimmunoassay. RNA was isolated from homogenized brain sections and inflammatory and oxidative expression patterns were evaluated using quantitative PCR. The data were compared to physician-reported fatigue, and orexin and cytokine CSF protein levels collected pre- and post-radiation from a cohort of 11 pediatric patients receiving proton radiation for primary brain cancer. Data were analyzed by t-test or 2-way ANOVA with post hoc Bonferroni corrected t-test. Significance was set at $P<.05$.

RESULTS

LMA was decreased in WBRT-treated rats starting following the first fraction and continued to decrease until reaching a nadir following the 5th and final fraction. LMA slowly recovered after that point, returning to baseline. Food intake and weight gain were significantly reduced in WBRT-treated rats, recovering to match sham rats within 2 weeks of the first fraction. The onset of fatigue is associated with widespread neuroinflammatory gene expression and decreased CSF orexin levels, which resolves as fatigue improves. Orexin levels were decreased and cytokine levels increased in CSF samples from patients for whom fatigue was recorded as a toxicity during treatment.

CONCLUSION

Brain radiation-induced fatigue is associated with neuroinflammation and decreased orexin levels in both preclinical and clinical samples. These data provide potential therapeutic avenues to address this disabling and pervasive toxicity of brain radiation.

CLINICAL RELEVANCE/APPLICATION

Neuroinflammation and orexin signaling appear to underlie brain radiation-induced fatigue, providing potential therapeutic targets.

SSA23-02 Translocation Frequency in Patients with Repeated CT Exposure: Comparison with CT-Naive Patients

Sunday, Nov. 25 10:55AM - 11:05AM Room: E353A

Participants

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PURPOSE

To compare translocation frequency between patients with repeated computed tomography (CT) exposure and CT-naïve patients and to assess the relationship between radiation exposure and translocation frequency.

METHOD AND MATERIALS

This study was approved by our institutional review board. 48 cases with repeated CT exposure and 48 age- and sex-matched CT-naïve controls were prospectively enrolled in this single-institution study. Absorbed dose using dose-length product was used as a metric for radiation exposure and translocation frequency was assessed by using chromosome-specific fluorescent hybridization probes. The comparison of translocation frequency between cases and CT-naïve controls was performed by using Wilcoxon test (paired samples) and the relationship between radiation exposure and translocation frequency was assessed by partial correlation coefficient.

RESULTS

A statistically significant difference was present in translocation frequency between cases and CT-naïve controls (P = .0003). The median translocation frequency was 7 (95% confidence interval: 6, 8) for cases and 4 (95% confidence interval: 3, 6) for controls. By using translocation frequency as the response variable and radiation exposure (accumulated, maximum, and mean) as the effect variables, statistically significant correlation was found between accumulated radiation exposure and translocation frequency (r = .4279, P = .0030).

CONCLUSION

Chromosomal translocation was more common in patients with repeated CT exposure than CT-naïve patients, and a positive association was noted between accumulated radiation exposure and translocation frequency.

CLINICAL RELEVANCE/APPLICATION

Our results added evidence favoring a non-threshold response for radiation-associated cancer induction at low-level radiation exposure in medical practice.

SSA23-03 DNA Damage in Peripheral Blood Lymphocytes Induced By Low-Dose Chest CT: Comparison with Standard Dose Chest CT

Sunday, Nov. 25 11:05AM - 11:15AM Room: E353A

Participants
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PURPOSE

The purpose of this study was to evaluate the DNA damage in peripheral blood lymphocytes induced by a low-dose chest CT scan using γ-H2AX foci as a DNA damage maker.

METHOD AND MATERIALS

We obtained institutional review board approval and the written informed consent from 217 patients, who were prospectively enrolled in this study. A total of 146 patients underwent low-dose chest CT (120 kV, 50 mAs, pitch factor 1.39), and 71 patients underwent standard-dose chest CT (120 kV, AEC, pitch factor 0.813). Blood samples were obtained before and after CT scan. Lymphocytes were isolated and stained against γ-H2AX (phosphorylated histone variant H2AX). The number of γ-H2AX foci in at least 4,000 lymphocytes was analyzed automatically with fluorescence microscopy. Significant differences between the number of foci were tested by using paired t-test, Wilcoxon test.

RESULTS

There were no significant difference in the character of patients between low and standard dose chest CT groups. The mean dose length product was 132 mGy·cm in low-dose CT and 455 mGy·cm in standard-dose CT groups, respectively. There was no significant difference in the baseline level of γ-H2AX foci between low and standard dose groups before CT examination.The numbers of γ-H2AX foci of patients in low-dose CT group before and after CT scan were 0.90 (standard deviation: 0.50) and 0.93 (0.51), respectively. There was no significant difference in the number of γ-H2AX foci before and after low-dose CT. The numbers of γ-H2AX foci in standard-dose CT group increased from 1.00 (0.45) to 1.07 (0.48) after CT scan. In contrast to the low dose group, the number of γ-H2AX foci in the standard dose group showed significant increase after CT (p=0.025).

CONCLUSION

Radiation effect by a low-dose chest CT was too low to be detected by γ-H2AX assay.

CLINICAL RELEVANCE/APPLICATION

γ-H2AX assay may be useful to determine the optimal radiation dose for low-dose CT in lung cancer screening

γ-H2AX assay may be useful to determine the optimal radiation dose for low-dose CT in lung cancer screening.

SSA23-04 A Novel Molecularly Targeted Radiotherapeutic Agent (MTRT) to Deliver Immunomodulatory Radiation to Multiple Pediatric and Adult Solid Tumors

Sunday, Nov. 25 11:15AM - 11:25AM Room: E353A

Participants
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PURPOSE

Radiation therapy (RT) has been shown in preclinical studies to enhance the efficacy of several types of immunotherapies. However, traditional external beam radiation therapy (EBRT) is typically only delivered to a few sites of disease, with larger field sizes being associated with systemic lymphopenia. Because many patients have widespread disease, it is nearly impossible for them to benefit from the efficacy enhancements afforded by immunotherapies using standard RT. Conversely, our RT delivery approach using a novel, tumor-selective form of molecularly targeted radiation therapy (MTRT), Y90-NM600, may augment tumor specific immune-priming by delivering RT to multiple sites of disease.

METHOD AND MATERIALS

Syngeneic mice were inoculated with tumors from adult and pediatric solid tumor lines B78 (melanoma), LLC (lung), MOC1 (Head and Neck), 4T1 (breast), Panc02 (Pancreas), GL261 (high grade glioma), K7M2 (Rhabdomyosarcoma), NXS2 and 9464D (neuroblastoma). Mice were injected with 250 µCi of Y86-NM600 and scanned via PET/CT at 2, 24, 48, and 72 h. Organs were then harvested for bio-distribution (BioD) via gamma scintigraphy. Another cohort of mice with bi-lateral B78 flank tumors were treated with 12 Gy EBRT to a primary tumor and anti-CTLA4 and were randomized to be treated w/wo 50 µCi MTRT. Tumor growth and survival was monitored. All mice with complete response (CR) were re-challenged with B78.

RESULTS

PET/CT and BioD data showed preferential uptake of NM600 in all tumor lines with highest uptake in Panc02 pancreatic tumors (10-fold increase of uptake in tumor compared to bone marrow, 2-fold increase compared to spleen). In our therapeutic 2-tumor trial, addition of MTRT resulted in decreased tumor growth ($p < 0.05$) of both primary and secondary tumors when combined with immune checkpoint inhibitor and EBRT (primary tumor) compared to a matched cohort randomized to just EBRT (primary tumor) and anti-CTLA4 alone. 50% of mice in the MTRT arm had a complete response and memory to B78 re-challenge compared to 0% in the no MTRT (EBRT + anti-CTLA4 alone) arm.

CONCLUSION

NM600 is a novel form of MTRT that shows preferential uptake in multiple solid tumors and can deliver immunomodulatory RT to distant tumors to increase response rates to T cell checkpoint blockade.

CLINICAL RELEVANCE/APPLICATION

MTRT sensitizes metastatic cancer cells to immunotherapy and improves response rates to systemic immune checkpoint blockade therapy.

SSA23-05 Identifying the Effect of Hereditary Factors on Radiation-Induced Cardiac Toxicity Using Novel Genetic Rat Models

Sunday, Nov. 25 11:25AM - 11:35AM Room: E353A

Participants
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PURPOSE

Radiation therapy is used in most cancer patients, but dose is limited by damage to normal tissue. The use of defined genetic models to assess radiation toxicity, followed by genetic mapping of radiosensitivity phenotypes, will allow for maximization of tumor dose while limiting normal tissue toxicity. In this study, we utilize consomic rats, which are genetically identical except that one chromosome is inherited from a second inbred rat strain.

METHOD AND MATERIALS

Adult male and female Salt Sensitive (SS) rats and SS.BN3 consomic rats, (SS background with Brown Norway chromosome 3), received image-guided localized whole heart radiation at a dose of 24 Gy or 9 Gy x 5 fractions. Echocardiograms with strain analysis were performed at baseline, 3, and 5 months. The student's t-test was used to compare values. RNA-seq from left ventricle samples at 1 and 10 weeks post radiation was performed and analyzed with IPA software.

RESULTS

Our previous studies have demonstrated that the SS.BN3 tumors are more radiosensitive than SS tumors. In the 24 Gy study, cardiac toxicity increased in SS compared to SS.BN3 male and female rats. End diastolic volume (EDV), a measure of ventricular dilation, was elevated after radiation in SS rats (EDV: 0.62 vs 0.49 ml, $p<0.01$). Systolic function measured with ejection fraction (EF), and contractility measured with radial strain, were lower in SS rats at 5 months (EF: 81 vs 94%, $p<0.01$, radial strain: 33 vs 68%, $p<0.01$). Left ventricular mass was elevated at 3 months in SS rats ($p<0.001$), and moderate-to-large pericardial effusions were present in 6/6 SS rats compared to 1/7 SS.BN3 rats at 5 months. Similar results are seen with the 9 Gy x 5 fractions. Gene expression analysis comparing SS and SS.BN3 females showed inflammatory and mitochondrial pathways with greatly altered expression, most notably at 1 week post-radiation.

CONCLUSION

These data show that SS rats are more sensitive to cardiac radiation than SS.BN3 rats, demonstrating the role of heritable factors in determining cardiac radiosensitivity. Gene expression analysis identified a number of cardiac-related targets on chromosome 3 for future studies of radiation protection. Further genetic mapping will aid in narrowing the causative target(s) for potential therapies.

CLINICAL RELEVANCE/APPLICATION

This project has the potential to enhance the effectiveness and toxicity profile of radiation therapy in cancer and to delineate new therapeutic targets.

SSA23-06 Role of Radio-Immunotherapy in the Treatment of Local and Distant Tumors in Prostate Cancer

Sunday, Nov. 25 11:35AM - 11:45AM Room: E353A

Participants
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CONCLUSION

These results suggest that the use of SRB for sustained in-situ delivery of CD40 antibody could significantly enhance the abscopal effect of radiotherapy in treating prostate adenocarcinoma.

Background

Metastasis is the cause of death in most cancers including prostate. It has been observed by Mole and others that radiotherapy at one site may lead to regression of metastatic cancer at other sites, which were not irradiated; this phenomenon is called 'abscopal' effect. Unfortunately, this regression is not predictable. Some studies have observed an enhancement by systemic application of immunoadjuvants, which also has limited application because of generalized adverse effect. The purpose of this study is to evaluate the enhancing the abscopal effect of radiotherapy (RT) by in-situ delivered anti-CD40 using Smart Radiation Biomaterials (SRB) in the treatment of prostate cancer where treatment in one site (location) able to cure the tumors in other locations of the body.

Evaluation

A syngeneic mouse model of prostate adenocarcinoma was generated in both flanks of C57/BL6 background mouse. The palpable sized tumor of right flank was treated as randomized cohorts: control, treatment with 5 Gy of RT, anti CD40 antibody (20 µg/tumor), and in combination. Another cohort was created by sustained delivery of anti CD40 antibody using SRB where SRB material by itself demonstrates some degree of antineoplastic activity in our previous studies. A Small Animal Radiation and Research platform (SARRP) was used for image-guided RT at 220 kVp. Our result shows that in-situ application of antiCD40 antibody with radiation significantly enhances the effect of radiotherapy ($p<0.01$), whereas using the SRB for AntiCD40 delivery in situ further enhances the survival ($p<0.001$). Reduction of tumor volume was observed in both sides. 2 out of 5 mice showed total regression of the untreated tumors in the RT+SRB delivered AntiCD40 group.

Discussion

These promising findings provide a good basis for further/ongoing studies investigating RT and CD40 antibody dosing and scheduling and use of SRB for sustained in-situ delivery of such immunoadjuvants to further optimize the treatment outcomes with minimal systemic toxicities.

SSA23-07 Imaging and Treatment of Primary and Metastasized Tumors Through Immunotherapy Using Targeted Antigen-Capturing Nanoparticles with Serum Amyloid A1 along with Radiation and PD-L1 Blockade

Sunday, Nov. 25 11:45AM - 11:55AM Room: E353A

Participants
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PURPOSE

We aimed to image and treat primary and metastasized tumors in vivo using microcapsules that release antigen-capturing nanoparticles (AC-NPs) with serum amyloid A1 (SAA1) in three radiation sessions under PD-L1 blockade.

METHOD AND MATERIALS

For session 1, liposome-protamine-hyaluronic acid nanoparticles (LPH-NPs) containing 5% iopamiron and 400 μg anti-PD-L1 Ab were mixed with 1 mL 4.0% alginate, 3.0% hyaluronate, and 1 μg/mL P-selectin solution and incubated with 0.5 mM FeCl2 with 1 μg/mL a4ß1 Ab. Microcapsules 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, AC-NPs generated by nanoprecipitation of 4 mg/ml polylactic-co-glycolic acid (PLGA) and 1000 ng/ml SAA1 were mixed with the cocktail described above and sprayed into 0.5 mM FeCl2 and 1 μg/mL anti-P-selectin Ab. Microcapsules (1 × 1010) were injected IV. After 9 h, tumors were irradiated as before. For session 3, 4 cGy 60Co whole-body γ-rays were administered at 24 h intervals for 5 d.

RESULTS

In session 1, anti-a4ß1 microcapsules accumulated around primary and metastatic tumors and were detected by CT. Microcapsules released P-selectin and anti-PD-L1 Ab in response to the initial irradiation. In session 2, microcapsules accumulated around the primary tumor via a P-selectin Ag-Ab reaction. PLGA AC-NPs and SAA1 were released after the second radiation dose. PLGA AC-NPs captured tumor-derived protein antigens released by the second radiation dose and transported them to SAA1-recruited and activated dendritic cells (DCs) that drove cross-priming of CD8+ T cells. In session 3, primed antitumor CD8+ T cells were activated by whole body radiation. These treatments significantly increased the antitumor effect (EF 1.7) and reduced metastasis by 74.3%.

CONCLUSION

Our CT-detectable microcapsules exhibited targeted AC-NP-mediated immunotherapeutic and abscopal effects, which could be used to advance tumor diagnoses and treatments.

CLINICAL RELEVANCE/APPLICATION

Targeted AC-NP-mediated immunotherapy with SAA1 directed by radiation enhanced the primary and metastatic antitumor effects of radiotherapy under PD-L1 blockade.

SSA23-08 Evaluation in Predicting Radiotherapy Efficacy for Esophageal Carcinoma Using Magnetic Resonance Diffusion-Weighted Imaging

Sunday, Nov. 25 11:55AM - 12:05PM Room: E353A

Participants
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PURPOSE

To evaluate magnetic resonance diffusion-weighted imaging (MR-DWI) technique in predicting the efficacy of radiotherapy for esophageal cancer

METHOD AND MATERIALS

Two related tests were performed in this experimental study. Test 1 included 40 Eca-109 nude mice models with esophageal cancer xenogrfts (test group=24; control group=16), and Test 2 included 42 and 42 mice models in test and control groups, respectively. The test group was given a single dose of 15Gy (6MV X-rays) during radiation therapy. In Test 1, sixteen time points included at 1 day before and 1 day after radiotherapy and then very two days during radiotherapy until 29th day. In the time points, all mice models underwent MRI scan with T1WI, T2WI, and DWI. In Test 2, MRI scans were performed at seven time points until 29th day and pathology results were obtained immediately after scans. The tumor volume and ADC value were evaluated in Test 1 and ADC values were compared with pathological cell density and necrosis in Test 2

RESULTS

Test 1, the growth doubling time was 17 days in test group and 5 days in control group. ADC values in test group rapidly increased at the 3rd day (highest at the 7th day) and then gradually decreased and returned to pre-therapy levels from the 17th day. In control group, the ADC values gradually decreased from the first day and kept at a low level from the 9th day. In Test 2, tumor cell density decreased from the 3rd day in test group compared with a gradual increased (highest at the 5th day) and then decreased in control group. Cell density in test group was lower than that in control group from the 3rd day after radiotherapy ($P<0.05$). ADC values were negatively correlated with cell density ($rs=-0.703$, $p=0.000$). The radio of necrosis of tumor in test group was higher than that in control group after the 3rd day ($P<0.05$). ADC values were positively correlated with the tumor necrosis ($rs=0.658$, $p=0.003$).

CONCLUSION

MR-DWI values could change earlier than morphological size during radiotherapy for esophageal cancer and ADC values showed good correlations with pathology findings, which has the potential in predicting the efficacy of radiation or other therapy.

CLINICAL RELEVANCE/APPLICATION

provide theoretical basis for the rational application of this technique in clinical practice

SSA23-09 Pseudoprogression versus Progression: The Role of Diffusion MRI During Immunotherapy for Solid

Tumor

Sunday, Nov. 25 12:05PM - 12:15PM Room: E353A

Participants
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PURPOSE

The aim of our study is to evaluate the role of diffusion-weighted MR sequences in the study of patients undergoing immunotherapy for stage IV solid tumors. The study aims to identify patients with pseudoprogression by calculating ADC and to differentiate them precociously from patients with true progression.

METHOD AND MATERIALS

Between September 2017 and March 2018 were evaluated with MRI with diffusion-weighted sequences (b value up to 800) 8 patients treated with immunotherapy (4 with renal cell carcinoma, 2 with pulmonary adenocarcinoma and 2 with melanoma). 11 target abdominal lesions were considered, positioning a ROI for the calculation of ADC in MRI performed at the beginning of therapy (RMt0), at the second infusion cycle (RMt1) and concomitantly with the revaluation TC, at approximately 8- 9 weeks (RMt2) after the start of treatment. Patients were staged at t0 and re-staged at t2 with toraco-abdominale and head contrast enhanced CT (TCt1 and TCt2) and were therefore classified as: progression (PD), partial response (PR), stable disease (SD) or pseudoprogression (PP) according to immuno-RECIST criteria.

RESULTS

Among the 8 patients evaluated, 2 died during immunotherapy (PD). Of the 6 patients on therapy, based on the immuno-RECIST criteria, 1 was considered PD, 1 PR, 3 were SD and 1 was definied in pseudoprogression (PP). The pseudoprogression is represented by a dimensional increase of the target lesion at t2. The ADC values calculated in the three MRI exams performed during immunotherapy are not significantly changed (mean ADC RMt0 0.71 ± 0.14, ADC RMt1 0.91 ± 0.39, ADC RMt2 0.76 ± 0.16).

CONCLUSION

Immunotherapy in solid tumors causes a transient increase in intratumoral lymphocyte infiltrate changing cell density in the lesion. The target lesions evaluated after the start of immunotherapy showed changes both in size and ADC value. The main limitation of our study is represented by the small number of patients currently evaluated.

CLINICAL RELEVANCE/APPLICATION

Despite an increase in size of target lesions in solid tumors (pseudo progression) ADC values calculated in MRI during immunotherapy are not significantly changed.

SSA24

Vascular Interventional (Aortic and PAD)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S502AB

VA IR

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

FDA Discussions may include off-label uses.

Participants
Gordon McLennan, MD, Chagrin Falls, OH (*Moderator*) Grant, Siemens AG; Grant, Surefire Medical, Inc; Speakers Bureau, Medtronic plc; Speakers Bureau, General Electric Company; Speakers Bureau, Stryker Corporation; Advisory Board, Siemens AG; Advisory Board, Surefire Medical, Inc; Advisory Board, Stealth Medical; Advisory Board, Rene Medical, Inc; Advisory Board, F. Hoffmann-La Roche Ltd; Advisory Board, Bristol-Myers Squibb Company; Advisory Board, B. Braun Melsungen AG; Advisory Board, General Electric Company;
Dimitrios Filippiadis, MD, PhD, Athens, Greece (*Moderator*) Nothing to Disclose

Sub-Events

SSA24-01 Transarterial Computed Tomographic Angiography in Patients with Renal Function Impairment Undergoing Endovascular Aortic Repair

Sunday, Nov. 25 10:45AM - 10:55AM Room: S502AB

Participants
Giovanni F. Torsello, MD,BA, Berlin, Germany (*Presenter*) Nothing to Disclose

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PURPOSE

Endovascular aneursym repair (EVAR) of aortic aneurysms is the treatment of choice in most cases. Computed tomography angiography (CTA) is crucial in the preoperative planning and postoperative surveillance. Renal function impairment secondary to high volumes of contrast media however limits pre- and postoperative assessment especially of complex aortic aneurysms. The aim of this study is to evaluate the safety and diagnostic value of a novel technique in the setting of patients undergoing EVAR.

METHOD AND MATERIALS

Between January 2011 and August 2016, 145 patients with chronic kidney disease underwent transbrachial placement of an angiography catheter in the ascending aorta for i.a. contrast medium administration in the setting of a CTA. 45 patients with normal kidney function and aortic aneurysms were included in the analysis as a control group. Primary endpoint was the change in serum creatinine. Secondary security endpoints were access site complications and cerebrovascular accidents. Imaging quality endpoints were attenuation levels and contrast-to-noise-ratios in predefined vessels, validated by intraclass correlation coefficients.

RESULTS

Mean creatinine change was -.12 mg/dL, mean GFR change was 2.15% in the intervention group. There were two (1.3%) false aneurysms and one access site hematoma (0.7%). Two cerebrovascular accidents (1.3%) were transient. Transarterial CTA attenuation values varied between 228.98 (±78.66) and 266.21 (±110.82) Hounsfield units (HU), and 306.35 (±63.27) to 321.39 (±70.12) HU in the control group. The mean amount of contrast medium used in the catheter group was significantly reduced (31.70 ±5.82 mL) compared to a standard dose of 120 mL in the control group ($p = 0.001$). Contrast-to-noise ratios varied between 9.1 (±4.8) and 11.1 (±4.4) in the different segments. Intraclass correlation coefficients between the readings were very good (0.987-0.992).

CONCLUSION

This study demonstrates that a catheter-based transarterial computed tomographic angiography is a safe and efficacious way to evaluate patients with aortic aneurysms, both prior to and after endovascular aneurysm repair.

CLINICAL RELEVANCE/APPLICATION

Transarterial CTA is a safe means of assessing complex aortic aneurysms and yields high imaging quality for preoperative assessment and postoperative follow-up in patients with decreased renal function.

SSA24-02 Morphological Changes Within 365 Days Predict Late Adverse Events in Uncomplicated Type B Aortic Dissections

Sunday, Nov. 25 10:55AM - 11:05AM Room: S502AB

Participants
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PURPOSE

Patients with medically treated type B aortic dissection (TBAD) remain at significant risk for late adverse events (AEs). We hypothesize that not only initial morphological features, but also their change over time are associated with late AEs.

METHOD AND MATERIALS

Baseline and 188 follow-up CT-scans (median and interquartile range: 4 years [2-5]) of 47 patients with acute uncomplicated TBAD were retrospectively reviewed. Morphologic CT imaging features were qualitatively and quantitatively assessed at baseline and each follow-up. Medical records were reviewed for late AEs, defined according to current guidelines. Predictive value of changes of morphological features (aortic diameter, size of intima tear, number of secondary tears, length of dissection, circumferential extent of false lumen and false lumen thrombosis) within 365 days for AEs was assessed using Cox proportional hazard regression with time-dependent covariates. Significant predictors were combined into a prediction model (cut-off p-value for model inclusion $p<0.15$)

RESULTS

21 AEs occurred in 47 patients. Multivariate analyses revealed following predictors for late AEs: maximum major aortic diameter: (HR=1.03[0.99-1.07] per mm increase p=0.06), number of secondary tears: (HR=1.02[0.90-1.15] per tear number increase p=0.80), area false lumen thrombosis: (HR=1.07[1.01-1.14] per mm2 increase p=0.03). The model with significant predictors showed following significant independent predictors: major aortic diameter: (HR=1.03[1.01-1.06] per mm increase $p<0.01$) and area false lumen thrombosis: (HR=1.07 [1.01-1.14] per mm2 increase p=0.03).

CONCLUSION

Increase in aortic diameter and false lumen thrombosis area within 365 days after onset are both significantly associated with greater risk of late AEs.

CLINICAL RELEVANCE/APPLICATION

Patients with increase of false lumen diameter and thrombosis within the first year after TBAD may benefit from shorter follow-up intervals and evaluation thereafter.

SSA24-03 Aneurismal Sac Remodeling After Nellix Endovascular Aneurysm Sealing System (EVAS) in Patients with Abdominal Aortic Aneurysm (AAAs): A Magnetic Resonance Imaging (MRI) Study

Sunday, Nov. 25 11:05AM - 11:15AM Room: S502AB

Participants
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PURPOSE

The Nellix endovascular aneurysm sealing system (EVAS) is a valid option for the treatment of infrarenal abdominal aortic aneurysm (AAAs) that has distinctive design comprising two balloon-expandable endoframes, each sorrounded by a polymer-filled endobags. This technique was conceived with the intention of reducing risk of endoleak by filling the aneurysmal lumen excluded by endoprosthesis. However the long-term impact of EVAS on sac remodeling and thrombus modification is still unclear.Our aim was to evaluate the modifications in aneurysmal sac in patients treated by EVAS for AAAs in terms of morphology and thrombus characteristics using MRI at one-year follow-up.

METHOD AND MATERIALS

We enrolled 10 patients EVAS candidates for AAAs. All patients underwent MRI before, 1-week and 1-year after EVAS treatment. We determinated AAA morphological features (diameter, proximal neck, lenght, AAA sectional areas, sac volume, endoleak presence and lumen volume) and thrombus characteristics (thrombus volume and maximal thickness, T1 and T2 signal).

RESULTS

No early or late endoleaks were observed in all patients after EVAS. We observed significant reduction of sac and thrombus volume (mean value:44.5mL Vs 40.9mL and 7.5mL Vs 3.5mL, respectively, p:0.01-0.23). Diameter and thrombus thickness did not change significantly at 1- year follow-up after EVAS (48.5mm vs 47.3mm, 12.4 vs 11.3mm, respectively, $p > .05$ for both). The MRI signal of thrombus showed a reduction of T1 and T2 values (mean difference: -45% and -30%, respectively, p:0.01-0.03) at the 1-year

follow-up.

CONCLUSION

Filling the endobags inside the aneurysmal sac leads to the progressive reduction of thrombus volume and lowering of T1/T2 values, probably due to thrombus organization and squeezing of fluid content into collateral vessels. EVAS could be associated to an acceleration of thrombus remodeling after AAAs treatment

CLINICAL RELEVANCE/APPLICATION

The accelerated thrombus remodeling, in addition to the intrinsic advantages offered by Nellix technology, could further reduce the rates of device-related complications, such as endoleak , endograft migration, component separation and sac enlargement.The positive pressure exerted by two endobags anchored to the endoprosthesis probably facilitate thrombus organization and compaction, by confering more stability to the whole system.

SSA24-04 Remodeling of Aorta After Thoracic Endovascular Aortic Repair for Aortic Dissection

Sunday, Nov. 25 11:15AM - 11:25AM Room: S502AB

Participants
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PURPOSE

It is well known that favorable remodeling of the aorta after thoracic endovascular aortic repair (TEVAR) does not occur and leads to enlargement of the distal aorta in some patients with aortic dissection (AD). The objective of this study is to determine the most appropriate timing of TEVAR for AD in terms of remodeling of the aorta.

METHOD AND MATERIALS

Since March 2004 through March 2017, 99 patients with AD underwent TEVAR. Among them, 36 patients who were followed-up with CT over 1 year were included in this study. There were 28 men and 8 women. Mean age was 66 ± 9 years. The diameters of the aorta, the true lumen, and the false lumen were measured at the levels of the most dilated descending aorta (level M) and the diaphragm (level D) on contrast enhanced CT. In addition, the ratio of the diameter measured on CT before TEVAR to that 1 year after TEVAR was calculated in each measurement.

RESULTS

The cut-off interval of 2.5 months between the onset of AD and TEVAR was determined by means of a receiver operating characteristic curve in terms of existence of shrinkage of the aortic diameter at level D on 1-year follow-up CT (AUC:0.724). According to this interval, patients were divided into two groups: patients who underwent TEVAR within 2.5 months of the onset of AD (n=16, group A) and patients who underwent TEVAR over 2.5 months (n=20, group B). At level M, the diameter of the aorta and the false lumen significantly decreased and that of the true lumen significantly increased in both groups ($P<0.01$). At level D, the diameter of true lumen significantly increased and that of the false lumen significantly decreased in both groups ($P<0.01$) although there was no significant difference in the diameter of the aorta. In terms of the diameter ratio, the false lumen shrank more in group A compared to group B at both levels of M ($P=0.017$, CI:0.044-0.424) and D ($P=0.015$, CI:0.078-0.667).

CONCLUSION

To obtain favorable remodeling of the aorta, it seems to be more effective to perform TEVAR within 2.5 months of the onset of AD.

CLINICAL RELEVANCE/APPLICATION

To obtain favorable remodeling of the aorta, it seems to be more effective to perform TEVAR within 2.5 months of the onset of AD.

SSA24-05 Early Intervention for Penetrating Aortic Ulcer Leads to Improved Outcome and Overall Survival

Sunday, Nov. 25 11:25AM - 11:35AM Room: S502AB

Participants
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PURPOSE

The natural history of penetrating aortic ulcer (PAU) has been variably described and clear guidelines are lacking. We reviewed our experience with penetrating aortic ulcers in a tertiary referral center.

METHOD AND MATERIALS

Imaging reports from January 2010 – December 2017 were retrospectively searched for the diagnosis of penetrating aortic ulcer.

Imaging reports from January 2010 - December 2017 were retrospectively searched for the diagnosis of penetrating aortic ulcer. Diagnosis was confirmed by review of imaging studies. Patient demographics, presenting symptoms, and anatomic characteristics were collected and analyzed for associations with need for surgical intervention, aortic complication, and overall survival.

RESULTS

One hundred and six patients with PAU were identified. Locations included: 57 (53.8%) aortic arch, 24 (22.6%) descending thoracic, and 25 (23.5%) abdominal aorta. Dissection was present in 12 (11.4%) and acute rupture in 4 (3.8%) cases. At presentation 57 (53.8%) patients were symptomatic. Forty-six (43.8%) patients were evaluated by endovascular interventionalists. Thirteen (12.3%) underwent endovascular repair and 10 (10.4%) had a change in medical management. Long term follow-up was available in 30 patients for a mean 2.3 (2.0) years. Twenty-one (70%; 21/30) demonstrated disease stability or resolution and 9 (30%, 9/30) worsened with 3 undergoing endovascular repair. No PAU ruptured during follow-up. Patient demographics, presenting symptoms, and PAU morphology did not predict disease progression. Referral to a endovascular interventionalist at initial presentation was associated with a 40% decreased likelihood of disease progression (p=0.046) and a 30% survival advantage at LTFU (p=0.037).

CONCLUSION

PAU disease progression occurs in 30% of patients at long-term follow up of 2.3 (2.0) years. All patients identified with PAU on diagnostic imaging should be referred for an evaluation and follow-up, as referral to endovascular interventionalist is associated with improved disease course and overall survival.

CLINICAL RELEVANCE/APPLICATION

Early intervention for penetrating aortic ulcer leads to improved outcome and overall survival

SSA24-06 New 3D-Arterial Analysis Software to Evaluate Carotid Atherosclerotic Plaque in Comparison With CEUS, CTA, and Histological Examination

Sunday, Nov. 25 11:35AM - 11:45AM Room: S502AB

Participants
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PURPOSE

To assess the effectiveness of ultrasonographic 3D-Arterial Analysis in characterizing stenosis percentage and vulnerability of carotid plaques as compared with CEUS, CTA and histology results.

METHOD AND MATERIALS

Sixty seven 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%. Eventually all patients underwent endarterectomy and samples were histologically assessed for instability features. 3D-Arterial Analysis provided a colour map to evaluate plaque vulnerability and a 3D volumetric stenosis evaluation. Its diagnostic performance was compared to histological examination for plaque's vulnerability and to CEUS and CTA for stenosis' grading.

RESULTS

Histological examination identified 47 vulnerable plaques 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 42, 41 and 41 of these 47 vulnerable plaques respectively, with 89%, 87% and 87% sensitivity and 100% specificity. 3D-Arterial Analysis software and CEUS were able to evaluate stenosis percentage with 88% sensitivity and 100% specificity compared to CTA, identifying 59/60 severe stenosis.

CONCLUSION

3D-Arterial Analysis software and CEUS seem effective tools to assess plaque's vulnerability and stenosis severity, providing useful information for surgery planning.

CLINICAL RELEVANCE/APPLICATION

Multiparametric ultrasound is a safe and effective modality to provide comprehensive information on carotid plaques. Further studies are needed to determine which could be its clinical role.

SSA24-07 EZ-Access: A Novel 3D Printed Groin Puncture Device

Sunday, Nov. 25 11:45AM - 11:55AM Room: S502AB

Participants
Rahmi Oklu, MD,PhD, Phoenix, AZ (*Presenter*) Nothing to Disclose
Hassan Albadawi, MD, Phoenix, AZ (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Exsanguination is the leading cause of death after vascular trauma. Resuscitative endovascular balloon occlusion of the aorta (REBOA) can control torso hemorrhage. However, adoption of this approach specifically by the military has been limited by challenges in achieving femoral artery access in austere combat environments. To address this need, we developed a novel 3D printed minimally invasive device, termed EZ-Access, to enable successful vascular access without the need for ultrasound

guidance or specialized training for use in the field by first responders.

METHOD AND MATERIALS

EZ-Access was modeled using SolidWorks and 3D printed with a methacrylated resin using FormLabs2 printer. The device measured 14x2x1cm with two concave thumb rests on either side of a central plate containing 6 equidistant holes spaced at 0.8cm. The holes were fitted with a variable number of 21-gauge 7cm percutaneous entry needles followed by extensive testing. Multiple trials involved IR staff, residents, college and high school students to test success of accurate access of femoral artery using SimuLab models (Seattle, WA). Trial 1 consisted of 3 needles in alternating holes (n=40). Trial 2 used 6 sequentially placed needles (n=42). The needles within the device were inserted without ultrasound (US) guidance, two fingerbreadths lateral to the pubic symphysis. The device was angled along the groin crease and the needles entered the skin at a 45 degrees. After each puncture, US was used to confirm vessel entry. A control trial was also performed using standard single-entry access needle (n=5) by staff IR. Statistical analysis performed using Prism software (P=0.05).

RESULTS

The control trial demonstrated vessel entry rate of 20%. Using 3 alternating needles, successful vessel entry increased to 40% (p=0.396). With 6 sequential needles, vessel entry success significantly increased to 100% (p<0.001) regardless of operator experience.

CONCLUSION

EZ-Access has demonstrated overwhelming success in obtaining consistent percutaneous vascular access in a simulated clinical scenario independent of the operator's experience without the need for imaging guidance. The device has promising applications in pre-hospital resuscitation.

CLINICAL RELEVANCE/APPLICATION

Access into arterial system can be challenging especially in austere environments; EZ-Access may lead to a higher use of REBOA and improve outcomes.

SSA24-08 Effect of Rosuvastatin and Aspirin Therapy for Abdominal Aortic Atherosclerotic Plaque in Rabbits: A Magnetic Resonance Imaging Study

Sunday, Nov. 25 11:55AM - 12:05PM Room: S502AB

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PURPOSE

To evaluate the therapeutic effect of rosuvastatin, aspirin and two-drug combination on atherosclerotic plaque by conventional magnetic resonance imaging, explore its inhibition of inflammatory cells.

METHOD AND MATERIALS

160 New Zealand rabbits were given endothelial denudation combined with a cholesterol-enriched diet to induce abdominal aortic atherosclerosis. all rabbits were assigned randomly to control group (high fat diet), group A (high fat diet with aspirin), group T(high fat diet with rosuvastatin) and group AT(high fat diet with aspirin as well as rosuvastatin), 40 for each group. Four groups of animals were divided randomly into 1 week , 2 weeks 1month and 2 months subgroup. All rabbits underwent MR scan. Specimens of abdominal aorta were obtained within 24 hours after MR scan, afterwards HE stain and macrophages RAM - 11 ICH staining was performed. Using software CASCADE quantitatively analyse abdominal aorta MRI, to acquire the wall standardized(NWI). Using the software Image-Pro Plus quantitatively analyse the RAM-11 ICH Image. Through compare NWI of group A, T, AT with control group at different time, study the changes of NWI, the number of plaque macrophages after drug treatment.

RESULTS

1) At four time points, the NWI of A, T and AT group is lower than the control group. At 1 week,1 month,2 month, the difference was statistically significant ($P < 0.05$).At 2 weeks, there was no significant difference ($P > 0.05$). 2) At four time points, the arterial intima gradually thickened in the control group over time.1month and 2 months, rendering the appearance of foam cell aggregation, lipid drops calm, disordered arrangement of collagen fiber hyperplasia. At each time point, the degree of arterial intimal thickening in group A,T,AT was less than that in the control group, and the accumulation of foam cells and deposition of lipid droplets were decreased compared with the control group.3)At 2 months,the macrophage of plaque with group A,T,AT were all decreased compared with the control group.

CONCLUSION

1) Rosuvastatin, aspirin and two drug combination can restrain plaque load, reduce inflammatory response. MR can response the inhibition, thus MR can be used in the evaluation of drug therapy. 2)Rosuvastatin combined aspirin can better reduce plaque load, reduce the number of macrophages.

CLINICAL RELEVANCE/APPLICATION

Black blood MR technology can be used to evaluate the effect of drugs on plaque treatment.

SSA24-09 18F-FDG Uptake as a Predictive Factor for Late Aortic Enlargement in Subacute Aortic Dissection

Sunday, Nov. 25 12:05PM - 12:15PM Room: S502AB

Participants
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PURPOSE

Purpose: Although previous study demonstrated that greater uptake of 18F fluoro-2-deoxy-D-glucose (FDG) in the dissected aortic wall was significantly associated with an increased risk for adverse aortic events in acute aortic dissection (AD), clinical assessment in subacute aortic dissection remains unexplored. This study was aimed to clarify the relationship of 18F-FDG uptake and late aortic enlargement in medically treated patients with subacute AD.

METHOD AND MATERIALS

Materials and Methods: A total of 16 medically treated patients with subacute AD (age: 69±9, 2 Stanford type and 14 type B) were prospectively enrolled in this study. PET/CT images were acquired 60 minutes after 18F-FDG injection in all patients. All patients underwent 18F-FDG PET/CT between 2 weeks and 4 months from the onset of aortic dissection. In all examinations, 10-mm circular regions of interest were drawn at the site of the dissected aortic wall with maximal focal 18F-FDG uptake. Areas with maximal focal 18F-FDG uptake were visually detected and the maximal standardized uptake value (SUV) was measured. The maximal SUV was divided by the blood-pool SUV, yielding a target-to-background ratio (TBR) for dissected aortic segment.

RESULTS

Results: During a median follow up of 21 (range 12-28) months, surgical repair was required in 4 patients due to aortic enlargement. In these patients, aortic diameter enlarged by more than 10mm compared to that of the onset. There was significant difference in TBR between patients undergoing surgical repair and the other patients (p=0.012). With TBR of 1.8 as cutoff level for the predictor of aortic enlargement, the sensitivity, specificity, and positive and negative predictive value, accuracy, and odds ratio were 75%, 75%, 50%, 90%, 75%, and 9.0, respectively.

CONCLUSION

Conclusion: Greater uptake of 18F-FDG in subacute AD was significantly associated with an increased risk for aortic enlargement. 18F-FDG PET/CT may be useful for predicting the unfavorable aortic enlargement in medically treated patients with subacute AD.

CLINICAL RELEVANCE/APPLICATION

(dealing with 18F-FDG PET/CT) 'Greater uptake of 18F-FDG in subacute aortic dissection was significantly associated with an increased risk for aortic enlargement.'

SSA25

Vascular Interventional (Chemo-Embolization and Radio-Embolization)

Sunday, Nov. 25 10:45AM - 12:15PM Room: S503AB

IR NM OI VA

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

Participants
Kevin Kim, BA, Arcadia, CA (*Moderator*)

Sub-Events

SSA25-01 Nomogram and Artificial Neural Network for Prognostic Performance on the Albumin-Bilirubin Grade for HCC Undergoing TACE

Sunday, Nov. 25 10:45AM - 10:55AM Room: S503AB

Awards
Trainee Research Prize - Medical Student

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PURPOSE

The albumin-bilirubin (ALBI) grade is a newly raised objective liver function assessment tool as well as an emerging alternative of the Child-Turcotte-Pugh (CTP) grade in hepatocellular carcinoma (HCC). We aimed to construct ALBI and CTP grades based nomograms as well as develop an artificial neural network (ANN) to compare the prognostic performance of these two grades.

METHOD AND MATERIALS

This multicentric retrospective study included all patients with HCC who underwent TACE monotherapy as initial treatment between January 2008 and December 2016 at four institutions. In the training cohort, independent risk factors associated with overall survival (OS) were identified by univariate and multivariate Cox proportional hazards analyses. The prognostic nomograms and ANN were then established in the training cohort and validated in the two validation cohorts.

RESULTS

Totally, 838 patients (548, 115, and 175 in the training cohort and validation cohorts 1 and 2, respectively) were included. The median OS was 10.4, 15.7, and 9.2 months in the training cohort and validation cohorts 1 and 2, respectively. In the training cohort, independent risk factors were identified as: higher Eastern Cooperative Oncology Group (ECOG) grade, portal vein tumor thrombosis (PVTT), extrahepatic spread (exclude PVTT), higher ALBI/CTP grade, a-fetoprotein level greater than 200 ng/mL, multiple tumors, and tumor size larger than 5 cm. The ALBI and CTP grades based nomograms were then established separately, and showed comparable prognostic performance when assessed externally in two independent validation cohorts (C-index in validation cohort 1: 0.823 vs. 0.802, P =0.417; in validation cohort 2: 0.716 vs. 0.729, P =0.793). ANN showed that ALBI grade had higher importance on survival prediction than CTP grade.

CONCLUSION

The ALBI grade outperforms the CTP grade on survival prediction for HCC patients who undergo TACE. Considering the easy application, the ALBI grade should be regarded as an alternative to CTP grade.

CLINICAL RELEVANCE/APPLICATION

The ALBI grade should be regarded as an alternative to CTP grade about prognostic prediction for HCC underwent TACE.

SSA25-02 Predicting Patient Survival After TACE for HCC Using a Neural Network: A Promising Tool

Sunday, Nov. 25 10:55AM - 11:05AM Room: S503AB

Participants
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PURPOSE

Transarterial chemoembolization (TACE) is the standard of care for intermediate stage hepatocellular carcinoma (HCC). Nevertheless, even for experienced investigators it can be challenging to decide when to repeat and when to stop TACE-treatment. To objectify treatment decisions, several scoring systems have been developed, e.g. ART, ABCR, and SNACOR. However, the predictive ability was only poor-moderate in several attempts of external validation. Therefore, our aim was to develop a survival prediction model for patients with intermediate stage HCC undergoing TACE using novel machine learning algorithms.

METHOD AND MATERIALS

For this retrospective analysis, we included 792 patients who underwent TACE for HCC at our tertiary referral centre between 01/2005-01/2017. Clinical parameters were acquired from the institutions clinical registry and laboratory system. Radiological response was evaluated in consensus by two board certified radiologists experienced in HCC imaging. Consecutively, we built an artificial neural network, which included all parameters used by the aforementioned clinical risk scoring systems (i.e. ART-, ABCR-, and SNACOR-score): baseline BCLC stage, alpha-fetoprotein level, tumour size and number, as well as change of Child-Pugh stage, AST, and radiological response after the first TACE.

RESULTS

With ten-fold cross validation, the neural network showed a promising performance at predicting one-year survival with an area under the ROC curve of 0.69 and a positive predictive value of 78.6%. This outperforms other established risk stratification scores such as ART, ABCR, and SNACOR.

CONCLUSION

Neural networks could prove superior in predicting patient survival after TACE for HCC compared to other commonly used scoring systems. Inclusion of additional parameters in the prediction model is likely to further increase its performance.

CLINICAL RELEVANCE/APPLICATION

Once established, such novel prediction models could easily be deployed in clinical routine and help in determining optimal patient care.

SSA25-03 Experimental Study on Transarterial Administration of Bevacizumab Combined with Transarterial Chemoembolization in Rats with Hepatocellular Carcinoma

Sunday, Nov. 25 11:05AM - 11:15AM Room: S503AB

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PURPOSE

To evaluate the effects of transarterial administration of Bevacizumab (Avastin), an inhibitor of vascular endothelial growth factor (VEGF), combined with transarterial chemoembolization (TACE) to treat hepatocellular carcinoma in rats.

METHOD AND MATERIALS

Subcapsular implantation of a solid Morris hepatoma 3924A (2 mm3) in the liver was carried out in 20 male ACI rats. Animal subjects were assigned to group based on which treatment-drugs were injected into the hepatic artery: group A: TACE (mitomycin C + lipiodol + degradable starch microspheres) + bevacizumab; group B: TACE alone. Tumor volumes of the post-treatment (V2) and pre-treatment tumor (V1) were assessed by magnetic resonance imaging (MRI) and the mean ratio (V2/V1) was calculated. Immunohistochemical expression of MMP-9 and VEGF in the tumor was semi-quantified in all rats.

RESULTS

The rate of tumor implantation reached 100 % in all the rats receiving tumor implantation with Morris hepatoma 3924A. None of the animals died during implantation or interventional therapy. A total of 20 individual HCC tumors were observed with unenhanced MR imaging in the livers of 20 rats (100%) before treatment. After different interventional treatments, intrahepatic metastases developed in one of the 10 rats in group B. The mean value of the volume ratios [V2 (postreatment /V1 (pretreatment] were 1.6649 ± 0.1255 in group A, and 3.0061 ± 0.1910 in group B, respectively. Significant differences of mean volume ratio (V2/V1) were observed between the two groups using an unpaired t test ($P<0.0001$) (Fig.1) (Fig.2). The angiogenesis of tumor was evaluated using anti-VEGF antibodies, and the metastasis of tumor was assessed using anti-MMP-9 antibody. MMP-9 and VEGF were expressed in all specimens. The immunoexpression of these proteins was confirmed by the presence of red cytoplasmic staining in tumor cells. Higher expressions of MMP-9 (4.9 ± 0.199) and VEGF (4.2 ± 0.79) in hepatocellular carcinoma were observed in the group B (TACE alone) than the MMP-9 (1.9 ± 0.733) and VEGF (2.9 ± 0.678) in group A (TACE + Bevacizumab). Statistical significance was calculated using Wilcoxon signed ranked test (both $P<0.0020$) (Tab.1) (Fig3).

CONCLUSION

Transarterial administration of bevacizumab combined with TACE noticeably inhibit the growth of hepatic carcinoma and intrahepatic metastases in rats.

CLINICAL RELEVANCE/APPLICATION

N/A

SSA25-04 Tc-99m-MAA Lung Shunt Fraction Studies Prior to Y-90 Radioembolization Have Limited Utility in Non-Hepatocellular Carcinoma Malignancies

Sunday, Nov. 25 11:15AM - 11:25AM Room: S503AB

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PURPOSE

Lung shunt fraction (LSF) studies using Technetium-99m macro aggregated albumin (Tc-99m-MAA) are routinely performed prior to Yttrium-90 (Y90) radioembolization in all eligible patients regardless of underlying malignancy. This study evaluates the utility of performing Tc-99m-MAA lung shunt fraction studies in patients with hepatocellular carcinoma (HCC) compared to those with non-HCC liver tumors.

METHOD AND MATERIALS

A multi-hospital retrospective analysis of all pre-Y90 Tc-99m-MAA LSF studies between November 2012 to March 2018 was performed. Patient records were evaluated for age, gender, LSF, and underlying malignancy. Tc-99m-MAA studies were evaluated for mean LSF and were compared between HCC and non-HCC cases (p=.05).

RESULTS

A total of 734 Tc-99m-MAA studies were identified among 653 patients. Among these cases 368 (50.1%) involved HCC, 112 (15.3%) colorectal cancer metastatic to liver, 89 (12.1%) neuroendocrine tumor metastatic to liver, 59 (8.0%) cholangiocarcinoma, 27 (3.7%) breast cancer metastatic to liver, and the remaining 79 cases (10.7%) involved other primary malignancies metastatic to liver. The mean LSF of non-HCC cases, 7.4%, was significantly lower than the mean LSF of HCC cases, 11.7% (p=0.0001). There was only one non-HCC case in which a Y-90 radioembolization was not pursued due to high LSF (69.3%), a case of metastatic GIST to liver, in which large scale shunting through the 8 cm mass was grossly apparent on the angiogram. This is compared to at least 37 HCC cases (mean LSF 35.1%) in which LSF was too high to pursue radioembolization.

CONCLUSION

Tc-99m-MAA LSF is low among patients with liver malignancies that are not HCC. This study indicates that pre-Y90 Tc-99m-MAA studies have limited utility in non-HCC liver malignancies.

CLINICAL RELEVANCE/APPLICATION

Patients with non-HCC liver malignancies may only require a consolidated single procedure selective Y-90 radioembolization without prior Tc-99m-MAA nuclear medicine scan.

SSA25-05 Post-Radioembolization Lung Shunt Fraction Assessment of Yttrium-90 Microspheres with Digital Photon Counting PET/CT: Intra-Individual Comparison with Conventional Photomultiplier Tube-Based PET/CT

Sunday, Nov. 25 11:25AM - 11:35AM Room: S503AB

Participants
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PURPOSE

The purpose of this study is to assess the clinical feasibility and estimate 90Y microsphere lung shunt fraction (LSF) following radioembolization using both digital photon counting PET detector (dPET) and conventional photomultiplier tube-based PET detector (cPET) technologies and compare to pre-radioembolization 99mTc macro-aggregated albumin (MAA) LSF.

METHOD AND MATERIALS

In a Phase I intra-individual comparison trial, pre-radioembolization 99mTc MAA was performed in 8 patients who were then treated with 90Y glass microspheres for hepatic malignancies/metastases. Investigational 90Y dPET/CT (Vereos, Philips) and cPET/CT (Gemini, Philips) imaging of the lungs and liver was performed in each patient (4 - 50 hrs following radioembolization). Intra-individual comparison of PET image quality and volumetric assessment of intrahepatic radioactivity was performed by a blinded reader panel. 99mTc MAA LSF was routinely calculated using planar scintigraphy. PET estimation of 90Y LSF was performed using MIMVista (MIM Software).

RESULTS

All patients had evaluable MAA and 90Y PET images for qualitative assessment of radioactivity distribution. Qualitatively, dPET enabled more precise localization of 90Y radioactivity when compared with cPET. Quantitatively, 90Y-treated liver volumes were consistently smaller with dPET than cPET (660 +/- 429 mL for dPET and 944 +/- 595 mL for cPET). There were no instances of significant 90Y microspheres shunting outside of the liver or in the lungs. PET estimation of 90Y LSF was consistently and significantly less (dPET was 0.1 +/- 0.2 % and cPET was 0.2 +/- 0.3 %) than MAA LSF (7 +/- 5 %, $P < 0.001$).

CONCLUSION

There remains an unmet clinical need to improve the quantification of 90Y biodistribution following radioembolization. These results demonstrate the feasibility of 90Y LSF assessment using new dPET and cPET approaches that may identify patients with smaller or larger than anticipated LSFs.

CLINICAL RELEVANCE/APPLICATION

Digital PET technologies may enable new quantitative methodologies for 90Y-dosimetry and improve our understanding of vascular shunting in various liver malignancies/metastases.

SSA25-06 Hepatocellular Carcinoma Prognostication Survival Based on Scoring System Developed and Validated on Combined Milieu Intérieur and Milieu Extérieur

Sunday, Nov. 25 11:35AM - 11:45AM Room: S503AB

Participants
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;

PURPOSE

To explore role of routine laboratory parameters in prediction of overall survival (OS) for hepatocellular carcinoma (HCC) treated with transartrerial radioembolization (TARE) and develop/validate a prognostic scoring system.

METHOD AND MATERIALS

With IRB approval, we selected all HCC patients who received TARE and had alpha-fetoprotein (AFP)>100 ng/dl at baseline. Routine labs [neutrophil-lymphocyte (N/L) (inflammatory-immune response), albumin-bilirubin (ALBI) grade (liver function), and AFP (tumor marker)] were measured at baseline and at 1, 3 and 6 month post-TARE Landmarks. Univariate/multivariate analyses were performed to evaluate OS predictability of these parameters. Scoring systems were developed based on baseline imaging (including PVT, metastases, ascites, portal hypertension); baseline labs and labs at respective landmark (including ALBI and AFP). Cohort was divided randomly into two groups: Predicting Group and Validating Group. This scoring was investigated and validated in the predictability of HCC. Using this score, time-dependent receiver operating characteristics (ROC) were evaluated with survival outcomes at each landmark.

RESULTS

345/401, 238/401, and 167/401 patients had laboratory parameters available at the 1, 3, and 6 month Landmarks, respectively. ALBI score and AFP response were significant OS prognosticators at all Landmarks. Laboratory Score [ALBI+(0.3xLnAFP)] was developed to predict OS from these Landmarks in the Predicting Group and was internally validated. For developing and validating groups; at 1-month landmark, 1-year survival was 69% and 71%, at 3-month landmark ($p<0.001$), 1-year survival was 72% and 66%, at 6-month landmark ($p<0.001$), 1-year survival was 78% and 82% respectively ($p<0.001$). Area under ROCs were correlative with significant survival prognostication.

CONCLUSION

Post-therapeutic AFP response and ALBI scores are easily calculable values from routinely performed blood tests. Our proposed Laboratory Score combines post-therapeutic ALBI score with AFP response and is independent of imaging findings. Following TARE, changes in labs can predict survival earlier even in absence of apparent imaging response.

CLINICAL RELEVANCE/APPLICATION

For HCC survival, imaging response is standard but it may take time. As per our study, laboratory values can also surrogate the HCC survival with earlier results and outcomes.

SSA25-07 Prospective Randomized FAST I Trial: Evaluation of Tumor Response of Colorectal Liver Metastases after Transarterial Chemoembolization with Two Different Protocols Using MRI

Sunday, Nov. 25 11:45AM - 11:55AM Room: S503AB

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PURPOSE

To prospectively evaluate therapy response of third-line transarterial chemoembolization (TACE) for colorectal liver metastases with either degradable starch microspheres (DSM) or Lipiodol (cTACE) using regular and diffusion MRI.

METHOD AND MATERIALS

In total, 50 patients (35 males, 15 females, mean 62 years, range 40-79) underwent TACE. They were randomly assigned into two groups: group A receiving DSM and group B receiving Lipiodol as embolization agents. Chemotherapy consisted of a combination of Cisplatin, Irinotecan, Mitomycin. Therapy response was evaluated using MRI with diffusion imaging and unenhanced MRI sequences, which were performed before each of the three TACE cycles to obtain tumor volume and apparent diffusion coefficient (ADC). In addition, contrast-enhanced MRI sequences were performed before the first and after the last TACE cycle. Local tumor response was evaluated using the RECIST criteria and survival data were analyzed using the Kaplan-Meier estimator.

RESULTS

Evaluation using the RECIST 1.1 criteria showed partial response (PR) in 33% of cases, stable disease (SD) in 13% of cases, and progressive disease (PD) in 53% of cases in the cTACE group while the DSM group showed 23% cases of PR, 59% cases of SD, and 18% cases of PD. Over the course of the therapy, the DSM group showed a statistically significant reduction in the average tumor volume ($p=0.006$). A statistically significant difference in tumor response was not found between the cTACE and DSM groups ($p=0.37$). Maximum ADC values after the last MRI session correlated signficantly with therapy response ($p=0.005$), pre-treatment ADC values, however, did not ($p=0.34$). Median survival in the cTACE group was 13 months and 16 months in the DSM group.

CONCLUSION

A statistically significant reduction in tumor volume was found in the DSM group. No significant difference in tumor response was found comparing the Lipiodol and DSM group. Maximum ADC values may be used to assess therapy response after completion of one or more TACE cycles.

CLINICAL RELEVANCE/APPLICATION

Both the Lipiodol and DSM group show similar results with greater tumor volume reduction for the DSM group.

SSA25-08 Liver Transplantation Following Yttrium-90 Radioembolization: A Comprehensive Report of Short and Long-Term Outcomes of a 170-Patient Cohort

Sunday, Nov. 25 11:55AM - 12:05PM Room: S503AB

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PURPOSE

To report short and long-term outcomes of liver transplantation (LT) for hepatocellular carcinoma (HCC) patients bridged or downstaged by Y90 radioembolization

METHOD AND MATERIALS

Between 2004 and 2017, 170 HCC patients underwent LT after receiving Y90. Patients were staged using the United Network of Organ Sharing (UNOS) staging system at the times of their Y90 and LT. Early post-operative outcomes were recorded. Recurrence-free survival (RFS) and overall survival (OS) were calculated using Kaplan Meier Method.

RESULTS

170 patients underwent LT after Y90, with a median time to LT of 7.4 months (IQR: 4.4-10.3). Only 1 patient grade 3 albumin (<3 gm/dl) toxicities and 9 patetients had grade 3 bilirubin toxicities could be attributed to Y90.138 patients were successfully bridged to LT (maintained within Milan criteria) while 11 patients were down-staged to Milan criteria. 12 (7%) developed post-operative complications. Three-month mortality rate after LT was 6/170 (3.5%). 75 (44%), 49 (29%) and 46 (27%) patients showed complete, extensive and partial tumor necrosis on explants pathologic assessment. Three, five and ten-year OS rates were 86%, 80%, and 56% respectively. 20 patients developed recurrence, with 3, 5 and 10-year RFS rates of 79%, 67% and 40%. Median RFS was 119 (95%CI: 68-119) months. There were no significant differences in OS or RFS for bridged or downstaged patients. There was significant difference in terms of number of recurrences and RFS between patients who had complete or extensive necrosis vs patients who had partial necrosis (p<0.0001).

CONCLUSION

Y90 can be used as a locoregional therapy that permits bridging or downtaging to LT. LT after Y90 represents a curative treatment for HCC with excellent OS rates comparable to LT for non-malignant causes. Patients who achieved extensive or complete necrosis have better recurrence free survival outcomes.

CLINICAL RELEVANCE/APPLICATION

Y90 has proven to be not only beneficial for HCC patients with bridging or downstaging to LT but also with good tumor response pre-LT and prolonged recurrence free survival post-LT.

SSA25-09 Predicting Treatment Response of Primary and Secondary Lung Neoplasms to Transpulmonay Chemoembolization (TPCE) and Transarterial Chemoperfusion (TACP) Using Diffusion-Weighted MRI (DWI): Value of Pretreatment Apparent Diffusion Coefficient (ADC)

Sunday, Nov. 25 12:05PM - 12:15PM Room: S503AB

Participants
Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Presenter*) Nothing to Disclose
A. T. Hoppe, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose
Tatjana Gruber-Rouh, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To examine predictive value of apparent diffusion coefficients (ADC) derived from diffusion-weighted MR imaging (DWI) in patients with unresectable primary and secondary lung cancer undergoing transpulmonary chemoembolization (TPCE) and transarterial chemoperfusion (TACP) treatment.

METHOD AND MATERIALS

31 patients with 42 lesions (non-small cell lung cancer (NSCLC) n=13; and lung metastases n=18) underwent examination with DWI prior to first treatment and one month thereafter. Lesion diameter and volume were measured at the beginning and end of each treatment cycle (mean 3.1 procedures per patient) in about 4-week intervals between January 2014 and December 2017. Decreases by at least 30% regarding tumor volume were classified as partial response (PR), an increase by 20% or more was defined as progressive disease (PD), while remaining lesions were categorized as stable disease (SD).

RESULTS

The PR group contained 9 lesions (NSCLC n=8; metastasis n=1), mean pretreatment ADC was 1.164 x 10-3 mm2/s, increase in mean ADC after first intervention was 32.9%. The PD group had 14 lesions (NSCLC n=1; metastases n=13), mean pretreatment ADC was 1.418 x 10-3 mm2/s, increase in mean ADC was 5.0%. Difference between ADC changes in the response groups was significant p<0.01). Lesion pretreatment ADC recorded fair diagnostic value for predicting response (AUC 0.774). Applying a threshold ADC increase of 20.71%, response can be predicted with a sensitivity and specificity of 88% and 78%, respectively (AUC 0.838). In primary lung cancer lesions, correlation of ADC changes with changes in tumor diameter and volume of -0.87 and -0.66, respectively. In metastatic lesions, correlation coefficients were -0.18 and -0.35.

CONCLUSION

A correlation was documented between early increases in ADC and tumor size reduction. Furthermore, responding lesions showed lower pretreatment ADC. DWI seems a suitable method for response prediction. The findings correlated better with primary lung cancer than with lung metastases.

CLINICAL RELEVANCE/APPLICATION

DWI provides the interventionalist with information going beyond morphological tumor aspects and response prediction assists in prioritising treatment locations in patients with multiple lesions

SSC01

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

Monday, Nov. 26 10:30AM - 12:00PM Room: S504CD

CA CT

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

Participants
Yeon Hyeon Choe, MD, PhD, Seoul, Korea, Republic Of (*Moderator*) Nothing to Disclose
Gregory Kicska, MD, PhD, Seattle, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSC01-01 Cardiac Keynote Speaker: Prognostic Role of Coronary CT Angiography

Monday, Nov. 26 10:30AM - 10:50AM Room: S504CD

Participants
Gregory Kicska, MD, PhD, Seattle, WA (*Presenter*) Nothing to Disclose

SSC01-03 The Intermediate-Term Impact of Coronary CT Compared to Stress Echocardiography During Risk Assessment in Patients Undergoing Liver Transplantation: A Prospective Follow-Up Study in a Consecutive Patient Population

Monday, Nov. 26 10:50AM - 11:00AM Room: S504CD

Participants
Patricia Tischendorf, Frankfurt, Germany (*Presenter*) Nothing to Disclose
Claudia Frellesen, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose
Christophe Arendt, MD, Frankfurt am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
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Ralf W. Bauer, MD, Frankfurt, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG; Speakers Bureau, Bayer AG; Speakers Bureau, General Electric Company

PURPOSE

Aim of this study was to evaluate the intermediate-term impact of coronary Computed Tomography (cCT) versus Stress Echocardiography (STE) as a cardiac risk stratification prior to liver transplantation in a consecutive patient population with unknown coronary artery disease (CAD).

METHOD AND MATERIALS

From 2014 to 2017, 139 consecutive patients, who underwent cCT or STE as a part of the institutional liver transplantation evaluation procedure, were enrolled unless they met the predefined exclusion criteria. 67 patients underwent non-enhanced CaSc followed by prospectively ECG-triggered sequential coronary CTA, in addition to the Agatston-Score, we used the CAD-RADS classification for risk assessment. 72 patients were examined by STE. Follow-up information concerning the primary endpoint, consist of cardiac or non-cardiac death and the combined endpoint of cardiac death, myocardial infarction, revascularisation and stroke was obtained from general practitioners, or treating hospitals, respectively.

RESULTS

The mean follow-up period was 569±442 days. During this time, 40 primary endpoints and 7 combined endpoints occurred. There was no significant difference in the incidence of primary endpoints in patients with pos. cCT or STE compared to patients without a pathological finding. In patients with pos. cCT, significantly more combined endpoint were observed than in the control group (p=0.0004). Moreover, the absence of a pathological finding in cCT or STE was shown to exhibit high negative predictive value. On multivariate analysis, Child-Pugh C liver status was the strongest independent predictor for an primary endpoint, with a 5-fold increased risk. While pos. cCT was the strongest independent predictor for an combined entpoint.

CONCLUSION

cCT and STE both provide excellent risk stratification and intermediate-term prognostic value in patients with unknown CAD. cCTA shows promising results in the initial work-up of unselected liver transplantation candicates with perviously unknown CAD. Patients with positive findings in cCT were successfully routed towards revascularization leading to a non-significant difference concerning the primary endpoint combared to patients with neg. cCT (p=0.47).

CLINICAL RELEVANCE/APPLICATION

Different cardiac imaging methods need to be investigated to avoid cardiac complications in patients undergoing liver transplantation, because the prevalence of asymptomatic CAD is relatively high in this population.

SSC01-04 Utilization of Coronary CT Angiography in Private Offices and Hospitals: Reversal of Earlier Trends and Implications for Radiologists

Monday, Nov. 26 11:00AM - 11:10AM Room: S504CD

Participants
David C. Levin, MD, Philadelphia, PA (*Presenter*) Consultant, HealthHelp, LLC; Board Member, Outpatient Imaging Affiliates, LLC
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PURPOSE

To assess recent trends in utilization of coronary CT angiography (CCTA), based upon place-of-service and provider specialty.

METHOD AND MATERIALS

The nationwide Medicare Part B Physician/Supplier Procedure Procedure Summary Master Files for 2006-2016 were the data source. CPT-4 codes for CCTA were selected. The files provided procedure volume for each code. Utilization rates per 100,000 Medicare fee-for-service enrollees were then calculated. Medicare's place-of-service codes were used to identify CCTAs performed in private offices, hospital outpatient departments (HOPDs), emergency departments (EDs), and inpatient settings. Physician specialty codes were used to identify CCTAs interpreted by radiologists, cardiologists, and all other physicians as a group. Because these files represent an entire population count, sample statistics are not required.

RESULTS

The overall CCTA utilization rate per 100,000 Medicare enrollees rose abruptly from 99.1 in 2006 to 210.3 in 2007, but then progressively dropped to 107.1 by 2013. However, thereafter it rose each year, reaching 131.0 in 2016. The private office CCTA utilization rate increased abruptly from 70.3 in 2006 to a peak of 150.1 in 2007, but thereafter dropped rapidly to 39.5 in 2016. The HOPD rate rose from 22.9 in 2006 to 46.1 in 2007, then declined to 36.1 by 2010. However, it thereafter increased progressively to 69.8 in 2016. The ED rate increased continually from 0.4 in 2006 to 5.3 in 2016. Among inpatients, the rate was 11.0 in 2007 and remained relatively unchanged through 2013. But in the 3 subsequent years, it increased to 16.4 by 2016. Radiologists' CCTA market share in the 4 venues in 2016 were: offices 44%, HOPDs 62%, EDs 85%, inpatients 66%. Radiologists' overall share had been 32% in 2007 (the peak year), compared with 60% for cardiologists. However, by 2016, radiologists' overall share was 58%, compared with 38% for cardiologists.

CONCLUSION

After years of declining CCTA utilization, the rate is now increasing, primarily in hospital settings. The private office rate has declined sharply. In a noteworthy reversal of another earlier trend, radiologists currently predominate in this procedure.

CLINICAL RELEVANCE/APPLICATION

After years of decline, the frequency of use of CCTA appears to be increasing, especially in hospital settings and among radiologists.

SSC01-05 Radiomics-Based Machine Learning Differentiates Early from Advanced Coronary Lesions: A Proof of Concept

Monday, Nov. 26 11:10AM - 11:20AM Room: S504CD

Awards
Trainee Research Prize - Fellow

Participants
Marton Kolossvary, MD, Budapest, Hungary (*Presenter*) Creator and Developer - Radiomics Image Analysis
Julia Karady, MD, Budapest, Hungary (*Abstract Co-Author*) Nothing to Disclose
Yasuka Kikuchi, MD, Sapporo, Japan (*Abstract Co-Author*) Nothing to Disclose
Alexander Ivanov, Moscow, Russia (*Abstract Co-Author*) Nothing to Disclose
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Michael T. Lu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Borek Foldyna, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Hugo Aerts, PhD, Boston, MA (*Abstract Co-Author*) Stockholder, Sphera Inc
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PURPOSE

Coronary plaques can be classified into the following histological categories: adaptive and pathological intimal thickening (AIT, PIT), fibrous plaque (Fib), early and late fibroatheroma (EFA, LFA) and thin-cap fibroatheroma (TCFA). Advanced atherosclerotic lesions (EFA, LFA, TCFA) carry higher risk versus early plaques (AIT, PIT, Fib). We sought to assess if radiomic analysis of coronary CTA is superior to conventional CTA plaque assessment performed by experts to identify early vs. advanced lesions and to classify plaques into the six histological categories.

METHOD AND MATERIALS

Coronary cross-sections of 95 plaques in 7 ex-vivo hearts were analyzed. Overall, 607 histology slides and coronary CTA cross-sections were co-registered and analyzed in random order. We derived 1015 radiomic features from each CTA plaque cross-section. Principal components accounting for 90% of the variation were derived. A multivariate k-nearest neighbors machine learning (ML) model was built based-on these parameters. We calculated the diagnostic accuracy of the radiomics-ML model and plaque attenuation pattern classification by experts to differentiate early from advanced atherosclerotic plaques and to classify CTA

cross-sections into the six histological categories. We compared the diagnostic accuracies between the models using the McNemar-test.

RESULTS

After excluding sections with heavy calcium (n=32) and no visible atherosclerotic plaque on CTA (n=134), we analyzed 411 cross-sections of which 30.4% (134/441) were advanced atherosclerotic lesions. The radiomics-ML model which included 13 parameters correctly differentiated early from advanced plaques with a diagnostic accuracy of 82.3%, whereas the expert classification had a diagnostic accuracy of 76.0% (p=0.001). Our ML model was able to classify 63.0% of the CTA cross-sections into the six histological categories correctly.

CONCLUSION

Radiomics-based ML outperforms experts to identify advanced atherosclerotic lesions on coronary CTA. However, ML-based classification of coronary plaques into the corresponding six histological categories has moderate accuracy. Further analysis with larger samples size and validation is needed.

CLINICAL RELEVANCE/APPLICATION

Radiomics-based machine learning could increase the diagnostic accuracy of coronary CT angiography to identify gold-standard histological entities.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Udo Hoffmann, MD - 2015 Honored Educator

SSC01-06 Diagnostic Accuracy of Low Dose Dynamic Stress Computed Tomography Myocardial Perfusion (CTP) in Intermediate-to-High-Risk Patients for Suspected Coronary Artery Disease (CAD)

Monday, Nov. 26 11:20AM - 11:30AM Room: S504CD

Participants
Andrea Baggiano, Milan, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The aim of this study is to evaluate the incremental diagnostic value of stress CTPdyn over CCTA in intermediate to high risk patients scheduled for invasive coronary angiography (ICA) plus clinically indicated invasive fractional flow reserve (FFR) for suspected CAD by using a low dose acquisition protocol with last generation of whole-heart single beat CT scanner.

METHOD AND MATERIALS

Consecutive symptomatic patients with intermediate-to-high pre-test probability of CAD and scheduled for clinically indicated ICA+FFR, were prospectively enrolled. All patients underwent rest-CCTA followed by stress-CTP protocol with adenosine and with injection of 0.7 ml/kg of iodixanol 320 as additional test. CCTA and CTP were defined positive for the presence of >= 50% stenosis and for the presence of subendocardial hypoenhancement encompassing >= 25% of transmural myocardial thickness within a specific coronary territory, respectively. At ICA, obstructive CAD was defined by the presence of >= 50% stenosis and hemodynamically significant CAD was defined by the presence of > 50% stenosis on left main coronary artery, severe (> 80%) or occlusive stenosis or FFR < 0.80. The additive value of CTP versus CCTA alone to rule out the presence of hemodynamically relevant stenosis was assessed on a per-vessel basis.

RESULTS

Forty-eight patients [mean age: 65 ± 8 years, male: 35 (73%)] were included in our study. Obstructive CAD was found in 38% (54/144) of vessels and in 73% (35/48) of patients. Hemodynamically significant CAD was present in 23% (36/144) of vessel and in 54% (26/48) of patients. In a vessel-based model, CCTA alone and CCTA+CTPdyn showed a sensitivity, specificity, negative predictive value, positive predictive value and diagnostic accuracy of 92%, 64%, 96%, 46%, 71% and 89%, 89%, 96%, 76%, 89%, respectively. CCTA+CTPdyn showed a significant improvement in specificity (p: <0.001), positive predictive value (p: 0.002) and diagnostic accuracy (p: <0.001) to rule out haemodynamically significant CAD as compared to CCTA alone. The mean radiation exposure due to CTPdyn alone is 5.13 ± 1.51 mSv.

CONCLUSION

In patients with intermediate-to-high pre-test likelihood of CAD, low dose dynamic CTP had incremental value over CCTA alone to diagnose the presence of hemodynamically significant CAD.

CLINICAL RELEVANCE/APPLICATION

Combination of CTP an CCTA can improve diagnosis of hemodynamically significant CAD.

SSC01-07 Triple-Rule-Out CT Angiography in Low-intermediate and High Risk Patients with Acute Chest Pain: Impact on Patient Management

Monday, Nov. 26 11:30AM - 11:40AM Room: S504CD

Participants
Christian Tesche, MD , Munich, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

To investigate the impact of triple-rule-out cardiac CT angiography (TRO-CTA) on patient management in patients presenting with chest pain to the emergency department (ED) compared to standard of care (SOC) work-up.

METHOD AND MATERIALS

In this IRB-approved, HIPAA-compliant study we analyzed data of 2156 patients who presented to the ED with chest pain. Patients were divided into two groups according to their cardiovascular risk: low-intermediate risk (<=1 risk factor regardless of body-mass-index [BMI]) and high risk (>=2 risk factors and BMI >=30kg/m2 or >=4 risk factors regardless of BMI). Patients received either TRO-CTA as an initial test or SOC without initial CTA. ED length of stay, downstream utilization of additional tests, and hospital costs were compared between both groups.

RESULTS

515 patients were assigned to the high-risk group (TRO-CTA, n=274; SOC, n=241) and 1610 to the low-intermediate risk group (TRO-CTA, n=837; SOC, n=773). No significant differences between groups and corresponding treatment arms were observed for age, gender, or race. The rate of diagnosis of coronary artery disease (CAD), pulmonary embolism (PE), or aortic dissection (AD) was significantly higher in the TRO-CTA vs. the SOC arm for the low-intermediate risk group (all $p<0.05$). Median ED wait time (5.0 vs. 7.0hrs, $p<0.001$), median total length of hospital stay (48.0 vs. 72.0hrs, $p<0.001$), additional downstream testing, rate of invasive coronary angiography (11.6% vs. 38.7%, $p<0.001$), and total costs (9.184$ vs. 17.253$, $p<0.001$) were significantly lower in the TRO-CTA vs. the SOC arm. No significant difference in the diagnosis of CAD, PE, or AD was found between TRO-CTA vs. SOC in the high-risk group with significant lower median ED waiting time (4.0 vs. 8.0hrs, $p<0.001$), median total length of hospital stay (48.0 vs. 72.0hrs, $p<0.001$), additional downstream testing, invasive coronary angiography (16.4% vs. 34.0%, $p<0.001$), and total costs ($10,532 vs. $21,518, $p<0.001$) in the TRO-CTA vs. the SOC arm.

CONCLUSION

TRO-CTA as an initial imaging test in ED patients presenting with acute chest pain was associated with shorter ED and hospital length of stay, lower utilization of downstream testing, and lower total cost both for the episode of care and overall.

CLINICAL RELEVANCE/APPLICATION

TRO-CTA is a robust imaging modality with lower resource use and lower cost in the work-up of patients presenting to the ED with chest pain regardless of their a-priori risk.

SSC01-08 Prognostic Role of Adenosine Stress Cardiac Magnetic Resonance Compared to CCTA in the Long-Term Outcome of Heart Disease Patient

Monday, Nov. 26 11:40AM - 11:50AM Room: S504CD

Participants
Pierpaolo Palumbo, MD, L'Aquila, Italy (*Presenter*) Nothing to Disclose
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Camilla De Cataldo, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Coronary heart disease is still the leading cause of death and the need for a prognostic assessment of CAD patients is continuously increasing. With this regard, the anatomic and morphological approach is not completely satisfying in the CAD definition. The purpose of our study was assessing the prognostic role of Adenosine Stress Cardiac Magnetic Resonance compared to Computed Tomography Angiography (CTA) in the outcome of the heart patient

METHOD AND MATERIALS

55 patients with previous PTCA-stenting who underwent CTA examination and CMR with adenosine were included in our study. A 5-year follow-up was carried out to evaluate the clinical evolution of these patients

RESULTS

Nine patients showed negative CTA and CMR under stress, with reported well-being in the 5-year follow-up. 78% of the remaining patients showed stent filling defects in the CTA examination; among these, 86% showed also perfusion defect in the CMR, associated to major cardiovascular symptoms referred in the follow-up, while the remaining 14% were negative for perfusion CMR and for symptoms.22% of patients who showed perfusion alterations in CMR, although in absence of stent apparent filling defects in CTA examination, reported acute myocardial infarction treated with re-stenting. 5 patients out of 18 with positive LGE images developed MACE (arrhythmias, cardiac death).

CONCLUSION

Our experience shows how, despite a CTA examination positive for the presence of moderate stenosis, a negative Adenosine Stress CMR represents a positive prognostic factor for the patient outcome. On the other hand, also with a negative CTA, the positivity of Adenosine Stress CMR is strongly associated with a high probability of developing a cardiovascular accident and constitutes a negative prognostic factor

CLINICAL RELEVANCE/APPLICATION

Our study demonstrates the prevalent role of Stress CMR in comparison to Computed Tomography as a predictive prognostic factor in the outcome of heart patient

SSC01-09 Additional Diagnostic Value of CT Perfusion Over Coronary CT Angiography in Stented Patients with Suspected In-Stent Restenosis or Coronary Artery Disease Progression: ADVANTAGE Study - Preliminary Results

Monday, Nov. 26 11:50AM - 12:00PM Room: S504CD

Participants
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PURPOSE

Aim of the study is to assess the diagnostic performance of CCTA alone, CTP alone and CCTA plus CTP performed with the latest scanner generation that combine a whole-heart coverage with high spatial and temporal resolution, by using invasive coronary angiography (ICA) as standard of reference.

METHOD AND MATERIALS

A cohort of consecutive patients referred for a clinically ICA for suspicion of ISR or progression of native CAD were enrolled. The feasibility of CCTA, CTP and the combined evaluation CCTA plus CTP were calculated in a stent-based, territory-based and patient-based analysis. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of CCTA, CTP, combined evaluation CCTA-CTP vs. ICA in a stent-based, territory-based and patient-based analysis. Radiation exposure of CCTA, CTP and ICA was recorded.

RESULTS

Ninety-eight patients were enrolled (83 male, mean age 64 ± 9 years-old). CTP feasibility was significantly higher than CCTA feasibility in a stent-based, territory-based and patient based analysis (97% vs. 87%, p=0.001; 98% vs. 92%, p=0.001; 97% vs. 70%, p<0.0001, respectively). The feasibility of the combined evaluation CCTA-CTP was significantly higher than CCTA feasibility in a stent-based, territory-based and patient based analysis (96% vs. 87%, p=0.001; 99% vs. 92%, p<0.001; 100% vs. 70%, p<0.0001, respectively). The diagnostic accuracy of CCTA was 81%, 85% and 79%, in a stent-based, territory-based and patient based analysis, respectively; the diagnostic accuracy of CTP was 90%, 93% and 84%, respectively; the diagnostic accuracy of combined CCTA-CTP was 85%, 90% and 83%, respectively; the diagnostic accuracy of concordant CCTA-CTP was 95% and 92% in a territory and patient-based analysis, respectively. The diagnostic accuracy of CTP was higher than that of CCTA in a stent-based (p=0.001) and territory-based (p<0.0001) analysis. The mean effective dose of the entire CT assessment (CCTA-CTP) was 2.76 ± 2.32 mSv.

CONCLUSION

The CTP assessment appears as more feasible and more accurate than the anatomical evaluation alone by CCTA in patients with coronary stents. When results of CCTA and CTP are concordant, the diagnostic accuracy of the combined evaluation is very high and associated with very low radiation exposure.

CLINICAL RELEVANCE/APPLICATION

Evaluation with cardiac CT of both anatomy and perfusion

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSC02

Cardiac (Myocardial Ischemia and Viability (MRI): I)

Monday, Nov. 26 10:30AM - 12:00PM Room: S502AB

CA MR

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

FDA Discussions may include off-label uses.

Participants
Hajime Sakuma, MD, Tsu, Japan (*Moderator*) Research Grant, Fuji Pharma Co, Ltd; Research Grant, DAIICHI SANKYO Group; Research Grant, FUJIFILM Holdings Corporation; Research Grant, Siemens AG; Research Grant, Nihon Medi-Physics Co, Ltd; Speakers Bureau, Bayer AG
Friedrich D. Knollmann, MD, PhD, Wynnewood, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSC02-01 Comparison Between Radio-Water PET and Model-Based Quantitative Analysis of 3.0T Myocardial Perfusion Magnetic Resonance Imaging

Monday, Nov. 26 10:30AM - 10:40AM Room: S502AB

Participants
Masaki Ishida, MD, PhD, Tsu, Japan (*Presenter*) Nothing to Disclose
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PURPOSE

Radio-water PET is the most accurate method in quantifying myocardial blood flow (MBF). Model-based analysis of perfusion MRI with corrections of blood saturation and flow-dependent alteration in extraction fraction of gadolinium contrast medium may permit quantification of absolute MBF. The purpose of this study was to determine the accuracy of MR measurements of rest and stress MBF at 3.0T by using radio-water PET as a reference.

METHOD AND MATERIALS

Twenty-nine patients with suspected coronary artery disease underwent MRI including stress and rest perfusion MRI and LGE MRI at 3.0T and radio-water PET. ATP stress and rest perfusion MRI were performed with injections of 0.03mmol/kg of Gd-DOTA. Dual bolus method was used to correct blood saturation. Patlak plot method was employed in quantifying MBF. Myocardial unidirectional influx constant (K1) was determined from blood input and myocardial output functions in 16 myocardial segments. The extraction fraction of Gd-DOTA (E) was determined using K1 and PET-derived MBF (MBFPET) for the first 15 patients. For validation, MRI-derived absolute MBF (MBFMRI) was calculated using the relation between E and MBF for the remaining 14 patients and compared with MBFPET. The segments including myocardial infarction were excluded from the analysis.

RESULTS

In the first 15 patients, K1 by perfusion MRI was 0.60±0.21 ml/min/g at rest and 1.07±0.37 ml/min/g during stress, while MBFPET was 1.15±0.35 ml/min/g at rest and 3.08±0.81 ml/min/g during stress. The relationship between E and MBF was E=1-exp(-(0.24xMBF+0.63)/MBF). In the remaining 14 patients, MBFMRI at rest and during stress were 1.24±1.16 ml/min/g and 2.63±1.48 ml/min/g, while MBFPET at rest and during stress were 1.17±0.61 ml/min/g and 2.69±0.70 ml/min/g, respectively. MBFMRI showed a good linear correlation with MBFPET ($r=0.71$, $p<0.001$). The measurement bias in measuring MBF between MRI and PET was 0.01±1.06ml/min/g.

CONCLUSION

Model-based analysis of perfusion MRI at 3.0T with corrections of blood saturation and flow-dependent alteration of extraction of gadolinium contrast medium allows for accurate quantification of MBF both at rest and during ATP stress.

CLINICAL RELEVANCE/APPLICATION

Accurate quantification of myocardial blood flow by using perfusion MRI may permit objective assessment of myocardial ischemia and early detection of high risk patients in the routine cardiac MRI.

SSC02-02 Oxygenation-Sensitive Cardiovascular Magnetic Resonance for Differentiation of Reversible and Irreversible Myocardial Damage by Evaluation of the Balance between Supply/Demand in Myocardial Oxygenation after ST-Segment-Elevation Myocardial Infarct

Monday, Nov. 26 10:40AM - 10:50AM Room: S502AB

Participants
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PURPOSE

T2* BOLD imaging is a quantitative magnetic resonance imaging(MRI) technique allowing for evaluation of the balance between supply/demand in myocardial oxygenation and myocardial hemorrhage. We sought to investigate the ability of T2* BOLD imaging to differentiate reversible and irreversible myocardial injury as well as the time course of myocardial oxygenation after reperfusion in patients with ST-segment elevation myocardial infarction (STEMI).

METHOD AND MATERIALS

Twenty two patients(age, 60±11 years;77.27% male)with STEMI underwent cardiac MRI on four occasions: at 1 day, 3 days, 7 days, and 30 days after (percutaneous coronary intervention)PCI. T2* BOLD MRI was performed on a 3T scanner to assess myocardial oxygenation in myocardial infarcted regions with or without intramyocardial hemorrhage (IMH), salvaged myocardium, remote myocardium and normal myocardium.

RESULTS

T2* BOLD value in myocardial infarction(MI) with IMH was lowest(9.77±3.29ms), while that of the salvaged zone was the highest(33.97±3.42ms). Hyperemia induced by inflammation may increase blood flow in the salvaged area. T2* BOLD value in salvaged myocardium demonstrated a unimodal temporal pattern from 1 day(37.91±2.23ms) to 30 days(30.68±1.59ms).

CONCLUSION

T2* BOLD MRI performed in post-STEMI patients allows for accurate evaluation of myocardial damage severity, and can discriminate between reversible and irreversible myocardial injury. The increased T2* BOLD values may imply the pathophysiological mechanism of salvaged myocardium. T2* BOLD could represent a more accurate alternative without contrast to late gadolinium enhancement (LGE) imaging in acute STEMI patients.

CLINICAL RELEVANCE/APPLICATION

BOLD MRI could evaluate the balance between supply/demand in myocardial oxygenation and myocardial damage severity, and discriminate between reversible and irreversible myocardial injury and is recommended in the initial evaluation of STEMI patients.

SSC02-03 Intra-Myocardial Hemorrhage and Microvascular Obstruction After Acute Re-Perfused Myocardial Infarction: Are They Really Two Different Complications?

Monday, Nov. 26 10:50AM - 11:00AM Room: S502AB

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PURPOSE

To evaluate the performance of T2* mapping for intra-myocardial hemorrhage (IMH) detection in acute re-perfused myocardial infarction and to demonstrate in vivo the pathophysiological coincidence of microvascular obstruction (MVO) and intra-myocardial hemorrhage (IMH) at the level of the infarcted zone.

METHOD AND MATERIALS

74 consecutive Patients (Pts) after primary percutaneous intervention for first acute myocardial infarction (AMI) underwent cardiovascular MR (CMR) within 1 week after treatment, using a standard protocol (T2 3IR-FSE, cine-SSFP, rest FGRET and 2D IR-FGRE). Before gadolinium administration, we performed T2* mapping at the level of the infarct zone. T2* images were analyzed with a dedicated software (Reportcard 4.0, GE Medical Systems), considering a T2* value <=20 ms as positive for IHM. First-pass perfusion images were acquired during administration of different Gadolinium chelates at a standard dose of 0.1 mmol/kg; early and late gadolinium enhancement (EGE and LGE) were obtained at 2-3 and 12-15 minutes after contrast injection, respectively.

RESULTS

On the basis of post-Gadolinium sequences, MVO in the infarct area was demonstrated in 34 Pts at the first pass perfusion images, in 29 Pts at EGE and in 26 Pts in LGE images.A focal IMH was identified in 13/74 Pts at T2 3IR-FSE images, while on the basis of T2* mapping IMH was detected in 28/74 Pts.We found that IMH coincided with the area of MVO: all 13 Pts with IMH at T2 3IR-FSE images showed MVO at first pass perfusion and/or at EGE and LGE; all 28 Pts positive for IMH at T2* mapping showed MVO at EGE, while only 2 Pts did not show MVO at LGE.

CONCLUSION

T2* imaging should be the preferred CMR method for assessment of IMH because its higher sensitivity than conventional T2 images. Reperfusion IMH is closely associated with the presence of MVO and they represent patho-physiologically the same complication of the ischemia-reperfusion injury.

CLINICAL RELEVANCE/APPLICATION

We demonstrated that MVO and IMH represent the same complication in re-perfused AMI. T2* mapping (better than T2) can be used to assess MVO also in Pts not suitable for gadolinium administration.

SSC02-04 Intramyocardial Hemorrhage May Not Change from 48 Hours to 7days While Myocardial Ischemia and Myocardial Edema Decrease After Reperfusion: A Rat Study at 7T

Monday, Nov. 26 11:00AM - 11:10AM Room: S502AB

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PURPOSE

To study the change of intramyocardial hemorrhage(IMH), myocardial edema(ME) and myocardial ischemia(MI) in reperfused myocardial ischemic rat from 48h to 7d in a 7.0T MR scanner.

METHOD AND MATERIALS

Nine rats (SD, 250-300g, male) with 60min myocardial ischemia followed by 48h and 7d were investigated. The myocardial ischemia was induced by occluding the proximal left anterior descending coronary artery, which was then released for reperfusion. The T2*-mapping and T2-mapping pulse sequences (T2-mapping: TR/TE=1500ms/10,20,30 ms, MTX=192×192, FOV=50×50mm, slice thickness=1.5mm. T2*-mapping: TR/TE=1000ms/3.5,7,10.5,14,17.5,21,24.5,28,31.5 ms, FA (Flip angle)=30°, MTX=192×192, FOV=50×50mm, slice thickness=1.5mm) were implemented and optimized on a 7.0T MR system (BRUKER BIOSPEC 70/30, Germany). Images were acquired on the short axis slices during mid-diastolic phase in each end-inspiratory period using both ECG and respiratory gating systems. After the acquisition of T2*-mapping and T2-mapping images, Late gadolinium enhancement (LGE) imaging was performed by FISP(TR/TE=5.2ms/1.8ms, FA=25°, MTX=256×256, FOV=50×50mm, slice thickness=1.5mm) to evaluate the extent of myocardial ischemia after an injection of gadolinium diethylenetriamine pentaacetic acid (Gd-DTPA, Magnevist, Bayer Health Care Pharmaceuticals) at a dose of 0.15 mmol/kg. The T2*-maps and T2-maps were calculated using a custom-made software. The areas of edema regions were defined by high T2 values (> mean ± 2SD in remote areas) on T2 maps. The areas of hemorrhage were identified as a hypointense core within a hyperintense territory on T2* maps. All areas were expressed as a percentage of the whole myocardial tissue of left ventricle.

RESULTS

The area of ME and MI decreased from 48h (31.2±7.9%; 21.9±10.2%) to 7d (23.6±3.8%, $p<0.01$; 10.8±6.6%, $p<0.01$). However, they were not significant different between the area of IMH at 48h (4.8±3.3%) and 7d (5.1±3.4%, $p>0.05$).

CONCLUSION

The area of ME and MI decreased, which may indicate the self-healing of myocardial edema and myocardial ischemia after reperfusion. However, intramyocardial hemorrhage, caused by reperfusion injury, would not recover in this duration.

CLINICAL RELEVANCE/APPLICATION

Reperfusion will decrease myocardial ischemia and myocardial edema, but also cause sustained intramyocardial hemorrhage, which should be recommended as an important risk point for percutaneous coronary intervention of myocardial ischemic patients.

SSC02-05 Larger Myocardial Ischemia May Cause Larger Intramyocardial Hemorrhage and Smaller Area at Risk in Acute Reperfused Myocardial Ischemic Rats

Monday, Nov. 26 11:10AM - 11:20AM Room: S502AB

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PURPOSE

To study the correlations between myocardial infarction and intramyocardial hemorrhage, area at risk in reperfused myocardial ischemic rats with a comprehensive method on 7.0T MR.

METHOD AND MATERIALS

Eleven rats (SD, 250-300g, male) with 60min myocardial ischemia followed by 48hours reperfusion were investigated. The different degrees of myocardial ischemia were induced by occluding the different section of proximal left anterior descending coronary artery. The T2*-mapping and T2-mapping pulse sequences (T2-mapping: TR/TE=1500ms/10,20,30 ms. T2*-mapping: TR/TE=1000ms/3.5,7,10.5,14,17.5,21,24.5,28,31.5 ms, FA (Flip angle)=30°) were implemented and optimized on a 7.0T MR system (BRUKER BIOSPEC 70/30, Germany). Images were acquired on the short axis slices during mid-diastolic phase in each end-inspiratory period using both ECG and respiratory gating systems. After the acquisition of T2*-mapping and T2-mapping images, Late gadolinium enhancement (LGE) imaging was performed by FISP(TR/TE=5.2ms/1.8ms, FA=25°) to evaluate the extent of myocardial ischemia after an injection of gadolinium diethylenetriamine pentaacetic acid (Gd-DTPA) at a dose of 0.15 mmol/kg. The T2*-maps and T2-maps were calculated using a custom-made software. Area at risk were defined as the difference between edema areas with high T2 values(> mean ± 2SD in remote normal tissue areas) in T2 maps and positive enhanced area in LGE images. The areas of hemorrhage were identified as a hypointense core within a hyperintense territory on T2* maps. All areas were expressed as a percentage of the whole myocardial tissue of left ventricle.

RESULTS

Myocardial ischemia ranged from 9.5% to 47% (22.7±10.4%), intramyocardial hemorrhage ranged from 1.25% to 17% (5.3±4.5%), area at risk ranged from 2.8% to 15.2% (8.4±3.9%). There was a significant positive correlation between myocardial ischemia and intramyocardial hemorrhage ($r=0.85$, $P<0.01$), while a negtive correlation was found between myocardial ischemia and area at risk ($r=0.77$, $P<0.01$).

CONCLUSION

Larger myocardial ischemia may cause larger intramyocardial hemorrhage and smaller area at risk in 48h reperfused myocardial ischemic rats.

CLINICAL RELEVANCE/APPLICATION

The prognosis of intramyocardial hemorrhage and area at risk could be made by the area of reperfused myocardial ischemia, which should be recommended as a critical index before percutaneous coronary intervention of myocardial ischemic patients.

SSC02-06 Fully Automated Analysis of LGE MRI in Post-Infarct Patients Using Convolutional Neural Networks: Simultaneous Segmentation of Ventricular Myocardium and Myocardial Infarction

Monday, Nov. 26 11:20AM - 11:30AM Room: S502AB

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PURPOSE

To investigate the feasibility of deep-learning convolutional neural network (CNN) image segmentation for fully automated analysis of late gadolinium enhanced (LGE) MRI in post-infarct patients.

METHOD AND MATERIALS

In 180 consecutive post-infarct patients LGE MRI was acquired prior to ICD implantation. An inversion-recovery 3D turbo-field echo sequence was used with parallel imaging, in one or two breath-holds and reconstructed into 20-24 levels in the short-axis view with a typical image resolution of 1.56×1.56×5 mm. For reference, an experienced observer manually traced the endocardial and epicardial contours and assessed the region of myocardial scar using the Full Width Half Maximum (FWHM) method, followed by visual correction, if needed. The cohort was randomly divided into a training set of 150 (3,606 images) and a testing set of 30 subjects (726 images). The training images were augmented into a total of 144,240 images by applying moderate rotation (-15 to 15 degree) and scaling (0.8 to 1.25). The U-Net CNN architecture was adopted to learn the manual segmentation from the training set, using cross entropy as the metric, with a learning rate of 10-4, in 50 epochs, initialized from a previously trained network for cine MR segmentation. The trained network was evaluated on the 30 independent testing subjects. We evaluated: (1) the accuracy of endocardial and epicardial contour in terms of average perpendicular distance (APD) in pixels, and (2) the accuracy of identified myocardial scar size per subject.

RESULTS

On the independent training set, the APD was 1.10±0.39 and 1.09±0.29 pixels for the endocardial and epicardial contours, respectively. The identified scar size per subject was not significantly different between the CNN and the human observer: 29.1±21.3 g vs. 31.7±20.8 g ($p=0.2$). The processing time for CNN based segmentation was less than 0.2 seconds per subject.

CONCLUSION

Deep-learning CNN shows great promise in the challenging segmentation problem of automated LGE MRI quantification in post-infarct patients, by simultaneously identifying the left ventricle and myocardial scar in a fully automated manner.

CLINICAL RELEVANCE/APPLICATION

With further validation, the developed deep-learning CNN can be used to rapidly identify and quantify the myocardial scar from LGE MRI, avoiding time-consuming and user-dependent scar assessment and contour tracing.

SSC02-07 Myocardial Edema and Necrosis after ST-Segment Elevation Myocardial Infarction by T2-Weighted and Late Gadolinium Enhancement MR Imaging: A Meta-Analysis

Monday, Nov. 26 11:30AM - 11:40AM Room: S502AB

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PURPOSE

To analyze existing data on the extent of myocardial edema and necrosis measured by T2-weighted and late gadolinium enhancement (LGE) magnetic resonance (MR) imaging after ST-segment elevation myocardial infarction (STEMI).

METHOD AND MATERIALS

We searched MEDLINE, EMBASE, and ISI Web of Science for patient studies reporting the extent of myocardial edema and necrosis measured by T2-weighted and LGE MR imaging after STEMI. All information on patient demographics, treatment features, and imaging techniques reported by included studies were extracted. Multiple imputation was used for missing data and mixed-effects models to identify significant predictors of edema and necrosis. Follow-up data were used to evaluate the further temporal evolution of edema and necrosis.

RESULTS

Forty-four studies with 5028 patients were included. Overall, edema area measured using T2-weighted MR imaging during the first week after STEMI was 33.8% of left ventricular (LV) myocardium (confidence interval [CI]: 31.9, 36.5), necrosis area measured using LGE MR imaging was 18.1% of LV myocardium (CI: 14.7, 21.4), and the proportion of edematous myocardium without necrosis was 42.0% (CI: 34.6, 49.4). Each hour of delay in revascularization increased necrosis by 3.6% of LV myocardium (95% CI: 1.1, 6.0; P = .013) and decreased the proportion of edematous myocardium without necrosis by 12.5% (95% CI: 6.9, 18.1; P = .002), while edema was not significantly affected. Other significant predictors were the degree of obstruction of the culprit artery before revascularization and the applied method for interpreting MR images. Within 6 months after STEMI, edema disappeared, while necrosis decreased only slightly but significantly.

CONCLUSION

This meta-analysis indicates that myocardial edema on T2-weighted MR imaging delineates the area at risk after STEMI and can be used to quantify the proportion of reversibly injured myocardium, commonly defined as myocardial salvage index, when combined with LGE MR imaging of necrotic myocardium.

CLINICAL RELEVANCE/APPLICATION

Quantification of the proportion of reversibly injured, salvaged myocardium after STEMI by T2-weighted and LGE MR imaging allows evaluation of therapeutic efficiency.

SSC02-08 Detection of Occult Myocardial Scars with Cardiovascular Magnetic Resonance Imaging in Patients with Asymptomatic Type 2 Diabetes Mellitus: The ACCREDIT Study

Monday, Nov. 26 11:40AM - 11:50AM Room: S502AB

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PURPOSE

To determine the prevalence of occult myocardial scars (OMS) on contrast-enhanced cardiovascular magnetic resonance imaging (CMR) in asymptomatic patients with type 2 diabetes mellitus (DM) and to assess the relationship between the occurrence of OMS detected with CMR and coronary atherosclerosis observed with contrast-enhanced coronary computed tomography angiography (CCTA).

METHOD AND MATERIALS

This multi-center, prospective, open-label study included asymptomatic patients with type 2 DM and at least two identified cardiac risk factors, scheduled to undergo CMR and CCTA procedures. CMR and CCTA were performed with gadoterate meglumine (Dotarem®, Guerbet) and iobitridol (Xenetix®, Guerbet), respectively. The prevalence of OMS was calculated on CMR. For each main coronary artery, stenosis degree and plaque characteristics were assessed on CCTA. For each myocardial segment with OMS, the corresponding infarct-related artery (IRA) was identified according to the American Heart Association recommendations. The

characteristics of the plaques located in IRA were compared to those located in non-IRA.

RESULTS

Among the 348 patients included (mean (±SD) age: 60.2±6.5 years; male: 60.9%; mean BMI: 25.4±3.1 kg/m2), 322 patients completed both CMR and CCTA procedures. At least one OMS was detected by CMR in 23 patients (7.1%). CCTA showed a significant stenosis (>50% diameter reduction) or occlusion for 13 (56.5%) of the 23 patients with OMS and for 67 (22.4%) of the 299 patients without OMS. Sixty-two IRA plaques and 52 non-IRA plaques were identified with CCTA in patients with OMS. In IRA, 16.1% plaques were non-calcified, 22.6% mixed and 61.3% calcified while in the non-IRA, 30.8% were non-calcified, 17.3% mixed and 51.9% calcified. No differences in calcification status were demonstrated between IRA and non-IRA plaques (p=0.175, Chi²).

CONCLUSION

OMS were identified with CMR in 7.1% of asymptomatic patients with type 2 DM. No significant difference was demonstrated in plaque characteristics between IRA and non-IRA in patients with OMS. Further investigations are still required to determine whether the occurrence of OMS is related to atherosclerosis detected with CCTA.

CLINICAL RELEVANCE/APPLICATION

CT and MRI screening in diabetes patients without chest pain can provide the information of occult myocardial infarction and its relationship to coronary arterial disease.

SSC02-09 Multi-Parametric Rest and Dobutamine Stress Cardiovascular Magnetic Resonance in Assessment of Myocardial Viability: Could Feature Tracking Strain Analysis Add Value?

Monday, Nov. 26 11:50AM - 12:00PM Room: S502AB

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the diagnostic accuracy of multi-parametric CMR in assessment of myocardial viability in chronic ischemic patients using 4 different techniques; delayed gadolinium enhancement(DGE) as gold standard for detection of scar burden, CMR feature tracking(CMR-FT) at rest and with low dose dobutamine(LDD), visual assessment of myocardial contractility with LDD and LV end-diastolic wall thickness(EDWT)

METHOD AND MATERIALS

15 patients(53±12years) &10 controls(38±11years) were prospectively enrolled. All subjects had CMR exams on 1.5T scanner. A LDD IV infusion was administrated in 2 stages, 3 minutes each, with a dose of 5 µg/kg/min that is increased to 10 µg/kg/min in 2nd stage. LV was divided into 16 segments and FT parameters were derived from SSFP Cine images using dedicated software. Viable myocardium was defined as a dobutamine induced increase in resting FT values of >20 % & systolic wall thickening of >=2 mm by visual assessment. A segment with no or <=50 % fibrosis on DGE & EDWT of >5 mm was defined as viable

RESULTS

240 segments were analyzed for patients at rest & with LDD &160 segments for controls at rest. 44 segments were non-viable based on DGE &196 were viable. Both peak global circumferential(Ecc) & radial(Err) strains were significantly impaired in ischemic patients compared to healthy(-12.84±7.72 vs -19.63±7.08,P<0.0001 & 22.07±15.19 vs 30.90±18.59,P=0.0039)respectively. With segmental Ecc, 50 segments were identified as non-viable & 190 as viable(sensitivity 72%,specificity 91% &diagnostic accuracy 87%).With segmental Err, 49 segments were identified as non-viable & 191 as viable(sensitivity 54%,specificity 87% & diagnostic accuracy 81%).By visual assessment of myocardial contractility with LDD, 43 segments were identified as non-viable & 197 as viable(sensitivity 70%,specificity 86% & diagnostic accuracy 88%).Based on EDWT assessment, 41 segments were identified as non-viable & 199 as viable(sensitivity 50%,specificity 90%& diagnostic accuracy 83%)

CONCLUSION

Quantitative assessment of Ecc & Err with FT, along with EDWT & qualitative visual assessment of myocardial contractility at rest & with LDD may improve diagnostic accuracy of non-viable segments with moderate sensitivity & high specificity

CLINICAL RELEVANCE/APPLICATION

FT and EDWT are non-contrast parameters that could be of particular importance in determining viability in patients with impaired glomerular filtration rate or patients with known hypersensitivity to contrast agents

SSC03

Chest (Lung Cancer Screening)

Monday, Nov. 26 10:30AM - 12:00PM Room: E451A

AI CH CT OI

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

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Sub-Events

SSC03-01 Predicting the Likelihood of Various Major Diseases from Lung Cancer Screening Chest CT Using 3D Convolutional Neural Networks

Monday, Nov. 26 10:30AM - 10:40AM Room: E451A

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PURPOSE

A large number of patients undergo annual lung cancer screening with low-dose chest CT. The CT data contains significant information about health of the patient, beyond simple lung cancer status. The National Lung Cancer Screening (NLST) database provides a large dataset with correlated clinical metadata, which can be used to train machine learning algorithms to extract as much useful health information as possible. The aim of the study is to develop and validate a 3D convolutional neural network algorithm on these CT studies to predict the likelihood of various major diseases: diabetes, heart disease, COPD, and stroke.

METHOD AND MATERIALS

We extracted random samples of 16,780 scans from NLST. Data preprocessing consisted of isotropic resolution resizing and standardization to 350 x 350 x 35 pixel size. Data was augmented with random rotations between -15 and 15 degrees. The processed samples were passed through a 3D convolutional neural network (CNN) with architecture loosely inspired by the VGG-Net. Modifications included generalization to 3D dataset, more gradual pooling across the z-axis, and use of batch normalization. Stochastic gradient descent optimizer and sparse categorical crossentropy loss function were utilized. Final results were gathered using a separate testing set extracted from the NLST dataset. Error analysis was conducted.

RESULTS

We performed training and testing for classification of the following diseases: diabetes, heart disease, COPD, and stroke. For each disease respectively, we achieved an ROC AUC of 0.75, 0.70, 0.74, 0.69 on the test sets. ROC curves are displayed in Figure (1). For each of these results, a single radiologist with deep learning expertise manually inspected random samples of correct and incorrect predictions to ensure absence of any systematic errors. None was identified. Testing sets were confirmed to be an accurate representation of the training sets with regards to positive/negative example ratios.

CONCLUSION

Our 3D CNN model successfully predicted the likelihood of various diseases from lung cancer screening chest CT studies.

CLINICAL RELEVANCE/APPLICATION

The algorithm can be used to provide patients with useful health information about major diseases, in addition to the formal lung cancer screening interpretations by radiologists.

SSC03-02 Improving Specificity of Lung Cancer Screening CT Using Deep Learning

Monday, Nov. 26 10:40AM - 10:50AM Room: E451A

Participants
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PURPOSE

Evaluate the utility of deep learning to improve the specificity and sensitivity of lung cancer screening with low-dose helical computed tomography (LDCT), relative to the Lung-RADS guidelines.

METHOD AND MATERIALS

We analyzed 42,943 CT studies from 14,863 patients, 620 of which developed biopsy-confirmed cancer. All cases were from the National Lung Screening Trial (NLST) study. We randomly split patients into a training (70%), tuning (15%) and test (15%) sets. A study was marked "true" if the patient was diagnosed with biopsy confirmed lung cancer in the same screening year as the study.A deep learning model was trained over 3D CT volumes (400x512x512) as input. We used the 95% specificity operating point based on the tuning set, and evaluated our approach on the test set. To estimate radiologist performance, we retrospectively applied Lung-RADS criteria to each study in the test set. Lung-RADS categories 1 to 2 constitute negative screening results, and categories 3 to 4 constitute positive results. Neither the model nor the Lung-RADS results took into account prior studies, but all screening years were utilized in evaluation.

RESULTS

The area under the receiver operator curve of the deep learning model was 94.2% (95% CI 91.0, 96.9). Compared to Lung-RADS on the test set, the trained model achieved a statistically significant absolute 9.2% (95% CI 8.4, 10.1) higher specificity and trended a 3.4% (95% CI -5.2, 12.6) higher sensitivity (not statistically significant).Radiologists qualitatively reviewed disagreements between the model and Lung-RADS. Preliminary analysis suggests that the model may be superior in distinguishing scarring from early malignancy.

CONCLUSION

A deep learning based model improved the specificity of lung cancer screening over Lung-RADS on the NLST dataset and could potentially help reduce unnecessary procedures. This research could supplement future versions of Lung-RADS; or support assisted read or second read workflows.

CLINICAL RELEVANCE/APPLICATION

While Lung-RADS criteria is recommended for lung cancer screening with LDCT, there is still an opportunity to reduce false-positive rates which lead to unnecessary invasive procedures.

SSC03-03 New Algorithm Incorporating Machine Learning Improves Lung Cancer Risk Calculation on Screening CT Scans

Monday, Nov. 26 10:50AM - 11:00AM Room: E451A

Participants
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PURPOSE

Lung-RADS is widely used to classify nodules detected on lung cancer screening CT. Using data from the National Lung Cancer Screening Trial (NLST), we examined whether integration of patient demographics, clinical history, and CT texture features could improve our ability to predict long-term lung cancer development. Since most screening CTs detect early stage lung cancers, we further examined if our algorithm could predict cancer progression and overall survival in patients with resected stage I lung cancers.

METHOD AND MATERIALS

Demographics, clinical history, and baseline CT images from 24,386 NLST participants were analyzed using survival machine learning (SML). Nodule volume was calculated by V=3.14LR2 where L=longest diameter, R=longest perpendicular diameter/2. Subjects were partitioned into 4 risk groups to test hazards ratios (HR). The SML partition was compared to that from Lung-RADS. For the stage I lung cancer subgroup, the time from lung cancer diagnosis to death was used as the SML endpoint.

RESULTS

At the time of baseline CTs, the 4 risk groups were classified by: high (largest nodule L>10mm, V>6358mm3; n=85), mid-high (largest nodule L>10mm, V<=6358mm3; n=1219), mid-low (largest nodule L=5~10mm, smoking>40 years; n=1736), and low (all

others; n=21346). Compared to our low risk group, HRs for time to lung cancer onset were 91.5, 11.1, 4.0 for high, mid-high, and mid-low risk groups respectively (all p<0.0001). In contrast, the HRs from Lung-RADS categories 4, 3, and 2 were 5.68, 1.27, and 0.75 respectively as compared to category 1 (p values: <0.0001, 0.056, 0.058). For stage 1 lung cancers, demographics, nodule margins, lymph node enlargement, and blood vessel involvement jointly affected the rate of cancer progression and overall patient survival.

CONCLUSION

Using the NLST data, our new classification outperforms Lung-RADS in stratifying risk and predicting long-term lung cancer development. Furthermore, in pathologically defined stage 1 patients who received surgery, our new classification can identify those with poor survival suggesting that it can do so independently of cancer stage.

CLINICAL RELEVANCE/APPLICATION

Our new classification outperforms Lung-RADS in stratifying risk and predicting long-term lung cancer development and can identify stage 1 patients with poor survival suggesting that it can do so independently of cancer stage.

SSC03-04 Effect of Semiautomated Segmentation and Computer-Aided Detection of Lung Nodules on Lung Cancer Screening with Low Dose CT: Experience from a Nationwide Lung Cancer Screening Project

Monday, Nov. 26 11:00AM - 11:10AM Room: E451A

Participants
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PURPOSE

To evaluate the effect of semiautomated segmentation and computer-aided detection (CAD) system for lung nodule on lung cancer screening based on the Lung-RADS.

METHOD AND MATERIALS

We utilized the data from an ongoing nationwide multi-center lung cancer screening project with low dose chest CT. This project started with a visual assessment and manual measurement system (a manual system) and changed into a cloud-based software system which equipped with a semiautomated nodule segmentation and CAD system (a software system). In a software system, an average diameter of a nodule for the Lung-RADS was calculated on a plane showing the maximal cross sectional area of a nodule. For this study, an average diameter on axial planes was also calculated. We compared the number of detected lung nodules and distribution of Lung-RADS categories between two systems. When the results of before and after CAD were available (the number of cases, 2374), the effect of CAD was evaluated.

RESULTS

The number of cases and the number of nodules for both systems are as follows: a manual system, 1821 cases, 1630 nodules; a software system, 4665 cases, 6116 nodules. Significantly greater number of nodules (0.90 vs. 1.31 nodule/case) were detected at a software system. The size of nodule was significantly larger (5.5 vs. 4.6 mm) at a software system, but there was no significant difference in the size of nodules between two systems when axial planes were used in calculating an average diameter in a software system. Both the per-case (9.8% vs. 17.4%) and per-nodule (12.9% vs. 17.9%) proportion of positive test (category 3/4) were significantly higher at a software system. By applying the CAD results, not only the number of the detected nodules (0.77 vs. 1.23 nodule/case) but also the per-case proportion of positive test (11.6% vs. 17.1%) were significantly increased.

CONCLUSION

By applying a semi-automated segmentation and CAD system, the number of detected nodules and the proportion of positive test were significantly increased.

CLINICAL RELEVANCE/APPLICATION

Semiautomated segmentation and CAD have important effects on the Lung-RADS positive rate. Therefore, detailed guidelines should be provided for the use of software in lung cancer screening.

SSC03-05 Randomized Clinical Trial of CAD versus No CAD as First Reader of Lung Cancer Screening CT: Preliminary Report

Monday, Nov. 26 11:10AM - 11:20AM Room: E451A

Participants
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PURPOSE

The accuracy of radiologists reading lung cancer screening CT in a previous study shows a false-negative rate (FN) of 3.5% to 8.1%. The purpose of this study was to assesses if CAD can reduce the FN and CT reading time.

METHOD AND MATERIALS

We conducted a randomized trial in 148 smokers participating in our ongoing Lung Cancer Screening Project (75M:73F, 66±7yrs, 59 ex- vs. 89 current-smoker). Chest CTs were randomized into two arms. In the CAD and Technician first arm (CAD+Tech-1st), CAD findings were displayed first, a technician accepted or rejected CAD findings and added probable nodule(s), then a chest radiologist accepted or rejected the CAD +Tech findings adding additional nodule(s). In the RAD-first arm (RAD-1st) the same radiologist read the CT first with CAD marks hidden, then turned on CAD to accept true nodules including those only found by CAD and delete the non-nodule CAD findings. The number of true nodules and reading time were recorded.

RESULTS

The reading times were 6.2 ± 3.4 min (range: 2-18) vs. 8.3 ± 5.4 min (range: 3-30) for CAD+Tech-1st vs. RAD-1st arms (p=0.012) for CTs with >=1 nodule; and 4.4±1.5 min (range: 2-10) vs. 8.7±9.5 min (range: 3-30) for those without nodules (p=0.07). By the three detection methods, 212 true nodules were found in 97 CTs in the CAD+Tech-1st arm. CAD detected 82 and technician added 93 true nodules, giving a combined sensitivity of 83%. There were 37/212 nodules found only by the radiologist; 12/37 were the most important nodule, and 1/37 was the only nodule that drove follow-up. In the RAD-1st arm 71 true nodules were found in 51 CTs; 36/71 (51%) were found by both CAD and radiologist. The radiologist missed 2 true nodules in 2 participants (2/51, 4%) which were detected by CAD and altered their follow-up protocol. The radiologist's detection sensitivity slightly increased with CAD (97% to 100%). CAD missed 33/71(46%) true nodules found by the radiologist, 16/33 (48%) were key nodules and 11/16 were the only nodule, changing follow-up.

CONCLUSION

CAD+Tech speed up the radiologist's nodule detection on screening chest CT. CAD detected nodules in 4% subjects where no nodule was identified by the radiologist, changing imaging follow-up protocol.

CLINICAL RELEVANCE/APPLICATION

While CAD+Tech as first reader cannot replace the radiologist, CAD could play an important role in lung cancer screening by saving radiologists' time, and importantly reduce their FN rate by 4%.

SSC03-06 Understanding Gaps Between Mental Health and Radiology Care: Population-based Cross-Sectional Survey Analysis of Lung Cancer Screening Eligibility and Smoking Prevalence Among Patients with Mental Illness

Monday, Nov. 26 11:20AM - 11:30AM Room: E451A

Participants
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PURPOSE

Prior studies have found that patients with mental illness are more likely to smoke compared with patients without mental illness. Lung Cancer Screening (LCS) with LDCT decreases lung cancer mortality in eligible current or former smokers. There is limited population-based information about LCS eligibility in patients with mental illness. Our purpose was to determine if patients with self-reported mental illness are more likely to be eligible for LCS and smoking cessation interventions compared to patients without mental illness using nationally representative federal cross-sectional survey data.

METHOD AND MATERIALS

Retrospective analysis of 2015 National Health Interview Survey (NHIS), a nationally representative, federal cross sectional survey was conducted. Individuals 55-77 yrs without lung cancer were included. The proportion of survey participants eligible for LCS was calculated and compared in patients with and without self-reported mental illness. Multiple variable logistic regression analyses were conducted comparing LCS eligibility in patients with and without self-reported mental illness, adjusted for potential confounders (age, race, and insurance status). Adjusted odds ratios were calculated with 95% confidence intervals. Analyses were performed accounting for complex survey design elements.

RESULTS

11,325 individuals between ages 55-77 were included (mean age 64.1, 52.8% female, 74.9% white) of whom 2.8% reported at least

one mental illness. Of individuals with self reported mental illness, 18.7% met eligibility criteria for LCS and 25.8% were current smokers. Of individuals without self reported mental illness, 10.6% met eligibility criteria for LCS and 12.9% were current smokers. Patients self-reporting mental illness were more likely to be eligible for LCS (Adjusted OR 1.89, 95% CI 1.30 to 2.75, p = 0.001) and more likely to be current smokers (Adjusted OR 2.20, 95% CI 1.59 to 3.07, p < 0.001) than patients without mental illness.

CONCLUSION

Patients with self-reported mental illness have a higher smoking prevalence and are nearly twice as likely to be eligible for LCS compared with patients without mental illness.

CLINICAL RELEVANCE/APPLICATION

Radiologists have an opportunity to collaborate with psychiatry and primary care in developing targeted LCS outreach efforts for patients with mental illness who are at increased risk of developing lung cancer due to their higher smoking prevalence.

SSC03-07 Lung Cancer Screening in a Socioeconomically Disadvantaged Population: Baseline and 1st Annual Rescreening Results

Monday, Nov. 26 11:30AM - 11:40AM Room: E451A

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

To describe the results of the first two rounds of screening of our clinical low-dose CT lung cancer screening program targeting a minority, socioeconomically disadvantaged, high-risk population different from that studied in the National Lung Screening Trial.

METHOD AND MATERIALS

All participants met USPSTF and/or NCCN eligibility criteria for lung cancer screening. A coordinator enrolled eligible individuals, scheduled their screening exams, and organized their transportation.

RESULTS

1029 individuals were referred from 7/21/2015 through 3/20/2018. 119 individuals declined screening, and 230 were unable to be contacted. Of 717 participants who agreed to participate, 411 met eligibility criteria for lung cancer screening. 370 patients underwent their baseline LDCT during this time period. 203 males (55%) and 167 females received baseline LDCT, with a mean age of 60 years. The median pack-years was 42 (range 20-132), and 81% of participants were current smokers. The ethnic makeup of the population was 77% black, 9% white, 8% Hispanic/Latino, and 5% Asian. 57% of participants had no more than a high school education. 33% of participants reported occupational exposure to one or more lung carcinogens. 84% (312) of patients received a Lung-RADS score of 1 (92) or 2 (220), 8% (29) received a score of 3, 5% (19) a score of 4A, and 3% a score of 4B (8) or 4X (2). 3 patients have been diagnosed with lung cancer to date: 1 stage IIB, 1 stage IIIB, and 1 stage IV. 28% (105) of patients had potentially significant incidental findings including interstitial lung disease (16), severe emphysema (14), aortic aneurysm (7), moderate-severe coronary calcifications (45), extrapulmonary masses (32), and pulmonary hypertension (4). 54% (147/271) of participants who were due for annual rescreening returned for their first annual LDCT. 93% (136) of these patients received a Lung-RADS score of 1 (21) or 2 (115), 3% (4) received a score of 3, 1% (2) a score of 4A, and 3% a score of 4B (5) or 4X (0).

CONCLUSION

Lung cancer screening with LDCT in a minority, socioeconomically disadvantaged, high-risk population is feasible but may yield a different lung cancer profile than screening in more privileged communities. Adherence to annual rescreening and follow-up recommendations is challenging in this population.

CLINICAL RELEVANCE/APPLICATION

Minority, socioeconomically disadvantaged populations may experience different benefits from LDCT lung cancer screening.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Cameron Hassani, MD - 2018 Honored EducatorFarhood Saremi, MD - 2015 Honored Educator

SSC03-08 Performance of the Vancouver Risk Calculator Compared to ACR Lung-RADS in an Urban, Diverse Clinical Lung Cancer Screening Cohort

Monday, Nov. 26 11:40AM - 11:50AM Room: E451A

Participants
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PURPOSE

To compare the performance of the Vancouver Risk Calculator (VRC) with ACR Lung-RADS for a lung cancer screening cohort in an urban, diverse clinical setting.

METHOD AND MATERIALS

IRB approval was obtained. All lung cancer screening patients who had their initial screening CT from December 2012-June 2016 demonstrating a nodule comprised the study population. Each exam was assigned a Lung-RADS score, with 4A and 4B considered positive. The VRC calculates the risk of cancer at different thresholds using 9 patient and imaging variables, with a 5% threshold considered positive. Analysis was performed on a per-patient level based on the largest nodule. Follow-up information was obtained via EMR, cancer registry and NDI. Patients with initial studies suspicious for malignancy but without histologic confirmation were adjudicated on a case-by-case basis. Performance characteristics to predict lung cancer were compared for Lung-RADS and VRC.

RESULTS

486 patients, 261(53.7%) women, mean age 63±5.2, comprised the study population. Mean follow-up time was 36.9± 11.1 months, and 61(12.6%) patients were lost to follow-up. Lung cancer was diagnosed in 35(7.2%). Lung-RADS had 10 FP and 14 FN while VRC 5% had 30 FP and 8 FN. Overall sensitivity, specificity and accuracy for Lung-RADS was 61.1%, 97.8%, and 94.9% and for VRC 5% was 77.8%, 93.3%, and 92.2%, respectively.

CONCLUSION

In comparison with Lung-RADS, the VRC demonstrated higher sensitivity but lower specificity and accuracy in predicting malignancy among patients in a diverse clinical lung cancer screening program.

CLINICAL RELEVANCE/APPLICATION

LungRADS and VRC achieved complementary results in a diverse urban clinical lung cancer screening program. Use of the two, in concert, may improve lung cancer prediction.

SSC03-09 Lung MRI as a Cost-Effective Alternative to Low-Dose CT Lung Cancer Screening: A Markov Cohort Analysis

Monday, Nov. 26 11:50AM - 12:00PM Room: E451A

Awards
Student Travel Stipend Award

Participants
Bradley D. Allen, MD, Chicago, IL (*Presenter*) Nothing to Disclose
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Hans-Ulrich Kauczor, MD, Heidelberg, Germany (*Abstract Co-Author*) Research Grant, Siemens AG Research Grant, Bayer AG Speakers Bureau, Boehringer Ingelheim GmbH Speakers Bureau, Siemens AG Speakers Bureau, Koninklijke Philips NV Speakers Bureau, Bracco Group Speakers Bureau, AstraZeneca PLC
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Gordon Hazen, PhD, Evanston, IL (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The purpose of this study was to evaluate the potential performance of lung MRI (MRI) vs. low dose CT (LDCT) using a Markov model of lung cancer screening. We hypothesized that MRI would be a cost-effective alternative to LDCT.

METHOD AND MATERIALS

We converted the MISCAN Lung microsimulation of lung cancer progression into a Markov cohort model with transition probabilities based on histology/stage. Our model uses published data to specify lung cancer incidence and background non-lung cancer mortality based on gender, age and smoking burden, and survival after diagnosis by gender, histology and stage. Published LDCT screening sensitivity (Sn) and specificity (Sp) by stage/histology was used to populate the LDCT model parameters. For MRI, the Sn and Sp were based on published data of solid nodules using size and T2 contrast-to-noise ratio. Our model follows a large cohort of age-60 males with 2 packs/day smoking history for 20 years. The time-0 composition of the cohort was a mixture of well and undiagnosed cancer patients from the model when run from age 42. At each annual screening, portions of the surviving cohort experience true/false, positive/negative outcomes with true positives moving to treatment. Costs for screening LDCT ($256), work-

up, and treatment were extracted from CMS procedure cost data and the literature. Sensitivity analysis was performed on Sn/Sp of MRI and costs of MRI. Results of interest include life-years/patient (LYs), net monetary benefit (NMB), and cost-effectiveness (C/E) of MRI relative to LDCT.

RESULTS

LYs for MRI screening were 13.28 vs. 13.29 for LDCT. Using an acceptable cost/LY of $100,000, MRI resulted in a net-monetary benefit (NMB) of $3,744 over LDCT. MRI saves $2656/patient over LDCT, while losing only 3.97 life days, for a favorable C/E ratio of $244,189/LY. Cost ranging from $256 to $375 result in a favorable C/E ratio for MRI.

CONCLUSION

Based on this simulation, MRI provides an equivalent LY benefit with cost-savings over LDCT lung cancer screening at reasonable MRI costs. This finding is driven by improved specificity of MRI for solid nodule characterization.

CLINICAL RELEVANCE/APPLICATION

Markov simulation of a high-risk screening cohort shows that Lung MRI has the potential to be a cost-effective alternative to low-dose CT screening.

SSC04

Emergency Radiology (Thoracic, Cardiac and Vascular)

Monday, Nov. 26 10:30AM - 12:00PM Room: S504AB

CA CH CT ER VA

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

Participants
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Sub-Events

SSC04-01 Model-Based Iterative Reconstruction on 80kV CT Pulmonary Angiography: Image Quality and Radiation Dose Saving Compared with Hybrid Iterative Reconstruction on 100Kv CT Study

Monday, Nov. 26 10:30AM - 10:40AM Room: S504AB

Participants
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PURPOSE

To evaluate dose reduction and image quality of 80 kV CT pulmonary angiography (CTPA) reconstructed with model-based iterative reconstruction (IMR), and compared with 100 kV CTPA with hybrid iterative reconstruction (iDose4).

METHOD AND MATERIALS

One hundred and fifty-one patients were prospectively investigated for pulmonary embolism; a study group of 76 patients underwent low-kV setting (80kV,automated mAs) CTPA study, while a control group of 75 patients underwent standard CTPA protocol (100kV; automated mAs); all patients were examined on 256 MDCT scanner (Philips iCTelite). Study Group images were reconstructed using IMR while the Control Group ones with iDose4. CTDIvol, DLP and ED were evaluated. Region of interests placed in the main pulmonary vessels evaluated vascular enhancement (HU); signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated.

RESULTS

Compared to iDose4-CTPA, low kV IMR-CTPA presented lower CTDIvol (6.41 ± 0.84 vs 9.68 ± 3.5 mGy) and DLP (248.24 ± 3.2 vs 352.4 ± 3.59 mGy x cm), with ED of 3.48 ± 1.2 vs 4.93 ± 1.8 mSv. Moreover IMR-CTPA showed higher attenuation values (670.91 ± 9.09 HU vs 292.61 ± 15.5 HU) and a significantly higher SNR (p<0,0001) and CNR (p<0,0001). The subjective image quality of low kV IMR-CTPA was also higher compared with iDose4-CTPA (p<0,0001).

CONCLUSION

Low dose CT with IMR represents a feasible protocol for the diagnosis of pulmonary embolism in the emergency setting and permits to achieve excellent diagnostic images (in terms of subjective quality) with extremely low noise, and a significant reduction of the dose led to the patient (in terms of mSv) within reasonable reconstruction times (less than 120 seconds).

CLINICAL RELEVANCE/APPLICATION

Low kV IMR approach allows a significant dose reduction of CTPA studies improving attenuation values, SNR and CNR in the pulmonary vessels, as compared with standard kV iDose4-CTPA.

SSC04-02 A Proposal of a New System Score to Evaluate With Lung Ultrasound the Necessity of a Drainage Tube in Pneumothorax in Emergency Room

Monday, Nov. 26 10:40AM - 10:50AM Room: S504AB

Participants
Maria Luisa De Cicco, MD, Roma, Italy (*Presenter*) Nothing to Disclose
Vittorio Miele, MD, Florence, Italy (*Abstract Co-Author*) Nothing to Disclose
Vincenza Di Giacomo, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Chiara Andreoli, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Stefania Ianniello, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Aim of this study was to evaluate the validity of a new system score and its utility in the Emergency Room to estabilish the necessity to drainage pneumothorax diagnosed by ultrasound in unstable adults major trauma.

METHOD AND MATERIALS

Retrospective observational study that involved, from January 2015 to January 2018, 274 adults patients with pneumothorax, evaluated by lung ultrasound in Emergency Room during Primary Survey. All ultrasound were performed with portable ultrasound machine in Emergency Room, with patients lying on the spinal board stretcher. It was applied a system score which included the evaluation of the lung point site (parasternal =1, emiclavear =2 or axillary line=3), the presence of pleural effusion (><300 ml=1 o 0) and the position of the heart (with o without dislocation=1 o 0). Cut off estabilished to indicate the necessity of the thorax drainage was 4. All patients underwent to MDCT (gold standard) and the results compared.

RESULTS

Among the enrolled patients with pneumothorax 184/274 had a score > 4 and the necessity of a drainage was indicated on the report. Of these in 164 the necessity was confirmed by CT, while in 20 the patients were just observed. Among the 20 'false positive to need drainage' of our retrospective review, someone had a high BMI (8), someone had subcutaneous emphysema (5), while in the other or there was an overvaluation by the US evaluation or the patients conditions improved (7).

CONCLUSION

Our data regarding the validity of a new system score should be useful in deciding the necessity of a draining tube in major trauma unstable patients. This score would allow an early diagnosis and a promptly therapeutic decision, avoiding wasting time, essential in patients with many traumatic lesions and above all with serious pneumothorax.

CLINICAL RELEVANCE/APPLICATION

Identify an useful new scoring system, helpful to estabilish the necessity to drainage pneumothorax diagnosed by ultrasound, in unstable adults major trauma

SSC04-03 Identifying Patients with Low Cardiac Output Using Vessel Density at CTPA

Monday, Nov. 26 10:50AM - 11:00AM Room: S504AB

Awards
Student Travel Stipend Award

Participants
Andrew D. Chang, MSc, Providence, RI (*Presenter*) Nothing to Disclose
Scott Collins, RT, Providence, RI (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Cardiac output (CO) is an important metric that has diagnostic and prognostic value in emergency and inpatient settings. However, determining CO currently requires invasive or costly procedures such as Swan-Ganz catheterization (SGC) or cardiac MR (CMR). CT for pulmonary angiography (CTPA) is a commonly performed examination that provides a snapshot of exogenously administered contrast as it distributes through the thoracic vasculature in a manner chiefly determined by CO. We hypothesized that by measuring attenuation in different vessels we could (1) identify patients with reduced CO and, potentially, (2) quantify CO.

METHOD AND MATERIALS

We retrospectively identified patients who underwent SGC or CMR within 14 days of CTPA between 1/1/2006 to 12/30/2016. Using CO values from SGC or CMR as the gold standard, patients were stratified into three groups: CO < 4 L/min (low), 4-8 L/min (normal), and over 8 L/min (high). All CT studies were performed using a standardized protocol with a fixed delay of 22 sec and an injection rate of 4 cc/s. For each patient, density (HU) was measured in the superior vena cava [SVC], main pulmonary trunk [PT], and ascending aorta [AO] on a single mid-thoracic transaxial slice. Densities and density differences were then compared with measured vales of CO.

RESULTS

We identified 119 patients with concurrent CO measurements and CTPA studies within the study period. Compared to patients with normal CO (n=76, 63.9%), patients with low CO (n=35, 29.4%) exhibited higher attenuation in the SVC (1305±846 vs 944.4±556.8 HU, p=0.026) and PT (518.4±149.6 vs 385.3±122.4 HU, p<0.001). Adjusting for body surface area, PT-AO difference predicts low CO (OR per unit increase 1.007, 95% CI 1.004-1.010, p<0.001). ROC analysis yielded a PT-AO difference threshold of 130 HU for differentiating low from normal CO, with sensitivity and specificity of 74.3% and 87.7% (AUC 0.776, p<0.001).

CONCLUSION

This study provides a simple approach to estimate low CO status by measuring vessel density on a single transaxial CTPA image at the level of the mid-ascending aorta. We found that the greater the attenuation difference between the PT and AO, the greater the odds of low CO, with a difference of 130 HU serving as a useful threshold distinguishing low from normal CO.

CLINICAL RELEVANCE/APPLICATION

Using a standardized CTPA protocol it may be possible to confidently identify patients with reduced cardiac output.

SSC04-04 Multi Factorial Comparative Study of Dual Source CT Scanners in Acute Pulmonary Embolism

Monday, Nov. 26 11:00AM - 11:10AM Room: S504AB

Participants
Waleed Abdellatif, MD, Vancouver, BC (*Presenter*) Nothing to Disclose
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PURPOSE

To compare mean acquisition time, image quality and diagnostic accuracy of two dual-energy CT scanners for the evaluation of acute pulmonary embolism (PE).

METHOD AND MATERIALS

Total of 50 scans on the 2nd generation dual source SOMATOM Definition Flash CT scanner (the Flash) and 49 scans on the 3rd generation dual source SOMATOM Force (the Force) were included. Scans with inadequate opacification of pulmonary artery or known chronic PE were excluded. Imaging acquisition parameters were adjusted to be the same on both the Force and the Flash. In a randomized blinded design, two radiologists independently reviewed both sets of scans in two settings (3-week interval) for image quality using a 5-point scale. The interobserver reliability and diagnostic accuracy were calculated for each reviewer. Diagnosis of acute PE was made using clinical data (acute chest pain), laboratory data (D-Dimer > 500 ug/L) and CTPA.

RESULTS

Mean acquisition time for the Force (x= 2.81 sec, SD= 0.1) and the Flash (x= 9.7 sec, SD = 0.15) was found to be very statistically significant (P= 0.0001; 95% CI = 6.8 - 6.9) with the Force 3.4 times faster than the Flash. The mean image quality was found to be 4.47/5 and 4/5 for the Force and the Flash respectively with statistical significance (P= 0.0064 on the unpaired t-test; 95% CI= 0.80-0.13). 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).Acute PE was diagnosed in 17 cases on the Force and in 21 cases on the Flash. Diagnostic accuracy was 94.1% and 98.2% on the Force and 90.2% and 94.8% on the Flash for reviewers one and two respectively. Although diagnostic accuracy was higher on the Force, the difference wasn't statistically significant. 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

Image quality is significantly higher on the Force CT scanner with significantly lower mean acquisition time and less motion artifact in comparison to the Flash.

CLINICAL RELEVANCE/APPLICATION

The improved image quality and speed of the Force CT scanner with resultant less motion artifact and repeated studies could be particularly useful in emergency radiology setting with large patient volume.

SSC04-05 Axial or Helical? CT Imaging of the Chest for Uncooperative Emergency Patients with 16-cm Wide Detector CT

Monday, Nov. 26 11:10AM - 11:20AM Room: S504AB

Participants
Yanan Li, Xian, China (*Presenter*) Nothing to Disclose
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Ganglian Fan, Xian, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare image quality and radiation dose between the fast-helical mode (FHM) and two-axial mode (TAM) in chest CT imaging for uncooperative emergency patients with 16-cm wide detector CT scanner.

METHOD AND MATERIALS

Thirty emergency patients who were unconscious or uncooperative with the breathing instructions underwent chest CT were prospectively divided randomly into two groups: FHM Group (n=15, helical scan mode with 80mm detector coverage and pitch 0.992:1), TAM Group (n=15, axial scan mode with 160mm detector coverage, two scans). Both groups used the 0.28s rotation speed and automatic tube current modulation. All scans were performed in free-breathing. CT value, image noise and signal-to-noise ratio (SNR) were measured at each of the following locations: descending thoracic aorta, lung parenchyma and paraspinal muscle at the level of the carina. Two radiologists assessed the images for subjective image quality, motion artefacts and diagnostic confidence. The volume CT dose index (CTDIvol) and dose-length product (DLP) were evaluated from the dose reports, and effective dose was calculated. All measurements between the two groups were statistically compared.

RESULTS

The mean total exposure time was significantly shorter for TAM group than FHM group (0.56s vs.1.12s, P<0.001). Image quality was generally better with TAM than with FHM (diagnostic confidence score, 3.87 vs. 3.47, P<0.05); However, there was no

significant difference in CT value, image noise and SNR between two groups. The DLP value was higher in FHM than TAM (123.92±38.54mGy·cm vs. 94.22±33.63mGy·cm, P=0.041), while CTDIvol was not significantly different. TAM group reduced the total effective radiation dose by 24% compared to FHM (1.32±0.50 mSv vs. 1.73±0.54mSv).

CONCLUSION

The use of the two-axial mode further reduces the scan time in chest CT for emergency patients and ensures good image quality with 24% radiation dose reduction, compared with chest CT that uses the fast-helical scan with 80mm collimation.

CLINICAL RELEVANCE/APPLICATION

The two-axial scan mode can be used for lung evaluation in uncooperative emergency patients in free breathing to obtain satisfactory image quality while reducing radiation dose.

SSC04-06 Utility of 3D Post-Processing Cinematic Rendering Reconstruction Images in Acute Trauma Setting: Initial Observations

Monday, Nov. 26 11:20AM - 11:30AM Room: S504AB

Participants
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Vahid Mehrnoush, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Multiple post-processing reconstruction techniques based on volumetric CT datasets are used to generate three-dimensional (3D) images to better depict complex anatomical details. Volume rendering (VR) is frequently used as a standard 3D technique, however recently an FDA-approved alternative called Cinematic Rendering (CR) is emerging with vast clinical potentials (1,2). Contrary to traditional VR reconstruction, CR utilizes a global illumination model to create high definition photo-realistic images. We describe our initial experience with CR images in the setting of acute trauma.

METHOD AND MATERIALS

A set of polytrauma patients with ISS score >16 with simple to complex injuries presenting to Vancouver General Hospital, level 1 trauma center were evaluated. Source DICOM images using a 2nd generation 128-slice dual-source CT (Somatom Definition Flash, Siemens Healthineers, Forchheim, Germany) were used to create CR images. Cinematic Rendering software (Siemens Syngo.via Frontier) was used applying default and customized presets. CR images were assessed for image quality, depth and shape perception, delineation of osseous, vascular, soft tissue and solid organ anatomy in comparison to VR images. The images were also evaluated for their role in clinical decision making and education. Multiple trauma surgeons assessed the images using Likert scale analysis with 1 being much lower, 3 equivocal, and 5 much higher. Frequencies, percentages, mean and standard deviation were calculated.

RESULTS

CR images were rated higher than VR images with a mean+/- SD of 4.0+/-0.8. 67 % of trauma surgeons categorized CR images as much higher for use as an education tool and 61% graded them as higher in helping with clinical decision compared to VR images.

CONCLUSION

Our observations are one of the very few initial studies to evaluate the clinical utility of CR images. Understanding complex and challenging anatomical and pathological details are imperative for better patient management from a trauma surgeon assessment. CR provides remarkable details relative to VR reconstructions in context of complex acute trauma

CLINICAL RELEVANCE/APPLICATION

Cinematic Rendering is a promising novel technique to display visually receptive 3D photorealistic high definition images with exquisite anatomical details. Formal evaluations and research is needed to assess the CR images in order to understand their clinical application in patient management.

SSC04-07 Improving Pulmonary Embolism Detectability for Computer-Aided Detection Software Using Optimal Kev Monochromatic Images in Dual-Energy Spectral CT

Monday, Nov. 26 11:30AM - 11:40AM Room: S504AB

Participants
Ma Guangming, MMed, Xianyang City, China (*Presenter*) Nothing to Disclose
Nan Yu, MD, Xian Yang, China (*Abstract Co-Author*) Nothing to Disclose
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Chenwang Jin, Xi'an, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare pulmonary embolism detectability using computer-aided detection (CAD) software with optimal keV monochromatic images and conventional images.

METHOD AND MATERIALS

Retrospectively analyzed CT images of 20 patients with clinically proven pulmonary embolism (PE). These patients underwent CT pulmonary angiography (CTPA) with spectral imaging mode. The conventional images (140kVp polychromatic, group A) were reconstructed. Using the standard Gemstone Spectral Imaging (GSI) viewer on an advanced workstation (AW4.6), an optimal energy level (group B) could be automatically obtained. The images in two group were independently analyzed for detecting PE using a commercially available CAD software. Two experienced radiologists reviewed all images and recorded the number of emboli, and the results were used as the gold standard. The attenuation in the main pulmonary artery (MPA) and the embolus (in the most substantial part of the embolus) were measured. The difference in attenuation (MPA-embolus), as well as the detectability for pulmonary embolism in each case (sensitivity, false positive rate) were calculated. Data were statistically compared between the two groups.

RESULTS

The optimal energy levels were 62.4keV. The attenuation in the MPA, difference in attenuation (MPA-embolus) for group A and B were (314.46±81.41HU vs. 446.30±151.88HU) and (281.89±73.82HU vs. 404.75±138.74HU), respectively (all $p<0.001$). The mean sensitivity for pulmonary embolism detection in group A was 74.63±6.16%, which was lower than the 82.17±4.51% in group B ($t=-4.26$, $p<0.001$). The mean false positive rate in group A was 32.71±4.89%, which was higher than the 13.41±3.02% in group B ($t=13.41$, $p=0.00$).

CONCLUSION

Compared with conventional images, the combination of optimal keV monochromatic images and CAD improves the diagnostic accuracy of CAD.

CLINICAL RELEVANCE/APPLICATION

The combination of optimal keV monochromatic images and CAD could improve the detection rate for emboli.

SSC04-08 Implementation of Fully Automated Computer-Aided Detection of Nodules in The Lung Bases on Emergent Abdominal CT Scans: Accuracy and Effect on Workflow

Monday, Nov. 26 11:40AM - 11:50AM Room: S504AB

Participants
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Pamela J. Lombardi, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Rishi Agrawal, MD, Chicago, IL (*Abstract Co-Author*) Speakers Bureau, Boehringer Ingelheim GmbH
Vahid Yaghmai, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the value of fully automated computer-aided diagnosis (CAD) for detection of lung nodules on emergent abdominal CT studies in.

METHOD AND MATERIALS

Abdominal CT scans of 50 patients in the emergency department were reviewed. A radiologist with 5 years' experience (RAD) reviewed the scans to detect pulmonary nodules in the lung bases. In order to simulate the emergency setting, time limit of 30 seconds was set in each case for RAD to review image datasets. The CAD detection performance was also evaluated in the same session by RAD. CAD nodule detection was fully automated and required no additional processing time by RAD. Fisher`s exact test and T-test were used to determine the differences between the rate of detection between RAD and CAD.

RESULTS

A total number of 54 nodules were detected by RAD in 50 patients (28 male, mean±SD age, 51.2±17.6 years). Adding the CAD increased the rate of detection by 30% (1.47 vs. 1.13 nodule/scan, $P<0.05$). Moreover, there was no significant difference in the rate of missed nodules per scan between CAD and RAD (0.33 nodule /scan vs. 0.25 nodule/scan), respectively. 25 out of 74 nodules detected by CAD were false positives .

CONCLUSION

Using fully automated CAD may significantly improve the performance of the radiologist in detecting nodules located in the lung bases on abdominal CT scans obtained in the emergency department.

CLINICAL RELEVANCE/APPLICATION

The role of CAD as a second reader may improve detection of lung base nodules on emergency department abdominal CT scans.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Vahid Yaghmai, MD - 2012 Honored EducatorVahid Yaghmai, MD - 2015 Honored EducatorVahid Yaghmai, MD - 2017 Honored Educator

SSC04-09 Spectrum of Radiological Manifestations of Melioidosis, Association with Risk Factors, and Its Role in Prognostication of Clinical Outcome

Monday, Nov. 26 11:50AM - 12:00PM Room: S504AB

Participants
Leena Robinson Vimala, MD, Vellore, India (*Presenter*) Nothing to Disclose

PURPOSE

Melioidosis being a mimicker of its more common clinical counterpart tuberculosis, is often mismanaged.The primary objective is to describe the spectrum of radiological manifestations of melioidosis. Secondary objectives are to evaluate the association between the organ involvement, known risk factors, predisposing conditions and also to predict effect on clinical outcome.

METHOD AND MATERIALS

Retrospective image analysis of all culture proven cases of Burkholderia pseudomallei,between January 2011 & October 2017 was done. Demographic data, clinical characteristics, risk factors and clinical outcome were anlaysed. Unfavourable clinical outcome considered were those patients with severe disease condition requiring ICU admission for administration of ionotropes, requirement of ventilation or death.

RESULTS

194 patients (162 males) with median age of 45 years,were included.Among the risk factors, diabetes mellitus was most common (63%), followed by alcohol abuse (28%).Table 1 demonstrates the radiological manifestation of organ/ system involvement of melioidosis.Patients with diabetes were found to have increased incidence of liver, spleen, bone and soft tissue involvement ($p<0.05$).Significant association of diabetes with liver, spleen and bone and soft tissue involvement seen, having odds ratios 3.213 (95% CI:1.048 - 9.855;p=0.04),3.478 (95% CI:1.728-7;p=<0.001)&2.668 (95% CI:1.232 - 5.778;p=<0.001) respectively. Statistical significant difference was identified in the melioidosis involvement of genitourinary tract between the positive and negative TB group. 25% of patients suffered unfavourable outcome. Mortality was 11%. Using univariate binary logistic regression analysis,lung involvement was found to have 4.3 times risk for unfavourable outcome (95% CI 1.971 - 9.496; $p< 0.001$),whereas spleen and lymph node involvement, protected from unfavourable outcome (odds ratio being 0.202 & 0.457 respectively).

CONCLUSION

The constellation of imaging findings could mimic disseminated tuberculosis or other pyogenic infection. Combination of organ involvement, associated superficial soft tissue involvement are imaging diagnostic clues.Knowledge about the radiological manifestations of melioidosis is essential for accurate diagnosis and management.

CLINICAL RELEVANCE/APPLICATION

Present study is the largest study that has illustrated the radiological manifestations of melioidosis and its association with clinical outcome and risk factors.

SSC05

Science Session with Keynote: Gastrointestinal (LiRADS)

Monday, Nov. 26 10:30AM - 12:00PM Room: N228

BQ GI MR OI US

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

Participants
Claude B. Sirlin, MD, San Diego, CA (*Moderator*) Research Grant, Gilead Sciences, Inc; Research Grant, General Electric Company; Research Grant, Siemens AG; Research Grant, Bayer AG; Research Grant, ACR Innovation; Research Grant, Koninklijke Philips NV; Research Grant, Celgene Corporation; Consultant, General Electric Company; Consultant, Bayer AG; Consultant, Boehringer Ingelheim GmbH; Consultant, AMRA AB; Consultant, Fulcrum Therapeutics; Consultant, IBM Corporation; Consultant, Exact Sciences Corporation; Advisory Board, AMRA AB; Advisory Board, Guerbet SA; Advisory Board, VirtualScopics, Inc; Speakers Bureau, General Electric Company; Author, Medscape, LLC; Author, Resoundant, Inc; Lab service agreement, Gilead Sciences, Inc; Lab service agreement, ICON plc; Lab service agreement, Intercept Pharmaceuticals, Inc; Lab service agreement, Shire plc; Lab service agreement, Enanta; Lab service agreement, Virtualscopics, Inc; Lab service agreement, Alexion Pharmaceuticals, Inc; Lab service agreement, Takeda Pharmaceutical Company Limited; Lab service agreement, sanofi-aventis Group; Lab service agreement, Johnson & Johnson; Lab service agreement, NuSirt Biopharma, Inc ; Contract, Epigenomics; Contract, Arterys Inc
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Sub-Events

SSC05-01 Gastrointestinal Keynote Speaker: LiRADS

Monday, Nov. 26 10:30AM - 10:40AM Room: N228

Participants
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SSC05-02 ACR Ultrasound LI-RADS: Multicenter Evaluation of Clinical Performance in HCC Screening and Surveillance

Monday, Nov. 26 10:40AM - 10:50AM Room: N228

Awards
Student Travel Stipend Award

Participants
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Mary K. O'Boyle, MD, La Jolla, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the clinical performance of the ACR Ultrasound Liver Reporting and Data System (US LI-RADS) Version 2017 for detecting hepatocellular carcinoma (HCC) in a population of patients at high risk for HCC.

METHOD AND MATERIALS

In this retrospective, multicenter, HIPAA-compliant, IRB-approved study, patients at 5 sites had undergone screening liver ultrasound from Jan-Sep 2017 and US LI-RADS visualization scores and management categories were assigned on a clinical basis. Ultrasound reports and patient records were then retrospectively reviewed and any follow-up imaging studies and/or pathologic reports recorded. Descriptive statistics were performed.

RESULTS

2050 patients at high risk for HCC (1078 men and 972 women; mean age 57.7 years) were included. The most common indications were cirrhosis (n=1054; 51.3%), non-cirrhotic HBV (n=555; 27.1%), and non-cirrhotic HCV (n=234; 11.4%). Among patients with cirrhosis, the most common etiologies were HCV (n=396; 19.4%), alcohol (n=194; 9.5%), and HBV (n=187; 9.2%). US LI-RADS scores had been assigned by 69 different readers with mean 19.3 years experience post-residency. US LI-RADS categories were: US-1 (Negative) in 90.4% (n=1854): US-2 (Subthreshold) in 4.6% (n=95); and US-3 (Positive) in 4.9% (n=101). Visualization scores were: A (No or minimal limitations) in 76.8% (n=1575); B (Moderate limitations) in 18.9% (n=388); and C (Severe limitations) in 4.2% (n=87). Confirmatory tests including contrast enhanced CT/MR (n=212) or histopathology (n=9) were available for 221 patients. Treating US-2 and US-3 as positive test results and LR-3, LR-4, LR-5, or LR-M imaging observations at CT/MR or tissue diagnosis of HCC as positive clinical outcomes, the sensitivity of US LI-RADS was 77.5%, specificity 58.9%, PPV 40.2%, and NPV 88.1%.

CONCLUSION

US LI-RADS visualization scores in over 2000 patients demonstrated >95% of US screening exams were diagnostically acceptable. Approximately 90% of exams were interpreted as negative, 5% subthreshold, and 5% positive. In the subset of patients with confirmatory testing, US LI-RADS exhibited moderately high sensitivity (77.5%) and NPV (88.1%), key characteristics of a screening test.

CLINICAL RELEVANCE/APPLICATION

During the first year after its release, ACR US LI-RADS was adopted into clinical practice and demonstrated promising clinical performance for HCC screening in multiple academic medical centers.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Katherine E. Maturen, MD - 2014 Honored Educator

SSC05-03 Classification of Primary Liver Cancers in Cirrhosis Using LI-RADS on Gadoxetic Acid-Enhanced MRI and Its Prognostic Implication

Monday, Nov. 26 10:50AM - 11:00AM Room: N228

Participants
Sang Hyun Choi, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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Kang Mo Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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Yong Moon Shin, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Moon-Gyu Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

This study aimed to evaluate the performance of the Liver Imaging Reporting and Data System (LI-RADS) v2017 in differentiating hepatocellular carcinoma (HCC) from intrahepatic cholangiocarcinoma (IHCC) and combined hepatocellular-cholangiocarcinoma (cHCC-CC) on gadoxetic acid-enhanced magnetic resonance imaging (MRI), and to determine its postsurgical prognostic implications.

METHOD AND MATERIALS

Our institutional review board approved this study and waived the requirement for informed consent. A total of 194 patients with single primary liver cancers surgically resected (53 cHCC-CCs, 44 IHCCs, and 97 HCCs) from cirrhotic livers were evaluated on gadoxetic acid-enhanced MRI. Two independent readers analyzed each nodule and assigned a LI-RADS category. Overall survival (OS), recurrence-free survival (RFS), and their associated factors were evaluated using the Kaplan-Meier method, the log-rank test, and the Cox proportional hazard model.

RESULTS

The sensitivity and specificity of the LR-5 category for diagnosis of HCC were 76.3% (74/97) and 84.5% (82/97), respectively; most (86.7%) false-positive diagnoses were misclassification of cHCC-CCs. In the multivariate analysis, the LI-RADS category was a significant independent factor for OS (HR=3.88; p<0.001) and RFS (HR=2.26; p=0.010). The LR-M category was associated with poorer OS and RFS than the LR-4 or LR-5 categories for all primary liver cancers (p<0.001, both), HCCs (p=0.012 and p=0.009, respectively), and cHCC-CCs (p<0.001 and p=0.002, respectively). The OS and RFS of the cHCC-CCs categorized as LR-4 or LR-5 did not significantly differ from those of HCCs (p=0.535 and p=0.074, respectively).

CONCLUSION

LI-RADS correctly classifies most HCCs and IHCCs, whereas differentiation of cHCC-CC from HCC presents a challenge. The LI-RADS category may predict the postsurgical prognosis of primary liver cancers, independent of the pathologic diagnosis.

CLINICAL RELEVANCE/APPLICATION

The LI-RADS v2017 guidelines correctly classify most HCCs and IHCCs, whereas differentiation of cHCC-CC from HCC is challenging, reducing the specificity of LI-RADS in the diagnosis of HCC. The LI-RADS category allows prediction of the postsurgical prognosis of primary liver cancers, independent of the pathologic diagnosis of the tumor.

SSC05-04 Liver Imaging Reporting and Data System: Frequency of Category Adjustment Using Ancillary Features on CT and MRI in Clinical Practice

Monday, Nov. 26 11:00AM - 11:10AM Room: N228

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PURPOSE

The Liver Imaging Reporting and Data System (LI-RADS, LR) uses ancillary features (AFs) to adjust the category code assigned by major features (MFs). This study assessed the frequency with which AFs are used to adjust category on CT and MRI in clinical practice.

METHOD AND MATERIALS

All MR and CT reports issued with a standardized LI-RADS template at one tertiary care center between 3/16-3/18 were identified. For each reported LR-3, LR-4, and LR-5 observation, the presence of every MF and every AF was extracted retrospectively from the clinical report. LI-RADS categories then were assigned using the v2017 LI-RADS algorithm based on the reported MFs and AFs and following the v2017 instructions: increase category by one and up to LR-4 for >=1 AF favoring malignancy (AF-M), decrease by one with >=1 AF favoring benignity (AF-B), and no change with >=1 AF-M and >=1 AF-B. Results were summarized descriptively.

RESULTS

314 patients (209 [66%] male, mean age 65 [±10] years) were identified. They had a total of 548 observations (median size 13mm, IQR 9-20mm) including 441 (median size 13mm, IQR 9-20mm) reported on MRI and 107 (median size 15mm, IQR 10-22mm) reported on CT. Without applying AFs, 42% (232/548) of all observations were categorized LR-3, 29% (161/548) LR-4, and 28% (155/548) LR-5; 45% (198/441) of MRI observations were categorized LR-3, 28% (124/441) LR-4, and 27% (119/441) LR-5; 32% (34/107) of CT observations were categorized LR-3, 34% (37/107) LR-4, and 34% (36/107) LR-5. Application of AFs caused the LI-RADS category to be increased in 24% (127/524) and decreased in 4% (24/524) of all observations, increased in 28% (123/441) and decreased in 5% (22/441) of MR observation, and increased in 4% (4/107) and decreased in 2% (2/107) of CT observations. In particular, AFs caused 55% (127/232) of LR-3 observations overall, 62% (123/198) of LR-3 MRI observations, and 12% (4/34) of LR-3 CT observations to be upgraded to LR-4.

CONCLUSION

Ancillary features can cause category adjustment in a substantial proportion of LI-RADS observations. Adjustments tend to upward, are more common in MRI than CT, and predominantly affect observations categorized LR-3 based on major features.

CLINICAL RELEVANCE/APPLICATION

Ancillary features cause a substantial proportion of LR-3 observations to be upgraded to LR-4 , which is likely to affect management.

SSC05-05 Deep Convolutional Neural Network Applied to the Liver Imaging Reporting and Data System (LI-RADS) Category Classification: A Pilot Study

Monday, Nov. 26 11:10AM - 11:20AM Room: N228

Awards
Student Travel Stipend Award

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PURPOSE

To explore the performance of deep convolutional neural networks (CNN) for determining Liver Imaging Reporting and Data System (LI-RADS) category on multiphase dynamic contrast-enhanced CT and MRI.

METHOD AND MATERIALS

This study used a de-identified HIPAA-compliant dataset comprised of multiphase contrast-enhanced images for 329 unique hepatic observations (168 on CT and 161 on MRI) in JPEG format with corresponding diameters and consensus categories assigned by 2 members of the LI-RADS Steering Committee using LI-RADS v2013. A radiologist manually cropped the observations, including a margin of peri-observation parenchyma. Two CNNs were applied: 1) custom-made un-pretrained CNNs with quadruple-phase images (pre, arterial, portal venous, and delayed phases), and 2) transfer learning with pretrained networks with triple-phase images (pre, arterial and delayed phases). Each method used on-the-fly data augmentation technique. Lesion diameters were included, processed through a fully-connected neural network, and concatenated with the CNN models. The dataset was randomly split into training, validation, and test set at a ratio of 70: 15: 15. Accuracy and the area under receiver operating characteristic curve (AUROC) for classifying categories LR-1/2/3 versus LR-4/5/M were calculated on the test set.

RESULTS

Of 329 observations, 150 were LR-1/2/3 and 179 were LR-4/5/M; 229, 50, 50 observations were assigned to the training, validation, and test sets, respectively. Accuracy and the AUROC for the test set was 82% and 0.90 for transfer learning method, and 82% and 0.85 for custom-made method.

CONCLUSION

Deep learning CNN models show promise for categorizing hepatic observations according to LI-RADS on multiphase dynamic contrast-enhanced CT and MRI.

CLINICAL RELEVANCE/APPLICATION

Deep learning convolutional neural network models may provide a future platform for augmenting radiologists' interpretation of hepatic observations.

SSC05-06 Validation of Ultrasound Liver Imaging Reporting and Data System Version 2017 in Patients at High Risk for Hepatocellular Carcinoma

Monday, Nov. 26 11:20AM - 11:30AM Room: N228

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PURPOSE

To evaluate diagnostic performance of the Ultrasound Liver Imaging Reporting and Data System version 2017 (US LI-RADS v2017) for diagnosing hepatocellular carcinoma (HCC) in high risk patients with liver cirrhosis and to investigate association between US visualization score and US category.

METHOD AND MATERIALS

This study was approved by the institutional review board of our institution. A prospective surveillance study cohort included 407 cirrhosis patients at high risk for HCC who underwent US between December 2011 and March 2013. US LI-RADS category (1, 2, or 3) and US visualization score (A, B, or C) were assigned. The sensitivity and specificity for diagnosing HCC were calculated on the basis of per-patient and per-lesion, respectively, using contrast-enhanced CT, gadoxetic acid-enhanced MRI, and pathology as reference standards. The association between US visualization score and US category was evaluated using chi-squared test.

RESULTS

Of the 429 nodule in 407 patients, 32 nodules were confirmed as HCC in 28 patients. The sensitivity and specificity of US category 3 for diagnosing HCC on per-patient analysis were 34.4% (95% confidence interval [CI], 20.3-51.8%) and 92.2% (95% CI, 89.1-94.5%), respectively, and those on per-lesion analysis were 39.3% (95% confidence interval [CI], 25.7-54.8%) and 92.9% (95% CI, 89.8-95.1%), respectively. US visualization score was significantly associated with US category ($p = 0.04$), i.e., 11.9% (5/42) US category 3 showed score C, whereas 29.1% (111/381) US category 1 showed score C.

CONCLUSION

US LI-RADS v2017 category 3 demonstrated a high specificity, but a low sensitivity for diagnosing HCC in the surveillance of patients at high risk for HCC. US category assignment was significantly associated with US visualization score.

CLINICAL RELEVANCE/APPLICATION

The low sensitivity of US LI-RADS category 3 might be a limitation for the diagnosis of HCC in high risk patients, and it is related to the poor US visualization score.

SSC05-07 Accuracy of the LI-RADS v2017 Treatment Response Algorithm for Treated HCC

Monday, Nov. 26 11:30AM - 11:40AM Room: N228

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the accuracy of the LI-RADS v2017 Treatment Response algorithm for assessing viability of potential hepatocellular carcinomas that have been treated with transarterial embolization.

METHOD AND MATERIALS

This retrospective study was approved by the Institutional Review Board and was HIPAA compliant. The requirement for informed consent was waived. Histopathology reports and imaging studies of patients who had undergone transarterial tumor embolization and subsequent liver transplantation between 2006 and 2016 were reviewed. Three radiologists independently evaluated each patient's pre- and post-embolization imaging and assessed all lesions using the LI-RADS v2017 CT/MRI (pre-embolization) and Treatment Response (LR-TR, post-embolization) algorithms, and inter-reader agreement was calculated using Fleiss' Kappa. Radiology and histopathology reports were then correlated. Lesions were categorized based on histopathologic necrosis as either completely (100%) or incompletely (<=99%) necrotic, and performance characteristics for the LR-TR viable and nonviable categories were calculated for each reader.

RESULTS

45 patients with 64 histopathologically proven lesions were reviewed. Interreader agreement for pre-embolization category was moderate (k=0.57, 95% CI=0.45-0.71) and similar to agreement for LR-TR category (k=0.56, 95% CI=0.42-0.66). For predicting complete tumor necrosis, accuracy was moderate (0.66-0.70) and negative predictive value was very good (0.81-0.87). For predicting incomplete tumor necrosis, accuracy was moderate (0.59-0.64), and positive predictive value was very good (0.86-0.96). By consensus, 27% (17/64) of lesions were rated as LR-TR equivocal; 12 of these were incompletely necrotic.

CLINICAL RELEVANCE/APPLICATION

There are currently no published data that evaluate the performance of the LI-RADS Treatment Response Algorithm for predicting degree of locoregional therapy induced necrosis in individual lesions.

SSC05-08 Distinguishing Intrahepatic Cholangiocarcinoma from Hepatocelluar Carcinoma in Patients with and without Risks: The Evaluation of the LR-M Criteria of Contrast-Enhanced Ultrasound Liver Imaging Reporting and Data System Version 2017

Monday, Nov. 26 11:40AM - 11:50AM Room: N228

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PURPOSE

To assess the diagnostic performance of the LR-M criteria of Contrast-Enhanced Ultrasound Liver Imaging Reporting and Data System version 2017 (CEUS-LIRADS v2017) for differentiating intrahepatic cholangiocarcinoma (ICC) from hepatocellular carcinoma (HCC) in patients with and without risks (i.e. cirrhosis or chronic hepatitis).

METHOD AND MATERIALS

54 ICC in patients with risks and 55 ICC in patients without risks, and matched control cases of HCC with and without risks (n=59 and n=55, respectively) were enrolled. The wash-in-washout patterns of ICC and HCC lesions on CEUS were retrospectively analyzed according to the LR-M criteria of CEUS-LIRADS v2017. The diagnostic performances were assessed by receiver operating characteristic (ROC) curve analysis.

RESULTS

Peripheral rim-like hyper-enhancement, early washout (<= 30 or 60seconds), marked washout did not differ between ICCs with and without risks, while all of these features were more common in ICCs than in HCCs (P < 0.05) no matter the risk factors. Using the LR-M criteria of CEUS-LIRADS v2017 to differentiate ICC from HCC, the area under the ROC curve (AUC), sensitivity, specificity and accuracy were 0.92, 97.25%, 87.72% and 92.38%, respectively. If onset of early washout were adjusted to <= 30 seconds and onset of marked washout were adjusted to <= 4 minutes, the specificity was significantly increased to 95.61% (P = 0.021), while the AUC, sensitivity and accuracy didn't significantly change (P > 0.05). The rate of HCCs misdiagnosed as ICCs would decrease from 12.3% to 5.3%.

CONCLUSION

The LR-M criteria of CEUS-LIRADS v2017 showed feasibility in distinguishing ICCs from HCCs in patients with and without risks. After adjustment, specificity was significantly increased.

CLINICAL RELEVANCE/APPLICATION

The LR-M criteria of CEUS-LIRADS v2017 could not only be used for distinguishing ICCs from HCC in patients with risk but also without risks. Adjustment of current criteria could reduce the rate of HCC being misdiagnosed as ICC.

SSC05-09 ACR Ultrasound LI-RADS: Clinical Predictors of Diagnostic Adequacy for HCC Screening

Monday, Nov. 26 11:50AM - 12:00PM Room: N228

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PURPOSE

Sonographic screening for hepatocellular carcinoma (HCC) may be limited by parenchymal heterogeneity and other factors. ACR Ultrasound Liver Reporting and Data System (US LI-RADS) Version 2017 uses visualization scores to reflect these limitations. The purpose of this study is to evaluate distribution and predictors of visualization scores.

METHOD AND MATERIALS

In this retrospective, multicenter, HIPAA-compliant, IRB-approved study, patients at 5 sites had undergone screening US from Jan-Sep 2017 and US LI-RADS visualization scores were assigned on a clinical basis. Ultrasound reports and patient records were retrospectively reviewed.

RESULTS

2050 patients at risk for HCC (1078 men and 972 women; mean age 57.7) were included. Most common indications were cirrhosis (n=1054; 51.3%), non-cirrhotic HBV (n=555; 27.1%), and non-cirrhotic HCV (n=234; 11.4%). Most common etiologies of cirrhosis were HCV (n=396; 19.4%), alcohol (n=194; 9.5%), and HBV (n=187; 9.2%). 10.3% (n=212) patients had ascites. US LI-RADS scores had been assigned by 69 different readers. 42.7% of studies were read by women and 57.3% by men, with mean 19.3 years of experience and 40.3% of clinical time on US. Visualization scores were: A (No or minimal limitations) in 76.8% (n=1575); B (Moderate limitations) in 18.9% (n=388); and C (Severe limitations) in 4.2% (n=87). Reader experience (p=.37) and clinical time on US (p=.76) were not associated with impaired visualization scores in univariate analysis. In multivariate logistic regression analysis, the clinical diagnosis of cirrhosis (OR 3.6), NASH as etiology of cirrhosis (OR 2.0), ascites (OR 1.4), and male radiologist gender (OR 1.5) were associated with moderate or severe limitations.

CONCLUSION

US LI-RADS visualization scores in over 2000 patients demonstrated <5% of exams were severely limited and <20% were moderately limited. Clinical diagnosis of cirrhosis and NASH as etiology of cirrhosis were the strongest independent predictors of moderate to severe limitations in visualization in multivariate analysis.

CLINICAL RELEVANCE/APPLICATION

Although most US screening exams for HCC are diagnostically adequate, clinical diagnosis of cirrhosis and NASH as etiology of cirrhosis are associated with limited visualization.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Katherine E. Maturen, MD - 2014 Honored Educator

SSC06

Gastrointestinal (Liver Diffuse Disease, Fibrosis)

Monday, Nov. 26 10:30AM - 12:00PM Room: N229

CT GI MR US BQ

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

SSC06-01 Comparison of 2D-Shear Wave Elastography (SWE), Magnetic Resonance Elastography (MRE), and Transient Elastography (TE) for the Diagnosis of Fibrosis in Non-Alcoholic Fatty Liver Disease (NAFLD)

Monday, Nov. 26 10:30AM - 10:40AM Room: N229

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PURPOSE

To compare the accuracy of 2D-SWE, MRE and TE for the diagnosis of fibrosis in patients with biopsy-proven NAFLD.

METHOD AND MATERIALS

In this IRB-approved study, 62 adult subjects (36F; 26M; age, 50±13 years; BMI, 35±7 Kg/m2) with biopsy-proven NAFLD were prospectively recruited. The distribution of fibrosis was as follow: F0=1; F1=17; F2=20; F3=15; F4=9. Subjects underwent a 2D-SWE which uses the comb-push technique (GE LOGIQ E9, GE Healthcare), MRE (2D-GRE; GE Healthcare) and TE (Fibroscan, Echosens) within one year of the biopsy. Area under the receiver operator curve (AUROC) and 95% confidence interval (CI) for the corresponding liver stiffness measurements (LSM, expressed in kPa) were calculated using as outcome significant (F>1) and advanced (F>2) fibrosis. Pairwise comparisons of AUROCs were conducted using the DeLong test. Statistical significance was set at $p<.05$.

RESULTS

Valid LSM were obtained in 57/62 subjects with 2D-SWE and in 59/62 subjects with TE. MRE was completed in 59/62 cases. Valid LSM measurements for all three techniques were available in 54/62 subjects. The AUROCs (95% CI) of 2D-SWE, MRE and TE were .796 (.673-.918), .847 (.744-.950), .766 (.638-.893) for significant fibrosis respectively and .890 (.803-.976), .950 (.887-1.00), .861 (.769-.953) for advanced fibrosis respectively. Pairwise comparisons revealed no statistically significant difference for significant (2D-SWE vs. MRE, p=.43; 2D-SWE vs. TE, p=.31; MRE vs. TE, p=.05) and advanced fibrosis (2D-SWE vs. MRE, p=.34; 2D-SWE vs. TE, p=.29; MRE vs. TE, p=.05).

CONCLUSION

2D-SWE, MRE and TE showed high accuracy for the diagnosis of advanced fibrosis in NAFLD with no significant difference at pairwise comparison.

CLINICAL RELEVANCE/APPLICATION

2D-SWE and TE are valid alternative to MRE for the diagnosis of advanced fibrosis in patients with NAFLD.

SSC06-02 Diagnostic Performance of Tomoelastography by Multifrequency Magnetic Resonance Elastography for Staging Hepatic Fibrosis

Monday, Nov. 26 10:40AM - 10:50AM Room: N229

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the diagnostic accuracy and cut-off values of full field-of-view tomoelastography stiffness maps of the liver in patients with hepatic fibrosis. We investigated novel multifrequency magnetic resonance elastography (mMRE) with piezoelectric driver and tomoelastography processing pipeline.

METHOD AND MATERIALS

In this prospective monocentre study, a total of 43 patients and 16 healthy volunteers underwent mMRE on a 1.5-Tesla MRI scanner (Magnetom Aera, Siemens Healthineers, Erlangen, Germany) using a piezoelectric driver and fast single-shot 3D wave-field acquisition at drive frequencies of 35, 40, 45, 50, 55 and 60 Hz. Acquisition parameters for each frequency were as follows: 9 slices, 8 time steps, 3 components, 256 x 256 matrix, 3 × 3 × 5 mm resolution and 2 averages. For patients, liver biopsy or definite morphological signs of cirrhosis were used as reference standard. Patients showed a wide range of chronic liver diseases including chronic hepatitis B and C, primary sclerosing cholangitis, nonalcoholic steatohepatitis and autoimmune hepatitis. Optimal cut-off values using the Youden-Index, area under the receiver-operating-characteristic-curve (AUROC), sensitivity and specificity were calculated accounting for compound multifrequency maps as well as single frequencies.

RESULTS

Mean values of mMRE shear wave speed (± standard deviation) of the liver across the entire cohort for 35, 40, 45, 50, 55, 60 and 35-60 Hz were 1.60 ± 0.29, 1.69 ± 0.37, 1.78 ± 0.43, 1.85 ± 0.49, 1.88 ± 0.51, 1.92 ± 0.54 and 1.77 ± 0.43 m/s, respectively. Tomoelastography stiffness maps showed high spatial resolution and anatomical details. E.g., 60-Hz cut-off values, AUROC values, sensitivity and specificity were as follows: fibrosis stage F>=1, 1.62 m/s, 0.92, 0.88 and 0.94; F>=2, 1.78 m/s, 0.93, 0.75 and 1.00; F>=3, 1.82 m/s, 0.97, 0.85 and 0.97; F4, 1.85 m/s, 0.98, 1.00 and 0.88.

CONCLUSION

Tomoelastography cut-off values show an excellent diagnostic accuracy for staging hepatic fibrosis. High-resolution stiffness maps enable the display of shear wave speed-related anatomical details including multiple organs such as liver and spleen.

CLINICAL RELEVANCE/APPLICATION

mMRE-based tomoelastography might reduce the need for invasive liver biopsies and indicate the distribution of fibrosis within the entire liver.

SSC06-03 Preoperative Liver Function Reserve Assessment and Future Liver Remnant Function Prediction in HCC patients with Gd-EOB-DTPA enhanced MRI: One-Stop Process

Monday, Nov. 26 10:50AM - 11:00AM Room: N229

Participants
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PURPOSE

Our aim is to determine the feasibility of preoperative Gd-EOB-DTPA enhanced MRI in quantitative assessment of liver function reserve and prediction of post-hepatectomy liver function in HCC patients.

METHOD AND MATERIALS

This study enrolled 133 HCC patients who underwent Gd-EOB-DTPA enhanced MRI and indocyanine green (ICG) tests before surgery. The liver volume(LV) and mean liver T1 relaxation time before (T1pre) and after (T1pos) contrast was measure with T1pos and LV were measured in Hepatobiliary phase (HBP) scaned 20 minutes after injection. Virtual hepatectomy was processed in 3D images with resection plan defined by multi-disciplinary team discussion and adjusted by surgery record. Remnant T1pre, T1pos and LV were measured in virtual hepatectomy. The T1 reduction rate T1% [(T1pos- T1pre)/ T1pre], functional liver volume

(FV=LV*T1%), functional liver volume to weight ratio (FV/W) and T1 relaxation time to liver volume ratio (T1pos/LV) were calculated, the same as the remnant T1%, rFV, rFV/W, rT1pos/LV and rFV%. Correlations between functional parameters (T1pre, T1pos, T1%,FV, FV/W, T1pos/LV) and ICG reduction rate (ICG-R15), ALBI grade were investigated. Child-Pugh score was evaluated in postoperative day 5. The differences of remnant function reserve parameters between Child-Pugh A group and B&C group were analyzed. Multiple Logistic regression test was used to find the possible predictor for postoperative hepatic insufficient.

RESULTS

Those function liver volume parameters T1pos, T1%, FV, FV/W, T1pos/LV (mean value: 248.4msec, 64.12%, 786.38ml, 12.75ml/Kg, 0.21msec/ml) have shown statistical significantly correlation with ICG-R15 (rho=0.275, -0.290, -0.446, -0.398, 0.438; p<0.001). In predicting preoperative ICG-R15>14%, the cut-off value of FV, FV/W and T1pos/LV were 682.8ml, 10.80ml/kg, 0.236msec/ml, with sensitivity of 73.5%, 74.4%, 81.3%, specificity of 75.0%, 75.0%, 76.9%, respectively. Preoperative measured rFV% was the only positive factor in predicting post-hepatectomy Child-Pugh B&C hepatic insufficiency with cut-off value of 0.683, sensitivity of 71.43% and specificity of 58.67%.

CONCLUSION

Quantitative function liver volume in Gd-EOB-DTPA enhanced MRI can provide 'one-stop process' assessment of liver function reserve and prediction of post-hepatectomy liver insufficient.

CLINICAL RELEVANCE/APPLICATION

This research provide a 'one-stop process' assessment for HCC surgical plan

SSC06-04 Accuracy of Liver Surface Nodularity Score on CT for Staging HCV Hepatic Fibrosis: A Multi-Institutional Study

Monday, Nov. 26 11:00AM - 11:10AM Room: N229

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PURPOSE

To assess the accuracy of the Liver Surface Nodularity (LSN) score on CT and FIB4 score for staging hepatitis C virus (HCV) hepatic fibrosis.

METHOD AND MATERIALS

For this IRB-approved HIPAA-compliant retrospective multi-institutional observational study, adult patients with HCV chronic liver disease and a random liver biopsy obtained with 6 months of a liver CT were included. Participating institutions (N=5) each submitted de-identified data and liver CT images from 40 consecutive patients (N=200 total patients) centrally to a core lab. A REDCap web-based database was used to capture demographics, lab values, and the Scheuer stage of fibrosis (F0-F4) on biopsy specimens. Patients with insufficient information for Scheuer staging of fibrosis (N=3) and CT images that could not be processed (N=4) were excluded. The LSN score was measured using custom software in the final cohort (N=193), while blinded to clinical data. The patients age and serum labs (ALT, AST and platelets) were used to calculate the FIB4 score, a method for assessing liver fibrosis severity. The accuracy for differentiating the various stages of liver fibrosis using the LSN score, FIB4 score, and a combination were assessed with ROC analysis and AUC.

RESULTS

193 patients (69 females / 124 males; mean age 54 years) had Scheuer fibrosis stage: F0-F1 (N=36), F2 (N=41), F3 (N=47), and F4 (N=67). LSN scores increased with higher stages of liver fibrosis (mean: F0-F1=2.2±0.3, F2=2.4±0.4, F3=2.4±0.3, F4=3.2±0.9; p=0.001). For differentiating significant fibrosis (>=F2), advanced fibrosis (>=F3), and cirrhosis (>=F4), the AUCs for the LSN score were 0.88, 0.82, and 0.89, for the FIB4 score were 0.87, 0.87, and 0.91, and for both combined were 0.90, 0.87, and 0.93, respectively.

CONCLUSION

The combination of LSN score on CT and FIB4 score was highly accurate at staging HCV hepatic fibrosis in a multi-institutional study.

CLINICAL RELEVANCE/APPLICATION

The LSN score on CT and FIB4 score are easy to obtain and could be used to noninvasively and accurately stage hepatic fibrosis in patients with HCV chronic liver disease.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Perry J. Pickhardt, MD - 2014 Honored EducatorPerry J. Pickhardt, MD - 2018 Honored EducatorMeghan G. Lubner, MD - 2014 Honored EducatorMeghan G. Lubner, MD - 2015 Honored EducatorMeghan G. Lubner, MD - 2018 Honored Educator

SSC06-05 Quantitative Assessment of Equilibrium Contrast-Enhanced CT to Evaluate Functional Hepatic Reserve and Liver Fibrosis

Monday, Nov. 26 11:10AM - 11:20AM Room: N229

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PURPOSE

To evaluate hepatic extracellular volume fraction (fECV) measurement using equilibrium CT images compared with both functional hepatic reserve that is assessed with 99mTc-diethylenetriamine-pentaacetic acid-galactosyl human serum albumin (GSA) scintigraphy, and liver fibrosis that is assessed with histopathological findings.

METHOD AND MATERIALS

A total of 86 patients (M/F=63/23; mean age, 67±13 years) who underwent routine dynamic liver CT and GSA scintigraphy for the clinical workup of hepatocellular carcinoma (n=74) and liver metastasis (n=12) were retrospectively studied. Absolute enhancement (in Hounsfield units) of the liver parenchyma (Eliver) and portal vein (Eblood) 3 minutes after contrast agent administration was measured on precontrast and equilibrium phase images. The fECV was calculated as the following equation: fECV(%) = Eliver x (100 - hematocrit(%)) / Eblood. Functional hepatic reserve was assessed with hepatic uptake ratio (LHL15) on GSA scintigraphy. Correlation between fECV and LHL15 was analyzed by the Spearman correlation coefficient. In 52 patients who underwent hepatectomy following the CT and GSA scintigraphy examinations, the fECV measurements were compared with the histopathological results of liver fibrosis staging ([F0-F4]: F0, absent of fibrosis; F4, severe fibrosis).

RESULTS

The fECV measurements showed a significant correlation with LHL15 ($r=-0.58$, $p<0.0001$). With an fECV threshold of 30.0%, the sensitivity and specificity for detecting reduced functional hepatic reserve (LHL15 < 0.91) was 90.5% and 86.2%, respectively. The areas under the ROC curve (AUC) of fECV for differentiating between normal and altered LHL15 was 0.90. The fECV measurements in F4 liver (30.4±4.3%) were significantly higher than that in both F0-1 (25.6±2.7%, $p=0.0004$) and F2-3 (26.9±3.1%, $p=0.02$), while no significant difference in fECV between F0-1 vs. F2-3 ($p=0.45$) was observed. With an fECV threshold of 28.8%, the sensitivity and specificity for differentiating between F0-3 and F4 was 75.0% and 77.5%, respectively. The AUC of fECV for F0-3 vs. F4 was 0.80.

CONCLUSION

Hepatic fECV measured with equilibrium CT imaging is associated with functional hepatic reserve and severity of liver fibrosis.

CLINICAL RELEVANCE/APPLICATION

Routine contrast-enhanced CT including equilibrium phase image may provide a means of assessing functional hepatic reserve and liver fibrosis.

SSC06-06 Comparative Diagnostic Accuracy of Ultrasound Shear-Wave Elastography and Magnetic Resonance Elastography for Classifying Fibrosis Stage in Adults with Biopsy-Proven Nonalcoholic Fatty Liver Disease

Monday, Nov. 26 11:20AM - 11:30AM Room: N229

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PURPOSE

There is limited data on the comparative accuracy of ultrasound (US) shear-wave elastography (SWE) and magnetic resonance elastography (MRE) for classifying fibrosis stage in nonalcoholic fatty liver disease (NAFLD). This study compares the diagnostic accuracy of SWE and MRE for classifying fibrosis stage in adults with NAFLD.

METHOD AND MATERIALS

This was an IRB-approved, HIPAA-compliant, prospective study of 46 adults (mean age 52 years; 25 women; mean body mass index [BMI] 32 kg/m2) with suspected NAFLD who from May 2016 to February 2018 underwent clinical liver biopsy followed by contemporaneous MRE and SWE for research. Fibrosis stage was scored (Nonalcoholic Steatohepatitis Clinical Research Network system). Receiver operating characteristics (ROCs) were assessed for SWE and MRE classification of dichotomized fibrosis stages (fibrosis stages >=1, >=2, >=3, and = 4) and the Youden index was used to select the corresponding thresholds. DeLong test was performed to compare the areas under the ROC curves (AUCs) of MRE and SWE pairwise.

RESULTS

Patients had the following fibrosis stages on histology: 0: 17; 1: 18; 2: 6; 3: 2; 4: 3. AUCs for SWE and MRE were 0.70 (95% confidence interval [CI], 0.55-0.85) and 0.83 (95% CI, 0.72-0.95), 0.77 (95% CI, 0.60-0.93) and 0.97 (95% CI, 0.92-1.00), 0.92 (95% CI, 0.82-1.00) and 0.93 (95% CI, 0.78-1.00), and 0.93 (95% CI, 0.84-1.00) and 1.00, for detecting fibrosis stage >=1, >=2, >=3, and =4, respectively. The differences were significant (p=0.02) for detecting fibrosis stage >=2 but not otherwise (p>=0.11). Youden-based SWE- and MRE-cutoffs for classifying stages >=1, >=2, >=3, and =4 with sensitivities/specificities were 8.67 kPa (45%/88%) and 2.29 kPa (69%/88%), 9.19 kPa (55%/89%) and 2.75 kPa (91%/97%), 8.67 kPa (100%/76%) and 4.19 kPa (80%/100%), and 9.40 kPa (100%/88%) and 5.04 kPa (100%/100%).

CONCLUSION

In adults with suspected NAFLD, clinically indicated biopsy, and low a priori probability of advanced fibrosis, SWE showed modest accuracy for detecting stage >= 1 or >= 2 fibrosis and high accuracy for detecting advanced (stage >=3) fibrosis. MRE may be more accurate than SWE at classifying fibrosis but greater power is needed to achieve significance.

CLINICAL RELEVANCE/APPLICATION

In adults with suspected NAFLD, SWE may have utility as an initial screen for advanced fibrosis. MRE may be required to reliably detect earlier stages of fibrosis.

SSC06-07 The Optimal Measurement Number of Shear Wave Elastography (SWE) for >=F2 Liver Fibrosis Diagnosis: Percentage of Color Filling Index (PCFI) Stratification Analysis using Automated Image Quality Analysis

Monday, Nov. 26 11:30AM - 11:40AM Room: N229

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PURPOSE

To explore the optimal and minimum number of SWE measurements for >=F2 fibrosis considering measurement variability and diagnostic accuracy.

METHOD AND MATERIALS

Prospectively collected adult patients who underwent SWE before non-focal liver biopsy in three years. 10 SWE measurements

were performed for each patient at the identical biopsy locations (Segment 8) by one experienced sonographer before the biopsy. Fibrosis stages were evaluate using METAVIR criteria (F0-F4). The optimal and minimum measurement number for >=F2 were analyzed: (1) for each measurement number (1-9), correlated median SWE estimates were obtained using a nested bootstrap simulation; (2) ROC curves, and the associated AUROC values, were estimated using each set of SWE measurements (e.g., 2-10 measurements); (3) steps (1) and (2) were repeated 1000 times to obtain empirical distributions of median SWE estimates, and AUC estimates. Two variation parameters were evaluated, including (1) intra-subject SWE variation (m/s): the absolute median difference between individual SWEs and median SWE, and (2) interval width difference (IWD): the width differences of AUC 95%CI between a measurement number (1-9) and 10. A subgroup of patients with >=50% PCFI images (percentage of valid SWE pixels over the entire SWE image box, a metric for SWE image quality assessment) were also selected.

RESULTS

245 cases were enrolled (mean 48.5±13.2 yr; men 109, women 136), with the fibrosis stages F0=93, F1=92, F2=27, F3=23, F4=10. The intra-subject variation of the median SWE estimate decreased from 3.12 to 0.46m/s in 1-10 measurements in overall patients (n=245), and decreased from 3.74 to 0.37 in images with >=50% PCFI (n=106). we didn't detect AUC differences between measurement numbers 1-9 and 10, but IWD, which represents the variation of diagnostic accuracy, dramatically increased when measurements number =50% group, depending on the clinicians desired precision of IWD (within 0.040 units).

CONCLUSION

Current results demonstrated that, for >=F2 fibrosis diagnosis, the minimum SWE numbers may be reduced to 7 in overall images, and 6 when >=50% PCFI was applied for image quality control.

CLINICAL RELEVANCE/APPLICATION

Automated image quality analysis may have the potential to reduce the SWE measurements number for liver fibrosis diagnosis, thus improving the scanning process and diagnostic performance of SWE.

SSC06-08 Hepatic Shear Wave Elastography: Correlation Between Liver Stiffness and Esophagogastric Varices

Monday, Nov. 26 11:40AM - 11:50AM Room: N229

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PURPOSE

To evaluate the role of liver stiffness measurement (LSM) measured by shear wave elastography (SWE) in predicting the presence of esophagogastric varices (EGV) in patients with portal hypertension and to determine the correlation between the LSM and endoscopic grade of EGV.

METHOD AND MATERIALS

This study included 331 patients with chronic liver disease being evaluated for portal hypertension and planned for esophagogastroduodenoscopy. SWE was performed in the right lobe of the liver by using a convex broadband probe on GE LOGIQ E9 ultrasound machine. The shear wave liver stiffness (in kPa) was recorded at ten locations and the median values calculated. Endoscopic findings were interpreted with reference to the presence of varices and grade of the varices. Correlation between LSM and grade of varices was analyzed with the Pearson correlation coefficient. Multiclass Receiver operating characteristic (ROC) curves were constructed, and the area under the ROC curves (AUC) was calculated to determine the discriminating power between the grades of the varices.

RESULTS

LSM and variceal grade showed no significant correlation (R = 0.351286, P <0001). The AUC for detection of the presence of varices was 0.7259. The AUC for differentiating between various grades of the varices was 0.6470, 0.5802, 0.6259 and 0.7692. Box plot of the LSM and grade of varices revealed no discrimination power. Hepatic shear wave stiffness was marginally useful in predicting the presence of varices. But the discriminating power of LSM among the grades of varices was poor.

CONCLUSION

We found marginal utility of LSM in predicting the presence of EGV. However, contrary to the existing knowledge, in our study, we found no correlation between liver stiffness measurement and grade of EGV. The liver stiffness measurement is not a reliable predictor of portal hypertension.

CLINICAL RELEVANCE/APPLICATION

In advanced fibrosis, liver stiffness measurements in isolation does not seem to predict the clinical severity of portal hypertension. The additional assessment of splenic stiffness should be considered.

SSC06-09 Diagnostic Accuracy of Combination of Quantitative Point Shear Wave Elastography (pSWE) and Serum Markers for the Assessment of Fibrosis in Patients with Chronic Liver Disease Using Liver Biopsy as the Reference Standard

Monday, Nov. 26 11:50AM - 12:00PM Room: N229

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PURPOSE

To evaluate individual and combined diagnostic performance of quantitative point shear wave elastography (pSWE) and serum markers for the assessment of liver fibrosis in patients with chronic liver disease.

METHOD AND MATERIALS

This prospective study received ethics approval, and all participants provided written informed consent. Shear wave speed (SWS) using pSWE (VTQ) and serum fibrosis markers (aspartate aminotransferase-to-platelet ratio index [APRI], King's score) were measured in 169 consecutive patients with chronic liver disease (mixed aetiology). Receiver-operating characteristic (ROC) analysis were performed to evaluate the diagnostic accuracy of their individual and combined performance in predicting significant (F>=3) and severe/cirrhosis (F>=5) liver fibrosis using ISHAK histologic fibrosis stages (F0-6) as reference. Cut-off values were determined using Youden Index. Spearman's correlation coefficient between the SWS, fibrosis marker and fibrosis stage were calculated.

RESULTS

Ishak histology stages were 0-2 (n=90, 53%), 3-4 (n=50, 30%), 5-6 (n=29, 17%). There was a good correlation between SWS, King's score, APRI and the Ishak stage (ρ=0.682, ρ=0.632 and ρ=0.584, respectively, P <= .001). The areas under the ROC curves (AUROC) for SWS, King's score, and APRI, were 0.86, 0.87, and 0.89 for the diagnosis of significant fibrosis (F>=3) and 0.98, 0.79, and 0.85 for the diagnosis of severe fibrosis/cirrhosis (F>=5), respectively. pSWE is superior than APRI (P=0.0005) and King's score (P=0.002) in predicting severe fibrosis/cirrhosis (F>=5), The optimum pSWE cut-off values for significant and severe fibrosis/cirrhosis were 1.22 and 1.86 m/s, respectively. The AUROC for combining the serum fibrosis marker and pSWE in diagnosing significant fibrosis were 0.93, outperforming using pSWE alone (P=0.0048).

CONCLUSION

pSWE is superior than serum markers in predicting severe fibrosis/cirrhosis is and comparable to serum markers for significant fibrosis. Combining pSWE and serum markers improves the diagnostic accuracy in predicting significant fibrosis.

CLINICAL RELEVANCE/APPLICATION

pSWE has excellent diagnostic accuracy for predicting cirrhosis. In addition, combining pSWE and serum markers significantly improve the diagnostic performance of significant fibrosis.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSC07

Science Session with Keynote: Genitourinary (New Techniques for Renal Imaging)

Monday, Nov. 26 10:30AM - 12:00PM Room: S503AB

AI CT GU OI

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

Participants
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Sub-Events

SSC07-01 Genitourinary Keynote Speaker: Renal Mass Characterization: Quantitation, Radiomics, and Machine Learning

Monday, Nov. 26 10:30AM - 10:40AM Room: S503AB

Participants
Ivan Pedrosa, MD, Dallas, TX (*Presenter*) Nothing to Disclose

SSC07-02 Utility of Google TensorFlow™ Inception Machine Learning to Discriminate Clear Cell Renal Cell Carcinoma from Oncocytoma on Multiphasic CT

Monday, Nov. 26 10:40AM - 10:50AM Room: S503AB

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PURPOSE

Although a renal mass can have imaging features of a typical clear cell renal cell carcinoma (ccRCC) on CT, up to 30% of these are found to be benign after surgery, most commonly oncocytoma (ONC). The purpose of our study was to develop a machine learning-based renal lesion classifier using open source Google TensorFlow™ Inception (TCI) Machine Learning to discriminate ccRCC from ONC on four-phase CT.

METHOD AND MATERIALS

With IRB approval and HIPAA compliance, we derived a cohort of 176 patients with 195 lesions (131 patients with 125 ccRCCs; 61 patients with 49 ONC) with preoperative four phase (unenhanced (UN), corticomedullary (CM), nephrographic (NP), excretory (EX)) CT imaging. Regions of interest were drawn around the tumor on every slice in each phase to create a 3D tumor volume. To preprocess the DICOM data into a format currently supported by TCI, 3D tumor data was extracted in the x, y and z plane and converted into a red, green and blue (RGB) jpeg image using the three color channels to encode each slice. 70% of the data was used in the training set and 30% in the testing set. We investigated several approaches to convert the data into a set of 2D JPEG images that adequately represented each tumor and were used to train the final layer of the neural network model.

RESULTS

When we analyzed 3 mid-slices of the tumor in the x, y and z plane in each post contrast phase, the EX phase had the highest accuracy in classifying both ccRCC (79.6%) and Onc (59.5%) compared to the accuracy in the CM (ccRCC=78.3%, Onc=46%) and NP (ccRCC=77.2%, Onc=46.5%) phases. The highest accuracy in classifying ccRCC was obtained by submitted all x,y and z planes in all phases as one image to TCI with an accuracy of 82.5%, however this lowered the correct classification of Onc to 52.2%.

CONCLUSION

In this pilot study, TCI enabled independent classification of clear cell RCC from oncocytoma on a four phase MDCT with an accuracy of 82.5%.

CLINICAL RELEVANCE/APPLICATION

A TCI based method if developed and validated prospectively may be an adjunct to radiologists for discrimination between clear cell RCC and Oncocytoma on multiphasic CT minimizing diagnostic uncertainty and enabling more accurate patient triage.

SSC07-03 Differentiation of Renal Cell Carcinoma and Oncocytoma Using Machine Learning-Based MR Radiomics

Monday, Nov. 26 10:50AM - 11:00AM Room: S503AB

Participants
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PURPOSE

To build a random forest predictive model for distinguishing between renal cell carcinoma (RCC) and oncocytoma that integrates clinical, preoperative, and multimodal automated features.

METHOD AND MATERIALS

Forty-one patients with histologically confirmed renal tumors (23 RCCs; 18 oncocytomas) were identified from a single institution. Two experts (HL and DP), with 23 and 10 years of experience of reading body MR respectively, blinded to the histologic diagnoses, made image diagnosis based on the preoperative MR images (T2-weighted and T1-contrast enhanced sequences). Histogram, geometric and texture features were extracted from preoperative MR images. Using a random forest algorithm, automated features were integrated with clinical data to generate a multivariate predictive model. Receiving operating characteristic curves (ROCs) and areas under the curve (AUCs) were used to assess model performance by using the Delong method for statistical comparison of ROCs.

RESULTS

Patients with oncocytoma had higher mean age than patients with RCC (65.8± 7.7 vs. 58.7 ± 11.4 years, p=0.022). Tumor size did not differ significantly between RCC and oncocytoma (average of 2.3 ± 0.9 vs. 2.5±1.0cm; p = 0.620). For each patient, 5 clinical features and 10566 automated features were included in the model. After feature reduction, 32 features remained. This included 30 T1-contrast enhanced features and 2 T2-weighted features. The tested model achieved accuracy of 80.5% (AUC = 0.80) with sensitivity of 82.6% and specificity of 77.8%. Shape Volume-Compactness (T1C), NGTDM-Busyness (T1C), GLSZM-ZSV (T1C), and Shape Volume-Volume (T2WI) were the features contributing most to the model. Compared to our model, expert 1 achieved accuracy of 63.4% (AUC = 0.59; p = 0.019) with 95.7% sensitivity and 22.2% specificity, and expert 2 achieved accuracy of 57.5% (AUC = 0.55; p = 0.005) with 65.2% sensitivity and 44.4% specificity.

CONCLUSION

Preliminary results using machine learning algorithms demonstrated improved accuracy in differentiation of RCC and oncocytoma when compared with expert interpretation. Further validation is needed in a larger cohort.

CLINICAL RELEVANCE/APPLICATION

Oncocytoma, a benign tumor, that cannot typically be distinguished from RCC based on routine clinical imaging. A machine learning based approach with high accuracy would potentially spare patients unnecessary surgery, ablation, and biopsy.

SSC07-04 The Utility of Radiomic Features in Differentiation of Clear Cell Renal Cell Carcinoma from Non-Clear Cell Renal Cell Carcinoma: A Preliminary Study

Monday, Nov. 26 11:00AM - 11:10AM Room: S503AB

Participants
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PURPOSE

To investigate the ability of radiomic features derived from the corticomedullary phase images to differentiate clear cell renal cell carcinoma (RCC) from non-clear cell RCC.

METHOD AND MATERIALS

This study involved 450 patients with 463 tumors histopathologically diagnosed as clear cell RCC (n=362), papillary RCC (n=54) or

chromophobe RCC (n=47), whose corticomedullary phase images were available. To conduct the study, 80% (n=371) and 20% (n=92) tumors were randomly selected as development and validation cohorts keeping the ratio of clear cell RCC to non-clear cell RCC consistent. Using the development cohort, a discriminative subset from 1023 radiomic features was selected by SVM with LASSO regularization. Receiver operating characteristic analysis was conducted to assess the predictive ability of the selected CT radiomic features in differentiation of clear cell RCC from non-clear cell RCC in the validation cohort. For contrast, a radiologist, with 6 years of experience in genitourinary imaging, was instructed to predict the subtypes (clear cell or non-clear cell RCC) of the validation cohort. The chi-square test was conducted to compare the accuracies between the SVM model and the radiologist.

RESULTS

Our research demonstrated that the SVM model combining 15 features was strongly discriminative in differentiation of clear cell RCC from non-clear cell RCC in the validation cohort. The sensitivity, specificity, overall accuracy, and area under the curves for the SVM model in the validation cohort were 84.7% (61/72), 85% (17/20), 84.8% (78/92), and 0.905, while the sensitivity, specificity, and overall accuracy for the radiologist were 94.4% (68/72), 60% (12/20), and 86.9% (80/92). According to the chi-square test, there was no statistically significant difference between the accuracies of the SVM model and the radiologist (p=0.672).

CONCLUSION

This study demonstrated that CT radiomic features derived from the corticomedullary phase images can aid in the differentiation of renal cell carcinoma subtypes, which is comparable to experienced radiologists.

CLINICAL RELEVANCE/APPLICATION

The effective SVM model combining 15 radiomic features could help the clinical management of patients with renal cell carcinoma, especially patients with non-clear cell renal cell carcinoma.

SSC07-05 Differentiation of Renal Lipid-Poor Angiomyolipoma from Renal Cell Carcinoma by Machine Learning Based on Whole-Tumor Texture Features of Three-Phase CT Images

Monday, Nov. 26 11:10AM - 11:20AM Room: S503AB

Participants
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PURPOSE

To determine the diagnostic performance of machine learning in the differentiation of lipid-poor angiomyolipoma (lp-AML) from renal cell carcinoma (RCC) based on whole-tumor quantitative texture features of three-phase CT images.

METHOD AND MATERIALS

A total of 40 patients with 41 pathologically proven lp-AML and 95 patients with 97 pathologically proven RCCs were included by this retrospective study. All patients underwent three-phase CT study which consisted of precontrast phase (PCP), corticomedullary phase (CMP) and nephrographic phase (NP). Texture features were extracted from whole-tumor images at three-phase, single PCP, CMP and NP, respectively. Then support vector machine with recursive feature elimination method based on five-fold cross-validation (SVM-RFECV) were utilized to establish the discriminative classifiers. The performance of classifiers based on three-phase, single PCP, CMP and NP were determined and compared with each other. The performance of machine learning classifier in the differentiation of lp-AML from RCC was compared with morphological interpretation by radiologists using Receiver operating character (ROC) analysis.

RESULTS

43, 34, 24, 20 features subset were extracted as candidate features in three-phase, PCP, CMP and NP by Boruta package for python respectively. Among of these, 13, 24, 9 12 optimal feature subset further screened by SVM-RFECV entered to establish machine learning classifier in the differentiation of lp-AML and RCC. The classifier base on three-phase whole tumor images achieved the best performance in discriminating lp-AML from RCC, with the highest accuracy, area under curve (AUC), sensitivity, and specificity of 92.78%, 0.96, 92.78% and 92.78%, respectively. The performance of morphological interpretation by radiologist was inferior to machine learning classifier in differentiating lp-AML and RCC, with lower accuracy, AUC, sensitivity and specificity of 69.57%, 0.66, 36.59% and 89.69%.

CONCLUSION

Machine learning classifier based on whole-tumor texture features from three-phase images could reach more accurate discrimination between lp-AML and RCC than conventional morphological interpretation.

CLINICAL RELEVANCE/APPLICATION

Machine learning classifier is more powerful than morphological interpretation by radiologists and is recommended as part of a MR study prior to renal tumor removal.

SSC07-06 Is Dual-Energy CT (DECT) Of Renal Masses Ready For Prime Time? Diagnostic Accuracy of Conventional Attenuation Change and Iodine Concentration Thresholds at Rapid-kVp-Switch DECT for Detection of Enhancement in Renal Masses

Monday, Nov. 26 11:20AM - 11:30AM Room: S503AB

Awards
Student Travel Stipend Award

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PURPOSE

Iodine concentration (i[]), measured on DECT, is an alternative to attenuation difference (ΔHU) for diagnosis of enhancement in renal masses. Reported i[] thresholds vary and may be too high to detect enhancement in hypoenhancing papillary renal cell carcinoma (pRCC). This study re-evaluates rapid-kVp-switch DECT i[] thresholds for diagnosis of enhancement in SRMs.

METHOD AND MATERIALS

With IRB approval, we evaluated 34 renal masses (including 9 pRCC) diagnosed histologically and 30 benign cysts with renal mass protocol rapid-kVp-switch DECT between 2015-2017. A blinded Radiologist measured i[] (mg/mL) and ΔHU. Enhancement was defined as: 1) i[]>2 mg/mL (Marin et al., Kaza et al.) 2) i[]>1.6 mg/mL (Zarzour et al.) and 3) ΔHU>20 HU. Diagnostic accuracy was tabulated and compared by ROC analysis.

RESULTS

There were no differences in age, gender or size of lesions between groups (p>0.05). Using i[]>2.0 mg/mL achieved sensitivity/specificity/Area under ROC curve (AUC) of 73.3%/100%/0.87. 23.5% (8/34) pRCCs were misclassified as non-enhancing with i[] ranging from 0.7-1.6 mg/mL. Using i[]>1.2 mg/mL, sensitivity/specificity/AUC of 86.7%/100%/0.93 was achieved. 11.8% (4/34) pRCCs were misclassified as non-enhancing with i[] range from 0.7-0.9 mg/mL. Using ΔHU>20 HU achieved sensitivity/specificity/AUC of 93.3%/94.1%/0.94. 5.9% (2/34) pRCCs were misclassified as non-enhancing and 6.7% (2/30) cysts were misdiagnosed as enhancing due to pseudoenhancement. There was no difference in AUC comparing the three methods for detecting enhancement (p>0.05), with higher false negatives encountered with i[] and false positives encounterd with ΔHU.

CONCLUSION

Published iodine concentration thresholds for enhancement in renal masses measured at DECT result in substantial false negative results among hypoenhancing papillary RCC, with the 1.2 mg/mL threshold outperforming 2.0 mg/mL. ΔHU is more sensitive for detection of enhancement compared to iodine concentration but with higher false positive results due to pseudoenhancement.

CLINICAL RELEVANCE/APPLICATION

ΔHU remains a robust method to diagnose enhancement in renal masses and is more sensitive for detection of low level enhancement in papillary tumors compared to published iodine concentration values; however, DECT remains valuable for diagnosis of pseudoenhancement.

SSC07-07 The Reality of Dual-Energy CT Iodine Quantification in High-Attenuating Renal Lesion: A Comparison to Standard Hounsfield Units Attenuation

Monday, Nov. 26 11:30AM - 11:40AM Room: S503AB

Participants
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PURPOSE

To determine if dual-energy CT (DECT) derived iodine quantification allows accurate characterization of indeterminate high-attenuating renal lesions, and to identify technique- and patient-related variables that may influence lesion characterization.

METHOD AND MATERIALS

220 patients with 265 high-attenuating renal lesions (mean attenuation 54 33HU; 83 malignant lesions) were included in this retrospective IRB-approved, HIPAA-compliant study. Each patient underwent a single-energy unenhanced CT followed by nephrographic phase DECT using four different state-of-the-art DECT platforms (two rapid-kV-switching DECT [rsDECT] systems and two dual-source DECT systems [dsDECT]). Quantitative iodine concentration values and conventional enhancement (ΔHU) were calculated for each lesion. Receiver operating characteristics area under the curve (AUC) for renal lesion characterization were determined. To calculate diagnostic accuracy, surgical resection with histological workup, biopsy, and imaging follow-up for >24 months were used to determine the final category. Receiver operation characteristics, with dedicated area under the curves (AUC) were calculated to differentiate malignant from benign renal lesions. Nominal logistic regression analysis was performed to identify technique- and patient-related variables that may influence lesion characterization.

RESULTS

Diagnostic accuracy for lesion characterization was significantly higher using ΔHU (AUC: 0.93 with an optimal cut-off of 20HU), compared to iodine concentration values (AUC: 0.83; p<0.0001). Optimal iodine concentration thresholds were significantly different for the rsDECT system (2.0mg/ml with AUC of 0.84) compared to the dsDECT system (1.0mg/ml with an AUC of 0.87) (p<0.0001). Using the dedicated iodine thresholds resulted in 32 false positive findings and 20 false negative findings. Lesion location relative to the dual-energy field of view, patient size and DECT platform did not demonstrate any effect on lesion characterization.

CONCLUSION

Conventional measurements of enhancement yield statistically significant higher accuracy compared to iodine concentration measurements for the characterization of indeterminate high-attenuating renal lesions.

CLINICAL RELEVANCE/APPLICATION

Conventional measurements of enhancement is statistically significantly superior to iodine concentration measurements in the characterization of indeterminate high-attenuating renal lesions.

SSC07-08 Clinical Evaluation of Virtual Unenhanced Images from Second-Generation Dual-Energy CT Gemstone Spectral Imaging

Monday, Nov. 26 11:40AM - 11:50AM Room: S503AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To assess virtual unenhanced (VUE) images from a second-generation dual-energy CT gemstone spectral imaging (GSI) technology and to evaluate how measured attenuation compares to that from true unenhanced (TUE) images.

METHOD AND MATERIALS

Our single-center, retrospective study was IRB-approved and HIPAA-compliant. Fifty-seven subjects (32 men, 25 women; mean age, 65 years) underwent a contrast-enhanced CT of the abdomen on a second-generation dual-energy CT GSI technology with fast kV switching (80/140 kV) between September 2017 and March 2018 for hematuria work-up (n=42) and renal mass evaluation (n=15). TUE images were acquired in all cases in single-energy mode at 120 kV. TUE and VUE images were reconstructed at a slice thickness of 2.5 mm. Attenuation values of liver, pancreas, kidneys, adrenal glands, psoas muscle, subcutaneous fat, aorta, IVC, and main portal vein were measured on TUE and VUE images. In addition, attenuation values were obtained from 24 patients with renal mass (cystic, n=5; solid, n=19). Number of renal stones detected on TUE and VUE were also recorded. Data were analyzed using a Student paired t-test.

RESULTS

There was no significant difference in measured attenuation between TUE and VUE images throughout the abdomen (P>.05, for all comparisons). Mean attenuation values from solid and cystic renal lesions were not significantly different (TUE: 18.4 HU and 9.8 HU vs. VUE: 18.6 HU and 8 HU; P=.76 and P=.38, respectively). We observed a significant difference in number of detected renal stones between TUE (n= 21) and VUE (n= 12) images (P=.01).

CONCLUSION

VUE images obtained from contrast-enhanced data acquired on a second-generation dual-energy CT with GSI technology represent a good approximation of TUE images for noncontrast evaluation of abdominal organs and focal renal lesions. Nevertheless, our preliminary data indicate that a considerable number of small renal stones may not be detected.

CLINICAL RELEVANCE/APPLICATION

Prospective implementation of VUE images may render opportunities for decreased radiation exposure in multi-phase abdominal CT protocols for evaluation of genitourinary pathology.

SSC07-09 Clinical Decision Algorithm for the Evaluation of Renal Cystic Lesions Using Single-Phase Split-Filter Dual-Energy CT

Monday, Nov. 26 11:50AM - 12:00PM Room: S503AB

Participants
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PURPOSE

To evaluate the diagnostic performance of single source split-filter dual energy CT (tbDECT) to exclude enhancement in renal cystic lesions at venous phase abdominal CT.

METHOD AND MATERIALS

A total of n=230 simple or minimally complicated renal cysts were identified in n=51 consecutive patients who underwent both abdominal tbDECT and magnetic resonance (MR) examination; the latter was used as the 'gold standard' to classify the cysts as Bosniak I or Bosniak II. Material decomposition images were processed off of venous phase series and regions of interest (ROI) were placed within each cystic lesion, blindly to MR. For each ROI, four parameters were assessed simultaneously (Virtual Unenhanced attenuation values [HU], contrast enhancement attenuation values [HU], iodine density [mg/dl] and ROI size [cm2]) to test different approaches for lesion characterization. Renal cysts were considered as not enhancing if contrast enhancement (CM) <= 10 HU and iodine density (IOD) <= 0.5 mg/dl. The ROI was considered small if size <= 0.2 cm2.

RESULTS

Using MR n=207 Bosniak I and n=23 Bosniak II cysts were identified. At virtual unenhanced images, 48% of the cysts were not hypodense (> 10 HU). Both CM and IOD alone gave high percentages of pseudoenhancement (false positive 47% and 33% respectively). The combination of criteria (IOD first then CM) improved specificity to 79%. Exclusion of small ROIs reduced false positives to 3%. An algorithm for the exclusion of enhancement, combining all the criteria, was created.

CONCLUSION

The combined evaluation of multiple criteria provided by tbDECT correctly characterizes Bosniak I and II renal cysts as not enhancing, reduces false positive findings and potentially avoids unnecessary work-ups. We propose an algorithm that can be easily implemented in clinical practice.

CLINICAL RELEVANCE/APPLICATION

Excluding enhancement in renal cystic lesions with 97% of specificity, applying an easy to use algorithm on single-phase dual-energy images from single source, split-filter twin-beam dual-energy CT.

SSC08

Health Service, Policy and Research (Education Research)

Monday, Nov. 26 10:30AM - 12:00PM Room: S104A

ED HP LM PR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 0

Participants
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Marc H. Willis, MMM,DO, Houston, TX (*Moderator*) Investor, Resonea

Sub-Events

SSC08-01 An Analysis of Three Years of Continuing Medical Education Exercises in the Journal 'Radiology': We Aren't Following the Rules... Even Our Own

Monday, Nov. 26 10:30AM - 10:40AM Room: S104A

Participants
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PURPOSE

To analyze the multiple choice questions (MCQ) in three years of *Radiology* CME exercises with regard to: adherence to accepted MCQ question-writing tenets comportment with the journal's own 'CME Question Writing Guideline' for its authors.

METHOD AND MATERIALS

308 multiple choice questions in *Radiology* CME exercises from 2015 through 2017 comprised the test group. They were analyzed by the three authors for: adherence to standard, validated question-writing tenets, such as those promulgated by the American Board of Radiology compliance with the 'CME Question-Writing Guideline' provided by the journal to its authors Test items that violated the question-writing tenets/guidelines were designated as flawed.

RESULTS

Of the 308 questions, 174 (56%) contained from one to four item-writing flaws. The most frequent flaws were: an unfocused question stem a negative question stem heterogeneous answer options. The adherence to guidelines in the CME examinations varied widely, ranging from zero flawed items, to 10 of 10 flawed items. There was no pattern of improvement over the time frame of the study.

CONCLUSION

In our specialty's most prestigious journal, more than half of the self-assessment CME questions do not follow standard, validated question-writing tenets, and do not comport with the journal's own guidelines for its authors.

CLINICAL RELEVANCE/APPLICATION

Our results should prompt a relook at the process of *Radiology*'s self-assessment CME exam creation, and in particular opportunities for author training to bolster test validity.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ David J. DiSantis, MD - 2014 Honored Educator

SSC08-02 A Metrics-Based Model For Allocating Research Protected Time and Salary Awards Significantly Increase Publication Productivity in an Academic Radiology Department

Monday, Nov. 26 10:40AM - 10:50AM Room: S104A

Participants
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PURPOSE

To determine whether a quantitative model for evaluating research productivity and distributing research salary awards with protected time increased the publication productivity of an academic radiology department.

METHOD AND MATERIALS

A metrics based, research protected time (RPT) model awarding research salary awards with protected time was designed through a tripartite consensus process between the Departmental Academic Chair, Faculty Radiologists and Radiologist practice plan, first implemented in January 2010. A retrospective analysis was performed tabulating all unique PubMed indexed publications by Department Faculty members between January 1, 2003 and December 31, 2017 by calendar year. The annual publication productivity for the Department was compared between the non-RPT period (January 1, 2003 to December 31, 2009) and RPT-period (January 1, 2010 to December 31, 2017), in absolute numbers and also normalized to the radiologist FTE (full time equivalent) count. A sub-analysis of those faculty members who had both RPT and non-RPT status years during the period of evaluation was also performed comparing the productivity between the two statuses. Statistical analsyis employed paired t-test, with level of significance set at 0.05. The proportion of publications from those in the RPT program was calculated.

RESULTS

There was significantly greater annual departmental publication productivity in the RPT versus the non-RPT periods, in absolute numbers (75.1 vs 18.4, p=0.007) and also when normalized to FTE count (1.55 vs 0.50, p=0.004). Twenty-three faculty members were identified as having both RPT and non-RPT years during the period of evaluation. There was significantly higher mean annual publication productivity during their RPT versus their non-RPT years (5.1 vs 1.3, p=0.011). On average, 62% of annual unique publications were from faculty members with RPT, although the RPT faculty members comprised only 26% of the overall faculty membership.

CONCLUSION

The implementation of the RPT program with funded protected time led to a significant increase in departmental publication productivity. At the individual level, faculty members' productivity was significantly greater during the years in which they received RPT.

CLINICAL RELEVANCE/APPLICATION

Models of funded research time with quantitative measure of publication output should be considered in academic departments wishing to increased their publication productivity.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Frank J. Rybicki III, MD, PhD - 2016 Honored Educator

SSC08-03 Mentorship Matters: A Call for More Effective Mentorship Programs for Early-Career Radiologists

Monday, Nov. 26 10:50AM - 11:00AM Room: S104A

Participants
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Katarzyna J. Macura, MD,PhD, Baltimore, MD (*Abstract Co-Author*) Author with royalties, Reed Elsevier; Research Grant, Profound Medical Inc; Research Grant, GlaxoSmithKline plc; Research Grant, Siemens AG
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PURPOSE

To assess early-career radiologists' satisfaction with their professional mentorship, as well as to gain insights into the design of future mentorship programs.

METHOD AND MATERIALS

A 10-question survey was distributed by email in September 2017 to a random sample of 2,000 practicing radiologists who are members of the Young and Early-Career Professionals Section (YPS), which includes radiologists who are either under age 40 or within their first 8 years of practice. The survey was designed by the ACR YPS Executive Committee and the ACR Commission for Women and Diversity. Survey questions addressed respondents' satisfaction with their current mentorship and preferences for subsequent mentorship opportunities.

RESULTS

Responses included 51% male, 49% female; 37% academic, 35% private practice, 14% hospital employed. 69% responded that their practice did not have a formal mentoring program. Of those with a formal mentoring program, 47% were not satisfied with the program, and an additional 21% were only somewhat satisfied. 44% of respondents reported having no mentor, and 21% had a single mentor. 78.09% responded that having a mentor would be valuable, very valuable, or extremely valuable. A mentor was described as extremely valuable by 39% of women, vs. 14% of men. Having a mentor of the same gender was described as extremely or very valuable by 44% of women vs. only 5% of men. When asked what are the most valuable characteristics of a mentor, the highest rated options were: (1) greater level of experience, (2) same subspecialty, (3) same practice type, and (4) national reputation. Respondents felt overall more strongly that mentors be able to serve as advocates for career growth outside of, rather than within, the mentee's own institution.

CONCLUSION

Early-career radiologists commonly lacked a formal mentor or were unsatisfied with their mentor, and strongly desired greater mentorship opportunities; women radiologists more strongly expressed this desire. Radiologists generally desired an experienced mentor of a similar subspecialty and practice type who could facilitate their growth beyond the local institution.

CLINICAL RELEVANCE/APPLICATION

More robust mentorship programs are needed to combat burnout, promote job satisfaction, and foster the professional development and career success of the next generation of radiologists.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Katarzyna J. Macura, MD, PhD - 2012 Honored EducatorKatarzyna J. Macura, MD, PhD - 2014 Honored Educator

SSC08-04 May I Please Speak with the Radiologist: Introducing First Year Radiology Residents to Their Consultant Role

Monday, Nov. 26 11:00AM - 11:10AM Room: S104A

Participants
Karla A. Sepulveda, MD, Houston, TX (*Presenter*) Nothing to Disclose
Marc H. Willis, MMM,DO, Houston, TX (*Abstract Co-Author*) Investor, Resonea

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PURPOSE

An education portal with case vignettes of common clinical scenarios a first year radiology resident may be consulted on was created to assist in the transition to their new role as consultants on appropriate imaging ordering. The portal emphasizes concepts of evidence based imaging utilization, patient safety and patient centered care.

METHOD AND MATERIALS

A web based education portal with 20 vignettes of common clinical scenarios seen in an emergency room was created. Residents were asked to select the most appropriate imaging for the given clinical history. The questions incorporated clinical decision support technology with integrated ACR Appropriateness Criteria to provide evidence based recommendations for imaging indications. Radiation safety, IV contrast and cost questions were also included. The module ended with 2 open ended questions asking learners how they would manage clinical scenarios requiring interactions with referring clinicians, patients, and patient's family. The 12 residents participated in the pilot during their first week of residency. Following an introductory lecture highlighting concepts of high value, patient-centered care, residents took the self directed module in a virtual classroom. Residents then returned for a debrief session that included a patient discussing her perspective on radiologist communication, review of the responses to the open ended questions, and a qualitative post-assessment.

RESULTS

The portal was well received. 90% of participants believed the module should be included in an introductory curriculum for radiology residents. 80% thought the patient centered cases and patient discussion helped them to be more aware of the patient perspective. The majority of the residents reported increased comfort level in consultation regarding appropriate imaging, IV contrast, radiation exposure, cost of imaging and patient safety following the module.

CONCLUSION

A web based education module with integrated clinical decision support is an innovative approach to introducing first year radiology residents to their new role as consultants on high quality appropriate imaging. The portal reinforces imporant medical education concepts and encompasses multiple ACGME competencies.

CLINICAL RELEVANCE/APPLICATION

High value, patient-centered care can be emphasized with incoming first year radiology residents by a web based education module with integrated clinical decision support.

SSC08-05 The "Look Ahead" Technique: A Novel Way to Engage Medical Students in the Reading Room with Minimal Disruption to the Preceptor's Workflow

Monday, Nov. 26 11:10AM - 11:20AM Room: S104A

Participants
Jennifer Huang, MD, Greensboro, NC (*Presenter*) Nothing to Disclose
Brian Bingham, MD, Nashville, TN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Engaging medical students during a Radiology course can be challenging. We sought a way to actively engage students with live cases, allow them to interact with the PACS workstation, and experience what it is like to be a radiologist. This educational model has not been studied before.

METHOD AND MATERIALS

All medical students enrolled in Diagnostic Radiology or Medical Imaging and Anatomy course at our institution between May 2016 and June 2017 were eligible. The "Look Ahead" technique is as follows: during a routine read-out, a preceptor identifies several non-urgent imaging studies and allows the students to look at the images first and make their own findings and conclusions. When ready, the students present their findings, discuss the case, and observe the preceptor generate a final report. Students were emailed a post-course survey to compare the "Look Ahead" technique with the current standard (observing a preceptor interpret imaging studies with accompanying teaching points).

RESULTS

Thirty-four (56.7%) of 60 potential respondents completed the post-course survey. Of these 34 students, 24 (70.6%) reported at least one reading room case (mean 4.6) in which they had the opportunity to employ the technique with a mean of 2.4 unique preceptors. When compared to the current standard (0=not to 100=very interested/engaged/valuable/memorable), the 'Look Ahead' technique was associated with increased student-reported interest (92.5 vs 75.1, $p<0.01$), engagement (94.0 vs 70.3, $p<0.01$), educational value (92.5 vs 73.2, $p<0.01$), memorability of the case (88.5 vs 73.2, $p<0.01$) and of teaching points made by the preceptor (90.1 vs 76.7, $p<0.01$). All students agreed that compared to the current standard, the 'Look Ahead' technique increased their confidence in reviewing and interpreting imaging studies.

CONCLUSION

The findings suggest that students benefit significantly from the 'Look Ahead' technique, with increased interest, engagement, educational value, and memorability. The potential benefits warrant further investigation on a grander scale, with greater faculty and student involvement. It would be interesting to investigate if there are any longer term effects of this technique on student performance or career choice.

CLINICAL RELEVANCE/APPLICATION

The "Look Ahead" technique of medical student instruction in the radiology reading room promotes active student engagement with minimal disruption to the preceptor's workflow.

SSC08-06 Beyond Cadaveric Dissection: Through Virtual Dissection, Radiology Adds Educational Value to Medical Undergraduate Anatomy Education

Monday, Nov. 26 11:20AM - 11:30AM Room: S104A

Awards
Trainee Research Prize - Resident

Participants
Kathryn Darras, MD, Vancouver, BC (*Presenter*) Education Advisory Committee, Sectra AB
Rebecca Spouge, Vancouver, BC (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Virtual dissection is performed with CT scans on near life-size anatomy visualization tables, which function like touchscreen PACS workstations. Students work together to manipulate the data and perform their dissection. The purpose of this study was to develop and qualitatively assess the educational value of virtual dissection laboratories for first year medical students as well as to understand students' preferred pedagogical approaches for learning from this new technology.

METHOD AND MATERIALS

Following IRB approval, all first year medical students were included in this study (n = 292). A Basic Virtual Dissection Curriculum focused on normal anatomy was offered to all students concurrently with their cadaveric laboratories and an extra-curricular Advanced Virtual Dissection Curriculum focused on pathology was offered to interested students. 36.6% of students participated in this Advanced Curriculum. Following the sessions, students were surveyed to determine their attitude toward virtual dissection and the pedagogical approaches they perceived to be the most useful for learning with this technology. Results were statistically analyzed using the Schulze method.

RESULTS

Student response rate was 69.2% for the Basic Curriculum and 82.9% for the Advanced Curriculum. 93.1% indicated that virtual dissection was 'definitely' a valuable addition to the anatomy lab. 88.5% of respondents 'agreed' or 'strongly agreed' that virtual dissection improved their understanding of disease and 94.2% of students 'agreed' or 'strongly agreed' that it improved their understanding of the role of the radiologist in patient care. Students reported that the aortic aneurysm case was the most memorable case because the imaging made it easier to understand the pathogenesis of the disease. Students felt that small group demonstration and problem-based learning would be the best teaching approaches for this technology.

CONCLUSION

Virtual dissection adds value to medical undergraduate anatomy teaching by increasing students' understanding of the clinical relevance of anatomy. Students' preferred pedagogical approaches for learning from this technology were small group demonstration and problem based-learning.

CLINICAL RELEVANCE/APPLICATION

Virtual dissection is a new technology that can be used provide formal radiology teaching to medical students and thereby increase their awareness of the speciality.

SSC08-07 Evidence of Gender Bias in Recommendation Letters for Women in Radiology: Are We There Yet?

Monday, Nov. 26 11:30AM - 11:40AM Room: S104A

Participants
Alejandra Duarte, MD, New York, Colombia (*Abstract Co-Author*) Nothing to Disclose
Jenny T. Bencardino, MD, Lake Success, NY (*Presenter*) Nothing to Disclose
Christine M. Glastonbury, MBBS, San Francisco, CA (*Abstract Co-Author*) Author with royalties, Reed Elsevier
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PURPOSE

To evaluate for gender bias language used in recommendation letters written for women trainees and faculty seeking to be hired in academic or clinical positions, promotion or professional society membership

METHOD AND MATERIALS

109 letters written by 4 senior academic radiologists (1 man, 3 women) were independently assessed by 2 reviewers. The quality of the letters was scored using the University of Arizona Commission on the Status of Women (UA CSW) guidelines. Positive 1 point qualifiers included: mention of research, mention of publications, more than 1 page length, use of adjectives that emphasize accomplishments and ability, and use of adjectives that denote leadership. Negative 1 point qualifiers included the use of adjectives that evoke gender stereotypes and emphasize effort, mention personal life, and express doubt. Using these guidelines, a ranking system was created with letters classified as excellent (4-5); very good (3-4); good(2-3); fair(0-2); and poor(<0). Other positive adjectives not included in the UA CSW were recorded. Positive1 point qualifier adjectives used more than 5 times in this collection of letters were added to a revised scoring system

RESULTS

The average score using the UA CSW guidelines was good (2.5). There was no significant difference between those letters written by the only male (56) versus female letter writers (53) (M: 2.5; W: 2.4). 81% mentioned publications while only 60% mentioned research involvement. 70% of letters contained adjectives that emphasized accomplishments and ability but only 17% used adjectives that denote leadership. In one-fifth of the letters, adjectives that denoted gender stereotype were used. When using a modified scoring system, the average score rose to very good (3.2). Again, no gender difference was noted between man (3.2) versus women (3.2) letter writers using the revised scoring system.

CONCLUSION

In our preliminary sample, gender bias language was found in 21% of the letters written for women by senior faculty members without distinction of the writer's gender. Only 60% mentioned research and only 14% included leadership qualifiers. We encourage academic faculty to keep handy guidelines to write persuasive and gender bias-free letters for their women trainees and colleagues.

CLINICAL RELEVANCE/APPLICATION

Based on preliminary results, we developed modified UA CSW guidelines that aim to help writing persuasive, gender-bias free letters for women radiologists.

Honored Educators

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SSC08-08 Appearance-Based Discrimination in Radiology Resident Selection

Monday, Nov. 26 11:40AM - 11:50AM Room: S104A

Participants
Charles M. Maxfield, MD, Durham, NC (*Presenter*) Nothing to Disclose
Matthew P. Thorpe, MD, PhD, Savoy, NC (*Abstract Co-Author*) Nothing to Disclose
Terry S. Desser, MD, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate for discrimination in radiology resident selection based on the physical appearance of the applicant.

METHOD AND MATERIALS

We carried out a simulated resident selection process utilizing deception of reviewers. Seventy-four core faculty (37 male and 37 female) from five academic radiology departments reviewed mock residency applications under the guise of resident application screening. Applications included demographic information and a photograph, representing a spectrum of facial attractiveness and

obesity, combined with randomized academic and supporting variables. Reviewers independently scored applications on their desirability for interview. Comparisons were made between reviewer scores and the application variables using linear mixed fixed and random effects models.

RESULTS

Reviewers evaluated 5447 applications (mean: 74 applications per reviewer). The applicant's facial attractiveness strongly predicted reviewer rating (attractive versus unattractive, B = 0.30 ± standard error 0.056); neutral versus unattractive, B = 0.13 ± 0.028). Obesity (versus not obese) was less influential but predictive of rating (B = -0.14 ± 0.024). Overall, United States Medical Licensing Examination Step 1 scores were the strongest predictor of reviewer rating (ß = 0.49 ± 0.030). Less influential but still significant predictors included preclinical class rank (B = 0.25 ± 0.040 for 1st vs. 3rd quartile), clinical clerkship grades (B = 0.23 ± 0.034 for top vs. bottom tertile), race/ethnicity (B = 0.25 ± 0.059 for black/Hispanic vs. white), and Alpha Omega Alpha membership (B = 0.21 ± 0.032). Using the 85th percentile of reviewer rating as a cutoff for projected interview selection, 90% of obese and facially unattractive applicants would be rejected, compared to only 76% of non-obese facially attractive applicants ($p<0.01$).

CONCLUSION

Our study provides evidence of discrimination against obese and facially unattractive applicants in admissions to radiology residency programs. Notably, obesity and facial attractiveness were as influential in the selection of applicants for interview as were well-established academic factors.

CLINICAL RELEVANCE/APPLICATION

Resident selection committees should invoke strategies to detect and manage appearance-based bias

SSC08-09 Structured Tool for Screening Candidates for Academic Neuroradiology Faculty Positions

Monday, Nov. 26 11:50AM - 12:00PM Room: S104A

Participants
Maria Braileanu, MD, Atlanta, GA (*Presenter*) Nothing to Disclose
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Mark E. Mullins, MD,PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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Brent D. Weinberg, MD, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Interview selection of candidates for an academic radiology faculty position is variable and subject to unconscious biases, such as gender and race. The purpose of this study was to retrospectively apply a quantitative resume rubric as a screening tool to identify qualified candidates for an interview in the hiring process.

METHOD AND MATERIALS

All resumes from 2012 to 2017 for a total of 8 neuroradiology faculty positions at our institution were collected and anonymized. One blinded reviewer scored the resumes based on categories that included: education (board certification, medical school ranking, residency ranking, fellowship years, degrees), work experience (years), extracurricular experience (leadership, societies, committees, teaching, honors, volunteerism), and research (abstracts, oral presentations, manuscripts, chapters). Maximum total score was 24 points. The relationship between 1) resume score and interview status, and 2) resume score and job offer was examined using logistic regression. Non-parametric ROC analysis based on resume score and job offer was performed using STATA. This study was IRB exempted.

RESULTS

102 anonymized resumes were scored. The overall mean was 13.6±3.8 with a range of 5-22. A total of 17 interviews were conducted and 10 candidates were eventually offered a position. Higher resume score significantly increased the likelihood of an interview ($p=0.02$) but was not significantly associated with a job offer ($p=0.07$). The area under the curve in the ROC analysis for differentiating interview selection based on resume scoring was 0.69 (95%CI 0.56-0.82). At a cutoff of 14, the model is 82.4% sensitive, and 54.1% specific.

CONCLUSION

We demonstrated that standardized scoring of resumes as an initial screening tool in the hiring process is feasible. A higher resume score was associated with interview selection. This tool can potentially be applied in the future to reduce unwanted bias in the hiring process as it is neutral to factors such as gender and race.

CLINICAL RELEVANCE/APPLICATION

Standardized resume screening is feasible, with a higher score associated with interview selection in retrospective analysis, and may be applied in the future to reduce unwanted bias in the initial steps of the hiring process.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Elizabeth A. Krupinski, PhD - 2017 Honored Educator

SSC09

Science Session with Keynote: Informatics (Artificial Intelligence in Radiology: Bleeding Edge)

Monday, Nov. 26 10:30AM - 12:00PM Room: E450A

AI BQ IN

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

FDA Discussions may include off-label uses.

Participants

George L. Shih, MD, MS, New York, NY (*Moderator*) Consultant, Image Safely, Inc; Stockholder, Image Safely, Inc; Consultant, MD.ai, Inc; Stockholder, MD.ai, Inc;
Ronald M. Summers, MD,PhD, Bethesda, MD (*Moderator*) Royalties, iCAD, Inc; Royalties, Koninklijke Philips NV; Royalties, ScanMed, LLC; Research support, Ping An Insurance Company of China, Ltd; Researcher, Carestream Health, Inc; Research support, NVIDIA Corporation; ; ; ;
Safwan Halabi, MD, Stanford, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSC09-01 Informatics Keynote Speaker: Bleeding Edge Medical AI

Monday, Nov. 26 10:30AM - 10:40AM Room: E450A

Participants
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SSC09-02 Relationship Learning and Organization of Significant Radiology Image Findings for Lesion Retrieval and Matching

Monday, Nov. 26 10:40AM - 10:50AM Room: E450A

Awards

Trainee Research Prize - Fellow

Participants
Ke Yan, Bethesda, MD (*Presenter*) Nothing to Disclose
Xiaosong Wang, PhD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Radiologists mark and measure significant image findings in their daily work to assess patients' conditions and therapy responses. These large-scale and diverse clinical annotations can be great data sources to train data-hungry algorithms (e.g. deep learning) for medical image analysis. However, they are basically unsorted and lack semantic annotations like the lesion type and location. We aim to organize and explore them by learning a deep feature embedding for each lesion. It can help us to 1) know their types and locations; 2) find similar lesions in different patients, i.e. content-based lesion retrieval; and 3) find similar lesions in the same patient, i.e. lesion matching across scans for disease tracking.

METHOD AND MATERIALS

We built a large-scale and comprehensive dataset, DeepLesion, by mining the PACS. It contains 32,735 lesions from 10,594 CT studies of 4,427 patients. The lesions are quite diverse, and include e.g. lung nodules, liver lesions, adenopathy, and bone lesions. The train/val/test sets have 70%, 15%, 15% of the data split in patient level. We learn a feature embedding for each lesion that keeps the similarity relationship of the type, location, and size, i.e. lesions with similar attributes should have similar embeddings. We get the lesion types and locations by label propagation and self-supervised body-part regression. Size is directly obtained from the radiological marking. A triplet network with a sequential sampling strategy is utilized to learn the embedding. The network is a multiscale multi-crop convolutional neural network that can exploit both context and detail of the lesion images. The learned embeddings can be applied in lesion retrieval and matching by nearest neighbor searching.

RESULTS

In the test set of DeepLesion, we achieve 91.5±0.1%, 92.8±0.0%, and 94.9±0.0% accuracy in lesion retrieval w.r.t. the lesions'

type, location, and size, respectively. The area-under-curve value for lesion matching is 95.9% in a manually labeled test set of 1313 lesions from 103 patients.

CONCLUSION

We proposed an algorithm to learn feature embeddings for a variety of lesions to encode their type, location, and size. Experiments showed its effectiveness in lesion retrieval and matching.

CLINICAL RELEVANCE/APPLICATION

The proposed algorithm can be used in content-based lesion retrieval and intra-patient lesion matching, which can help radiologists find similar lesions and track lesions in follow-up studies.

SSC09-03 Multi-Stage Deep Disassembling Networks for Generating Bone-Only and Tissue-Only Images from Chest Radiographs

Monday, Nov. 26 10:50AM - 11:00AM Room: E450A

Participants
Jaehong Aum, Seoul, Korea, Republic Of (*Presenter*) Employee, Lunit Inc
Sunggyun Park, Seoul, Korea, Republic Of (*Abstract Co-Author*) Employee, Lunit Inc
Donggeun Yoo, Seoul, Korea, Republic Of (*Abstract Co-Author*) Employee, Lunit Inc
Chang Min Park, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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CONCLUSION

Deep neural network based automatic disassembling network for CRs is demonstrated and its performance is validated by SSIM proving its potential to improve interpretability of CRs and aid pysicians for accurate diagnosis.

Background

Dual-energy subtraction technique produces bone-only and tissue-only images to improve interpretability of chest radiographs (CRs). However, the use of this technique was limited because it requires a specialized hardware device for capturing the CRs. In order to overcome this limitation, we developed a deep disassembling networks for CRs (DDCN) which generates bone-only and tissue-only images from a normal CR.

Evaluation

To develop DDCN, we collected a total of 617 CRs with both bone-only and tissue-only images, which were produced by dual energy subtraction technique. To clean the dataset, we excluded 100 cases with suboptimal image quality. Furthermore, we refined the remaining 517 cases using guided filter and non-local means filter to remove image noises. Subsequently, we randomly divided the 517 datasets into the training dataset (n=467) and validation dataset (n=50). We designed a novel two-stage deep convolutional network where the first-stage is designed for observing context of a CR and the second-stage is for producing bone-only and tissue-only images given the first-stage output. The network is constructed with residual architecture, 40 convolutions for the first-stage and 14 convolutions for the second-stage. We quantitatively measured the performance of our network using SSIM which measures the structure difference between a given ground truth image and our network-producing image. In validation dataset, the measured SSIM comparing ground truth tissue-only images and our network-producing results was 0.9678. When we limit the region of interest (ROI) as lung area, the SSIM was measured as 0.9835. In the case of bone-only image, it was 0.9877 and 0.9870 when we limit ROIs as whole image and lung area, respectively.

Discussion

DDCN produces bone-only and tissue-only images from CRs taken by conventional X-ray device. We believe it is the first introduction of deep neural network for disassembling bone and tissue from a CR.

SSC09-04 Non-invasive Tracking of Cancer Evolution using Deep Learning-Based Longitudinal Image Analysis

Monday, Nov. 26 11:00AM - 11:10AM Room: E450A

Participants
Yiwen Xu, PhD, Boston, MA (*Presenter*) Nothing to Disclose
Ahmed Hosny, MSc, Cambridge, MA (*Abstract Co-Author*) Nothing to Disclose
Thibaud Coroller, MS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Roman Zeleznik, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Hugo Aerts, PhD, Boston, MA (*Abstract Co-Author*) Stockholder, Sphera Inc

PURPOSE

Tumors are continuously evolving biological systems, and medical imaging is uniquely poised to monitor those changes in patients, before, during, and after treatment. While it is trivial to track tumor lesions over space and time, it is much harder to develop models encompassing all the time points. Here we investigated the use of recurrent deep learning network capable of analysing time series CT images of locally advanced non-small cell lung cancer (NSCLC) patients.

METHOD AND MATERIALS

Dataset A consists of 179 stage III NSCLC patients treated with definitive radiation therapy (581 scans, mean 3.2 scans per patient). This dataset was separated into independent training/tuning (n=107), and test (n=72) cohorts. Transfer learning through convolutional neural networks (CNN) merged with a recurrent neural network was trained on serial scans. Survival was analyzed for a separate test set with AUC and Kaplan Meier curves. Further pathologic response validation of the CNN model was performed on Dataset B (n=79 patients, 158 scans, 2 per patient) treated with chemoradiation followed by surgery. This cohort was used to

validate pathological tumor response and compared to performance with volume change.

RESULTS

Enhanced performance on the test set was observed with the addition of each follow-up scan into the CNN model for 2-year survival (AUC=0.64, 0.69, 0.74, p<0.05), comporable results were demonstrated for one-year survival. The models with 3 follow-up scans showed strong stratification power for high and low risk groups of the predictions using Kaplan-Meier analysis (Log-rank, p<0.05). The hazard ratios for the one-year and 2-year survival models were 6.16 and 2.38, respectively (p<0.05). The CNN model significantly stratified pathological responders and cases of gross residual disease in Dataset B (AUC=0.65, p<0.05), with predictive results comparable to tumour volume change.

CONCLUSION

This study demonstrates promising results using deep learning to combine patient scans at multiple time points to improve clinical survival and response predictions. Pathologic validation of this biomarker was shown on an independent validation cohort.

CLINICAL RELEVANCE/APPLICATION

Tracking of cancer evolution using deep learning applied to medical imaging showed promising predictions of patient outcome and pathologic response, without the need for manual tumor contours.

SSC09-05 Interpretation of Computed Tomography Without Reconstruction: Reading Sinograms to Detect Intracranial Hemorrhage

Monday, Nov. 26 11:10AM - 11:20AM Room: E450A

Participants
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PURPOSE

In the current medical practice, diseases or conditions, such as intracranial hemorrhage (ICH), are usually diagnosed using reconstructed images that are generated from sophisticated reconstruction algorithms. In this study, we explore the feasibility to directly detect ICH from non-contrast head computed tomography (CT) in data domain instead of image domain by applying deep learning techniques on CT sinograms.

METHOD AND MATERIALS

A total of 889 head CT examinations were retrieved from our institutional database, and each axial slice was annotated by 5 board-certified neuroradiologists. The pixel values of CT images were then converted into linear attenuation coefficients, upon which the 2D parallel-beam Radon transforms were applied to generate simulated sinograms. To investigate the effects of number of projection views and detector size on ICH detection, 3 sets of sinograms were produced: '360 x 729', '120 x 240' and '40 x 80', where 'm x n' means the sinogram obtained from m projection views and n detectors. The sinograms were then randomly splitted into training (635 cases), validation (127 cases) and testing (127 cases) sets, which were used to train, validate, and evaluate a convolutional neural network (CNN) that inputs a sinogram and outputs the probability of ICH. To improve generalization, data augmentation was used for training by applying affine transformations (translation, scaling, rotation and reflection) on CT image slices followed by Radon transforms. For comparison, another CNN was built and trained with reconstructed CT images.

RESULTS

The CNN model using CT images as inputs achieved 91.5% test accuracy on ICH detection, and the models using "360 x 729", "120 x 240" and "40 x 80" sinograms as inputs detected ICH with 80.2%, 78.1%, and 76.7% accuracy, respectively.

CONCLUSION

This study shows the potential of direct detection of ICH using CT raw data without image reconstruction. The results also suggest the possibility of using sparse projection views and large-size detectors without sacrificing the ICH detection accuracy, which could lower the radiation dose and equipment costs.

CLINICAL RELEVANCE/APPLICATION

Direct detection of critical conditions like ICH using sinograms without image reconstruction will save the processing time that is critical in situations like emergency rooms. The potential of radiation dose and equipment cost reduction is also of interest to radiologists.

SSC09-06 Image Annotation by Eye Tracking: Accuracy and Precision of Centerlines of Obstructed Small Bowel Segments Placed Using Eye Trackers

Monday, Nov. 26 11:20AM - 11:30AM Room: E450A

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PURPOSE

To determine the accuracy and precision of centerlines of obstructed small bowel segments placed using eye trackers.

METHOD AND MATERIALS

This HIPAA-compliant IRB-approved retrospective pilot study included seven subjects diagnosed with small bowel obstruction (SBO) by CT. For each subject, an obstructed segment of bowel was chosen. Three observers then annotated the centerline of the segment with three methods: manual fiducial placement or visual fiducial placement using either a Tobii x3-120 or 4c eye tracker, which report the location on the screen at which an observer is looking. This location was mapped to 3D coordinates within the CT volume using a custom 3D Slicer module. Each annotation was repeated three times. The distance between centerlines was calculated after alignment using dynamic time warping (DTW) to account for the variable number of fiducials placed. Intra-observer DTW distance between manual and visual centerlines was calculated as a measure of accuracy. Intra- and inter-observer DTW distances between centerlines placed with each method were calculated as measures of precision. One-sample t-tests were performed to assess whether mean DTW distances were less than 1.5 or 3 cm for each measure of accuracy or precision respectively.

RESULTS

DTW distances between manual and visual centerlines ranged from 1.1±0.2 to 1.8±0.2 cm, and were significantly less than 1.5 cm for two of three observers using both visual methods ($P<0.01$). Intra- and inter-observer DTW distances for manual centerlines were 0.6±0.1 and 0.8±0.2 cm, and for visual centerlines ranged from 1.0±0.4 to 1.9±0.6 cm, but were less than 3.0 cm in all cases ($P<0.01$).

CONCLUSION

Eye trackers may be used for visual annotation of the centerlines of obstructed small bowel segments with accuracy and precision that compare favorably to the threshold diameter of 3 cm for diagnosis of SBO on CT. Accuracy varied among observers, but precision was consistently favorable.

CLINICAL RELEVANCE/APPLICATION

SBO is a common and important disease, for which machine learning tools have yet to be developed. Image annotation is a critical first step in machine learning, but manual annotation of small bowel is prohibitively time-consuming. Image annotation by eye tracking is sufficiently accurate and precise relative to the diameter of obstructed small bowel to serve as a potential first step in the development of machine learning tools that facilitate diagnosis of SBO on CT.

SSC09-07 Big Data Interpretability: Automatically Identify Mislabeled Data in Medical Imaging Deep Learning

Monday, Nov. 26 11:30AM - 11:40AM Room: E450A

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PURPOSE

In big data applications, data quality and variations can significantly influence performance of deep learning models. Manual labeling or natural language processing-based labeling inevitably generates some mislabeled data. We developed a dedicated method for deep learning to automatically identify potentially mislabeled data.

METHOD AND MATERIALS

We proposed a novel algorithm framework using entropy loss and influence functions to measure data's relevance and correlation strengths with respect to classification performance in convolutional neural network (CNN) models. We identified a clinically-acquired digital mammographic imaging data and their BI-RADS breast density categories (a/b/c/d). Category a (fatty) and d (extremely dense) each has 350 images, while Category b (scattered fibroglandular density) and c (heterogeneously dense) each has 2,000 images. We implemented a CNN-based binary classification model on distinguishing Category a vs d and another similar model for Category b vs c. We did two experiments: 1) Before training models, we purposely flipped the labels for 10% randomly selected data in each category and used our method to identify those flipped data; and 2) We ran our method on the original un-flipped data to identify those potentially mislabeled images by radiologists and evaluate the effect by using a published scheme that assesses the "correctness" of clinically-assigned BI-RADS breast density categories.

RESULTS

The AUC is 0.99 and 0.96 for the Category a vs d model and for the Category b vs c model, respectively. For experiment 1), our method can identify 98% of the purposely flipped data in Category a and d, and 92% in Category b and c, by automatically examining as small as only 30% of the full dataset. For experiment 2), there is 78% (or 96%) overlap in the potentially mislabeled data between those identified by our method and those specified by the "correctness" assessment method, by examining 50% (or 90%) of the full dataset.

CONCLUSION

We developed an automated method for deep learning and demonstrated it can identify vast majority of mislabeled data in the BIRADS-based clinical breast density assessment in digital mammograms.

CLINICAL RELEVANCE/APPLICATION

Fully-automated identification of mislabeled data for deep learning can significantly improve data quality, model's performance and reliability, as well as stratified data interpretability.

SSC09-08 Approaching Chest-CT-Level Performance on Chest X-Rays with Deep-Learning

Monday, Nov. 26 11:40AM - 11:50AM Room: E450A

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PURPOSE

To determine whether deep learning algorithms can detect abnormalities on chest X-rays (CXR) before they are visible to radiologists.

METHOD AND MATERIALS

We trained deep learning models to identify abnormal X-rays and CXR opacities using a set of 1,150,084 chest X-Rays. We used a retrospectively obtained independent set of de-identified chest X-rays from patients who had undergone a chest CT scan within 1 day (TS-1, n=187), 3 days (TS-3, n=197) and 10 days (TS-10, n=230) of the X-ray to evaluate the algorithms' ability to detect abnormalities that were not visible to the radiologist at the time of reporting on the X-ray. Natural language processing algorithms were used to establish ground truth from radiologist reports of the CT scans, on 2 parameters - 'any abnormality' and 'hyperdense abnormality (HA)' - defined as any abnormal focal or diffuse hyperdense abnormality in the lung fields including but not limited to nodule, mass, fibrosis and calcification. The CT scans were used as ground truth to evaluate the accuracy of the original CXR report and the deep learning algorithms.

RESULTS

Of 187 CT scans in TS-1, 153 contained an HA. 52 of these (34%) had been picked up on the original CXR by the reporting radiologist, and 63 of these (41%) were picked up by the deep learning algorithm. Of 180 abnormal scans in TS-1, 106 (59%) had been picked up as abnormal on the original CXR by the reporting radiologist, and 120 of these (67%) were picked up by the deep learning algorithm. To detect HA, this amounts to an accuracy of 0.49, sensitivity of 0.41 and specificity of 0.85 for the algorithm, versus an accuracy of 0.44, sensitivity of 0.34 and specificity of 0.91 for the original radiologist read of the chest X-ray. To detect any abnormality, the accuracy, sensitivity, and specificity are 0.67,0.67 and 0.71 respectively for the algorithm, and 0.59,0.59 and 0.71 respectively for the reporting radiologist. Similar results were observed on TS-3 and TS-10, as shown in the figure below

CONCLUSION

Deep learning algorithms can pick up abnormalities that have been missed on chest X-rays but identified on a subsequent chest CT.

CLINICAL RELEVANCE/APPLICATION

Using deep learning algorithms to screen chest X-rays could result in higher sensitivity at identifying abnormal scans than currently possible, with only a small corresponding increase in the number of false positives.

SSC09-09 A Portable Automated X-Ray Imaging System and Reading Solution for Screening Lung Diseases

Monday, Nov. 26 11:50AM - 12:00PM Room: E450A

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CONCLUSION

The AXIR system allows clinicians to save time and money while providing patients with good service at any location. The AI-based

automation facilitates its use as a screening and diagnosis tool, allowing doctors to make real-time decisions with high precision and reliability. The system, in the future, may cover other anatomical regions while the AI-engine can be enhanced to diagnose broader disease indications.

Background

A chest x-ray is a commonly used examination for screening and diagnosis of lung diseases. Artificial intelligence (AI) solutions, for automated image analysis, have been implemented as cloud-based solutions centered on hospitals with well-equipped infrastructures. However, two-thirds of the planet does not have access to radiology services due to lack of infrastructure and expertise. We have developed a portable automated X-ray imaging system and reading solution (AXIR) with embedded AI technology to solve this problem.

Evaluation

The AXIR system comprises of a low power portable generator (3kW), a wireless detector (resolution > 4lp/mm), an image pre-processing tool, an AI-based analysis engine, and a mobile viewer. The AI engine screens images for abnormalities and displays the location. Abnormalities can further be classified as pleural effusion, cardiomegaly, opacity, infiltrate, consolidation, fibrosis, hilar enlargement, and calcification. The AI models were trained using public datasets and with images acquired using the AXIR system. The system is being validated at a poor infrastructure site handling about 1000 chest X-rays / month. The performance of the system is evaluated by measuring the accuracy, sensitivity, and specificity of diagnosis.

Discussion

Access to diagnostic imaging services has a great impact on public health and can potentially increase, for example, early detection. AXIR's portable X-ray system with embedded AI-based analytics is a novel highly accessible medical device. In our initial test, we achieved a diagnostic accuracy of 92% with a sensitivity of 94% and specificity of 90%. At our pilot site, the system reduced the diagnosis time from an average of 3 days to less than 10 minutes and brought the patient re-visit rate down to 1% from 20%.

SSC10

Science Session with Keynote: Musculoskeletal (Body Composition)

Monday, Nov. 26 10:30AM - 12:00PM Room: S102CD

CT MK MR BQ

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

SSC10-01 Musculoskeletal Keynote Speaker: SSR 2018 Paper Award: Brown Adipose Tissue and Cancer Activity

Monday, Nov. 26 10:30AM - 10:40AM Room: S102CD

Participants
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SSC10-03 Association of DXA Markers of Sarcopenia with Inflammation and Adiposity Related Hormones in an Elderly Population: A Gender-Based Analysis

Monday, Nov. 26 10:50AM - 11:00AM Room: S102CD

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PURPOSE

Sarcopenia consists of loss of muscle mass and strength/function. As adipose tissue expands and muscle and bone tissue decrease with aging, there is a concomitant increase in proinflammatory and a reduction in anti-inflammatory factors contributory to chronic inflammation. We aimed to evaluate associations of several inflammatory markers with DXA-measured sarcopenia markers in a representative sample of European healthy adults aged 65-79 years.

METHOD AND MATERIALS

Baseline whole-body DXA scan was performed and fresh blood samples collected in 1122 participants enrolled in the NU-AGE trial, a one-year, multicenter, randomized, single-blind, controlled trial (NCT01754012) testing the effects of a dietary intervention. Appendicular lean mass (ALMI, lean mass from arms plus legs/height2) and skeletal mass index (SMI, lean mass from arms plus legs/weight) were used as DXA markers of sarcopenia. Quantitative determination of inflammatory markers was performed by ELISA. After a log-transformation of DXA parameters the Pearson Product-Moment Correlation was applied to test the associations between body composition and inflammation markers in both genders.

RESULTS

In male population, a positive association was found between ALMI and albumin (ρ=0.20; p < .05) and SMI and ghrelin (ρ=0.19; p < .05). A negative association was found between ALMI and adiponectin (ρ=-0.23; p< .001), while SMI was negatively correlated with leptin (ρ=-0.70; p<.001) and C-Reactive Protein(CRP) (ρ=-0.24; p<.001). In females, ALMI was positively associated with leptin (ρ=0.19; p<.01), and CRP (ρ=0.22; p<.01). SMI was positively associated with ghrelin (ρ=0.24; p<.001), while negatively with leptin (ρ=-0.62; p<.001), CRP (ρ=-0.23; p<.001), and AGP (ρ=-0.26; p<.001).

CONCLUSION

Sarcopenia correlates with an increase of inflammatory status in elderly. In males and females, SMI correlates positively with ghrelin, an anti-inflammatory molecule, and negatively with pro-inflammatory markers such as leptin, CRP and AGP; while ALMI showed ambiguous associations with inflammatory markers. Thus, SMI appears to be a better predictor of inflammatory risk status in the elderly.

CLINICAL RELEVANCE/APPLICATION

DXA-derived sarcopenia markers show a correlation with inflammatory markers useful to picture patients' risk status. SMI may predict inflammatory status better than ALMI; but further research is required.

SSC10-04 Automated Segmentation of Thoracic Paraspinous Muscles: Pipeline for Large-Scale Data Mining on CT

Monday, Nov. 26 11:00AM - 11:10AM Room: S102CD

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PURPOSE

To compare automated pipeline for thoracic paraspinous muscle segmentation with manual segmentation on chest CT examinations.

METHOD AND MATERIALS

Atlas-based automated pipeline for thoracic paraspinous muscle segmentation was developed using open-source medical image analysis tools: Advanced Normalization Tools (ANTs), the Oxford Centre for Functional Magnetic Resonance Imaging of the Brain Software Library (FSL), and the scikit-image Python image processing library. After the correct image at T12 level was identified, the left paraspinous muscle was automatically segmented and the muscle attenuation and cross-sectional area were recorded. Ground truth was obtained using 475 non-contrast chest CT exams by manually segmenting the left paraspinous muscle at T12 level with muscle thresholds set at -29 to +150 HU (Mimics software version 19.0; Materialise, Leuven, Belgium). The CT images are heterogeneous in field of view, voxel spacing, convolution kernel, scanner manufacturer and model, reconstruction algorithm, and image quality. Dice and Jaccard similarity indices were determined.

RESULTS

Compared to manual segmentation, the automated pipeline had a mean Dice index of 0.85 (SD=0.07) and a mean Jaccard index of 0.74 (SD=0.09). Mean accuracy error for muscle attenuation was 1.2 HU; range: 0-4.9 HU. Mean accuracy error for muscle cross-sectional area was 1.83 cm2; range: 0-9.3 cm2.

CONCLUSION

The automated pipeline for thoracic paraspinous muscle segmentation is sufficiently accurate to allow for large-scale data mining of heterogeneous chest CT images.

CLINICAL RELEVANCE/APPLICATION

Current CT image evaluation of sarcopenia requires manual segmentation, unrealistic for large datasets. The automated pipeline for sarcopenia evaluation on chest CTs could be adapted to other body regions including abdomen, pelvis, and extremities.

SSC10-05 Assessment of Sarcopenia on Computed Tomography (CT): A Systematic Review of Technical Parameters

Monday, Nov. 26 11:10AM - 11:20AM Room: S102CD

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PURPOSE

Computed tomography (CT) is being increasingly used for the assessment of sarcopenia, often by non-radiologists who may not be aware of the impact of technical parameters on muscle metrics. We sought to perform a systematic review of all relevant studies that used CT muscle measurements to assess sarcopenia to identify the differences between technical parameters used.

METHOD AND MATERIALS

A comprehensive search of PubMed from 1983-2017 was performed to identify studies that used CT measurements of muscle to assess for sarcopenia. Review articles were excluded. The following technical parameters used to measure muscle metrics were compared: slice thickness, kVp, mAs, helical pitch, reconstruction method, and use of intravenous (IV) contrast.

RESULTS

From the 654 articles identified, 388 studies met the inclusion criteria for the systematic review. Slice thickness was not reported in 63% of studies. When reported, the most commonly used slice thickness was 10 mm (14%). kVp was not reported in 73% of studies. When reported, the most common kVp was 120 (19%). mAs was not reported in 75% of studies. When reported, the most common mAs values were between 200 and 300 (7%). Helical pitch and reconstruction algorithm were not reported in 98% of studies and IV contrast use was not reported in 94% of studies.

CONCLUSION

There is a significant deficiency in reporting of CT technical parameters used for measuring muscle indices which may affect the generalizability of results in the sarcopenia literature.

CLINICAL RELEVANCE/APPLICATION

Comparison between publications in the sarcopenia field is hampered by deficiency in reporting of CT technical parameters.

SSC10-06 Inter- and Intraobserver Variability of an Anatomical Landmark-Based, Manual Segmentation Method by MRI for the Assessment of Skeletal Muscle Fat Content and Area in Subjects from the General Population

Monday, Nov. 26 11:20AM - 11:30AM Room: S102CD

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PURPOSE

Changes in skeletal muscle composition, such as fat content and mass, may exert unique metabolic and musculoskeletal risks; however, the reproducibility of their assessment is unknown. We determined the variability of the assessment of skeletal muscle fat content and area by magnetic resonance imaging (MRI) in a population-based sample.

METHOD AND MATERIALS

A random sample from a prospective, community-based cohort study (KORA-FF4) was included. Skeletal muscle fat content was quantified as proton-density fat-fraction (PDFF) and area as cross-sectional area (CSA) in multi-echo Dixon sequences (TR 8.90ms, six echo times, flip-angle 4°) by a standardized, anatomical landmark-based, manual skeletal muscle segmentation at level L3 vertebra by two independent observers. Reproducibility was assessed by intra-class correlation coefficients (ICC), scatter and Bland-Altman plots.

RESULTS

In 50 included subjects (mean age 56.1±8.8years, 60.0% males, mean BMI 28.3±5.2) 2'400 measurements were obtained. Inter-observer agreement was excellent for all muscle compartments (PDFF: ICC0.99, CSA: ICC0.98) with only minor absolute and relative differences (-0.2±0.5%, 31±44.7mm2; -2.6±6.4% and 2.7±3.9%, respectively). Intra-observer reproducibility was similarly excellent (PDFF: ICC1.0, 0.0±0.4%, 0.4%; CSA: ICC1.0, 5.5±25.3mm2, 0.5%, absolute and relative differences, respectively). All agreement was independent of age, gender, BMI, body height and visceral adipose tissue (ICC0.96-1.0). Furthermore, PDFF-reproducibility was independent of CSA (ICC0.93-0.99).

CONCLUSION

Quantification of skeletal muscle fat content and area by MRI using an anatomical landmark-based, manual skeletal muscle segmentation is highly reproducible.

CLINICAL RELEVANCE/APPLICATION

An anatomical landmark-based, manual skeletal muscle segmentation provides high reproducibility of skeletal muscle fat content and area and may therefore serve as a robust proxy for myosteatosis and sarcopenia in large cohort studies.

SSC10-07 Cortical Bone Porosity Assessment in Human Tibial and Fibular Cortex Using Ultrashort Echo Time Magnetization Transfer (UTE-MT) MRI

Monday, Nov. 26 11:30AM - 11:40AM Room: S102CD

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PURPOSE

To investigate the relationship between macromolecular fraction (MMF), obtained from UTE-MT modeling, and bone porosity, as measured using high-resolution micro-computed tomography (µCT).

METHOD AND MATERIALS

Eighteen cortical bone specimens were harvested from human tibial and fibular midshafts (63±19 and 52±18 years old). Specimens were scanned using an 8-channel knee coil on a 3T clinical scanner (MR750, GE). The UTE-MRI scans involved: A) an actual flip angle-variable TR (AFI-VTR) method, (AFI: TE=0.032, TR=20,100 ms, FA=45°; VTR: TE=0.032, TR=20 to 100 ms, FA=45°) for T1 measurement, which is a prerequisite for accurate MT modeling, and B) a 3D UTE-Cones-MT sequence (saturation pulse power=500,1000,1500°, frequency offset=2 to 50 kHz, FA=7°) for MT modelling. Field of view (FOV), matrix dimension, nominal in-plane pixel size, and slice thickness were 14 cm, 256×256, 0.54 mm, and 2 mm, respectively. Afterward, specimens were scanned using a Skyscan 1076 (Kontich, Belgium) µCT at 9 µm3 voxel size. Pearson's correlations were calculated between UTE-MT results and µCT-based measures (porosity and bone mineral density, BMD) using the data in 12 and 4 ROIs in each tibial and fibular sample, respectively. ROIs were selected at different cortical bone bands to provide an adequate range of porosity.

RESULTS

Figures 1a-f show MMF, porosity, and BMD pixel maps for a representative tibial and fibular specimen, respectively. Regions of higher MMF corresponded to the regions of lower porosity in the porosity maps. Figures 1g-j demonstrate the correlations between MMF and µCT measures for tibial and fibular bone specimens, respectively. MMF presented very good correlations with µCT measures.

CONCLUSION

MMF obtained from MT modeling, as a measure for collagen content, showed very good correlations with µCT measures regardless of the fibular of tibial harvesting sites. This study highlighted UTE-MT MRI techniques as a useful method to assess bone porosity, which may be used in future clinical studies.

CLINICAL RELEVANCE/APPLICATION

A UTE-MRI-based technique, to estimate the collagen backbone content which correlates greatly with the bone porosity may help diagnose bone diseases earlier and more accurately.

SSC10-08 Diagnostic Performance of Phantomless Dual-Energy CT for Volumetric Bone Mineral Density Assessment in Comparison to CT Hounsfield Unit Measurements Using Dual X-Ray Absorptiometry as Standard of Reference

Monday, Nov. 26 11:40AM - 11:50AM Room: S102CD

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PURPOSE

To evaluate the diagnostic performance of a phantomless dual-energy computed tomography (DECT) postprocessing algorithm for volumetric bone mineral density (BMD) assessment of the lumbar spine compared to Hounsfield unit (HU) measurements.

METHOD AND MATERIALS

We retrospectively analyzed 200 lumbar vertebrae in 53 patients who had undergone third-generation dual-source DECT and dual x-ray absorptiometry (DXA) examinations of the lumbar spine within 7 days between March and December 2017. For volumetric BMD assessment, dedicated phantomless DECT postprocessing software which allows for freely rotatable color-coded three-dimensional visualization of trabecular BMD distribution using three-material decomposition was applied. In addition, HU measurements were performed on standard bone reconstructions by defining five trabecular regions of interest (ROI) per vertebra. Results of both approaches were compared regarding the diagnostic accuracy using the DXA T-score according to the World Health Organization as standard of reference for detecting osteoporosis.

RESULTS

DXA revealed a total of 92 osteoporotic lumbar vertebrae. A BMD cut-off of 92 mg/cm³ at phantomless DECT yielded 98.9% sensitivity and 91.6% specificity for detecting osteoporosis; 93.3% of vertebrae below this threshold were diagnosed with osteopenia/osteoporosis according to DXA and 80.2% above showed normal BMD at DXA. A trabecular ROI attenuation cut-off of 157 HU showed 71.0% sensitivity and 66.4% specificity for osteoporosis; 73.3% of vertebrae below this threshold were diagnosed with osteopenia/osteoporosis according to DXA and 41.0% above showed normal BMD at DXA. Area under the curve for detecting osteoporosis was 0.953 for phantomless DECT and 0.754 for HU-based analysis (p<0.001). Pearson product-moment correlation showed higher correlation between BMD results of phantomless DECT and DXA (r=0.848) compared to HU and DXA values (r=0.438) (p<0.001).

CONCLUSION

A phantomless DECT postprocessing algorithm for volumetric BMD assessment of the lumbar spine is significantly superior compared to HU measurements regarding the diagnostic accuracy for detecting osteoporosis.

CLINICAL RELEVANCE/APPLICATION

Opportunistic screening for osteoporosis using HU measurements on CT images as previously suggested in recent literature is less accurate than a phantomless color-coded DECT postprocessing algorithm which can be applied to routine DECT without requiring protocol changes.

SSC10-09 Effects of Nutrition, Exercise, and Medication on Bone Microarchitecture Assessed by HR-pQCT Measurements in Long-Term HIV-Infected Individuals

Monday, Nov. 26 11:50AM - 12:00PM Room: S102CD

Participants
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PURPOSE

In long-term HIV-infected individuals, low bone density and increased fracture risk have emerged as significant comorbidities. Our aim was to assess the influence of exercise, nutrition, and medications on bone microarchitecture using high-resolution peripheral quantitative CT (HR-pQCT) in long-term HIV-infected individuals.

METHOD AND MATERIALS

Twenty-nine HIV-infected subjects (3 postmenopausal women, 26 men) were prospectively enrolled in our study (BMI 26.1±4.3 kg/m2, age 56.9±5.6, years diagnosed with HIV 20.7±8.8). Questionnaires included the revised Community Healthy Activities Model Program for Seniors (CHAMPS), the Mini Nutritional Assessment (MNA) as well as medication assessments. Participants underwent radius and tibia HR;pQCT and laboratory evaluation. Multivariable linear regression models were used to evaluate the effects of exercise, nutritional status, tenofovir disoproxil fumarate (TDF) and protease inhibitor (PI) use on bone microarchitecture, adjusting for all demographic risk factors.

CONCLUSION

Cortical bone in HIV-infected individuals is detrimentally affected by malnutrition, while trabecular bone is detrimentally affected by previous use of TDF in combination with a PI. In long-term HIV-infected subjects, nutritional support could potentially be more relevant for bone health compared to physical activity.

CLINICAL RELEVANCE/APPLICATION

Long-term HIV-infected individuals could particularly benefit from nutritional assessment and intervention as well as avoiding use of TDF with PIs to prevent compromised bone health.

SSC11

Neuroradiology/Head and Neck (Trauma Imaging: Picking Up the Pieces)

Monday, Nov. 26 10:30AM - 12:00PM Room: S402AB

ER HN MR NR

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

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Sub-Events

SSC11-01 Collaborative Study of CTA Utilization in Patients Presenting With Blunt Cervical or Head Injury: A Retrospective Assessment of Current Clinical Practice and Its Impact on Clinical Outcome

Monday, Nov. 26 10:30AM - 10:40AM Room: S402AB

Participants
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PURPOSE

Blunt cerebrovascular injury (BCVI) occurs in 0.2-2.7% of blunt trauma patients, and is the cause of stroke in approximately ~2% of all patients and 10-25% of young patients. BCVI patients are at highest risk of stroke within 10-72 hours following injury, with the likelihood of stroke increasing with dissection grade. The Denver screening criteria are the most commonly implemented criteria for screening BCVI.The study aims to quantify the variance of current practice at our institution from the established Denver criteria.

METHOD AND MATERIALS

A retrospective chart review was conducted on consecutive blunt trauma patients admitted to our institution from Jan 1, 2010-Dec 31, 2015. Imaging studies were reviewed by a neuroradiologist and an emergency radiologist. Patients were assessed for clinical and radiological Denver criteria, presence of dissection on CTA, medical history, treatment, and outcome.

RESULTS

3004 consecutive patients were included. 757 (25.2%) patients were Denver positive, but only 336 received a CTA, and nearly half with detectable dissections. Of the Denver positive patients, 54 (7.1%) patients had an in-hospital stroke (total 122 strokes), with 15 (26.8%) patients having a detectable stroke on their primary CT scan. 33 strokes were due to traumatic vessel injury; 43 were due to arterial compression; and 46 did not have a discernable cause, in part due to lack of CTA screening. Of the strokes due to dissection, 3 (9.1%) were Biffl Grade (Gr) 1; 6 (18.2%) Gr2; 12 (36.4%) Gr3; 10 (30.3%) Gr4; 2 patients had an injury in a vessel other than the carotid or vertebral. 7 patients had an arterial injury requiring neurological intervention, including intracranial ICA and ACA pseudoaneurysms. 156 (6.9%) of Denver negative patients underwent CTA, with 19 having detectable dissections. A total of 13 Denver negative patients had stroke, only 3 due to dissection: 2 Gr3 and 1 Gr4.

CONCLUSION

Almost 30% of Denver positive patients have a stroke earlier than the estimated 10-72 hour window, highlighting the need for early medical assessment and preventative measures. CTAs are underutilized and a considerable amount of patients have stroke as a result of lower-grade (1-2) dissections.

CLINICAL RELEVANCE/APPLICATION

Early screening for arterial injury and early insitiution of antiplatelet or interventional therapy, depending on the degree of vessel injury, may help to prevent post traumatic strokes.

SSC11-02 Brain Extraction in Susceptibility-Weighted MR Images Using Deep Learning

Monday, Nov. 26 10:40AM - 10:50AM Room: S402AB

Participants

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PURPOSE

Brain extraction methods in MRI have so far been exclusively developed for T1- and T2-weighted images. A deep neural network is presented to segment the brain tissue in susceptibility-weighted images (SWI) in healthy individuals and patients with traumatic brain injury (TBI).

METHOD AND MATERIALS

In total, MRI scans from 33 patients with moderate to severe TBI and 18 healthy controls were collected. SWIs were acquired with 27ms TR, 20ms TE, 15° flip angle, and 0.98x0.98x1.00mm³ voxel size on a 3T Siemens MRI scanner. A small scale 2D-U-Net was implemented (18 convolution layers, max. 256 features per layer) processing a volume in axial direction. The U-Net architecture allowed the model to utilize both local and contextual information. The output probability maps were thresholded and possible outliers were removed by taking the largest connected component. 20 TBI patients and 10 controls served as a test set, the remaining patients were used for training. The reference standard were brain masks obtained with SPM, a publicly available software package commonly used for brain extractions in MR neuroimaging, but not optimized for SWI sequences. These annotations were visually inspected. The results of the deep learning method were visually inspected for completeness and overall quality. Dice similarity coefficient (DCS) and the modified Hausdorff (MHD) distance were reported for the test set.

RESULTS

The DCS was 0.98±0.002 per volume at the chosen operating point on the SPM standard and the MHD was 0.93±0.11mm per volume. It took less than 10 seconds to compute the complete 3D brain mask on a modern GPU. Overall, our method was capable of learning from a sub-optimal reference standard and extracting the brain from an SWI scan. It mimicked some of the deficiencies of the SPM brain masks, such as occasional failures in the most inferior or superior axial slices, but also mitigated others through generalization over the training set. Holes in the mask caused by contusions or hematomas were less prevalent with the 2D-U-Net than with SPM.

CONCLUSION

The 2D-U-Net method provides fast brain extractions in MR-SWI.

CLINICAL RELEVANCE/APPLICATION

SWI is the best modality to establish the extent of cerebral microbleeds in TBI. Brain extraction in SWI is the first step in the development of computer-aided systems detecting these microbleeds.

SSC11-03 Subconcussive Head Impacts May Alter Metrics Associated with Normal Pruning in Youth and High School Football Players

Monday, Nov. 26 10:50AM - 11:00AM Room: S402AB

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PURPOSE

To determine whether exposure to repetitive subconcussive impacts affects fMRI metrics associated with normal pruning in youth and high school football players over a single season.

METHOD AND MATERIALS

Youth and high school football players are exposed to high numbers of head impacts over the course of a season [1]. The spectral power of resting state networks typically decreases as a function of age and has been interpreted as a sign of normal Gray Matter (GM) pruning [2]. We hypothesized that a season of contact sports will alter this relationship. Specifically, there will be an increase in power of the DMN and consequent change in GM volume (GMV) associated with normal pruning.Sixty age matched players without history of developmental, neurological, or psychiatric abnormalities and no history of concussion during or prior to the season were split into high impact (HI) (24) and low impact (LI) (36) groups, respectively based on each player's risk-weighted cumulative exposure (RWEcp)[3,4]. The RWEcp represents the summed risk of concussion for each impact over the season as derived by the Head Impact Telemetry System (HITS) data [1]. High order ICA (n=60) was performed to extract independent components using the GIFT toolbox [5]. Subject specific time courses for each subject were converted into a power spectrum through power spectral decomposition. Five components of the DMN were identified and changes in the power of the network were computed as post-season minus pre-season values (ΔPSD). Following bonferroni correction, only the anterior cingulate network

demonstrated a significant difference in ΔPSD and was used as a mask to determine GMV using VBM8. A two-sample t-test was performed to determine significant changes in ΔPSD and ΔGMV between the groups.

RESULTS

The frontal DMN (FDMN) demonstrated a significant increase in power in the HI group (p-value: 0.00018). A significant increase in GM volume was found in the same frontal regions of the DMN (p-value: 0.005) (Fig.1) for HI group.

CONCLUSION

Our results suggests that normal GM pruning is affected in the HI group, over a single season of contact sport. Longitudinal studies are needed to understand the long-term changes in resting state networks and effects on functional brain health.

CLINICAL RELEVANCE/APPLICATION

This work demonstrates that playing a season of contact sports may affect normal GM pruning in high school and youth football players

SSC11-04 Source Space MEG Delta Waves Increase Following Concussion

Monday, Nov. 26 11:00AM - 11:10AM Room: S402AB

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PURPOSE

The purpose of this study is to determine if delta waves, measured by magnetoencephalography (MEG), increase due to a sports concussion.

METHOD AND MATERIALS

From a larger study on subconcussive impacts in high school football, five players were diagnosed with a concussion during the season (mean age=16.1). Subjects followed returned-to-play protocols. Eight minutes of eyes-open, resting-state MEG data were acquired for each subject and control using a 275 channel CTF whole-head system. Football players were scanned pre-season, within 36 hours post-concussion, and post-season. Seven age and gender matched non-contact sports athletes (controls) were also recruited (mean age=16.2). Controls received baseline and follow-up scans 4 months later. Using Brainstorm, MEG data were baseline corrected, band-stop filtered (60Hz), down-sampled to 250Hz, and band-pass filtered to 1-100Hz. Eye blinks, and muscle artifacts were removed using independent component analysis. Data was source localized using a minimum norm method. The average whole-brain power of the delta frequency and total power was computed for each scan. The delta frequency power was normalized by the total power. In the concussed football players, pre-season delta power was subtracted from post-concussion delta power. For the control subjects, baseline delta power was subtracted from the 4-month follow-up scan. A t-test was performed to compare the change in delta power of controls to the change in delta power of concussed football players.

RESULTS

The change in delta power following concussion was significantly different from controls (p=0.014). In addition to the statistical difference, delta waves visibly increased from pre-season to post-concussion (Figure 1).

CONCLUSION

We demonstrate that a single concussion can visibly and statistically increase delta frequency power in MEG.

CLINICAL RELEVANCE/APPLICATION

Traditional imaging is typically unremarkable in concussion. This study demonstrates that MEG may be a new and useful diagnostic tool for concussion.

SSC11-06 Longitudinal Hippocampal Subfield Volume Changes in Collegiate Football Athletes

Monday, Nov. 26 11:20AM - 11:30AM Room: S402AB

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PURPOSE

Collegiate football athletes are subject to repeated head impacts. The hippocampus, a structure crucial for memory, is of particular interest in the study of football. There is a lack of prospective, longitudinal data on the hippocampus in football.

METHOD AND MATERIALS

A prospective cohort study was conducted over a 4-year period composed of 63 football and 34 volleyball male collegiate athletes. Automated segmentation provided hippocampal subfield volumes from whole brain axial T1 images and high-resolution coronal-oblique T2 images. At baseline, these volumes were linearly regressed to compare football with volleyball. For the longitudinal data, a linear mixed-effects model assessed the interaction between sport and time.

RESULTS

Comparing sports at baseline, the football athlete group showed a smaller subiculum volume (coefficient=-67.77, 95% CI [-120.20, -15.33], P=.012). The longitudinal interaction between sport and time demonstrated a significant decrease in total hippocampal volume in athletes who play football relative to volleyball (coefficient=-90.27, 95%CI [-177.05, -3.48], P=.041), most significantly within the CA1 hippocampal subfield (coefficient=-28.55, 95%CI [-50.94, -6.17], P=.012). This interaction within CA1 was significant even when in-study concussions were excluded (coefficient=-34.22, 95%CI [-60.79, -7.65], P=.012). Within the right CA1, this volume decrement was observed in football even in isolation from volleyball (coefficient=-22.96, 95%CI [-40.13,-5.80], P=.009).

CONCLUSION

A prospective longitudinal evaluation comparing football and volleyball athletes showed a decrease in hippocampal volumes over time in football athletes. This longitudinal divergence was most significant in CA1, in contradistinction to baseline differences that were most significant in the downstream subiculum.

CLINICAL RELEVANCE/APPLICATION

Given these observed hippocampal volume alterations, further research must be done to assess the potential relevance to cognitive function.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Max Wintermark, MD - 2018 Honored Educator

SSC11-08 Detection of Mild Traumatic Brain Injury by Support Vector Machine Classification with Voxel-Mirrored Homotopic Connectivity: A Longitudinal Perspective

Monday, Nov. 26 11:40AM - 11:50AM Room: S402AB

Participants
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PURPOSE

To examine dynamic inter-hemispheric functional connectivity in mild traumatic brain injury (mTBI) patients with longitudinal observations and how machine learning can be used alongside voxel mirrored homotopic connectivity (VMHC) to accurately separate mTBI patients from healthy controls and predict the future long-term development of clinical significant cognitive impairment following mTBI.

METHOD AND MATERIALS

Sixty-one patients with mTBI and forty-four age- and gender-matched subjects underwent clinical and neuropsychological evaluations with fMRI scanning. All of patients was initially evaluated within 14 days post-injury and follow-up at 6-12 months.We adopted VMHC to quantifies the functional connectivity between bilateral homotopic voxels. Next, the multivariate analysis of VMHC results was performed with linear support vector machines (SVM). The commonly affected functional brain regions were selected as the feature metrics combined with SVM to predict clinical outcome in individual patients.

RESULTS

Compared with healthy controls, mTBI patients showed decreased VMHC in the dorsal lateral prefrontal cortex and supplementary motor area and increased VMHC in the ventrolateral prefrontal cortex, orbitofrontal cortex and posterior cingulate cortex(P <0.005) in sub-acute phase. In 6-12 months, decreased regions were completely disappeared while original increased regions showed continuously and extend patterns. The SVM classifier based on the sub-acute phase VMHC results yielded an accuracy rate of 82% (with a sensitivity of 88.1% and specificity of 92.9%) after 1000 permutation, which was significantly better than chance (P<0.005). Combined the sub-acute phase VMHC results with support vector regression machines, we found significant positive correlations between actual neuropsychological values and predicted values in three clinical tests (PSS, R2 = 0.83; HAMD, R2 =0.87; FSS, R2 =0.91).

CONCLUSION

The VMHC results successfully revealed the time correlated functional connectivity alteration in some particular brain regions and their association with clinical outcomes. We further provided evidence that using VMHC with machine learning approache has the potential to augment diagnosis in individual patients following mTBI.

CLINICAL RELEVANCE/APPLICATION

We demonstrate relationships between inter-hemispheric functional connectivity abnormalities and predictions about individual patients' clinical outcomes.

SSC11-09 Is a Follow-Up CT After 4 Hours Necessary for Falx and Tentorial SDH?

Monday, Nov. 26 11:50AM - 12:00PM Room: S402AB

Participants
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PURPOSE

The mandatory 4 hour follow-up CT (4Hr-CT) has been the standard for patients with traumatic intracranial hemorrhage, including Subdural Hematoma (SDH) in the Tentorium (T-SDH) and Falx (F-SDH). The purpose of this study was to assess the effectiveness of 4Hr-CT for isolated F-SDH and T-SDH in the management of traumatic intracranial hemorrhage.

METHOD AND MATERIALS

182 consecutive cases with acute SDH treated at a major trauma center between December 2015 and March 2018 were retrospectively reviewed. Isolated F-SDH and/or T-SDH were identified in 54 patients (30%). All patients had initial and 4-HrCT. The size of the SDH was measured parallel or perpendicular to the falx or tentorium (long and short axis, respectively). The morphology of the SDH, mass effect, extent of involvement and interval change at 4-HrCT were evaluated.

RESULTS

All the F-SDH and T-SDH had a pancake-like configuration with the long-axis (median 38 mm) greater than the short axis (median 3 mm) by 10 fold on average (p<0.001). An interval increase along the short axis was seen in only 5 F-SDH (16%) and 7 T-SDH (19%), with a maximum change of 2 mm. Interval increases were more prominent along the long axis: 18 F-SDH (56%) and 19 T-SDH (51%), with a maximum change of 118 mm and 21 mm, respectively. F-SDH and T-SDH were contiguous in 14 out of the 18 patients with both hematomas. No patients had worsening focal neurological findings after initial diagnosis required surgical intervention or died during their hospital stay (rate 0%, 95% CI 0-6.6%).

CONCLUSION

Based upon our limited data, the current standard protocol of a mandatory 4-hour follow-up CT is not cost-effective in the management of patients with isolated F-SDH and/or T-SDH. These SDHs expand minimally along the short axis, if at all, without causing significant mass effect. The high incidence of continuity between co-existing F-SDH and T-SDH, characteristic anatomic structure, and deformability of the tentorium and falx may serve as a natural barrier limiting the overall growth of SDH, while providing potential space for decompression by longitudinal spread of the SDH.

CLINICAL RELEVANCE/APPLICATION

The current standard protocol of a mandatory 4-hour follow-up CT for acute intracranial hemorrhage is not needed for patients with isolated Falx and/or Tentorium Subdural Hematoma.

SSC12

Physics (MR: New Techniques, Systems, Evaluation)

Monday, Nov. 26 10:30AM - 12:00PM Room: N226

AI 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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Sub-Events

SSC12-01 Impact of Respiratory Training in Improving Image Quality: A Study Based on Free Breathing T1 Star VIBE MRI

Monday, Nov. 26 10:30AM - 10:40AM Room: N226

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PURPOSE

Our objective was to estimate the impact of respiratory training in improving image quality of images obtained from T1 Star VIBE magnetic resonance imaging (MRI).

METHOD AND MATERIALS

This prospective study was approved by the local ethics committee. Totally of 6 volunteers were in the study. The volunteers underwent 3 Tesla MR scanner (Siemens-Skyra) using T1 Star VIBE for two times within 24-48h. The MRI protocol (MAGNETOM 3.0T SKYRA MR scanner, Siemens healthcare, Erlangen, Germany) included a Prototyped T1-weighted 3D Star VIBE sequence(TE/TR:1.39/2.79,slice thickness 1.2mm)and T2 blade. The volunteers accepted MRI examination directly at the first scan, while they receive respiratory training before the MRI examination to make them keeping calm and breathing evenly. The observation of lung markings were used to evaluate image quality of each examination. The display of lung markings were observed in three zone (upper, middle and bottom according to the T4 and T8 vertebra level) by two experienced radiologists independently. And a 3-point system were used (3-point: no artifacts, noise, or with a little artifacts, less noise, the image quality is better; 2-point: more artifacts, more noise, image quality is acceptable; 1-point: obvious artifacts, large noise, image quality is poor.) The image quality of T1 Star VIBE MRI in two scans were compared.

RESULTS

All the volunteers finished MRI examination. The image quality scores of three zones(upper, middle and bottom)in first scans were 2.5±0.55,2.17±0.75,1.5±0.55, and those were 2.83±0.41,2.67±0.52,2.33±0.82 in the second scans. The image quality scores of the lower part of the lungs had significant difference among the two groups(t=2.71,p=0.042).

CONCLUSION

Respiratory training could improve the image quality,especially at the bottom of the lung and increase the lesion detection rate and accuracy of diagnosis.

CLINICAL RELEVANCE/APPLICATION

Respiratory training may be used to improve the image quality of images obtained from T1 Star VIBE magnetic resonance imaging.

SSC12-02 MRI Safety: Digital Measurement of Magnetically Induced Torque Based on ASTM F2213

Monday, Nov. 26 10:40AM - 10:50AM Room: N226

Participants
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CONCLUSION

Ferromagnetic stainless steel screws may exhibit large magnetically induced torque within the homogeneous magnetic field during MRI examination. For analysing of these magnetically induced torque a digital measuring device could be developed, which allows to simplify and accelerated the standard test method ASTM F2213.

Background

Performing MRI examinations in patients who use implantable medical devices involve safety risks both for the patient and the implant. The aim was a digital measuring device for measuring magnetically induced torque on medical implants in magnetic field center of 1.5T and 3T MR scanner.

Evaluation

An MR-safe measuring platform was developed according to the standard ASTM F2213 and combined with a precision balance (PCB 1600-2, Kern & Shon GmbH, Germany). The evaluation was performed with stainless steel screws (length 24, 47 and 71 mm) and a neurostimulator (LibraXP, St. Jude Medical, USA) in the magnetic field center of a 1.5T and 3T MRI (Magnetom Avanto and Magnetom Prisma, Siemens, Germany). The torque was measured at 10-degree increments as the implant was rotated relative to the static magnetic field for all possible orientations of the object.

Discussion

The measured force depends on the object orientation within the static magnetic field. The neurostimulator had a torque of 1 +- 1 N*mm (maximum 3 N*mm) for a rotation about the vertical axis, 39 +- 20 Nmm (maximum 64 N*mm) for rotation about the longitudinal axis and 40 +- 20 N * mm (maximum 64 N*mm)) for a rotation about the transverse axis. This corresponds to a maximum acting force of 1.28 N (mass 0.131 kg). The magnetostatic torque is proportional to the length of the test object. For the stainless steel screws, the torque is 66 +- 37 N*mm (maximum 108 N*mm) for a length of 24 mm, 139 +- 86 Nmm (maximum 247 N*mm) for a length of 47 mm and 252 +- 145 Nmm (maximum 434 N*mm) for a length of 71 mm.

SSC12-03 Numerical Simulation of Thermal Risk Assessment for a Compact MR Scanner

Monday, Nov. 26 10:50AM - 11:00AM Room: N226

Participants
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PURPOSE

Brain imaging on conventional MRI scanners commonly relies on a whole-body (WB) radiofrequency (RF) transmit coil to provide a uniform excitation (B1+) field. As such, patient RF power deposition may be an issue during high RF duty-cycle scanning. A recently developed compact 3T (C3T) MRI scanner with high performance gradients [1,2] has a dedicated RF transmit coil that exposes only the head region. For neuroimaging, the C3T scanner may provide lower RF power deposition compared to conventional WB scanners, thus enabling the development of advanced neuroimaging techniques.

METHOD AND MATERIALS

A 16-rung high-pass birdcage head coil (127.74 MHz, 37-cm ID, driven in quadrature) was modelled using full-wave electromagnetic FDTD simulation software, Sim4Life (ZMT, Zurich, Switzerland). Simulations were performed to predict specific absorption rate (SAR) distributions using the Duke human body model as a test phantom at a landmark location of the glabella. A large-diameter standard 3T 16-rung WB birdcage coil was also modeled for comparison. Input power on the larger coil was scaled to reach the same average B1+ for the glabella slice as in the C3T, and scaled SAR maps were used as inputs to a time-dependent Penne's bioheat equation [3] thermal solver. All thermal simulations were run using 200W continuous input power for 60 minutes, with the proper scaling for the WB coil according to B1+. All material properties were set to nominal literature values [4].

RESULTS

The following were observed as a result of the simulations of the C3T compared to whole-body MRI: (i) ~20% reduced average SAR in the head and neck region, (ii) lower (5.5°C vs 6.5°C) peak temperature rise in the brain regions, and (iii) minimal (~0°C) temperature rise in the neck region was observed in the C3T scanner compared to the ~7°C rise in the WB MRI, due to reduced body mass exposure in the dedicated scanner.

CONCLUSION

The C3T provides a reduction of ~20% in thermal risk over a conventional whole-body MRI due to the much smaller exposed body mass to achieve the same B1+ excitation field in the brain. This allows for improved performance from the SAR demanding applications. 1.FooT,MRM,2018 2.WeaversP,MPhys,2016 3.Pennes.JAPhys1948 4.GabrielS,PMB1996

CLINICAL RELEVANCE/APPLICATION

Advanced neuroimaging techniques require faster imaging thus creating potential for increased patient heating. Here we investigate the thermal risk of a recently developed head-only MRI scanner.

SSC12-04 Improving Resolution, Distortion, and SNR of Clinical Diffusion Weighted Images Using Deep Learning

Monday, Nov. 26 11:00AM - 11:10AM Room: N226

Participants
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PURPOSE

Diffusion weighted images (DWI) are commonly acquired with single-shot Echo-planar imaging (EPI) sequence, which is suffered from image distortion due to eddy current and B0 field inhomogeneity as well as low resolution especially in clinical settings. Multi-shot DWI has been demonstrated to outperform single-shot DWI in these aspects with optimized SNR. However, multi-shot DWI has not been widely adopted clinically due to long scan time.

METHOD AND MATERIALS

We proposed a method of generating high-quality DWI from its low-quality counterpart using fully convolutional neural network. Brain DWI data were acquired with a 3T MR system (uMR 780) using both single-shot (128*128) and four-shots (160*160) EPI sequences. The multi-shot EPI DWI, which has higher resolution and less distortion, served as ground truth in training process. Our dataset contains 38 pairs of single-shot and multi-shot DWI. Each pair of images were resized to 320x320 and then cropped randomly to generate 50 patches (128x128). To make full use of available data and reduce the bias, we adopted a 10-fold cross validation in experiments.

RESULTS

For quantitative evaluation, we calculated peak signal-to-noise ratio (PSNR) and structural similarity index (SSIM). Results showed that the proposed method gain 4.2dB in PSNR and 0.22 in SSIM compared with single-shot DWI. Additionally, perceptual results showed that our neural network can recover details and reduce distortion in single-shot DWI.

CONCLUSION

Results imply that we can improve resolution, SNR and reduce distortion of single-shot EPI-DWI using deep neural network, which potentially enables acquiring high quality DWI without lengthening scan time.

CLINICAL RELEVANCE/APPLICATION

This method could improve resolution, SNR and reduce distortion of clinical DW images without lengthening scan time.

SSC12-05 Fast Field-Cycling MRI Technology: Prototype Human Scanner and First Clinical Results

Monday, Nov. 26 11:10AM - 11:20AM Room: N226

Participants
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PURPOSE

A prototype human-scale Fast Field-Cycling (FFC) MRI scanner has been built, allowing good quality images at ultra-low field (0.2 mT) with enhanced T1-contrast. It has been used to image the brain in patients with acute ischemic stroke.

METHOD AND MATERIALS

FFC-MRI is a new method, designed to image at ultra-low field while preserving signal-to-noise ratio (SNR) and image quality. The main field (B0) is switched between values during the pulse sequence, with polarization at the scanner's highest field, evolution (relaxation) at low field, followed by gradients, RF pulses and signal detection at high field. Our in-house-built prototype scanner has a water-cooled resistive magnet (Tesla Engineering, UK; bore 0.5 m, length 2 m) providing a maximum field of 0.2 T, with the evolution field controllable between 0.2 mT and 0.2 T; switching time between fields is 20 ms. A home-built head birdcage coil (8.5 MHz) was used. Scanner control is via a commercial console (MR Solutions, UK), running pulse sequences which include control of B0. Magnet current (up to 1950 A) is from a low-noise power supply amplifier (International Electric Company, Finland). Following research ethics committee approval, patients (N=10) with acute ischemic stroke were recruited and gave informed consent. They were scanned by FFC-MRI within 24-96 h after presentation. Duration of the FFC-MRI examination was typically 45 minutes, including setup, scout and FFC images at five evolution fields (0.2 mT to 200 mT). Patients were scanned by CT prior to FFC-MRI and some had 3 T MRI (N=2) including DWI.

RESULTS

The usable range of B0 during the evolution period was validated in phantoms. In scans of patients with acute ischemic stroke, T1-

weighted FFC-MRI images exhibited hyper-intense regions, with contrast increasing markedly as the evolution magnetic strength field decreased, with maximum lesion intensity at the lowest field used (0.2 mT). The infarct region seen by FFC-MRI correlated well with the appearance in CT and DWI (where appropriate) images.

CONCLUSION

A whole-body FFC-MRI scanner was built and has been used to image the brain in patients with ischemic stroke, in the first-ever clinical demonstration of this technology.

CLINICAL RELEVANCE/APPLICATION

FFC-MRI is a new modality which can generate diagnostic-quality images at ultra-low magnetic fields (e.g. 0.2 mT), with significantly-enhanced endogenous T1-contrast compared to conventional MRI.

SSC12-06 Joint Cardiovascular Magnetic Resonance Image Reconstruction and Segmentation Using Deep Learning Image-to-Image Translation

Monday, Nov. 26 11:20AM - 11:30AM Room: N226

Participants
James W. Goldfarb, PhD, Roslyn, NY (*Presenter*) Nothing to Disclose
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PURPOSE

To develop and test a joint image reconstruction and semantic segmentation method for functional right and left ventricular cardiovascular MR imaging.

METHOD AND MATERIALS

Image-to-image translation using a generative adversarial network (GAN) was implemented using PyTorch v 0.3.0, translating source radial CMR sinograms (r-theta space) to semantic segmentation of the left and right ventricles. 1700 short axis cardiac MR images were used for training (n=1400), simulation and validation(n=300). Each had expert manual segmentation of the LV and RV bloodpools. Deep learning via a U-net convolutional neural network was used for image-to-image translation (so-called 'pix2pix'), providing semantic segmentation masks of the RV and LV directly from raw CMR k-space data. The U-net Generator was trained with an adversarial loss for 100 epochs. Reconstruction/segmentation of the RV and LV was studied with undersampling factors of up to 8. The Sørensen-Dice similarity index was used to compare RV and LV masks to manual segmentation in validation data, undersampled simulations, and prospectively collected CMR radial exams (n=15).

RESULTS

The GAN trained quickly, providing excellent segmentation of both the LV and RV with LV Dice index= 0.989±0.003 (range: 0.975-0.996) and RV Dice Index = 0.986±0.005 (range: 0.938-0.995). Deep learning provided segmentation consistent with clinical standards, where trabeculae and papillary muscles are included inside of ventricular bloodpool segmentations. With an acceleration factor of 8, quality segmentations were maintained with slightly reduced Dice Indices: LV Dice index= 0.961±0.016 (range: 0.872 - 0.993); RV Dice index= 0.937±0.023 (range: 0.734-0.981). In-vivo prospective reconstructions using complex radial CMR data yielded similar Dice Indices.

CONCLUSION

Image-to-image translation is a viable method for radial MR image reconstruction and provides a framework for image reconstruction, acceleration and segmentation. In this proof-of-concept study, simulations confirmed the feasibility of quantitative LV and RV imaging with image-to-image translation and prospective in vivo radial imaging yielded encouraging results with acceleration factors of up to 8.

CLINICAL RELEVANCE/APPLICATION

A deep learning approach is presented which 'translates' CMR data directly to quantitative LV and RV segmentation and eliminates the need for conventional backprojection and gridding along with manual segmentation.

SSC12-07 Optimization of Pulse Sequence Ordering for Automated Fat and Iron Quantification

Monday, Nov. 26 11:30AM - 11:40AM Room: N226

Participants
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PURPOSE

Commercially available pulse sequences with dedicated post-processing software can automate the creation of maps for fat and iron quantification and make them readily available on picture archiving and communication systems (PACS) workstations, obviating the need for dedicated post-processing to be performed by the radiologist. These most commonly use a gradient multi-echo Dixon technique for derivation of fat percent (or per mille, "per thousand") and R2*, from which iron deposition can be extrapolated. However, as patients at risk for fat or iron accumulation generally also have diffuse liver disease, these scans are often combined with contrast-enhanced imaging using a hepatobiliary agent (e.g., gadoxetate disodium) with a 20-minute delayed scan in the hepatobiliary phase for improved lesion detection. This results in "down time" between the equilibration phase, generally before 5 minutes after contrast administration, and the hepatobiliary phase. It is attractive to perform as many pulse sequences as possible during this "down time," but only if they are not adversely affected by the accumulation of the contrast agent and concomitant T1- and T2-shortening. Although acquisition of the fat- and iron-quantification could be acquired after contrast administration, the degree to which contrast accumulation affects signal for these acquisitions is unknown.

RESULTS

Twelve subjects were identified. Two were excluded as outliers (one for severe steatosis, one for iron overload). Adequate measurement of FP and R2* was performed before and after contrast for the remaining 10 patients. The student's t-test showed no significant difference for FP (p=0.21) but a significant increase in measured R2* after contrast (p=0.02). The control chart shows increased variability for those R2* values acquired after contrast.

CONCLUSION

Time is the ultimate non-renewable resource. Therefore, time optimization of magnetic resonance imaging is an important consideration for optimal utilization of resources. However, this should not sacrifice diagnostic accuracy, and thereby decrease value. This investigation of fat and iron quantification shows that fat quantification appears relatively unaffected by accumulation of a T1- and T2*-shortening contrast agent, whereas R2* is unreliably increased in this setting. Fat/water quantification to measure the degree of steatosis might therefore be possible in the delayed post-contrast phase, whereas quantification of iron accumulation must be done prior to contrast administration. The control chart in this case shows the opposite of the expected effect for R2*, with an increase in variability after the intervention (contrast administration).

METHODS

The gradient multi-echo Dixon sequences were acquired before and approximately 15 minutes after administration of gadoxetate disodium (Eovist, Bayer) at 0.025 mmol/kg and 2.0 mL/sec (LiverLab q-Dixon, Siemens Healthineers, TR/TE 15.6/2.4, 4 degree flip angle, 3.5 mm slice thickness) with automated deconvolution of R2* and fat per mille (FP) maps on the scanner and sent to PACS. All sequential patients during one month were de-identified and a region of interest at least 3 cm in diameter was drawn on a motion-free image of the right lobe, with the average value recorded. The values before and after administration of gadoxetate disodium were evaluated using paired student's t-test. A "control chart" is created showing values before and after administration of contrast.

PDF UPLOAD

http://abstract.rsna.org/uploads/2018/18016666/18016666_hnxa.pdf

SSC12-08 Management of Image Artifacts on a Clinical 7T MRI Scanner

Monday, Nov. 26 11:40AM - 11:50AM Room: N226

Participants
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PURPOSE

In 2017, 7T MRI entered the clinical arena with a first scanner obtaining 510(k) FDA clearance for clinical brain and knee imaging. As with previous generations of 7T (research) scanners, significant image artifacts were prevalent in the images from this system, arising from the underlying physics of the interaction of the 297 MHz radiofrequency (RF) energy with the dielectric properties of tissue and also from RF coil issues. In this paper, we present the development of techniques to mitigate these artifacts.

METHOD AND MATERIALS

Image non-uniformities arising from B1+ transmit (due to complex interference of RF waves) and B1- receive (due to RF coil receiver sensitivity problems) inhomogeneities were mitigated through the use of custom-made high permittivity dielectric pads made from a combination of CaTiO3, BaTiO3, hydroxyethyl-cellulose and D2O. Pads of differing dimensions were developed for different anatomical sites. Inter-voxel dephasing with signal drop-out due to significant magnetic susceptibility effects (e.g. at the base of the brain) was minimized through the use of localized B0 shimming techniques. DIstortions arising from long echo trains were mitigated throguh the use of high image acquisition acceleration factors facilitated by the SNR increase at 7T. Control of receiver and transmitter bandwidths were used to minimize the in- and through-plane chemical shift artifacts.

RESULTS

Tailored dielectric pads increased the SNR in areas of signal deficit by up to 27% and improved overall image uniformity. Clinical protocols were established for routine scanning in the brain (e.g. for seizure, tramautic brain injury, neurovascular diseases, fMRI-based surgical planning) and knee (e.g. meniscal tear, nerve visualization, cartilage repair); example images will be presented.

CONCLUSION

7T MRI offers significant advantages over lower-field systems, arising primarily from increased SNR and image contrast possibilities. However, the successful management of image artifacts and the development of consistent diagnostic image quality across all patient cohorts is key to its integration into a routine clinical workflow.

CLINICAL RELEVANCE/APPLICATION

This paper presents clinical protocols developed on a new generation of 7T MRI scanner, which successfully managed image artifacts and resulted in diagnostic image quality.

SSC12-09 Evaluation of Deep-Learning-Based Technology for Reducing Gadolinium Dosage in Contrast-Enhanced MRI Exams

Monday, Nov. 26 11:50AM - 12:00PM Room: N226

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

Gadolinium Deposition is one of the most urgent issues facing radiology community. In this work, we further validated a Deep Learning based contrast-boost method, on 200 patients with mixed indications, and demonstrated the generalization and robustness of the deep learning based solution to reducing gadolinium dosage while maintaining diagnostic quality.

METHOD AND MATERIALS

Dataset: A cohort of 200 patients were included in this study, with mixed indications and recieving clinically routine contrast-enhanced MRI (CE-MRI) exams. Sequences: Pre-contrast (zero-dose), post-contrast after 10% dosage administration (low-dose) and post-contrast after 100% dosage administration (full-dose) was collected with 3D T1 IR-FSPGR sequences for each patient. Method: Different series from the same patient wer corregistered and normalized. A deep convolutional neural network (3D U-Net) was trained to learn the approximation of the full-dose CE-MRI using low-dose and zero-dose images. 5-fold cross-validation was used to generate results for evaluation. Evaluation: Quantitatve metrics (PSNR, RMSE, SSIM) were used to evaluate the improvement of the enhanced contrast using deep learning. Qualitative metrics (image quality, contrast enhancement quality) were used to evaluate the result of the DL based enhancement. A non-infereiority test was conducted to demonstrate the performance of the method and validate the capability of reducing dosage without image quality loss.

RESULTS

Quantitative metrics demonstrated consistent (~4dB in PSNR and 10% in SSIM) and significant ($p<0.001$) quality improvement of the deep learning based solution, compared with low-dose CE-MRI. Qualitative ratings showed non-significant differences between the proposed method and acquired full-dose CE-MRI images, which was also verified with the non-inferiority testing. Initial results also demonstrated the possibility of synthesizing full-dose CE-MRI images with zero-dose MR images only.

CONCLUSION

With a large dataset, we demonstrated the DL solution can generalize well, achieving robust and significant quality improvement over the low-dose CE-MRI, using 10% or even less gadolinum dosage. It enables significantly (at least 10x) gadolinium dosage reduction without sacrificing diagnositic quality.

CLINICAL RELEVANCE/APPLICATION

Deep Learning solution is valuable in clinical radiology for fighting against gadolinium deposition.

Honored Educators

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SSC13

Physics (CT: New Systems)

Monday, Nov. 26 10:30AM - 12:00PM Room: N230B

CT PH

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

FDA Discussions may include off-label uses.

Participants
Marc Kachelriess, PhD, Heidelberg, Germany (*Moderator*) Nothing to Disclose
Ge Wang, PhD, troy, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSC13-01 Dynamic Fluence Field Modulation in CT with Multiple Aperture Devices

Monday, Nov. 26 10:30AM - 10:40AM Room: N230B

Participants
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PURPOSE

This work reports the implementation and assessment of a novel beam filter to achieve dynamic fluence field modulation (FFM) on x-ray CT systems.

METHOD AND MATERIALS

Multiple aperture devices (MADs) are designed and constructed with fine-scale alternating tungsten bars and air gaps to control the local transmission of x-rays. Relative motion between two MADs in sequence yields Moiré patterns permitting a wide range of fluence modulation profiles with small displacements. In physical experiments, dual MADs were combined with view-dependent mAs modulation to achieve phantom-specific FFM for different imaging objectives including, e.g., 1) a minimum mean variance objective to minimizes mean variance in filtered-backprojection reconstruction, and 2) a flat-field objective to homogenize noise in the reconstruction. Novel pre-processing approaches were developed to accommodate ray-dependent physical effects induced by the filters and to provide artifact-free reconstructions. Image quality assessments were performed for an ellipse phantom (25.8x14.1 cm) and a CatPhan sensitometry module.

RESULTS

The dual-MAD module is compact and yields narrow to wide fluence profiles covering 31.2° to 66.5° of the fan beam with just 0.44 mm of relative motion. The augmented pre-processing chain alleviates ring artifacts that are present in conventional gain correction methods while preserving high frequency structures in the phantom. Noise properties associated with the two imaging objectives agree with theoretical expectations, with the flat-field objective producing nearly homogeneous and isotropic noise, and with the minimum mean variance objective yielding the lowest average noise.

CONCLUSION

The dual MAD filter provides an effective approach to deliver dynamic FFM and image quality control for different imaging objectives and variable patient anatomies whereas traditional static bowtie filters cannot accommodate asymmetric patient cross-sections or varying patient size. The small form factor of the MAD system and the sub-mm motion requirement facilitates FFM implementation on clinical CT scanner.

CLINICAL RELEVANCE/APPLICATION

The dual MAD filter facilitates dynamic FFM on diagnostic CT, which allows dose reduction and image quality control customized to the specific anatomy of the patient.

SSC13-02 Imaging With a Full FOV Silicon-Based Spectral Photon-Counting Detector in a Clinical CT Gantry

Monday, Nov. 26 10:40AM - 10:50AM Room: N230B

Participants
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PURPOSE

A spectral photon-counting silicon edge-on detector with full field-of-view (FOV) has been mounted in a clinical CT gantry and evaluated for imaging. The aim is to demonstrate the benefit of high-resolution spectral photon-counting imaging in a clinical environment.

METHOD AND MATERIALS

The detector is based on high-resolution edge-on silicon-strip sensors. It has 2 slices, 50 cm FOV and is mounted on a clinical GE Lightspeed VCT gantry. The sensors have 8 energy bins that are used for spectral imaging, i.e. material decomposition. The x-ray tube is operated at clinically relevant fluxes.

RESULTS

The small detector pixels allow high-resolution imaging which will be demonstrated on anthropomorphic phantoms. High-resolution image acquisition also allows reducing the image noise for maintained spatial resolution (e.g. matching today's detector with 1mm pixels) and this effect is demonstrated for a soft-tissue imaging task. A demonstration of the spectral capability for separating materials (iodine, calcium and soft-tissue) is presented. Count-rate and pile-up are hot topics for photon-counting detectors in clinical environments. Here, the effect on the image quality when going up in the high-flux regime is demonstrated. It will be shown that the high-speed ASIC, together with the small pixels and the segmented edge-on design, is capable of handling very high count-rates without significant loss of image quality.

CONCLUSION

Silicon-based spectral photon-counting detectors are promising for use in high-flux clinical CT. The benefits from the higher resolution, better dose efficiency and spectral capabilities could lead to a new era in medical CT imaging.

CLINICAL RELEVANCE/APPLICATION

Photon-counting spectral detectors are emerging for use in clinical CT and the potential advantages are many, including: high-resolution, low-dose capability and full spectral imaging (simultaneous acquisition of more than 2 energies). Many studies have presented results from CZT-based prototype detectors, but this is to our knowledge the first full field-of-view clinical prototype of a silicon-based photon-counting detector. The benefits of silicon as a detector material include: high-resolution, spectral fidelity, count-rate resistance and manufacturability.

SSC13-03 Using 3D Depth Camera for Precise Automatic Patient Positioning in Computed Tomography

Monday, Nov. 26 10:50AM - 11:00AM Room: N230B

Participants
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PURPOSE

The aim of this study was to evaluate the accuracy of a three-dimensional (3D) camera algorithm for automatic and individualized patient positioning based on body surface detection and to compare the results with manual positioning performed by technologists in routinely obtained chest and abdomen computed tomography (CT).

METHOD AND MATERIALS

This study included data of 120 patients undergoing clinically CTs. 52 patients were scanned with CT using a table height manually selected by technologists; while other 68 were automatically positioned based on patient-specific body surface and contour detection. The ground truth table height was defined as the table height that aligns the axial center of the patient's body and the scanner isocenter. Off-centering was defined as the difference between the TGT and the table position actually used the CT. The t-test was performed to determine the significance of the differences in the vertical offset when automatic vs manual positioning was used. Chi-square test was used to check whether there was a relationship between patient size and the magnitude of off-centering.

RESULTS

We found a significant improvement in patient centering (offset of 5±3 mm) when using the automatic positioning algorithm with the 3D camera compared to manual positioning (offset of 19±10mm) performed by technologists ($p<0.005$). The absolute maximal offset was 39 mm and 43 mm for chest and abdomen CT, respectively, when patients were positioned manually, while with automatic positioning using the 3D camera the offset did not exceede15 mm. In chest CTs with manual patient positioning, the Chi-square test has shown the significant statistical correlation between the vertical offset > 20 mm and the patient size (BMI > 26 kg/m2)

(p<0.001). While in case of abdomen examinations this relationship was found to be insignificant (p=0.38).

CONCLUSION

The study indicates that automatic patient positioning using an algorithm based on 3D patient surface detection provides better patient centering as compared to manual positioning performed by technologist.

CLINICAL RELEVANCE/APPLICATION

Automatic individualized patient positioning can be successfully applied in the clinical routine for accurate patient positioning and in better radiation dose utilization.

SSC13-04 X-ray Induced Acoustic Computed Tomography (XACT): A Novel Technique for Low-Dose, High-Resolution, CT imaging

Monday, Nov. 26 11:00AM - 11:10AM Room: N230B

Participants
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PURPOSE

We are developing a low-dose, high resolution imaging modality, x-ray induced acoustic tomography (XACT). This novel technique can yield 3D x-ray bone density images via a single projection of a pulsed x-ray, therefore considerably lowering patient dose. In addition, XACT resolution is higher than that of conventional CT, with expected resolutions in the range of 100um.

METHOD AND MATERIALS

In XACT, a pulsed x-ray beam is absorbed by a sample. The absorbed x-ray energy is converted into heat and the subsequent thermoelastic expansion results in the emission of a detectable ultrasound (US) signal. This US is a spherical wave, and so yields 3D information. The detected signal can be used to compute the x-ray absorption, and important 3D clinical information. We have constructed an XACT imaging system, which previously imaged a lead sample We have extended the imaging capability of this system to biological samples and have acquired a signal from a chicken bone. We have optimized the signal generation, detection, and image reconstruction of this system. We aim to image biological samples using XACT and a transducer array to maximize imaging speed and utility.

RESULTS

We have obtained a signal and an image from a biological sample (chicken bone). We have also demonstrated the capability of XACT to image in vivo samples at a lower dose than that of conventional CT with higher imaging resolution. These promising results demonstrate that XACT is a viable imaging modality with high potential for clinical translation.

CONCLUSION

The high potential for clinical translation of XACT has been demonstrated. XACT allows for the high-resolution imaging of x-ray absorption at much lower doses than conventional x-ray imaging techniques. We believe that the clinical translation of XACT is possible, and can revolutionize x-ray imaging by providing 3D information with a single projection and at lower doses than that of conventional CT.

CLINICAL RELEVANCE/APPLICATION

XACT can obtain 3D x-ray absorption images via a single x-ray projection onto a sample. Therefore, the dose in XACT is substantially lower than that of conventional CT. The imaging versatility of XACT is on par with that of conventional CT, including 3D imaging capability of the breast and bone. However, XACT can perform this imaging at comparable resolutions without the need for scanning throughout the sample. This yields substantial improvement in both imaging speed and dose reduction.

SSC13-05 Artificial Neural Network Based Prediction of Contrast Agent Injection Parameters Using Real Time Test Bolus Information

Monday, Nov. 26 11:10AM - 11:20AM Room: N230B

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PURPOSE

Optimization of contrast agent (CA) administration protocols is a crucial component of medical imaging to obtain diagnostic quality images. Here we aim to develop an artificial neural network (ANN) framework to predict the required contrast injection parameters to achieve a desired contrast enhancement (CE) in a given organ (kidney in this study) based on test bolus (TB) information.

METHOD AND MATERIALS

Synthetic data was used to feed and train a machine learning model to predict patient-specific CM injection protocol for a desired enhancement in different organs. Applying a validated perfusion model and tweaking the different patient-specific parameters (50 total) such as age, sex, cardiac output, and organ and vessel sizes, as well as injection protocol parameters such as iodine concentration (270, 300, 320, and 350 mg/ml), volume (100, 115, 130, and 140 ml), and injection rate (2, 3, 4, 5, and 6 ml/s), we generated 4000 CE data in kidney. TB curves were generated using the same concentrations and constant rate of 5 ml/s and volume of 10 ml. Data were split into training and test sets (split factor 0.2), and an ANN regression model was trained. For 800 given kidney peak enhancement and time to peak, injection parameters were predicted.

RESULTS

To obtain the given CE in kidney (i.e., time-to-peak and peak enhancement) for individual patients, mean absolute percentage error in prediction of the main injection parameters, concentration, injection rate, injection time, and contrast volume were 3%, 4%, 8% and 9%, respectively. The mean error of the prediction model without including the TB information, was higher than the results reported above by maximum of 4%. Using the predicted parameters, the mean error for both time-to-peak and peak enhancement for kidney was less than 5%.

CONCLUSION

Our results showed that, in absence of enough clinical perfusion data from different organs, by using synthetic data from a validated perfusion model, in addition to the test bolus information, we could train an AI model to offer the required CA administration parameters in order to obtain the desired CE in any targeted organ or vessel.

CLINICAL RELEVANCE/APPLICATION

This technique offers the possibility to determine patient-specific contrast material injection parameters to provide higher accuracy and consistency in the way that contrast enhanced CT examinations are performed.

SSC13-06 Pre-Clinical Demonstration of Grating-Based Phase Contrast X-Ray Imaging for Cryoablation Therapy

Monday, Nov. 26 11:20AM - 11:30AM Room: N230B

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PURPOSE

Cryoablation, often guided by CT or MRI, is an important tool in the treatment of cancer and other conditions. This work uses phase contrast imaging (PCI) to detect temperature changes, demonstrating cryoablation as a potential application for PCI.

METHOD AND MATERIALS

Experiments were carried out using fresh pork loin obtained from a local grocer. The PCI system was a Talbot-Lau grating-based interferometer designed for 27 keV X-rays. Images with attenuation, phase, and dark field contrast were obtained. The first experiment tested whether temperature changes could be detected by each contrast mechanism. We imaged a porcine sample after it froze overnight in a -60°C freezer, and then again after thawing. In a second experiment, we tested if we could detect temperature changes induced by a cryoprobe. We imaged a porcine sample after forming an ice-ball with a cryoprobe (Galil Medical, IceSeed 1.5 MRI Needle). Prior to imaging, the sample was subjected to a 15 min. freeze followed by a partial thawing until the probe could be removed from the sample.

RESULTS

The addition of phase and dark field contrast mechanisms provided structural detail and good temperature differentiation. Histograms showing the distribution of values in the CT phase reconstruction vs. the CT attenuation reconstruction (voxel size 54x54x54 µm) show a larger change in signal between the frozen and thawed pork. This result is consistent with theory: for water imaged with 27 keV photons, the change in attenuation of 54 µm of liquid vs. frozen water is expected to be about 0.02%, whereas the change in phase is expected to be about 38%. Our data show that the mean attenuation changed by 3%, and the mean phase changed by 34%. Histograms of values from a projection image of the cryoablated pork qualitatively demonstrate that the dark field signal is more sensitive to temperature change than the attenuation signal, even for a small amount of thawing that took place over 46 min.

CONCLUSION

We demonstrated that PCI has potential application for temperature monitoring during cryoablation procedures. Phase and dark field contrast are very sensitive to interfaces and density changes, making them ideal for imaging temperature-sensitive processes.

CLINICAL RELEVANCE/APPLICATION

Cryotherapy is used in a wide variety of treatments, and phase and dark field information can be used to sensitively monitor cryogenic and other processes during surgery.

SSC13-07 Three-Dimensional CT Scout from Conventional Two-View Radiograph Localizers Using Deep

Learning

Monday, Nov. 26 11:30AM - 11:40AM Room: N230B

Participants
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PURPOSE

The purpose of this work was to develop a deep learning-based image reconstruction framework to enable the reconstruction of volumetric 3D scout CT images from the conventional two-view (lateral and AP) projection scout radiographs.

METHOD AND MATERIALS

751 clinically indicated chest-abdomen-pelvis (CAP) CT exams from 667 patients were retrospectively collected. Inclusion criteria were: 1. CT exams acquired with or without contrast media and 2. Either one of the following 6 scan coverages: chest-alone, abdomen-alone, pelvis-alone, chest-abdomen, abdomen-pelvis or CAP. To avoid potential data inconsistency, large patients (>50 cm lateral width) with significant truncation were excluded. CT image volumes were interpolated to a 1.0x1.0x1.0 mm3 isotropic voxel size and registered to the 2D scout radiographs using the patient positioning information in the DICOM header. A total of 163,840 CT images with 1120 radiograph localizers from 476 patients were used to train a 60-layer deep neural network which inputs the AP and lateral localizers and outputs a volumetric CT scout; 47,919 CT images with 382 radiograph localizers from 191 patients were used for testing and validation. To test the generalization error of the trained deep neural network, a Monte Carlo dose calculation of an axial CT scan was performed in three anatomical regions using both the diagnostic CT images and the 3D-scout of one subject. Gamma analysis with 10%/5mm dose-difference/distance-to-agreement criteria was performed to compare both radiation dose distributions.

RESULTS

The average gamma indices between the diagnostic CT and the 3D-scout images were 0.33, 0.37 and 0.34 for anatomical regions in the chest, abdomen and pelvis, respectively. Similarly, the percentages of voxels with passing gamma index ($\gamma<1$) were 97.3%, 97.3% and 98.2% for the three anatomical regions.

CONCLUSION

A deep learning method was developed to reconstruct volumetric scout CT images from two-view projection scout radiographs. The proposed method could enable more accurate radiation dose estimates and scanning parameter prescription prior to CT acquisition and thus potentially help overcome limitations of automatic exposure control schemes in diagnostic CT.

CLINICAL RELEVANCE/APPLICATION

The reconstruction of 3D-scouts from two-view localizers could revolutionize the prescription of radiation dose/image quality in diagnostic CT, enabling the next generation of intelligent CT scanners.

SSC13-08 Stopping Power Ratio (SPR) Uncertainty in Pencil Beam Scanning (PBS) Proton CT (pCT) Reconstruction: Dependency on Energy Straggling and Detector Energy Resolution

Monday, Nov. 26 11:40AM - 11:50AM Room: N230B

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PURPOSE

To investigate the effect of proton energy, energy straggling (ES), and detector energy resolution (DER) on the uncertainty of the SPR reconstruction in PBS pCT reconstruction.

METHOD AND MATERIALS

A Monte-Carlo model was developed based on PBS technology to simulate the pCT acquisition. An 8cm-diameter cylinder water phantom was used in the simulation, filled with three 2-cm cylinders comprised of ICRU bone, muscle, and adipose, respectively. 180 projections were generated with 252 spots (500 protons/spot) on each projection. Spot spacing and size on the detector were 5.4mm and 6mm, respectively. Simulations were conducted w/wo energy ES fitted to real clinical 120 and 200 MeV proton beams. DER were set to 2% and 10%, in order to simulate detector uncertainty in the measurement of proton residual energy. Mean and standard deviation (STD) of SPR within the background and the three cylinders were calculated.

RESULTS

Total dose to the phantom was<.4mGy. The reconstructed mean RSP for both w/wo ES were the same: .995(-.5%), .968(-.2%), 1.026(-.4%), and 1.702(-1.0%) for the water, adipose, muscle, and bone, respectively. The STDs of the reconstructed RSP

were<.006 for all energies when DER=2%. With DER=10%, the STD of reconstructed RSP at 200 MeV was significantly higher(.01 vs .006, p<.05).

CONCLUSION

As PBS pCT derives projection images from statistical analysis of PBS spots, it is not sensitive to variations in proton ES and DER up to 10%. This is the first study to demonstrate the PBS proton beams being used directly for RSP reconstruction with significantly less dependency to ES and DER. Further technology development is warranted and is in process to improve the image resolution and the RSP accuracy for small regions of interest.

CLINICAL RELEVANCE/APPLICATION

Although proton radiography was first reported 5 decades ago, there is yet a commercial product to be developed given proton's multi-coulomb medium scattering, the cost of the proton CT, and furthermore the complicated single proton tracking technique used in the current passive scattering based pCT devices. In this study, we report the very first relative stopping power (RSP) reconstruction based on PBS technology and statistical processing of protons within each spot. This novel pCT acquisition and reconstruction methods could be efficient and effectively implemented into a routine clinical proton PBS machine with the capability of pre-treatment and intrafraction imaging.

SSC13-09 Dual Source Photon-Counting-Detector CT with a Tin Filter: A Phantom Study on Iodine Quantification Accuracy and Precision

Monday, Nov. 26 11:50AM - 12:00PM Room: N230B

Participants
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PURPOSE

To evaluate the impact of a multi-source photon-counting-detector (PCD) CT configuration, including the use of a tin filter and increased number of energy bins, on iodine quantification.

METHOD AND MATERIALS

olllA multi-energy CT phantom (Sun Nuclear) with iodine inserts at concentrations of 0, 2, 5, 10, 15 mg/mL was scanned on a research PCD-CT system with one source/PCD array. A reference scan was performed with 140 kV, 2 energy thresholds (TL and TH) and 32 mGy CTDIvol. Various multi-source PCD configurations were emulated by performing separate scans with different tube potentials and energy thresholds. Scans were performed at tube potentials of 80, 100, 120, 140, and Sn140 kV (140 kV with a tin filter), and multiple-source configurations using all possible kV pairs were investigated. Tube current was adjusted so that the CTDIvol of each scan was half of the reference scan (16 mGy) so that the total radiation dose was matched for all scan combinations (32 mGy). For each kV pair, two scenarios were investigated: (1) dual-energy scan with only 1 energy threshold (TL) used from each detector; and (2) quad-energy scan with 2 energy thresholds used from each detector. Images were reconstructed using standard filtered backprojection. Image-based material decomposition was performed to generate iodine and water maps. Root mean square error (RMSE) was measured for all iodine inserts and for each kV and energy threshold combination.

RESULTS

Among dual-energy configurations, 80/140 had the lowest RMSE of iodine concentration, 14.7 mg/mL, which was lower than that of reference scan using 140 kV (15.8 mg/mL). The use of a tin filter reduced the RMSE to 10.2 mg/mL. The lowest RMSE, 9.1 mg/mL, was achieved with the quad-energy configuration. Use of 4 energy thresholds (instead of 2) reduced RMSE by 20-75% for the kV pairs of 100/140 and 120/140.

CONCLUSION

Performance of PCD-based multi-energy CT can be substantially improved using a multiple source configuration, a tin filter and multiple energy thresholds, with a 42% reduction of RMSE (15.8 to 9.1 mg/mL) in iodine quantification accuracy observed through phantom studies.

CLINICAL RELEVANCE/APPLICATION

Dual-source PCD-CT with a tin filter can potentially provide better image quality, more accurate material quantification and lower dose than that of single-source PCD-CT.

SSC14

Science Session with Keynote: Radiation Oncology (CNS Malignancies)

Monday, Nov. 26 10:30AM - 12:00PM Room: E353A

NR RO OI

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

FDA Discussions may include off-label uses.

Participants
Martin Colman, MD, Houston, TX (*Moderator*) Stockholder, Steward Health Care
John C. Grecula, MD, Columbus, OH (*Moderator*) Research Grant, Teva Pharmaceutical Industries Ltd; Research Grant, Soligenix, Inc;

Sub-Events

SSC14-01 Radiation Oncology Keynote Speaker: CNS

Monday, Nov. 26 10:30AM - 10:50AM Room: E353A

Participants
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SSC14-03 Fractionated Radiosurgery Compared to Single Fraction Radiosurgery in the Treatment of Unresected Large Brain Metastases: An International Meta-Analysis

Monday, Nov. 26 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

SRS is commonly utilized as a definitive therapy in patients with unresected large brain metastases (BrM), as it provides excellent rates of 1-year local control (LC); however, resultant radionecrosis (RN) is a known risk. fSRS is a treatment option intended to reduce the incidence of RN and improve LC in these patients. There is a paucity of prospective data comparing these two modalities; therefore, a meta-analysis of existing retrospective and prospective studies was conducted.

METHOD AND MATERIALS

The co-primary outcome measures were incidence of RN and LC at 1 year. Large BrM were defined according to Radiation Therapy Oncology Group 90-05, where Group A: 2-3 cm diameter (4-14 cc volume) and Group B: >= 3 cm diameter (>14 cc volume). PICOS/PRISMA/MOOSE guidelines were used to select studies where patients with large BrM: (1) RN rates and/or 1-year LC were available; (2) SRS and/or fSRS were administered as treatment for unresected metastases; (3) data regarding tumor size were reported. Weighted random effects meta-analyses were used to analyze RN and 1-year LC. Fractionation and size were analyzed as moderators using analysis of variance and omnibus test where the null hypothesis was rejected for $p<0.05$.

RESULTS

A total of 17 studies conducted from 1998-2016, in 6 nations, consisting of 1,007 large BrM, met inclusion criteria. Median patient age was 62 years, median follow up was 9.5 months, and the most commonly used radiosurgery platform was Gamma Knife (9/17 studies). The range of SRS doses was 15-20 Gy, and the range of fSRS doses was 24-35 Gy in 2-5 fractions. The most common SRS dose was 18 Gy/1 fraction, and the most common fSRS dose was 27 Gy/3 fractions. Incidence of RN at 1-year for all studies was 9.2%; and was 18.2% for SRS and 6.7% for fSRS, $p=0.008$. 1-year LC for all studies was 79.3%; and was 74.0% for SRS and 83.4% for fSRS, $p=0.20$. By tumor volume, the incidence of RN in Group A was 10.5% and in Group B was 7.7%, $p=0.51$. 1-year LC in Group A was 86.2% and in Group B was 76.3%, $p=0.07$.

CONCLUSION

Among patients with unresected large BrM treated with radiosurgery, fSRS is associated with decreased rates of RN and potentially improved 1-year LC compared to SRS.

CLINICAL RELEVANCE/APPLICATION

Fractionated stereotactic radiosurgery (fSRS) is a recent advancement in radiosurgery, although its relative safety and efficacy compared to single fraction stereotactic radiosurgery (SRS) is unknown.

SSC14-04 The Dancing Cord: Inherent Spinal Cord Motion and Its Effect on Cord Dose in Spine Stereotactic Body Radiation Therapy

Monday, Nov. 26 11:00AM - 11:10AM Room: E353A

Participants
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PURPOSE

Adherence to strict dose limits is critically important in stereotactic body radiation therapy (SBRT) for spine tumors to reduce the risk of neurologic complications. Validated dose constraints have been established. However, inherent motion of the spinal cord has not yet been explored with respect to dosimetric effects in spine SBRT.

METHOD AND MATERIALS

Dynamic cardiac-gated balanced fast field echo MR imaging was obtained as part of routine treatment planning imaging for VMAT-based spine SBRT in 8 patients with spine tumors. Imaging and dosimetric data were analyzed in a retrospective IRB approved study. Planning CT data sets, static T2-weighted (cordstat), and each of 15 phases of the dynamic MRI images (corddyn) were coregistered. Cord deformation and motion on the dynamic imaging was compared to the static T2-weighted images, with respect to cord area, Dice coefficient, Jaccard index and excursion of the corddyn beyond the cordstat and planning organ at risk volume (PRV) margins. Dose was compared between cordstat, and corddyn. Comparisons were made using the Wilcoxon signed rank test.

RESULTS

The cross-sectional areas were not significantly different between cordstat and corddyn (0.51±0.12 vs. 0.52±0.13 mm2, p=0.814), suggesting no major cord deformation. Assessing cord motion, Dice coefficient between cordstat vs. corddyn ranged from 0.70 to 0.96 (mean, 0.85±0.05). Jaccard index ranged from 0.54 -0.92 (mean, 0.75±0.08). In 4 of the 8 patients, the maximal dose to corddyn exceeded that of cordstat by 1.2 - 12.8% (mean 5.2±4.3%). The corddyn spatially moved outside the 1 mm PRV margin of cordstat in 4 of the 8 patients: 13% of the time in 2, and 27% of the time in 2 patients. Corddyn did not extend outside the 2 mm PRV margin of cordstat.

CONCLUSION

The spinal cord shows inherent motion, resulting in measurable dosimetric effects which should be considered during SBRT dosimetry. A PRV margin of 2 mm surrounding the cord is suggested to account for the inherent spinal cord motion.

CLINICAL RELEVANCE/APPLICATION

Accurate imaging of the spinal cord is critical to assure dose limits and prevent neurologic complications in patients receiving high-precision/high-dose stereotactic body radiation for spine tumors.

SSC14-05 Two-Fraction Radiosurgery (9Gy x 2) is an Effective and Safe Option in the Modern Era of CNS Penetrating Systemic Therapies

Monday, Nov. 26 11:10AM - 11:20AM Room: E353A

Awards
Student Travel Stipend Award

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PURPOSE

In the era of CNS-penetrating systemic therapies, stereotactic radiosurgery (SRS) has resulted in higher intracranial control rates

in the era of CNS-penetrating systemic therapies, stereotactic radiosurgery (SRS) has resulted in higher intracranial control rates as well as higher rates of radionecrosis. We sought to determine if lower biologically equivalent dose SRS, specifically 18Gy in 2 fractions (fx), can achieve adequate local control with reduced adverse events.

METHOD AND MATERIALS

We retrospectively reviewed patients who received SRS in our department from 2014-2015. In this period, we had implemented a fractionated SRS regimen of 18Gy in 2fx for >3 simultaneously treated lesions, with all lesions typically being <2 cm which some exceptions. Median GTV-PTV expansion was 2mm (range 0-5mm). Dose was prescribed to the periphery to the 65-90% isodose line. We documented lesion location, prior radiation, volume, largest single dimension, and if symptomatic radionecrosis occurred. Cancer subtype, systemic therapies, cause of death, and performance status was included as well. Cox proportional hazards models were used to determine factors affecting local control.

RESULTS

From 2014-2015, we treated 242 lesions from 59 patients using stereotactic radiosurgery. Within this cohort, 126 lesions from 27 patients were treated using 18Gy in 2fx. 22 of 27 patients treated using these two fraction regimens were followed until death. The majority of lesions of the two-fraction cohort came from a melanoma primary (n=94). Ten lesions were resected before SRS. For the two fraction regimen, local control was 59% at 1-year, and 59% at 2-years. Radionecrosis occurred in 2 lesions (1.6%). The majority of lesions (n=88) were <1cc, 35 were 1-10cc in volume, and the remaining 3 were 10-98cc in volume. On multivariate analysis of the entire cohort, maximum single dimension, and prior surgical resection were independent predictors of local failure. Number of fractions was not significantly associated with local failure.

CONCLUSION

In our cohort, 18Gy in 2fx delivered acceptable local control with very low rates of symptomatic radionecrosis.

CLINICAL RELEVANCE/APPLICATION

Lower-dose, two-fractionation radiosurgery may be appropriate for patients with high volume disease, poor performance status or patients receiving central-nervous system penetrating systemic therapies.

SSC14-06 T2WI Histogram Analysis for Differentiating Glioblastoma from Solitary Brain Metastasis

Monday, Nov. 26 11:20AM - 11:30AM Room: E353A

Participants
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PURPOSE

To study the value of T2 gray histogram analysis of differential diagnosis in glioblastoma and brain solitary metastasis.

METHOD AND MATERIALS

A retrospective analysis was conducted by brain MRI examination and pathology diagnosis of 57 cases of glioblastoma and brain solitary metastasis in our hospital .Among them, there were 29 cases of glioblastoma(there were 17 males and 12 females), 28 cases of astrocytoma(there were 15 males and 13 females).Respectively, to draw the region of interest(ROI) in the T2 MR transaxial images of two groups on maximum layer of tumor level by using Mazda software and analyze the whole tumors gray histogram, performing a statistical analysis on the two sets ofparameters obtained from histograms to find out statistical significance of each parameter.The kurtosis, skewness, the first percentile, the 10th percentile and the 90th percentile were in accordance with the normal distribution. Two independent samples t-test were used to compare the differences.Mean , Variance, the 50th percentile, the 99th percentile did not fit the normal distribution, using nonparametric test, P <0.05 was statistically significant.

RESULTS

Through histogram analysis of 9 parameters, these 7 parameters were statistically significant (all P <0.05),including mean , kurtosis,skewness, perc.10%,perc.50% ,perc.90% and perc.99%. Among them,the sensitivity of skewness was 82.1%, the specificity was 82.8%, the area under the curve was 0.865,and the best cut-off value was 0.58.

CONCLUSION

The T2WI gray histogram analysis is helpful for the identification of brain solitary metastasis from glioblastoma and the skewness has a high diagnostic efficiency.

CLINICAL RELEVANCE/APPLICATION

The T2WI gray histogram analysis is helpful for the identification of brain solitary metastasis from glioblastoma.

SSC14-08 18F-FDOPA PET/MR Based Target Definition in the 3D Based Radiotherapy Treatment of Glioblastoma Multiform Patients: Early Results of a Single Institute Study

Monday, Nov. 26 11:40AM - 11:50AM Room: E353A

Awards
Student Travel Stipend Award

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PURPOSE

In the staging and 3D radiotherapy planning process of glioblastoma multiforme (GBM) patients conventional MRI plays important role. The 18F-F-DOPA positron emission tomography (PET) imaging utilising metabolic radiotracers for better evaluation of the affectet area by the tumor. 18F-FDOPA penetrates into the cells by a process mediated by amino acid transporters and demonstrates higher sensitivity and specificity for gliomas than traditional 18F-FDG PET and contrast enhanced MRI imaging. Our aim was to present the feasibilty of this amino acid tracer in modern 3D radiotherapy planning.

METHOD AND MATERIALS

We present a retrospective analysis of the PET/MR based planning study with 18F-FDOPA in 4 patients with histologically proven GBM. In the contouring process The native planning CT scanes were fused with the PET/MR series (T1 contrast enhanced, T2 and 18F-F-DOPA sequences). We defined 18F-F-DOPA uptake volumen (BTV-F-DOPA), the T1 contrast enhanced MRI volume (GTV-T1CE), and the volume of area covered by oedema on the T2 weighted MRI scan (CTV-oedema) in all patients. We also registered the volume BTV-F-DOPA volumes not covered by the conventional MR based target volumes.

RESULTS

The mean 18F-F-DOPA tumor volumes was 37,1 cm3 (range 15,3-80,3; SD=29,48). The mean GTV T1 CE was 7,2 cm3 (range 2,6-13,2; SD=4,89). The mean CTV oedema volume was 57,4 cm3 (range 27,7-108,8; SD=36,49). The mean volume of the BTV-F-DOPA not covered by the CTV oedema volume was 8,6 cm3 (range 1-21; SD=9,22).

CONCLUSION

Based on our results the tumor area defined by the amino acid tracer is not fully identical with MRI defined T2 oedema CTV. 18F-FDOPA defined BTV can modifie the definiton of the PTV, and the radiotherapy treatment.

CLINICAL RELEVANCE/APPLICATION

18F-FDOPA PET/MR based target definiton in the 3D based radiotherapy treatment will provide better tumour extension characterization of patients suffering from glioblastoma multiforme.

SSC15

Vascular Interventional (Prostate and Uterine Embolization)

Monday, Nov. 26 10:30AM - 12:00PM Room: E352

GU IR MR VA

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

SSC15-01 MR-Guided Focused Ultrasound Treatment for Management of Organ-Confined Intermediate Risk Prostate Cancer: Evaluation of Safety and Effectiveness

Monday, Nov. 26 10:30AM - 10:40AM Room: E352

Participants
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PURPOSE

To evaluate the safety and effectiveness of Magnetic Resonance guided Focused Ultrasound (MRgFUS) ablation in patients with organ-confined intermediate risk prostate cancer in order to postpone or eliminate the need of definitive treatment (i.e. Radical Prostatectomy or Radiation therapy).

METHOD AND MATERIALS

This prospective single-arm study enrolled 19 patients, aged 50-74 years, with histologically proven organ-confined intermediate risk prostate cancer. Inclusion criteria for participation: Gleason score <= 7 (=3+4 or 4+3, no grade 5 pattern), T1-T2b, N0, M0 stage, PSA <= 20 ng/ml, lesion visible to dynamic contrast enhanced (DCE) MR imaging and no previous prostatic surgery, radiation therapy or androgen deprivation therapy. All patient underwent pre-treatment DCE (Gd-BOPTA, Bracco) MR examination (Discovery 750, GE) and MRgFUS treatment with ExAblate (InSightec). Safety of treatment was determined by evaluation of the incidence and severity of device related complications while clinical efficacy was evaluated monitoring MR imaging changes and PSA levels at 3, 6 and 12-months.

RESULTS

1 patient reported urinary incontinence while 2 patients referred erectile dysfunction after MRgFUS treatment. DCE MR imaging at 3, 6 and 12 months showed no recurrence/residual disease in treated patients. According to imaging, laboratory exams showed a progressive decrease of PSA level from an average value of 17,1 ng/ml before treatment to 2,2 ng/ml at 12 months follow-up. No one patient needed definitive treatment so far and can be considered free of clinically significant prostate cancer.

CONCLUSION

MR guided Focused Ultrasound appears as a safe and effective treatment for patients with organ-confined intermediate risk prostate cancer and can reduce the need of definitive treatment (i.e. Radical Prostatectomy or Radiation therapy).

CLINICAL RELEVANCE/APPLICATION

MRgFUS can reduce the need of surgery or radiation therapy in patient with intermediate risk prostate cancer representing a safe and effective treatment.

SSC15-02 Magnetic Resonance-Guided Focused Ultrasound (MRgFUS) Focal Treatment of Localized Prostate Cancer: Initial Experience and Follow Up from a Multi-Center Trial

Monday, Nov. 26 10:40AM - 10:50AM Room: E352

Participants
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PURPOSE

To evaluate the initial experience, safety and feasibility of MR targeted focused ultrasound treatment of localized prostate cancer

METHOD AND MATERIALS

Patients with biopsy proven prostate cancer enrolled in a prospective multi-center pivotal trial of the ExAblate 2100 prostate system. Eligibility criteria include men of 50 years or older, PSA < 20 ng/mL with either low or intermediate risk prostate cancer (Gleason Score 3+3, 3+4 or 4+3). A multi-parametric MR must confirm localized prostate cancer (Stage T1-T2) and tumor distance ≤ 4cm from rectal wall. All men are treated in 1.5 or 3T GEHC MR devices

RESULTS

38 eligible men have been enrolled and treated from 7 sites. Mean age 62.8 years, mean PSA 6.0ng/mL. Prostate MR demosntrated dominant lesions in 32 men, no lesion in 4 men and MR data was not availaible in 2. Pre-treatment prostate biopsy results showed Gleason 3+3 in 14, 3+4 in 19 and 4+3 in 9. All men successfully underwent MRguided FUS ablation of their focal lesion. All except one were discharged home later on the treatment day. Currently 6 men have completed follow up, 34 men are at 9 months, 27 at 12 and 12 at 18 months. There were 131 combined device or protocol related adverse events, which were Grade 1 (mild) in 117, Grade 2 (moderate) in 13 and Grade 3 (severe) in 1 (severe suprapubic pain 1 week post treatment, resolved the following day without permanent injury). Overall 77 events were procedure related, 48 were transient, 5 biopsy related and 1 device related.

CONCLUSION

Initial experience indicates that MRgFUS appears to be both feasible and safe. Enrolling men in a trial using image-gided focal therapy in prostate cancer is feasible. Accural is ongoing in this pivotal trial.

CLINICAL RELEVANCE/APPLICATION

MR guided Focused ultrasound focal prostate cancer ablation is both safe and feasible.

SSC15-03 Uterine Artery Embolization with Gelfoam for Acquired Symptomatic Uterine Arteriovenous Shunting After Gynecologic Procedures and Obstetric Events

Monday, Nov. 26 10:50AM - 11:00AM Room: E352

Participants
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PURPOSE

To evaluate the technical and clinical success rates and safety of bilateral uterine artery embolization (UAE) with gelfoam for symptomatic acquired uterine arteriovenous shunting presenting after obstetric or gynecologic events.

METHOD AND MATERIALS

In this HIPAA-compliant, IRB approved retrospective study with a waiver of informed consent, consecutive patients of reproductive age that presented with abnormal uterine bleeding after recent gynecologic procedure or obstetric event between 01/2013 and 02/2018 at tertiary referral center were included. Bilateral uterine artery embolization was performed in all patients using gelfoam slurry. Technical success was defined as angiographic resolution of AV shunting at the end of the procedure. Clinical success was defined as cessation of bleeding, resolution of findings on subsequent imaging, or minimal estimated blood loss (<50 cc) on a subsequent dilation and curettage procedure.

RESULTS

Eighteen patients (mean age 32.8±7.1y) were included in the study. In one patient coil embolization was used in addition to

gelfoam due to the size of the shunt. Another patient underwent a repeat UAE due to evidence of clinical and sonographic residual RPOC with subsequent technical and clinical success. Angiography demonstrated AV shunting in 18/18 (100%) with early venous drainage from the uterine arteries to internal iliac and / or gonadal veins. 7/18 (38.9%) patients underwent subsequent scheduled D&C due to remaining RPOC with EBL of 17.9 ± 15.6mL. No additional procedures were required. The technical success rate of gelfoam UAE was 17/18 (94.4%) and clinical success rate was 94.1% (16/17). There was 1/18 (5.6%) minor complication of a small groin hematoma that resolved without additional treatment and 1/18 (5.6%) asymptomatic mild pulmonary embolism (PE) detected on CT three days after a procedure,in a patient with history of PE. The average length of clinical follow-up after the UAE procedure was 18.9 ± 15.9 months. 38.8% (7/18) of the patients became pregnant during the follow up.

CONCLUSION

Uterine artery embolization with gelfoam slurry for symptomatic uterine arteriovenous shunting has a high technical and clinical success rate and low potential risk of pulmonary embolism.

CLINICAL RELEVANCE/APPLICATION

Uterine artery embolization with gelfoam slurry only is successful in treating symptomatic uterine arteriovenous shunting and can be used as an alternative to permanent embolization agents.

SSC15-04 Effect of Pelvic MRI on Clinical Management of Suspected Symptomatic Uterine Fibroids

Monday, Nov. 26 11:00AM - 11:10AM Room: E352

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PURPOSE

We aim to determine the impact of pre-procedural pelvic MRI on the clinical management and treatment of suspected symptomatic uterine fibroids.

METHOD AND MATERIALS

An IRB-approved retrospective study of 100 patients referred to Interventional Radiology (IR) for management of suspected symptomatic uterine fibroids between 2013 and 2017 was compiled. Electronic medical records and relevant imaging in PACS were analyzed for patient age, race, gynecological evaluation including pelvic ultrasound results, as well as therapeutic plan prior to and following MRI.

RESULTS

Of the 100 patients who underwent MRI related to IR consultation, 73 patients had previously had a pelvic US. MRI results definitively changed management in 20 patients. Of these, 4 patients had imaging characteristics concerning for malignancy, of which two had completed work-up at the time of this study with a negative endometrial biopsy and a benign teratoma, respectively. Three patients received a new diagnosis of adenomyosis, and the offered treatment plan shifted to uterine artery embolization (UAE) as adenomyosis is best treated with smaller embolic particles. An additional 13 patients were advised not to undergo uterine fibroid embolization (UFE) alone with alternatives pursued including myomectomy (n=3), myomectomy then UFE (n=1), hysterectomy (n=2), hysteroscopy with dilation and curettage (n=1), conservative management (n=1), or referral back to Gynecology prior to final decision making (n=4). An additional patient (n=1) pursued UFE despite recommendation of myomectomy vs. hysterectomy. Fibroid location and vascularity (n=9) was the most common reason for change in plan as devascularized fibroids were felt to be unlikely to respond to endovascular therapy.

CONCLUSION

Pre-procedural evaluation of suspected symptomatic uterine fibroids differs across various clinical settings. We demonstrate a significant impact of pre-procedural MRI in the evaluation of patients: 1 in 5 patients in our small sample had a change in clinical management, and 1 in 25 demonstrated imaging findings concerning for a malignancy not previously identified by pelvic US. MRI should be incorporated into the routine work-up of patients with likely symptomatic uterine fibroids.

CLINICAL RELEVANCE/APPLICATION

MRI offers invaluable information in the work-up of patients with suspected symptomatic uterine fibroids, can alter treatment planning, and can identify previously undiagnosed malignancy.

SSC15-05 Prostate Multiparametric Magnetic Resonance May Avoid Biopsies in Patients with Elevated PSA and Surgical Indication for Prostatic Enlargement Treatment

Monday, Nov. 26 11:10AM - 11:20AM Room: E352

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PURPOSE

to evaluate the performance of mpMRI using PIRADS score on men with surgical indication for BPH and elevated PSA levels, comparing it with TRUS-guided biopsy results.

METHOD AND MATERIALS

Retrospective analysis of consecutive men with BPH and surgical candidates and concomitant elevated PSA levels (>=4ng/mL or >=2g/mL if in use of 5 alpha-reductase inhibitor), from June 2016 to August 2017. All patients were submitted to mpMRI prior to TRUS biopsy. Prostate mpMRI was done using a 1.5-T scanner (GE 350™) without endorectal coil including high resolution T2 weighted (T2W), diffusion weighted imaging (DWI), and dynamic post-contrast enhanced sequences. .Systematic 14-core biopsies were performed and in cases where mpMRI was classified as PIRADS 3 with focal lesions, PIRADS 4 or PIRADS 5, additional 2 to 3 TRUS guided targeted fragments were obtained with fusion technique. Final PIRADS score of mpMRI was compared with biopsy results and transurethral or transvesical resection (when available). Two scenarios were evaluated: first, considering only PIRADS 1 and 2 as negative and second, considering also PIRADS 3 as negative. ISUP >= 2 was was considered as csPCa.

RESULTS

Forty men were included for final analysis, with median age of 68 years, median PSA 6.35 ng/dL and median prostatic volume 116.5 cc. Demographic data are summarized in table 1. Considering the first scenario, the sensitivity, specificity, positive (PPV) and negative (NPV) predictive values of mpMRI for any prostate cancer were 76.9%, 63%, 50%, and 85% respectively. For csPCa the sensitivity was 87.5%, specificity 59.4%, PPV 35% and NPV 95%. For the second scenario, the sensitivity, specificity, PPV and NPV of MP-MRI for any prostate cancer were 53.8%, 96.3%, 87.5%, and 81.3% respectively. For csPCa the sensitivity was 75%, specificity 93.8%, PPV 75% and NPV 93.8%.

CONCLUSION

Negative predictive value of mpMRI was high in patients with surgical indication for BPH and elevated PSA. Our results suggest that patients with PIRADS 1, 2 and 3 could avoid TRUS biopsies before undergoing surgical procedure.

CLINICAL RELEVANCE/APPLICATION

mpMRI may be indicated in patients with BPH and elevated PSA levels with high negative predictive value.

SSC15-06 MRI/TRUS Fusion Guided Focal Laser Ablation for "Super-Active Surveillance" of Prostate Cancer

Monday, Nov. 26 11:20AM - 11:30AM Room: E352

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PURPOSE

Prostate cancer is the most common cancer among men. Standard treatments include radiotherapy and surgery, which may lead to common side effects such as incontinence and impotence. Local focal nerve sparing treatment options often require intraoperative MRI for image guidance, with resulting limitations of cost and MR time, and requiring MR compatible equipment. MRI/TRUS fusion guided transperineal focal laser ablation may address these limitations and provide an alternative method for treating prostate cancer that might otherwise undergo active surveillance.

METHOD AND MATERIALS

A bi-plane endorectal ultrasound probe was attached to an encoded stepper which has two degrees of freedom for rotation about and translation along the probe's physical axis. At the beginning, A 3D ultrasound volume was acquired with a 2D sweep and registered to previously acquired T2w MRI. MRI/TRUS fusion was co-displayed on both transverse and longitudinal ultrasound planes. Pre-segmented MRI tumors were projected on the stepper's grid template in custom software to facilitate treatment planning. Thermocouples were placed at locations near the rectum, urethra, nerve, and bladder if needed. For each ablation, the physician picked a grid hole to insert an introducer. The software predicted the ablation zone based on the grid location and the insertion depth on longitudinal ultrasound. A side-firing laser fiber with a cooling catheter was inserted through the introducer to conduct an ablation for 2 minutes at 9-15 watts. The software estimated the residual tumor, identified regions at risk for under-treatment and planned for the next ablation. This process was iterated until the full tumor was ablated. After the procedure, a T1w contrast enhanced MRI was taken to validate tumor coverage.

RESULTS

Seven patients with a total of 9 tumors were treated. The tumor volume was 1.6±1.3cc. It took 6±2 ablations to treat one tumor. Post-operative MRI confirmed no residual tumor tissue following ablation. One post ablation abscess was observed in a patient without imaging evidence of residual tumor.

CONCLUSION

MRI/TRUS fusion guided focal laser ablation is effective, safe and can serve as a low-cost option for prostate cancer treatment.

CLINICAL RELEVANCE/APPLICATION

The proposed approach may provide a therapeutic option for pre-selected patients with prostate cancer who desire treatment more than active surveillance and less than full organ therapies.

SSC15-07 Outcome of Uterine Artery Embolization for Management of Delayed Bleeding Due to Retained Placenta in Patients with Placenta Accreta

Monday, Nov. 26 11:30AM - 11:40AM Room: E352

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PURPOSE

To retrospectively evaluate the outcome of uterine artery embolization (UAE) for management of delayed bleeding due to retained placenta in patients with placenta accreta (PA).

METHOD AND MATERIALS

A retrospective analysis of the records of all patients diagnosed with PA according to the clinical findings during delivery between January 2005 and December 2017 was performed. Twenty-eight patients were treated conservatively by leaving placenta in place and underwent UAE for bleeding subsequently. The control of hemorrhage, outcome of the placenta left in place, menses and fertility results were retrospectively reviewed.

RESULTS

The mean age was 31.4±6.7 years. Eight patients with massive vaginal bleeding underwent emergency UAE. The other 20 patients presented with intermittent vaginal blood loss and underwent selective UAE. The median time between delivery and UAE was 15 days. The mean retained placental volume obtained by ultrasound was 164±133 cm3.The technical success rate of embolization was 100%. Angiography revealed uterine arteriovenous malformations in two patients. Bleeding was controlled in all patients during follow-up (10.7±7.9 months). The retained placentas were spontaneously passed vaginally or absorbed in 15 patients. Ten patients underwent curettage after UAE. Of these 10 patients, 7 retained placentas were completely removed and 3 retained placentas were partly removed and absorbed later. The other 3 retained placentas were resected for they did not decrease in size significantly after UAE. Menses returned 1-3 months after UAE in all patients and they had regular monthly cycles afterwards. And five patients delivered without complication during follow-up.

CONCLUSION

UAE is safe and effective for management of retained placenta associated with placenta accreta.

CLINICAL RELEVANCE/APPLICATION

Conservative management of the abnormal placenta, which is left inside the uterus at the time of delivery has been more and more used in clinial practice to minimize blood loss after delivery and to preserve the uterus in women with PA. UAE should be consided for subsequetly management of these patients.

SSC15-08 The Relationship of Embolic Particle Size to Patient Outcomes in Prostate Artery Embolization for Benign Prostatic Hyperplasia: A Systematic Review and Meta-Regression

Monday, Nov. 26 11:40AM - 11:50AM Room: E352

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PURPOSE

Prostate artery embolization (PAE) has been proven to be a safe, efficacious and cost-effective treatment for Benign Prostatic Hyperplasia (BPH). There has been much variation in the size of embolic particle agent used in existing studies and the degree of patient outcomes achieved. We aimed to explore the relationship of particle size to patient outcomes.

METHOD AND MATERIALS

A systematic review of MEDLINE, PubMed and Embase was undertaken to identify all existing studies using PAE for BPH. Inclusion criteria included studies reporting a baseline and 12 month International Prostate Symptom Score (IPSS). Exclusion criteria excluded overlapping studies. Data extraction from eligible studies included the size of embolic agent and Baseline and 12 month values for: IPSS, IPSS Quality of Life, Q-max, prostate volume, prostate specific antigen and post-void residual. A weighted linear regression analysis was then used to explore the relationship between particle size and the change in the outcome measures (from baseline to 12 months).

RESULTS

6 non-overlapping studies were identified for data extraction. The linear regression analysis did not demonstrate a statistically significant ($p<0.05$) relationship of particle size with the 12 month change in patient outcome measure. However, smaller particle size and greater reductions in IPSS approached statistical significance ($p=0.08$).

CONCLUSION

Our findings suggest that there is a possible association of smaller particle size with greater reductions in IPSS. Whilst not statistically significant, these findings impress upon the need for further research on determining the optimum particle size for PAE.

CLINICAL RELEVANCE/APPLICATION

Smaller embolic particle size may be associated with greater symptom severity reduction in patients undergoing PAE for BPH.

SSC15-09 Visualization of the Different Branches of the Internal Iliac Artery Before Prostatic Artery Embolization Using Three Dimensional Contrast-Enhanced MR Angiography

Monday, Nov. 26 11:50AM - 12:00PM Room: E352

Participants
Nagy N. Naguib, MD, MSc, Frankfurt Am Main, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate the ability of Three Dimensional Contrast Enhanced MR Angiography (3D-CE-MRA) in Visualizing the branches of the Internal Iliac Artery (IIA) in males prior to prostatic artery embolization (PAE).

METHOD AND MATERIALS

Pre-embolization CE-MRA studies from 30 males (mean age 68.18 years) were retrospectively evaluated by two radiologists in consensus. Studies were done using a 3 Tesla MRI unit and 3D images were reconstructed using Syngo Vessel View Application. Studies from 2 patients were excluded (due to incomplete coverage of the pelvis). A scoring system of 3 Grades was adopted where a score of 0 means that the artery was not seen, interrupted or its origin could not be identified, a score of 1 means that the artery was faintly seen but can be traced and has no missing segments till it gives off its first branch, finally score 2 means that the artery was clearly seen.

RESULTS

Of the studied 56 internal iliac arteries 9 different branches were evaluated. The superior gluteal artery detected in all studied arteries with a score of 2 in all of them and sensitivity 1. The inferior gluteal artery also detected in all IIA (Score 2 in all; overall sensitivity of 1). The internal pudendal detected in all IIA (Score 2 in 55, score 1 in 1; sensitivity 1). The obturator artery detected in all IIA (Score 2 in 52, score 1 in 4; sensitivity 1). The iliolumbar artery detected in all IIA (Score 2 in 53, score 1 in 3; sensitivity 1). The lateral sacral artery detected in 55 IIA (Score 2 in 49, score 1 in 6, score 0 in 1; sensitivity 0.98). The inferior vesical (prostatic) artery detected in 45 IIA (Score 2 in 26, score 1 in 19, score 0 in 11; sensitivity 0.80). The middle rectal artery detected in 21 IIA (Score 2 in 5, score 1 in 16, score 0 in 35; sensitivity 0.38). Lastly the superior vesical artery detected in 2 IIA with a score of 1 (sensitivity 0.04).

CONCLUSION

3D-CE-MRA is a helpful non invasive tool in detecting most of the branches of the internal iliac artery in males. It can detect up to 80% of the prostatic arteries before PAE.

CLINICAL RELEVANCE/APPLICATION

3D-CE-MRA is a reliable method for mapping the internal iliac artery prior to PAE which might help in reducing the procedure time.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

MSRO23

BOOST: Head and Neck-Science Session

Monday, Nov. 26 1:30PM - 2:30PM Room: E450A

AI HN NR OI RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Carryn Anderson, MD, Iowa City, IA (*Moderator*) Nothing to Disclose
John C. Grecula, MD, Columbus, OH (*Moderator*) Research Grant, Teva Pharmaceutical Industries Ltd; Research Grant, Soligenix, Inc;

Sub-Events

MSRO23-01 Low-Lying Lymph Node (LLLN) Involvement in Human Papillomavirus (HPV)-Associated Oropharyngeal Carcinoma (OPC)

Monday, Nov. 26 1:30PM - 1:40PM Room: E450A

Awards
Student Travel Stipend Award

Participants
Timothy Lin, BA, Bellaire, TX (*Presenter*) Nothing to Disclose
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PURPOSE

To characterize the incidence/pattern of LLLN involvement in HPV-associated OPC and correlation with outcomes after radiation therapy (RT).

METHOD AND MATERIALS

We reviewed diagnostic/planning images and clinical data of an IRB-approved cohort of HPV-associated OPC patients (pts) treated with definitive RT at our institution from 2004-13. Demographics and outcomes were retrieved from the medical records. LLLN+ were defined as any radiographically involved level IV or Vb nodes. AJCC 8th edition staging was used. Actuarial outcomes were calculated using Kaplan-Meier and compared by log-rank test. One-way analysis of variance was used to compare proportions.

RESULTS

In 796 pts, the incidence of LLLN+ was 12%, 13% in base of tongue and 10% in tonsil primaries, 10% in N1, 17% in N2, and 48% in N3. Median follow-up was 58 months (IQR: 42-77). Induction chemotherapy (IC) was used in 80% vs. 37% and concurrent in 78% vs. 65% for those with vs. without LLLN involvement, respectively. The proportion of LLLN+ patients receiving IC was 70%, 93%, and 100% for those with N1, N2, and N3 disease, respectively (p=.0034). Overall, LLLN+ was associated with worse 5-year rates for all disease control endpoints tested except freedom from distant metastasis (FDM) with a trend for OS. In patients with N1 disease, LLLN-involvement was associated with worse rates of FDM (87% vs. 94%, p=.0214); no significant differences were observed in N2 or N3 subgroups for any endpoint. In patients who received IC, LLLN+ was associated with worse 5-year local control (LC), regional control (RC), and relapse-free survival (RFS), differences ranging from 6-11% (p-value<0.004 for each). When stratified by IC and N-category, LLLN+ was associated with lower FDM rates in N1 (86% vs. 94%, p=.014) but not N2 or N3 disease.

CONCLUSION

Reflective of the patterns of care of those treated during this study time frame, most pts with LLLN+ received IC, which could have potentially offset any adverse correlation with subsequent distant failure. However, LLLN+ correlated with other disease control endpoints (LC, RC, and RFS), and thus could be considered a marker of regionally advanced disease in HPV-associated OPC, even for those with lower stage.

CLINICAL RELEVANCE/APPLICATION

LLLLN involvement was associated with poorer disease control outcomes, and a potential influence of IC on subsequent distant failure is hypothesized.

MSRO23-02 Automatic Gross Tumor Volume (GTV) Delineation for Nasopharyngeal Carcinoma (NPC) Radiotherapy on Multi-modal MRI: A Deep Learning Model Trained from 1000 Patient Dataset

Monday, Nov. 26 1:40PM - 1:50PM Room: E450A

Participants
Fu Li, Guangzhou, China (*Presenter*) Nothing to Disclose
Yao Lu, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Ying Sun, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Li Lin, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

GTV delineation of NPC is a critical and time-consuming process during intensity modulated radiotherapy. We are developing an automatic deep learning GTV delineation approach for NPC radiotherapy on multi-model MRI.

METHOD AND MATERIALS

With IRB approval, we retrospectively collected 1012 patients who underwent intensity modulated radiotherapy for NPC from Sept. 2016 to Aug. 2017. Multi-model MRIs (T1, T1C, T1W, T2) were acquired for GTV delineation of each patient with Philips MR imaging system and covered large variations in scanning parameters. Three experienced radiotherapists manually marked the GTV contours on MRI series (1 to 2 hours per case). In this study, a modified 3D U-net deep learning network was trained to perform volume-to-volume delineation of GTV. Multi-modal MRIs were regard as different channel input of the 3D U-net and feature maps from various layers were concatenated with deep supervision to generate the output as the corresponding GTV likelihood map. Binary cross-entropy was applied as loss function for network training. To increase receptive fields and capture contextual information, two-stride convolution was used to downsample feature maps instead of maxpooling operator. Besides, clinical anatomy characteristics were explored as post-processing to protect normal tissues and further improve the model performance. We randomly split the entire data set into training (850 cases) and independent testing (162 cases). Dice coefficient (DC), average percent volume error (AVE) and average absolute volume error (AAVE) were used to compare the computed GTV results with the experts' manual results.

RESULTS

The average DC, AVE and AAVE on test data are 0.79±0.05, -0.09±0.21, and 0.19±0.13, respectively. Comparing to 1-2 hours by the readers, our deep learning delineation takes less than 15 seconds per case.

CONCLUSION

Our results demonstrated the feasibility of deep learning approach for automatic GTV delineation of NPC during intensity modulated radiotherapy. Our automatic tool achieves good delineation quality on NPC GTV and greatly reduces the delineation time by hundred times compared to clinical doctors.

CLINICAL RELEVANCE/APPLICATION

Radiotherapy is one of the efficient routine treatment for NPC and accurate delineation of GTV is a key step in radiotherapy. Our automatic tool has potential to reduce the variability between human readers as well as improve the efficiency of the whole procedure.

MSRO23-03 Using Artificial Intelligence to Predict Oropharyngeal Cancer Recurrence After Radiation Therapy

Monday, Nov. 26 1:50PM - 2:00PM Room: E450A

Participants
William Su, New York, NY (*Presenter*) Nothing to Disclose
Martin Kang, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

HPV derived oropharyngeal cancers are less aggressive and more radiosensitive compared to non-HPV derived oropharyngeal cancers. In the HPV era, treatment de-escalation is one of the main areas of focus for clinical trials. However, recurrences still occur in HPV derived disease and can follow unique patterns, so it is important to identify patients at high risk of recurrence and ensure that they do not receive de-intensified treatment. Artificial intelligence can be used to analyze radiomic signatures and potentially predict recurrence. This would allow for personalized treatment planning based on radiographic risk profiles. Our purpose was to demonstrate that deep learning models have the potential to assess radiographic risk factors for oropharyngeal cancer recurrence.

METHOD AND MATERIALS

Radiotherapy planning CT scans of 108 patients with histologically proven oropharyngeal cancer were acquired from the TCIA Head-Neck-PET-CT collection. In this collection, all patients with recurrent cancer or metastases at presentation were excluded. Of 108 cases, 44 had loco-regional or distant recurrence of cancer after definitive radiation treatment. For each patient, a volume of interest (VOI) that embraces the Gross Tumor Volume was extracted from the entire CT scan. After being preprocessed for dimension standardization and intensity normalization, the VOI was input into a VGG16 based neural network to obtain a discriminative score, which indicates an estimate of the probability of recurrence of that tumor. Receiver Operating Characteristic (ROC) analysis was used to evaluate the classification performance of the VGG-based model.

RESULTS

By using 4-fold cross validation, the VGG-based classification model achieved an average accuracy of 0.59 and AUC of 0.60.

CONCLUSION

Our study shows that deep learning models have potential in predicting oropharyngeal cancer recurrence. This can eventually pave the way towards individualized radiation dosage planning based on radiomic signatures. A larger, multi-institutional dataset is required to further validate the model for clinical application.

CLINICAL RELEVANCE/APPLICATION

Artificial intelligence can be used to analyze radiographic features on CT simulation scans to predict recurrence risk and tailor radiation dosages in the HPV era of oropharyngeal cancers.

MSRO23-04 A Phase II, Proof-of-Concept Clinical Study of an Oral Mouth Rinse Containing Sandalwood Oil (SAO) for the Prevention of Oral and Oropharyngeal Mucositis Associated with (Chemo-) Radiation Therapy in Head and Neck Cancer Patients

Monday, Nov. 26 2:00PM - 2:10PM Room: E450A

Participants
Chul S. Ha, MD, San Antonio, TX (*Presenter*) Investigator, Santalis Pharmaceuticals, Inc
Ying Li, MD, San Antonio, TX (*Abstract Co-Author*) Investigator, Santalis Pharmaceuticals, Inc
Carol Jenkins, RN,MS, San Antonio, TX (*Abstract Co-Author*) Nothing to Disclose
Corey Levenson, PhD, San Antonio, TX (*Abstract Co-Author*) Officer, Santalis Pharmaceuticals

PURPOSE

Mucositis is one of the most debilitating side effects in patients treated with (chemo-) radiation therapy for head and neck cancer. This study was intended to evaluate the efficacy in alleviating mucositis, safety and tolerability of SAO (0.25% aqueous solution of an anti-inflammatory and anti-microbial essential oil from Santalum album trees).

METHOD AND MATERIALS

Patients to be treated with (chemo-) radiation therapy (>= 60 Gy) for cancers of oral cavity/oropharynx were asked to swish and gargle for 30 seconds, and spit, with 15 ml of the SAO three times a day throughout the radiation therapy. Pain in the oral cavity/oropharynx was measured using the numerical rating pain scale (NRPS) and mucositis was graded using the RTOG scale every week. Our data were compared with historical data in table 2 (incidence of mucositis), figure 1 (mean mucositis grade) and figure 2 (mean oral pain grade) from MD Anderson Cancer Center (MDACC) (doi:10.1016/j.ijrobp.2007.01.053) and table 4 (incidence of mucositis) from Memorial Sloan Kettering Cancer Center (MSKCC) (doi:10.1016/j.ijrobp.2010.10.041).

RESULTS

Fourteen subjects were enrolled but 6 withdrew (4 of them due to taste/smell of the rinse, 1 due to fatigue, 1 due to perceived ineffectiveness of the rinse). Among the 8 who completed the course of SAO treatment, 6 were treated with chemo-radiation and 2 with radiation only. IMRT was used for everyone. The median dose was 6,996 cGy in 33 fractions. There were no serious adverse events from SAO. The mean RTOG mucositis grades from weeks 3,6 and 9 were 1.125, 2.125 and 1.875. Two of 8 patients experienced mucositis >= 3. The corresponding mean NRPS were 3.700, 4.988 and 3.875.

CONCLUSION

The incidence of mucositis >= 3 were 70% from MDACC and 22% from MSKCC. Distribution of our mean NRPS and RTOG mucositis data compared favorably against figures 1 and 2 from MDACC. Though SAO was difficult to use due to poor taste/smell, it was otherwise well tolerated and appears to have enough signal to warrant further development as a potential alleviator of mucositis.

CLINICAL RELEVANCE/APPLICATION

This is a proof-of-concept clinical trial for an oral mouth rinse containing Sandalwood Oil for the prevention of mucositis associated with (chemo-) radiation therapy in head and neck cancer patients. We believe our results have generated enough signal to pursue further development of this preparation.

MSRO23-05 Locoregional Patterns of Failure (POF) following Therapeutic Dose Neck Radiation Therapy (RT) for Un-Resected Anaplastic Thyroid Cancer (ATC)

Monday, Nov. 26 2:10PM - 2:20PM Room: E450A

Awards
Student Travel Stipend Award

Participants
Amit Jethanandani, MPH, Houston, TX (*Presenter*) Nothing to Disclose
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PURPOSE

Despite aggressive therapy, patients (pts) with ATC often develop locoregional progression (LRP). We aimed to identify the pattern of LRP in pts with un-resected ATC who received therapeutic doses of neck RT (>45 Gy).

METHOD AND MATERIALS

An institutional ATC database was retrospectively reviewed for pts who received neck RT from 01/00-08/17. ATC pts with un-resected disease were eligible if they received RT > 45 Gy at our institution and had follow-up CTs to assess for LRP. Progressive gross tumor volumes (rGTVs) were segmented on diagnostic CTs that demonstrated LRP (rCTs) and were reviewed by a head and neck radiation oncologist. rCTs were co-registered with treatment planning CTs (pCTs) using deformable image registration (VelocityAI 3.0.1). rGTVs were compared to original RT plans using a centroid-based approach. Failures were classified into 5 types based on pre-defined spatial/dosimetric criteria; A (central high dose), B (central elective dose), C (peripheral high dose), D (peripheral elective dose), and E (extraneous dose).

RESULTS

129 ATC pts received neck RT; of these, 103 had available plans and only 73 had plans and follow-up CTs. Of the 73, pts were excluded for prior resection (n=37) or if RT dose was $\leq$ 45 Gy (n=17). Thus, 19 formed the cohort. Most (79%) were Caucasian; median age was 63.5 years; 58% were stage IVC; 95% received IMRT; and all received systemic therapy. Median RT dose was 66 Gy (IQR: 59-66); median dose per fraction was 2 Gy (IQR: 1.7-2.2). Median follow-up was 7.9 mos. Six pts (31.5%) developed LRP and 16 rGTVs were identified (6 in 1 pt, 4 in 1, 3 in 1, and 1 in 3 each). Median time to LRP was 2.3 mos (range: 0-43). Of rGTVs, 7 were local (thyroid bed) and 9 were regional (1 in the paratracheal region; 1 in base of tongue [BOT]; 3 in node levels IIa; 1 in III; 2 in IV; and 1 in paraspinal musculature [PSM]). Type A was the most common rGTV POF (56%), followed by Types E (31%; 3 nodal, 1 BOT, and 1 PSM), B and C (8% each). Actuarial locoregional control (LRC) was 73% at 6 and 12 mos. Four living patients without LRP had a median follow-up of 27.5 mos (range: 9.3-65).

CONCLUSION

The identified POF was largely Type A and rapid (<6 mos), suggestive of a radiation resistance profile.

CLINICAL RELEVANCE/APPLICATION

Rapid neck progression was avoided in most ATC pts and some exhibited durable neck control, which could allow pts to receive subsequent systemic or targeted therapies.

MSRO23-06 A Population-Based Study of the Effects of Therapy, Primary Tumor Characteristics, and Metastatic Disease Sites on Survival in Patients with Metastatic Head and Neck Cancer

Monday, Nov. 26 2:20PM - 2:30PM Room: E450A

Awards
Student Travel Stipend Award

Participants
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Deepinder Singh, MD, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Data is emerging that multimodality therapy (MMT) may improve overall survival (OS) in patients with metastatic head and neck cancer (M1-HNC). We aim to investigate the effects of MMT, tumor characteristics, and sites of metastatic disease on OS in M1-HNC patients using the Surveillance, Epidemiology, and End Results (SEER) database.

METHOD AND MATERIALS

2,827 patients from the SEER 18 registry diagnosed with M1-HNC from 2010-2014 were analyzed. Patients coded as having metastatic disease in bone, brain, liver, and lung were identified. Kaplan-Meier analyses and Cox proportional hazards models were used to assess the impact of MMT, primary tumor characteristics, and metastatic disease sites on OS.

RESULTS

Most patients were male (n=2,169, 76.7%), and had squamous carcinoma histology (n=2,009, 71.1%). Median age was 60 years and median OS was 10 months. Oropharynx (n=900, 31.8%) was the most common primary site. Patients coded as having metastases in lung and not in bone, brain, or liver (n=958, 33.9%) were the most common metastatic disease category. 518 patients (18.3%) received cancer-directed surgery (CDS), 1,458 patients (51.6%) received radiation (RT), and 1,690 patients (59.8%) received chemotherapy (CT). 579 patients (20.5%) received neither CDS, nor RT, nor CT (no therapy-group). With Cox regression accounting for age, sex, race, primary site, histology, grade, T stage, N stage, and metastatic sites, those who received CDS, RT, and CT (n=172, 6.1%) had the largest OS benefit (HR=0.22, 95% CI 0.17-0.28, p<0.001) compared to the no therapy-group. Patients receiving RT and CT were the most common MMT combination (n=879, 31.1%), and had improved OS (HR=0.35,

95% CI 0.30-0.40, p<0.001) compared to the no therapy-group. Primary and metastatic disease site-specific analyses showed that MMT combinations provided and OS benefit at all primary sites in the head and neck region and across metastatic sites with the exception of those coded as having metastases in bone and lung, and not in brain and liver.

CONCLUSION

In this hypothesis-generating study MMT is associated with improved OS in patients with M1-HNC. The OS benefit persists across primary and metastatic disease sites. Prospective study of MMT in M1-HNC patients is warranted.

CLINICAL RELEVANCE/APPLICATION

In this population-based, hypothesis-generating study multimodality therapy is associated with improved overall survival in patients with metastatic head and neck cancer.

MSRO27

BOOST: Breast-Science Session with Keynote

Monday, Nov. 26 1:30PM - 2:30PM Room: S103CD

BR RO OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Kathleen Horst, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Anna Shapiro, MD, Syracuse, NY (*Moderator*) Nothing to Disclose

Sub-Events

MSRO27-01 Invited Speaker:

Monday, Nov. 26 1:30PM - 1:50PM Room: S103CD

Participants
Jianling Yuan, MD, PhD, Minneapolis, MN (*Presenter*) Nothing to Disclose

MSRO27-03 Where Are the RCTs? Analysis of the 2018 American Society for Radiation Oncology (ASTRO) Evidence-Based Guidelines for Radiation Therapy to the Whole Breast as Treatment for Breast Cancer

Monday, Nov. 26 1:50PM - 2:00PM Room: S103CD

Participants
Norman R. Williams, PhD, London, United Kingdom (*Presenter*) Travel support, Carl Zeiss AG

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PURPOSE

Early in 2018, the American Society for Radiation Oncology (ASTRO) produced evidence-based guidelines on five key questions for radiation therapy to the whole breast as treatment for breast cancer [Smith et al PMID: 29545124]. An analysis was made of the publications supporting these guidelines to determine how many reported level-1 evidence from randomised clinical trials (RCTs), as this is the standard applied to chemotherapy and adjuvant hormonal therapy.

METHOD AND MATERIALS

All 112 references were scrutinized, and tabulated according to level of evidence (RCT or not), year of publication, country of lead author, and which of the statements (grouped into five key questions) they addressed.

RESULTS

Of the 33 statements, 12 are not supported by evidence from RCTs. In a further 9 statements, data from RCTs only partly support the consensus. Therefore, 21/33 (64%) of the statements are not directly supported by evidence from RCTs. There is no evidence from RCTs to support any of the statements regarding avoiding exposure of cardiac and other normal tissue (key questions 4 and 5). Such exposure has been linked to death from ischemic heart disease [Darby et al PMID: 23484825] and lung cancer [Taylor et al PMID: 28319436]. There is evidence that the effects of a course of whole breast radiation therapy induces early ECG changes [Tuohinen et al PMID: 29599341]; biological effects can be detected after a single fraction [Woolf et al PMID: 25045612]. Such measures could be used in the design of RCTs, particularly of patients with low-risk breast cancer in whom de-escalation of breast radiation therapy (using accelerated partial breast, intra-operative, etc.) may be warranted to reduce an imbalance in the efficacy/safety profile [Franco et al PMID: 29616366].

CONCLUSION

The majority of the 2018 ASTRO evidence-based guidelines for use of radiation therapy in breast cancer are not based on level-1 evidence from RCTs. Trials using techniques that minimize exposure to normal tissues are urgently required.

CLINICAL RELEVANCE/APPLICATION

Clinicians and patients should be aware that current guidelines for treatment of breast cancer using radiation therapy are mostly based on sub-optimal evidence.

MSRO27-04 Clinical Outcomes and Toxicity of Proton Beam Radiation Therapy for Re-Irradiation of Locally Recurrent Breast Cancer

Monday, Nov. 26 2:00PM - 2:10PM Room: S103CD

Awards
Student Travel Stipend Award

Participants

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Laura Ochoa, RN,PhD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Repeat radiation therapy (RT) using x-rays for locally recurrent breast cancer results in increased short and long-term toxicity. Proton beam RT (PBRT) can minimize dose to surrounding organs thereby reducing toxicity. Here, we report the toxicity and outcomes for women who underwent re-irradiation to the chest wall for locally recurrent breast cancer using PBRT.

METHOD AND MATERIALS

A total of 16 patients with locally recurrent breast cancer who underwent re-irradiation to the chest wall with PBRT between 2014-2018 were retrospectively analyzed. For their recurrences, 6 patients underwent salvage mastectomy, 8 patients had wide local excision, and 2 patients had biopsy only. The median dose for the first RT course was 50 Gy, and for the second course, 50.4 Cobalt Gy Equivalent. The target for re-irradiation was chest wall alone in 12 patients and chest wall plus regional nodes in 4 patients. A boost was delivered in 3 (18.8%) patients. Concurrent hyperthermia was used in 10 (62.5%) patients. For systemic therapy, 4 (25%) patients received chemotherapy and 8 (50%) patients received hormone therapy. Follow up was calculated from the start of second RT course. Toxicities were based on CTCAE 4.0.

RESULTS

The median age at diagnosis and at recurrence was 49.8 years and 60.2 years respectively. The median time between the two RT courses was 10.2 (0.7-20.2) years. The median follow up time was 10.6 (1.5-29.1) months. There were no local failures observed after re-irradiation. Only one patient developed distant metastasis and ultimately died. Grade 3-4 acute skin toxicity was observed in 5 (31.2%) patients. There were 4 (25%) patients who developed chest wall infections during or shortly (2 weeks) after re-irradiation. Grade 3-4 fibrosis was observed in only 3 (18.8%) patients. Grade 5 toxicities were not observed. Hyperpigmentation was seen in 12 (75%) patients. Other RT related toxicities such as pneumonitis, telangiectasia, rib fracture, and lymphedema occurred in 2 (12.5%), 4 (25%), 1 (6.3%), and 1 (6.3%) patients respectively.

CONCLUSION

Re-irradiation with PBRT for recurrent breast cancer has acceptable toxicities. There was a high incidence of grade 3-4 skin toxicity and infections, however, they resolved with skin care and antibiotics. Further follow up is needed to determine long-term clinical outcomes.

CLINICAL RELEVANCE/APPLICATION

PBRT can be safely used for re-irradiation of the chest wall for locally recurrent breast cancer.

MSRO27-05 Carcinosarcoma of the Breast: Treatment Patterns and Survival Outcomes

Monday, Nov. 26 2:10PM - 2:20PM Room: S103CD

Awards
Trainee Research Prize - Resident

Participants
William R. Kennedy, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose
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PURPOSE

Carcinosarcoma of the breast is a rare yet highly-aggressive tumor accounting for less than 1% of all breast cancers, for which guidance on optimal management and prognosis are sparse. The purpose of this study is to investigate population-based treatment patterns and overall survival (OS) outcomes in patients with this diagnosis.

METHOD AND MATERIALS

We queried the National Cancer Database for patients diagnosed with carcinosarcoma (Histology 8980) of the breast. All patients included were treated with surgery, with or without chemotherapy and/or radiation therapy. Patients with metastatic disease were excluded. Kaplan-Meier analysis was used to estimate OS. Univariate and multivariate cox analyses were used to determine predictive factors of OS.

RESULTS

A total of 329 patients from 2004-2012 were identified. Median age at diagnosis was 58 years (range, 24-90). Patients had T1 (21%), T2 (44%), T3 (25%), or T4 disease (10%). Most patients were node-negative at diagnosis (77%). Breast conservation surgery was utilized in 33% of patients. Chemotherapy was used in 66% of patients. Less than half (44%) of patients received radiation therapy to a median dose of 50.4Gy (range 35-56 Gy), with a median 10Gy boost used in 76%. With median follow-up of 39.9 months, 3-year overall survival was 74%. Multivariate analysis revealed that T-stage, margin status, and chemotherapy use all significantly influenced OS. There was a trend towards improved survival with the use of RT (HR 0.66, 95% CI 0.43-1.01, p =0.053). The 3-yr OS was 80% in patients receiving chemotherapy vs 59% without chemotherapy. The 3-yr OS was 82% in patients receiving RT vs 66% without RT.

CONCLUSION

Carcinosarcoma of the breast is associated with relatively poor rates of OS. The use of chemotherapy was associated with improved OS, with a trend towards improved OS with the use of RT.

CLINICAL RELEVANCE/APPLICATION

In the largest study to date investigating outcomes in carcinosarcoma of the breast, adding chemotherapy to surgery improved OS. A trend toward improved OS was also seen with adjuvant RT.

MSRO27-06 Quantitative Ultrasound Characterization of Radiation-Induced Acute Skin Toxicity in Breast Cancer Patients Receiving Radiation Therapy: A Feasibility Study

Monday, Nov. 26 2:20PM - 2:30PM Room: S103CD

Participants
Sylvia D. Tang, Johns Creek, GA (*Presenter*) Nothing to Disclose
Jiwoong Jason Jeong, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Xiaofeng Yang, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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Tian Liu, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Despite technological advances in radiotherapy, high dose of radiation may induce acute skin toxicity in the majority of women receiving breast-cancer radiotherapy. In current clinical practice, the severity of skin toxicity is often rated by clinicians through visual inspection and physics examination, which is subjective. The purpose of this study is to investigate the feasibility of quantitative characterization of radiation-induced acute skin toxicity via ultrasound morphological and texture analysis.

METHOD AND MATERIALS

Twelve patients receiving standard breast radiotherapy were enrolled in the longitudinal ultrasound study. Ultrasound B-mode images are acquired at various time points: prior to, weekly during, as well as 6 weeks and 3 months post radiotherapy. At each time point, 4 images (12, 3, 6 and 9 o'clock) were acquired on the irradiated breast and 4 mirror images were acquitted on the contralateral normal breast. To evaluate radiation-induced skin changes, we performed both morphological (area, height, perimeter and averaged skin thickness) and textural (contrast, angular second moment (ASM) and inverse difference moment (IDM)) analyses using ImageJ. Clinical assessment of skin toxicity was performed at each time point.

RESULTS

Changes in skin thickness and texture were observed in 5 patients as early as 1 week during treatment. In 2 cases with most severe acute toxicity, the average skin thickness of irradiated breast increases more than 175% and 188% at the end of fractionated therapy in comparison to the untreated contralateral breast, while their slopes in linear regression are 0.87 and 0.70, respectively. Acute skin toxicity was observed in differences in 5 cases in the angular second moment measurements and in 4 cases of entropy analysis over the patient's temporal treatment course.

CONCLUSION

Radiation-induced skin toxicity in breast cancer patients can be quantitatively assessed by ultrasound-based morphologic and textural characterization.

CLINICAL RELEVANCE/APPLICATION

Quantitative ultrasound characterization of radiation-induced acute skin toxicity in breast cancer patients receiving radiation therapy may be of clinical relevance for the optimization of treatment protocols and potential early intervention to prevent long-term breast toxicity.

SSE01

Breast Imaging (Breast Density and Risk Assessment)

Monday, Nov. 26 3:00PM - 4:00PM Room: E451B

BQ BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jennifer A. Harvey, MD, Charlottesville, VA (*Moderator*) Stockholder, Hologic, Inc; Research Grant, Volpara Health Technologies Limited; Stockholder, Volpara Health Technologies Limited;
Ioannis Sechopoulos, PhD, Atlanta, GA (*Moderator*) Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation; Speakers Bureau, Siemens AG; Scientific Advisory Board, Fischer Medical

Sub-Events

SSE01-01 Surrounding Regions of Tumor in FFDM are Associated with Breast Cancer Prognostic and Proliferation Markers

Monday, Nov. 26 3:00PM - 3:10PM Room: E451B

Awards
Student Travel Stipend Award

Participants
Dooman Arefan, PhD, Pittsburgh, PA (*Presenter*) Nothing to Disclose
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Jules H. Sumkin, DO, Pittsburgh, PA (*Abstract Co-Author*) Research Grant, Hologic, Inc; Research Grant, General Electric Company
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PURPOSE

Radiomic information of segmented tumors in breast images have been shown to be correlated with prediction of certain markers/surrogates for prognosis. Surrounding regions of tumor may have been affected by tumor development but its effects remain unclear for similar prediction purposes. We performed an investigation on the radiomic imaging features extracted from both tumor and surrounding regions in relation to prediction of breast cancer distant recurrence risk and tumor proliferation markers.

METHOD AND MATERIALS

We performed an IRB-approved retrospective study on 119 ER-positive and node-negative invasive breast cancer patients diagnosed (confirmed by pathology) during 2011-2016. All patients had FFDM scans (including MLO and CC views), Oncotype DX recurrence risk scores, and proliferation markers (Ki-67) available. Breast tumor was segmented by an expert breast imaging radiologist, and a varying size (diameter) of surrounding regions outside the segmented tumor were automatically separated using automated image processing techniques. A total of 23 radiomic features were extracted respectively from tumor and its surrounding region. The logistic least absolute shrinkage and selection operator (LASSO) regression model was used to estimate the Oncotype DX risk score and Ki-67 rate, respectively, using the same set of 23 features. AUC and Pearson's correlation coefficient (r) are performance metrics.

RESULTS

For features extracted from tumor alone, r was 27% ($p < 0.05$) and 35% ($p<0.05$) for estimating Oncotype DX and Ki67, respectively, while the corresponding AUC was 0.77 (High Oncotype DX vs Intermediate and low) and 0.58 (High Ki-67 vs low Ki-67). When imaging features from the surrounding regions (6 mm outer from tumor boundary) were incorporated additionally, r increased to 34% ($p<0.05$) and 47% ($p<0.05$) for estimating Oncotype DX and Ki-67, respectively, while the AUC was 0.78 and 0.63. The LASSO-selected features included the tumor solidity, surrounding region's skewness and intensity contrast.

CONCLUSION

Inclusion of the surrounding regions of breast tumor in FFDM increased the performance of predicting Oncotype DX recurrence risk scores and Ki-67 proliferation rate.

CLINICAL RELEVANCE/APPLICATION

Surrounding regions of breast tumor in FFDM may provide additional quantitative information over tumors to enhance prognosis and proliferation estimation

SSE01-02 Developing a Deep Learning Algorithm to Automatically Classify Breast Density According to 5th

Edition of ACR BI-RADS in Mammography

Monday, Nov. 26 3:10PM - 3:20PM Room: E451B

Participants
Yiming Ding, Berkeley, CA (*Presenter*) Nothing to Disclose
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PURPOSE

The current edition of BI-RADS assigns breast density qualitatively based on potential for obscuring breast cancer, rather than a simple quantitative summation of image intensities. The aim of this study is to develop a deep learning algorithm for breast density classification based on the new BI-RADS system and then retrospectively apply them to a separate set of digital mammograms to automatically classify breast density according to BI-RADS 5th Edition.

METHOD AND MATERIALS

A convolutional neural network with ResNet50 architecture was trained on 94,562 screening mammograms performed from 2014 to 2018 from a single institution following the current 5th edition of BI-RADS for mammography. Optimal neural network hyperparameters were selected via validation accuracy monitoring. The trained model was then applied to a hold-out test set of size 9,547 from the same institution. We then manually inspected all 13 cases in which the predicted label differed by more than 2 density labels from the ground truth. This algorithm was applied to 433,760 screening mammograms in large scale.

RESULTS

Our deep learning model achieved high sensitivity and specificity in assigning breast density category. Breast density distribution for the training data was 7,752 (A: 8.20%), 35,656 (B: 37.71%), 40,943 (C: 43.30%), and 10,211 (D: 10.79%). The AUCs of ROC curves on the test set were 0.97, 0.93, 0.92, and 0.96, respectively for each breast density category. Error analysis revealed that among the 13 cases where breast density differed by more than 2 classes between actual and predicted labels, 7 were due to breast implants, 4 were due to incorrect ground truth labels, and 2 remained equivocal. After the model was applied to the 433,760 screening mammograms, the model-predicted breast density distribution came to be 40,109 (A, 9.25%), 151,893 (B, 35.02%), 193,283 (C, 44.56%), and 48,475 (D, 11.17%).

CONCLUSION

Our deep learning algorithm successfully modeled the breast density classification scheme in the 5th edition BI-RADS system. This was retrospectively applied in large scale to 433,760 mammograms for further inspection.

CLINICAL RELEVANCE/APPLICATION

Qualitative breast density assessment by radiologists is subject to variability. Given widespread adoption of breast density notification laws in the U.S., automated breast density assessment based on masking can improve consistency of breast density assignment particularly between categories B & C.

SSE01-03 Using Quantitative Breast Density Analysis to Predict Interval Cancers and Node Positive Cancers in Pursuit of Improved Screening Protocols

Monday, Nov. 26 3:20PM - 3:30PM Room: E451B

Participants
Elizabeth S. Burnside, MD,MPH, Madison, WI (*Presenter*) Dr. Burnside has a research grant from Hologic
Lucy M. Warren, PhD, Guildford, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Louise S. Wilkinson, MBBCh,FRCR, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
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Jonathan Myles, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Stephen W. Duffy, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

This study investigates whether quantitative breast density can predict interval cancers and node positive screen detected cancers in order to serve as a biomarker to consider more aggressive screening to improve early detection.

METHOD AND MATERIALS

We conducted a case-control study of 1204 women drawn from the U.K. NHS Breast Screening Program aged 50-74 including 599 cases (comprising 302 screen detected cancers, 297 interval cancers; 239 node positive, 360 node negative) and 605 controls. Each woman had prior digital mammograms and 70% had unprocessed images. A radiologist assessed breast density using a visual analog scale (VAS) from 0 to 100 and BI-RADS 5th Edition density categories. Volpara software (V1.5.1) calculated fibroglandular volume (FGV) and volumetric density grade (VDG) on unprocessed images. Logistic regression determined whether the breast density measures could predict mode of detection (screen detected or interval); node-negative cancers; and node-positive cancers, all vs. controls.

RESULTS

FGV predicted both screen-detected ($p<0.01$) and interval cancers ($p<0.01$) compared to controls. VDG, VAS and BI-RADS

FGV predicted both screen-detected (p<0.01) and interval cancers (p<0.01) compared to controls. VDG, VAS and BI-RADS predicted interval cancers (all p<0.01) but not screen-detected cancers (p=0.16, p=0.18, p=0.46 resp.). FGV demonstrated impressive risk stratification with an age-adjusted relative risk (RR) of the 4th quartile compared to the 1st quartile of 3.7 overall, 2.8 for screen detected, and 5.3 for interval cancers. VDG also had notable risk stratification with an age-adjusted RR of 3.6 for interval cancers (Table). FGV predicted node-negative cancers as compared to controls (p<0.01) while BI-RADS, VAS, and VDG did not (p=0.07, p=0.09, and p=0.47 resp.). FGV, BI-RADS, and VDG predicted node-positive cancers (all p<0.01) while VAS did not (p=0.14).

CONCLUSION

FGV predicts interval, screen detected, node-positive and node-negative cancers compared to controls and provides remarkable stratification the RR of interval cancers. BI-RADS and VDG predict interval and node positive cancers. VAS only predicts interval cancers. The quantitative and automated nature of FGV and VDG and notable risk stratification based on RR indicates that these variables may be promising biomarkers.

CLINICAL RELEVANCE/APPLICATION

By predicting mode of detection and nodal status, FGV may be a biomarker for more intensive screening. By predicting interval cancers, BI-RADS, VAS, and VDG may act as supplementary biomarkers.

SSE01-04 Fully-Automated Volumetric Breast Density Estimation from Digital Breast Tomosynthesis: A Case-Control Comparison to Area-Based Density Measures from Digital Mammography

Monday, Nov. 26 3:30PM - 3:40PM Room: E451B

Participants
Aimilia Gastounioti, Philadelphia, PA (*Presenter*) Nothing to Disclose
Meng-Kang Hsieh, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Lauren Pantalone, BS, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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Despina Kontos, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate associations between breast cancer and fully-automated volumetric density measures extracted with digital breast tomosynthesis (DBT), while also comparing to area-based density measures from digital mammography (DM).

METHOD AND MATERIALS

We retrospectively analyzed contralateral combo DM-DBT studies (Selenia Dimensions, Hologic Inc.) from 174 women with unilateral breast cancer and 696 controls matched to cases on age, ethnicity and screening exam date at a 4:1 ratio. The publicly available 'LIBRA' software (v1.0.4) was adapted and used to estimate absolute dense volume (DV) and volumetric percent density (VPD) from DBT, and absolute dense area (DA) and area percent density (APD) from DM images. Quantra (v2.2; Hologic Inc.) was also applied to DM images, allowing to evaluate APD as well as to infer DV and VPD via physics-based models. Associations between the different density measures and breast cancer were evaluated via logistic regression after adjustment for age, ethnicity and body mass index (BMI). Area under the curve (AUC) of the receiver operating characteristic was used to assess case-control discriminatory capacity, where model performance was compared using the DeLong's test, and odds ratios (ORs) for each of the density measures were estimated.

RESULTS

All density measures had a significant association with breast cancer (OR = 1.24-2.40) after adjustment for age, ethnicity and BMI. Models based on volumetric density measures had significantly ($p < 0.05$) larger case-control discriminatory capacity (AUC = 0.59-0.63) than models considering area density (AUC = 0.57-0.59). Maximum breast cancer association was observed for DV with slightly ($p = 0.440$) improved performance when extracted with DBT (AUC = 0.63) relative to DV inferred from DM (AUC = 0.61).

CONCLUSION

Fully-automated, quantitative, volumetric evaluation of breast density from DBT is feasible and can result in larger case-control discriminatory capacity than area-based density measures from conventional planar mammography. Associations with breast cancer can potentially further improve when volumetric density evaluation is performed with the DBT reconstructed breast volume compared to physics-based models applied to DM.

CLINICAL RELEVANCE/APPLICATION

Our results further elaborate important clinical implications of breast density measures estimated with DBT, which may result in improved measures of breast density in breast cancer risk assessment.

SSE01-05 Predicting Masking Risk in Mammography

Monday, Nov. 26 3:40PM - 3:50PM Room: E451B

Participants
James G. Mainprize, PhD, Toronto, ON (*Presenter*) Institutional research agreement, General Electric Company
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PURPOSE

Masking in mammography is the reduction of lesion conspicuity by surrounding and overlying dense tissue. Masking risk is increased in dense breasts, leading to reduced sensitivity of breast screening. We have developed a masking index that can predict the likelihood of a masked or missed cancer and could be used in a screening program to stratify women at greatest risk of masking to alternative or supplementary imaging modalities to mammography.

METHOD AND MATERIALS

The study population were cancer cases collected (2003-2013) a case-control study used to develop a breast cancer risk model incorporating density measures. Cancers were classified as screen-detected cancers (SDC) found on a screening mammogram and non-screen detected cancers (NSDC) found by clinical symptoms or other imaging. The study had ethics board approval with informed consent All SDC found on baseline images were excluded. Inclusion as NSDC required at least one prior negative screening exam within two years of diagnosis. Images were analyzed with in-house algorithms and by volumetric breast density (VBD) software. The aim in this study was to create an index that differentiated mammograms which allowed for detection (SDC) from those for causing masking or missed lesions (NSDC). To avoid the influence of the lesion itself, only the contra-lateral breast images were used.

RESULTS

The study included 90 NSDC cases and 186 SDC controls. Univariate masking indices based on BMI, age, BI-RADS density, VBD or mean detectability yielded areas under ROC (AUC) of 0.61, 0.65, 0.67, 0.72 and 0.75 (±0.06 95% confidence) respectively. For cancers found within one year, the detectability AUC improved to 0.81.

CONCLUSION

Age and BMI are relatively weak predictors of masking risk whereas VBD and detectability measures have better performance. Further, adding textural measures improve predictions slightly, suggesting that the masking effects of anatomic noise and texture are informative. In future, we will validate the model in an independent population and test the result on normal mammograms to predict impact on a stratified screening program.

CLINICAL RELEVANCE/APPLICATION

A reliable masking index to predict when mammography will underperform would be a valuable tool in a stratified screening program which could be used to redirect women with highly masked mammograms to alternative or adjunct screening strategies such as tomosynthesis, MR or ultrasound.

SSE01-06 Quantitative MRI Background Parenchymal Enhancement and Contralateral Breast Cancer Risk

Monday, Nov. 26 3:50PM - 4:00PM Room: E451B

Participants
Lei Zhang, PhD, Pittsburgh, PA (*Presenter*) Nothing to Disclose
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Yue Liang, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Aly A. Mohamed, PhD, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Yiwei Tong, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Kunwei Shen, shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Shandong Wu, PhD, MSc, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

MRI background parenchymal enhancement (BPE) has been shown to be correlated with the risk of developing breast cancer in breast-cancer free women. History of breast cancer is a significant risk factor of contralateral breast cancer. We investigated the association between quantitative MRI BPE measures and risk of contralateral breast cancer development in a case-control setting

METHOD AND MATERIALS

A retrospective case-control (1:2 case-control ratio) study was performed using breast DCE-MRI scans from 135 newly diagnosed unilateral breast cancer patients (confirmed by pathology) from 2010-2016: 35 women had future contralateral breast cancer development after the initial breast cancer diagnosis and 70 were age- and year-of-MRI matched controls that remained breast cancer-free in the contralateral breasts after at least 1-year follow-up. The MRIs acquired at the initial diagnosis of the unilateral breast cancer were analyzed using published automated computer algorithms, generating two quantitative BPE measures computed from the first post-contrast series: the absolute BPE volume (|BPE|) and its relative amount over the whole breast volume (BPE%). Volumetric amounts of fibroglandular (dense) tissue (|FGT| and FGT%) were also automatically quantified from the MRI. Conditional logistic regression was performed to assess these BPE and FGT measures as predictors of the contralateral breast cancer development.

RESULTS

Average age was 52.2±13.1 (range 28-81) for cancers and 52.8±12.9 (range 28-80) for controls. 51% (or 49%) are post-menopause for cancers (or controls). Invasive other-cancer history was found in less than 10% of the patients for both cancer cases and controls. None of the |FGT|, FGT%, |BPE|, BPE% measures is statistically significant (all $p>0.05$) in terms of the difference between the cancer group and control group. Logistic regression showed that odds ratios of these four measures are very close to 1 with no statistical significance.

CONCLUSION

This pilot study showed that MRI BPE quantified in the contralateral breast of unilateral breast cancer patients is not associated with the future development of the contralateral breast cancers.

CLINICAL RELEVANCE/APPLICATION

BPE may be affected bilaterally even in unilateral breast cancer patients. Contralateral breast cancer risk markers can guide

treatment selection and risk reduction, meriting further investigation.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSE02

Breast Imaging (Patient-Centric Care)

Monday, Nov. 26 3:00PM - 4:00PM Room: E450B

BR HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Rachel F. Brem, MD, Washington, DC (*Moderator*) Board of Directors, iCAD, Inc; Board of Directors, Dilon Technologies, Inc ; Stock options, iCAD, Inc ; Stockholder, Dilon Technologies, Inc; Consultant, Dilon Technologies, Inc; Consultant, ClearCut Medical Ltd ; Consultant, Delphinus Medical Technologies, Inc
Priscilla J. Slanetz, MD, MPH, Belmont, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSE02-01 Communicating Mammography Results: What Method and How Quickly Do Women Want Their Screening Mammogram Results?

Monday, Nov. 26 3:00PM - 3:10PM Room: E450B

Participants
Julia Staschen, BS, Richmond, VA (*Abstract Co-Author*) Nothing to Disclose
Nghiem Pham, BA, Midlothian, VA (*Presenter*) Nothing to Disclose
Alicia Johns, Richmond, VA (*Abstract Co-Author*) Nothing to Disclose
Biren A. Shah, MD, Glen Allen, VA (*Abstract Co-Author*) Royalties, Wolters Kluwer nv; Royalties, Springer Nature

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PURPOSE

Expectations for when and how to receive results for mammograms are uncertain and the goal of this study is to explore expectations for patient care with regards to receiving mammogram results. The purpose of the study was to understand the majority preference with regards to the wait time for screening mammogram results, whether prompt communication of mammogram results was of importance to patients, whether the time frame to schedule an additional imaging follow-up appointment after an abnormal screening mammogram was of importance to patients, and how patients preferred to be given their screening mammogram results. From the survey, investigators wanted to determine whether any quality practice improvements are necessary at their academic breast imaging centers in order to improve the communication of screening mammogram results.

RESULTS

There were 2,245 patients who participated in the survey. A majority of patients preferred to receive results on Friday (N=1,868, 85.4%). Most individuals preferred to schedule their follow up appointments soon after their initial appointment, preferring either the next day or within 1-2 days. Finally, over half of the sample preferred to be contacted via a phone call, with letter and text messaging being the next most preferred methods. The preference for receiving results on Friday was evaluated by each of the patient characteristics. The responses by the patients for preference for receiving results on Friday were significantly different by ethnicity, education, and clinic. In particular, patients of other ethnicities besides African Americans and Caucasians responded with the highest percent to receiving results on Friday and Caucasians were the least inclined to prefer to receive results on Friday. Individuals with some college and college degrees were more likely to not prefer receiving results on Friday than those with no formal education or high school graduates. The preferred time for scheduling a follow up was assessed by each of the patient characteristics. Across all the patient characteristics, patients preferred to schedule their follow up appointment the next day. Lastly, first choice of contact was examined across each of the patient characteristics. Phone call was the overwhelming choice for method of contact for all patient characteristics.

CONCLUSION

The findings suggest that the patient population surveyed have a preference for their wait time, which is either to wait or receive them within 24 hours. Patients preferred to receive results on Friday, and the most frequent choice for scheduling a follow up appointment was the next day. A phone call was the preferred first choice for method of contact with e-mail being the least preferred. These suggestions can help clinics and providers make changes to how they communicate their results. These findings may help to streamline results for patients who prefer a shorter wait time, and highlight the overwhelming patient preference to receive their abnormal screening mammogram results on a Friday. The findings may also suggest how to contact patients in a different way, as phone calls were the preferred method of contact. The strong preference of patients receiving their screening mammogram results more promptly should help trigger alternative methods toward improving communication between the radiologist and the patient.

METHODS

Patients The study population was patients aged 18 or older, who completed an anonymous paper survey consisting of eight questions when coming in for a routine mammogram screening. The study period lasted from September to November 2017 at two academic breast-imaging centers. *Measures* The primary objective of the study was to summarize the results from a survey examining the communication of mammography results from the patient population. The association between patient demographics

and four outcomes, preferred wait time, preferred scheduling time for a follow-up appointment, preference for receiving screening results on Friday, and preferred methods of contact was investigated. Parameters of the survey are summarized in attached Table 1. *Statistical Methods* Frequencies and percentages for clinic site, age, ethnicity, education, and insurance were calculated. Pearson chi-square analyses were conducted to determine the association between wait time preference and each patient demographic, between preferred scheduling time for follow-up appointment and each patient demographic, between preference for receiving screening results on Friday and each patient demographic, and between the first choice of method of contact and each patient demographics. SAS version 9.4 was used for all analyses.

PDF UPLOAD

http://abstract.rsna.org/uploads/2018/18003961/18003961_3t99.pdf

SSE02-02 City Patterns of Screening Mammography Uptake and Disparity Across the United States

Monday, Nov. 26 3:10PM - 3:20PM Room: E450B

Awards
Trainee Research Prize - Resident

Participants
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James S. Babb, PhD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Rural disparities in screening utilization are known to be affected by lack of access to care providers; city-level screening mammography disparity has been less well evaluated, although over 30 million adult women live in the 500 largest cities. Our purpose is therefore to evaluate disparities in screening in US cities.

METHOD AND MATERIALS

This descriptive study used public data from the 500 Cities project--500 largest cities, 103,020,808 individuals--which includes self-reported screening uptake (127,298 women ages 50-74) from the Behavioral Risk Factor Surveillance System (BRFSS). Uptake was matched with BRFSS and American Community Survey national population/economic census data variables expected to impact screening: geographic region, health insurance, median household income, obesity, race, combined preventive care services (flu, pneumococcal shots, colorectal screening), and pap smear use. Cities with incomplete data were excluded, yielding 490 cities, 34,629,163 women. Univariable and multivariable analyses were performed. All statistical tests were conducted at the two-sided 5% significance level using SAS 9.3 software (SAS Institute, Cary, NC).

RESULTS

Mean city screening mammography utilization was 77.7% (62.8%-88.9%). Utilization was highest in New England cities ($p<0.002$), significantly positively correlated with pap smear ($r=0.75$), other preventive services ($r=0.3$), household income ($r=0.44$), %Asian race ($r=0.36$), weakly with %Black race ($r=0.10$); significantly negatively correlated with obesity ($r=-0.36$), poverty ($r=-0.30$), %White race ($r=-0.29$), no insurance ($r=-0.27$), ($p<0.05$ for all); not significantly correlated with population size ($p=0.651$). Multivariable analysis demonstrated Pap smear use, Asian race, private insurance, and geographic region to be significant independent predictors of utilization.

CONCLUSION

Screening mammography utilization varies across large cities in the U.S. with highest uptake in New England. Although the literature focuses on rural screening disparities, disparities also exist even across large cities without physical barriers to screening.

CLINICAL RELEVANCE/APPLICATION

Mammographic screening disparities exist at the city level; identifying predictors of uptake may aid in targeting areas and populations for screening education and intervention.

SSE02-03 Aligning Insurance Benefit Design with Patient Preference for Out-of-Pocket Cost Payments

Monday, Nov. 26 3:20PM - 3:30PM Room: E450B

Participants
Paniz Charkhchi, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose
Aaron Scherer, PhD, Iowa City, IA (*Abstract Co-Author*) Nothing to Disclose
Angela Fagerlin, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
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Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Alternative payment models encourage physicians to accept payment bundles. Their patients continue to pay fee-for-service (FFS) out of pocket costs, contrary to their preference for predictable out of pocket costs for a care episode. Using a hypothetical screening mammography diagnostic episode of care, we assessed patient preference for FFS vs bundled copayments (copays).

METHOD AND MATERIALS

After IRB approval, we recruited a population-based cross-sectional survey of women 40-75 years old through Survey Sampling International. Participants read a hypothetical scenario describing a screening mammography episode of care where 12% of women undergoing screening needed a follow-up breast ultrasound and 2% a breast biopsy. Estimated out-of-pocket (OOP) costs for these services and the characteristics of OOP payment types (FFS and a hypothetical bundled copay) were also described. We assessed OOP payment type preference and knowledge (7 true/false items, see Fig. 1), additional test cost worry (7-point scale from not at all to very worried), likelihood of mammogram use by OOP payment type and willingness to pay (WTP) for a breast screening episode bundle.

RESULTS

Participant (n=1,236) characteristics are described in Fig. 1. 82.9%preferred bundled copays over FFS and 70.8% answered at least half of the knowledge questions correctly. While most participants (74.5%) indicated they would get screened regardless of OOP payment type, 13.8%said they would only get screened with bundled copays and 3.4% with FFS. Sizeable percentages of participants were worried about costs associated with the ultrasound (42.0%) and biopsy (67.7%). Median WTP was $81 (25-75IQ=$34-$215) for a bundle to avoid paying additional OOP for possible ultrasound or biopsy.

CONCLUSION

Given worry over the cost over potential additional tests, participants preferred a predictable OOP cost for a breast screening episode, despite the low likelihood of additional testing. Although most participants would not defer mammography based on OOP payment type, a significant minority were more likely to screen if bundled copays were available. Insurers should consider incorporating these preferences in future benefits.

CLINICAL RELEVANCE/APPLICATION

Designing insurance plans to include bundled copays may decrease financial barriers to breast cancer work-up and diagnosis after screening mammography.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ruth C. Carlos, MD, MS - 2015 Honored EducatorRuth C. Carlos, MD, MS - 2018 Honored Educator

SSE02-04 Patient, Radiologist, and Examination Characteristics Affecting Screening Mammography Recall Rates in a Large Academic Practice

Monday, Nov. 26 3:30PM - 3:40PM Room: E450B

Participants
Catherine S. Giess, MD, Wellesley, MA (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate patient, radiologist, and examination characteristics affecting individual screening mammography recall rates in a large academic breast imaging practice.

METHOD AND MATERIALS

This Institutional Review Board approved retrospective study included all screening mammography examinations in female patients interpreted by thirteen breast imaging specialists at an urban academic center and two outpatient imaging centers from 10/1/2012-5/31/2015. Patient demographics were extracted via electronic medical record. A natural language processing algorithm captured breast density, BI-RADS assessment, and current and prior screening examination findings. Radiologists' annual screening volumes, years of clinical experience, and percentage of time doing breast imaging were calculated. Risk aversion, stress from uncertainty, and malpractice concerns were derived via online survey. Univariate and multivariate analyses assessed patient, radiologist, and examination characteristics associated with likelihood of mammography recall. Pearson product-moment correlation coefficient assessed relationship between cancer detection rate and recall rate.

RESULTS

Overall, 5,678 (9.3%) of 61,198 screening examinations were recalled. In multi-variate analysis, patient and radiologist characteristics associated with higher odds of recall included patient's age < 50 years ($p<0.0001$); calcification ($p<0.0001$), mass ($p<0.0001$), and higher density category ($p<0.0001$) on prior mammogram; baseline examination ($p<0.0001$); annual reading volume < 1250 screening exams ($p=0.0282$); and <10 years experience ($p=0.0036$). Radiologist's risk aversion, stress from uncertainty, malpractice concerns, or cancer detection rates were not associated with higher recall rates ($r=-0.36$, $p=0.23$).

CONCLUSION

In addition to patient and examination factors, screening recall variations were explained by radiologist's annual reading volume and experience. Interventions targeting radiologist factors may reduce unwarranted variation in screening recall and improve patient's care experience.

CLINICAL RELEVANCE/APPLICATION

Efforts to reduce screening recall rate variability and false positive recalls might include increasing annual screening interpretive volumes and review of uncertain screening findings for less experienced radiologists by more experienced breast imaging specialists.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Catherine S. Giess, MD - 2015 Honored EducatorCatherine S. Giess, MD - 2017 Honored Educator

SSE02-05 Preventive Care: How Comorbidities Affect Mammography Screening Rates

Monday, Nov. 26 3:40PM - 3:50PM Room: E450B

Awards
Student Travel Stipend Award

Participants
Cindy Yuan, MD,PhD, Chicago, IL (*Presenter*) Nothing to Disclose
Kirti M. Kulkarni, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Brittany Z. Dashevsky, MD,DPhil, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Here we evaluate the impact of comorbid conditions and age on screening mammography utilization.

METHOD AND MATERIALS

Data was retrospectively drawn from the 2011-2015 Medical Expenditure Panel Survey, which contained 40,752 women over the age of 40. Utilization was defined as a screening mammogram within the previous one or two years, analyzed separately. A logit model was employed to evaluate correlation of comorbidities with utilization. Statistical significance was defined by a p-value <0.05 by two-sided test.

RESULTS

Of the 36,575 women in the final sample, 45.9%, 43.6%, 3.9%, and 5.7% reported a history of hypertension (HTN), hyperlipidemia (HLD), prior heart attack (MI) and prior stroke (CVA), respectively. Among women without a comorbid condition, baseline annual mammography utilization was 47.3%. HTN and HLD were correlated with increased annual utilization [2.5 and 6.8 percentage points (pp)]. In comparison, prior MI and CVA were correlated with decreased annual utilization (-8.2 and -1.5 pp, not statistically significant in the latter). Results were similar for biennial utilization (3.0 and 7.6 pp increased utilization with HTN and HLD, respectively, and -6.5, and 0.1 pp decreased utilization for MI and CVA, respectively).

CONCLUSION

Screening utilization was increased in patients with HTN and HLD, and decreased in patients with prior MI and CVA. An understanding of how comorbid conditions influence screening may help better target specific populations and improve overall utilization of preventive care.

CLINICAL RELEVANCE/APPLICATION

HTN and HLD, comorbidities that require regular physician visits, are correlated with increased screening. However, prior MI or CVA, are correlated with decreased screening, possibly reflecting the effect of decreased life expectancy and increased morbidity. This is especially relevant as age-based guidelines fail to take into account individual comorbidities and life expectancy.

SSE02-06 Contrast-Enhanced Spectral Mammography (CESM) in the Screening Setting: Patient Preferences and Attitudes

Monday, Nov. 26 3:50PM - 4:00PM Room: E450B

Participants
Matthew M. Miller, MD, PhD, Charlottesville, VA (*Presenter*) Nothing to Disclose
Kathy L. Repich, Charlottesville, VA (*Abstract Co-Author*) Nothing to Disclose
Carrie M. Rochman, MD, Charlottesville, VA (*Abstract Co-Author*) Research Consultant, Theraclion
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PURPOSE

Contrast-enhanced spectral mammography (CESM) is an emerging imaging tool that has been shown to have greater sensitivity than conventional mammography and equal sensitivity with improved specificity relative to breast MRI in the diagnostic setting. Ongoing studies are evaluating CESM performance in the screening setting, but little is known regarding whether patients would agree to its use and the associated risks in screening. Our study aims to evaluate the attitudes and concerns of patients regarding

the use of CESM in a screening setting.

METHOD AND MATERIALS

In this IRB-approved HIPAA-compliant prospective study, patients with prior mammograms demonstrating heterogeneous or extremely dense breasts presenting for screening mammography were invited to complete a survey. Patients were asked to rate their perception of personal breast cancer risk compared to peers and their level of concern related to screening callbacks, radiation exposure, and contrast allergies, and then identify which factors might deter them from getting adjunct screening exams such as CESM.

RESULTS

512 patients with dense breasts undergoing screening mammography completed surveys. While 27% of surveyed patients reported previously having been called back from screening for a diagnostic workup, a majority (63%) expressed little or no concern for callbacks leading to additional imaging or biopsy. Most patients (63%) felt it was likely or very likely that cancer could be missed on their mammogram, but only 9% had undergone adjunct screening exams in the past 3 years. The most commonly cited deterrents to undergoing adjunct screening were cost (69%), pain (35%), and concern for an increased likelihood of having a biopsy or surgery recommended (32%). When asked to select from several hypothetical adjunct screening modality choices, patients reported a strong preference (63%) for a test that is most likely to detect their cancer, even if this would require IV-line placement. Only 5% preferred a common but less sensitive test that did not require IV-line placement.

CONCLUSION

Our study suggests that women with dense breasts may accept CESM as an adjunct screening exam and may actually prefer it over screening MRI or US given its relatively high sensitivity and low cost.

CLINICAL RELEVANCE/APPLICATION

Women with dense breasts may accept CESM as an adjunct screening exam given its sensitivity and low cost.

SSE03

Cardiac (CTA: General Topics)

Monday, Nov. 26 3:00PM - 4:00PM Room: N229

CA CT

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Smita Patel, FRCR,MBBS, Ann Arbor, MI (*Moderator*) Nothing to Disclose
Daniel Vargas, MD, Aurora, CO (*Moderator*) Nothing to Disclose

Sub-Events

SSE03-01 Association of Plasma Uric Acid and Creatinine with Coronary Artery Calcium Score

Monday, Nov. 26 3:00PM - 3:10PM Room: N229

Participants
Lei Zhang, MD, PhD, Songjiang, China (*Abstract Co-Author*) Nothing to Disclose
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Han Wang, MD, PhD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Shu Hong Fan, Shanghai, China (*Presenter*) Nothing to Disclose

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PURPOSE

The aim of this study was to conduct a statistical analysis of low-radiation-dose coronary computed tomography screening for coronary artery calcium score (CACS) to determine the correlation of the CACS with age, sex, systolic blood pressure, diastolic blood pressure, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), total cholesterol (TC), triglycerides (TG), uric acid (UA) and creatinine (Cr), as well as to investigate the predictive value of these traditional risk factors for coronary artery disease.

METHOD AND MATERIALS

There were 646 patients with chest pain or suspected coronary atherosclerosis, a clinical history, smoking habit, symptoms, high blood pressure, and high blood sugar. The following biochemical parameters were assessed: LDL-C, HDL-C, TC, TG, UA, and creatinine. All patients underwent a CT scan for coronary artery calcium score analysis. The scan was then analyzed in relationship to CACS levels and the above items for all patients.

RESULTS

In total, 326 patients were male (59.8%), and 219 patients were female (40.2%). The average age was 69.1 ± 10.2 years, and the mean CACS was 485 ± 814. Significant correlations of CACS with UA ($r = 0.1518$, $P < 0.05$) and creatinine ($r = 0.2752$, $P < 0.05$) were found. According to the multivariate Cox regression analysis, after adjusting for demographic characteristics and other serum parameters, serum UA levels (odds ratio [OR], 1.003, 95% confidence interval [CI], 1.001-1.005, $p = 0.003$) and creatinine levels (OR, 1.002, 95% CI, 0.999-1.005, $p = 0.002$) qualified as independent discriminators of the severity of coronary artery calcification.

CONCLUSION

We propose the need for identifying and managing UA and creatinine abnormalities to reduce excess coronary artery disease (CAD) risk. This proposal remains to be formally tested in a prospective study.

CLINICAL RELEVANCE/APPLICATION

The severity of coronary artery calcification score may indicated the UA and creatinine abnormalities in the blood.

SSE03-03 Feasibility Study of Coronary Computed Tomography Angiography in Patients with Free-Breathing Using 256-Detector CT

Monday, Nov. 26 3:20PM - 3:30PM Room: N229

Participants
Zhuo Liu, Beijing, China (*Presenter*) Nothing to Disclose
Nan Hong, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the feasibility of coronary computed tomography angiography (CCTA) in patients with free-breathing using 256-detector CT.

METHOD AND MATERIALS

616 patients underwent CCTA without heart rate control. 325 examinations were performed during free-breathing (group A), and the remaining 291 were performed during breath-holding(group B). The image quality scores were defined as 1 (excellent), 2 (good), 3 (adequate), and 4 (poor). 22 patients in group A and 24 in group B also underwent invasive coronary angiography (ICA) after CCTA within two weeks. The image quality score, diagnostic performance using ICA as reference, signal-to-noise ratio (SNR), and effective dose (ED) were compared between the two groups.

RESULTS

Mean heart rate during scanning was 70.8±13.8 bpm in group A and 70.7±13.2 bpm in group B (P=0.950). No significant differences were observed in the quality score between breath-holding and free-breathing groups (1.10±0.31 vs. 1.12±0.33; P=0.647). The SNR, effective dose were not significantly different between the two groups. In a segment-based analysis, the sensitivity and specificity in the detection of coronary stenosis of more than 50% were 82.1% and 96.8%, respectively in the breath-holding group and 82.2% and 96.6%, respectively in the free-breathing group with no significant differences for these parameters between the two groups.

CONCLUSION

CCTA for patients without heart rate control and with free-breathing using 256-detector CT showed no significant difference in image quality and diagnostic accuracy compared with patients with breath-holding.

CLINICAL RELEVANCE/APPLICATION

In patients without heart rate control, CCTA can be acquired during free breathing without substantial loss of image quality when using a 256-detector CT.

SSE03-04 Prognostic Value of Delayed Enhancement Imaging by Cardiac Computed Tomography in Predicting Major Adverse Cardiac Events in Patients with Suspected Coronary Artery Disease

Monday, Nov. 26 3:30PM - 3:40PM Room: N229

Participants
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PURPOSE

Myocardial CT delayed enhancement (CTDE) shares the same pathophysiological principle with late gadolinium enhancement MRI, and allows for infarct detection and viability assessment. However, the prognostic value of CTDE is unknown. The purpose of this study was to investigate whether the presence of delayed enhancement (DE) detected by CT is an independent predictor of major adverse cardiac events (MACEs) in patients with suspected coronary artery disease (CAD).

METHOD AND MATERIALS

We studied 429 consecutive patients with suspected CAD who underwent coronary CT angiography (CTA) and CTDE. Patients with known previous myocardial infarction (MI), percutaneous coronary intervention, coronary artery bypass surgery were excluded. MACEs were defined as severe cardiac events (cardiac death, nonfatal MI, unstable angina, heart failure necessitating hospitalization) and late revascularization (>180 days after CT examination). CTA results were divided into obstructive (>=50% luminal narrowing), mild (<50%), or no CAD groups. The Cox proportional hazards model was used to investigate the relationship between conventional clinical risk factors, coronary calcium sore and coronary CTA result and MACEs.

RESULTS

Follow-up information was obtained in 389 of the 429 patients (91%). DE was observed in 72 of the 389 patients (19%). During a median follow-up of 26 months, 24 cardiac events (2 cardiac death, 2 MI, 2 unstable angina, 6 heart failure and 12 late revascularization) were observed. When adjusted for obstructive CAD, the presence of DE maintained a significant association with risk of all cardiac events (adjusted hazard ratio, 5.9; $p< 0.0001$) and severe cardiac events (adjusted hazard ratio, 14.2; $p= 0.0002$). Kaplan-Meier curves demonstrated a significant difference in event-free survival between patients with DE and those without for severe cardiac events (log-rank test, $p< 0.0001$), as well as for all cardiac events (log-rank test, $p< 0.0001$).

CONCLUSION

The presence of CTDE was an independent predictor of MACEs and severe cardiac events in patients with suspected CAD among common clinical risk factors and coronary CTA findings.

CLINICAL RELEVANCE/APPLICATION

Acquisition of CTDE following coronary CTA seems to be useful since CTDE provides additional prognostic information in patients with suspected CAD.

SSE03-05 Factors Affecting FFRCT Analysis in Routine Clinical Practice

Monday, Nov. 26 3:40PM - 3:50PM Room: N229

Awards

Student Travel Stipend Award

Participants
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PURPOSE

Reports exist of the acceptance rates of CCTA for FFRCT analysis from trials performed in academic centres, however real world data is lacking. The aim of the current study was to examine the acceptance rate, and the factors associated with rejection for FFRCT analysis.

METHOD AND MATERIALS

All clinical CCTAs referred between July 2016 and March 2018 for HeartFlow FFRCT analysis were included. Metadata from the submitted CCTAs was used to extract information on patient factors, scanner type, acquisition parameters and dose while HeartFlow FFRCT analysis data was used for quantification of aortic enhancement.

RESULTS

Of 10,621 CCTAs submitted, 9,524(89.7%) were accepted for FFRCT analysis. Of the 1,097 rejected: 205(18.7%) were for technical limitations of the submitted data (slice thickness/spacing >=1mm, pixel size >=0.5mm); 181(16.4%) due to the presence of stents, bypass grafts, other cardiac hardware; and 711(64.8%) for image quality. Patient factors associated with rejection were: higher heart rate (64.0(IQR 12.3) vs. 59.0(IQR 10.0) bpm, p<0.001) and heart rate variability (9.0(IQR 21.0) vs. 8.0(IQR 10.0) bpm, p<0.001). Technical factors associated with rejection were: retrospective acquisition (54% vs 31% retrospective, p<0.001), systolic phase acquisition (25% vs. 12% systolic, p<0.001), higher slice thickness (0.63(IQR 0.15) vs. 0.63(IQR 0.07) mm, p<0.001), higher pixel size (0.43(IQR 0.09) vs 0.40(IQR 0.06) mm, p<0.001), lower aortic attenuation (368(IQR 147) vs. 431(IQR 167), p<0.001) and higher kVp (120(IQR 0) vs. 120(IQR 20) kVp, p<0.001). BMI (p=0.9), and image noise (p=0.07) were no different in those with accepted or rejected CCTAs. On logistic regression, heart rate, systolic image acquisition, aorta contrast, pixel spacing, and slice thickness all remained significant predictors of rejection for image analysis (p<0.001 for all).

CONCLUSION

Almost 20% of FFRCT rejection could be avoided by stringent post processing protocols, and a further 20% by appropriate case selection. For the remainder, utilization of CTFFR requires similar strict heart rate and contrast timing image optimization strategies required of CCTA.

CLINICAL RELEVANCE/APPLICATION

Stringent patient preparation, case selection and post processing strategies hold potential to improve the opportunity for successful utilization of FFRCT analysis.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jonathan Weir-McCall, MBBCh, FRCR - 2016 Honored EducatorJonathon A. Leipsic, MD - 2015 Honored Educator

SSE03-06 Interaction of Endurance Sport, Coronary Atherosclerosis and Flow by Coronary Computed Tomography Angiography (CTA): Insights from 3D CFD Modelling

Monday, Nov. 26 3:50PM - 4:00PM Room: N229

Participants
Gudrun Feuchtner, MD, Innsbruck, Austria (*Presenter*) Researcher, HeartFlow, Inc
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Christoph Beyer, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose
Stefan Rauch, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose
Fabian Plank, MD, Innsbruck, Austria (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

to investigate coronary atherosclerosis and flow physiology by coronary computed tomography angiography (CTA) including 3D computational fluid dynamics (CFD) (noninvasive CT-FFR) in endurance athletes compared to inactive controls (CR)

METHOD AND MATERIALS

90 subjects (age 56.2y, 26 females) were examined with 128-dual source coronary CTA. Coronary arteries were evaluated per

90 subjects (age 58.2), 20 females) were examined with 128 dual source coronary CTA. Coronary arteries were evaluated per segment (AHA-16-s-classification) for CAD:1) Stenosis severity (CADRADS 0-5) 2) Total plaque burden (segment involvement score, SIS) and G-score: a new indicator for non-calcified plaque burden3) High risk plaque features (LAP-HU, spotty calcification, NRS, RI) were quantified4) Coronary Fractional Flow reserve (FFR) was remodelled by CFD Study design was retrospective (matched case controlled, 45 endurance-athletes vs 45 CR)The endurance group was defined as "regular" training (cycling, running or others) for least 1h per unit and >=3 times per week. Years of training were recorded.

RESULTS

Coronary stenosis severity (CAD RADS) score was lower in the endurance group vs CR (1.44 vs 2.1, p=0.007). Total and non-calcified plaque burden (SIS and G-score) were also sign. lower (1.8 vs 3.3 ; p=0.003 and 3.5 vs 6.6, p=0.002) while calcium score was trended lower only (38.9 AU vs 137.2 AU, p=0.06)HRP prev. was eminenty lower in athletes (5 vs 14 (2.2% vs 31.1%) p=0.02), and NRS (4 vs 7), resp.Non-calcified and total plaque burden (G-score and SIS) were strongest and significantly correlated with declining distal FFR (RCA S4:r=-0.32 and r=-0.3; p=0.03 and p=0.02, LAD S8 r=-0.2,p=0.09 for G-score), while calcium score was not (S4:p=0.07 and S8:p=0.861, Spearman), in the entire cohort. There was no difference in distal FFR between athletes vs CR (p= 0.532, 0.203, 0.358, 0.343 ANOVA)

CONCLUSION

Regular endurance training (min. 1 h and >=3x/week) reduces CAD burden (coronary stenosis severity, total and non-calcified plaque burden and most eminenty, high-risk plaques). Total and non-calcified plaque burden (G-score) rather than coronary calcium predicts distal coronary flow limitations in both athletes and inactives

CLINICAL RELEVANCE/APPLICATION

Regular endurance training reduces CAD burden and risk, with a dominant effect on high-risk plaque. We describe a novel non-calcifying plaque burden score (G-score),which is easy- to-implement into clinical structural reporting and potentially predicts myocardial ischemia

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSE04

Cardiac (MRI: General Topics)

Monday, Nov. 26 3:00PM - 4:00PM Room: N226

CA MR AI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Pamela K. Woodard, MD, Saint Louis, MO (*Moderator*) Research agreement, Siemens AG; Research, Eli Lilly and Company; Research, F. Hoffmann-La Roche Ltd; ; ; ; ; ;
Harold I. Litt, MD, PhD, Philadelphia, PA (*Moderator*) Research Grant, Siemens AG ; ; ;

Sub-Events

SSE04-01 Convolutional Neural Network Based Guidance System for Multiplanar Cardiac MRI

Monday, Nov. 26 3:00PM - 3:10PM Room: N226

Awards
Student Travel Stipend Award

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PURPOSE

Cardiac MRI (cMRI) is the gold standard for quantitative cardiac evaluation. However, it requires specialized training and expertise to perform. To advance the accessibility and quality of cMRI, we developed a convolutional neural network (CNN) to localize key cardiac landmarks to guide plane prescription. We hypothesize that CNN-based landmark localization may generate similar imaging planes to those acquired by a dedicated cardiac technologist.

METHOD AND MATERIALS

With HIPAA-compliance and IRB waiver of informed consent, we retrospectively collected clinical cMRIs performed at our institution from February 2012 to June 2017, including 472 short axis (SAX) and 892 long axis (LAX) cine series. Anatomic landmarks were annotated by expert radiologists. U-Net CNNs were implemented to predict the location of these structures using heatmap localization. Data was split into 80% of cases for training and 20% for testing. SAX, 4, 3, and 2 chamber planes were computed from predicted anatomic localizations. We analyzed performance of localization by calculating distances between predictions and ground truth annotation, and report mean error and standard deviations. We assessed plane prescription by calculating the angle difference between CNN-predicted planes and those acquired by the technologist. Angle bias, mean error, and standard deviations are reported for each plane orientation.

RESULTS

From LAX images, the mean distance between annotation and predicted location was 7.70±5.90 mm for apex and 5.70±4.02 mm for the mitral valve. For SAX images, the mean distance was 11.99±7.80 mm for aortic valve, 10.20±5.65 mm for mitral valve, 12.56±5.10 mm for pulmonic valve, and 11.99±6.43 mm for tricuspid valve. For SAX stack prescription, average angle bias, mean error, and standard deviations were -7.80°, 7.80°±5.44°. For LAX prescriptions, average angle bias, mean error, and standard deviations were 5.64°, 6.65°±5.22° for 4-chamber, 10.86°, 11.95°±8.02° for 3-chamber, and 4.21°, 7.46°±7.36° for 2-chamber.

CONCLUSION

CNN-based anatomic localization is a feasible strategy for planning cMRI imaging planes. In this study, we show that this approach can produce imaging planes similar to those chosen by dedicated cardiac technologists.

CLINICAL RELEVANCE/APPLICATION

CNNs have the potential to improve the quality and accessibility of MRI, and may even benefit complex examinations like cardiac MRI, which require multiple double oblique image planes.

SSE04-02 Deep Learning for Accelerated CMR Image Reconstruction

Monday, Nov. 26 3:10PM - 3:20PM Room: N226

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PURPOSE

CMR acquisition is inherently time consuming and requires multiple breath-holds, which is not only challenging for many patients, but it also makes the modality susceptible to motion artefacts. The aim of this study is to accelerate the CMR data acquisition by reducing the amount of k-space data needed for reconstructing images from undersampled data.

METHOD AND MATERIALS

Fully sampled, short-axis cardiac cine MR scans from 10 volunteers were acquired. Each scan contains a single slice SSFP acquisition with 30 temporal frames, resolution of 256x256 pixels, FOV of 320x320 mm with slice thickness 10mm. The recombined single-coil images were retrospectively undersampled respecting a linear frequency/phase encode structure, while the central 8 lines in k-space were always included. Deep learning-based iterative denoising algorithms are proposed: 3D-convolutional neural network (CNN) and 2D-convolutional recurrent neural network (CRNN). The networks were trained to directly output clean image from the aliased image. The proposed methods were compared to state-of-the-art compressed sensing approaches: kt-FOCUSS and kt-SLR. The methods were evaluated using peak signal-to-noise ratio (PSNR) and reconstruction speed. We considered acceleration factors 6 and 9 and performed 3-fold cross validation.

RESULTS

The networks were trained within three days on GPU GeForce GTX 1080. Even from small number of training subjects one could train a network that works well on test data. For acceleration factor 6, PSNR was 32.5, 34.6, 37.2 and 37.37 dB for kt-FOCUSS, kt-SLR, CRNN and CNN respectively. For acceleration factor 9, the numbers were 29.7, 31.4, 33.3 and 34.95 dB respectively. The reconstruction speeds were 15, 450, 6 and 10 seconds respectively.

CONCLUSION

We have proposed deep learning-based approaches for CMR image reconstruction, which both outperform current state-of-the-art both in terms of speed and reconstruction quality for single-coil, retrospective undersampling study.

CLINICAL RELEVANCE/APPLICATION

The method will be able to accelerate the CMR acquisition, which reduces burden on patients and improves image quality. In future, parallel imaging extension and implementation on scanner is expected.

SSE04-03 Multiparametric Cardiovascular Magnetic Resonance Imaging Assessment in End Stage Renal Disease Patients with Preserved Left Ventricular Ejection Fraction

Monday, Nov. 26 3:20PM - 3:30PM Room: N226

Participants
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PURPOSE

Early detection of cardiac dysfunction in end stage renal disease (ESRD) patients is beneficial but challenging. Our study aimed to evaluate myocardial strain and tissue characteristic changes by cardiovascular magnetic resonance (CMR) imaging in ESRD patients with preserved left ventricular ejection fraction (LVEF), especially focused on those with no echocardiographic evidence of diastolic dysfunction.

METHOD AND MATERIALS

29 ESRD patients (17 males; mean age 44±11 years) with LVEF >50% in ultrasonagraphy and 43 healthy volunteers (24 males; mean age 43±10 years) underwent CMR imaging including cine, native T1 and T2 mapping. LV function, global LV strains as well as LV myocardial native T1 and T2 of the mid-cavity slice were measured and compared between the two groups. Correlations between LVMASS and CMR parameters were analyzed. According to ASE/EACVI recommendations for the evaluation of LV diastolic function by echocardiography, ESRD group were divided into normal diastolic function subgroup (n=11) and diastolic dysfunction subgroup (n=18). CMR parameters were compared among the two subgroups and the healthy group.

RESULTS

Native T1 and T2 were statistically higher in ESRD group (1296.2±38.4ms, 44.0±2.8ms) than healthy group (1260.1±51.9ms, 41.0±1.7ms; p=0.002, p<0.001). LV Global longitudinal strain (GLS) and global circumferential strain (GCS) were statistically

impaired in ESRD group (-14.5±2.9%, -16.4±3.0%) compared with the healthy group (-16.5±2.2%, -18.2±2.5%; p=0.002, 0.008). Increased LVMASS was strongly associated with impaired LV GLS and GCS (r= 0.72, 0.73; p<0.001) in ESRD group. In subgroup with normal diastolic function, T2 (43.2±1.5ms) and LV GLS (-14.3±3.0%) were statistically different from those in the healthy group (p=0.002, 0.008), while native T1 and LV GCS were similar with those in the healthy group.

CONCLUSION

ESRD patients with preserved LVEF demonstrated higher myocardial native T1, T2, and impaired LV GLS and GCS compared with healthy people. Myocardial edema and decreased myocardial compliance might exist in ESRD patients with preserved LVEF and normal diastolic function, as indicated by higher T2 and impaired LV GLS.

CLINICAL RELEVANCE/APPLICATION

Early stage of myocardial fibrosis, edema and decreased myocardial compliance might exist in ESRD patients with preserved LVEF, even when their diastolic function is normal on echocardiography.

SSE04-04 Subharmonic Aided Pressure Estimation (SHAPE) for Obtaining Intra-Cardiac Pressures Noninvasively in Real-Time: Preliminary Results

Monday, Nov. 26 3:30PM - 3:40PM Room: N226

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PURPOSE

Subharmonic aided pressure estimation (SHAPE) utilizes subharmonic signals from ultrasound contrast agents for pressure estimation. The purpose of this work was to evaluate the efficacy of intra-cardiac SHAPE using Definity (Lantheus Medical Imaging) and Sonazoid (GE Healthcare) microbubbles in patients scheduled for cardiac catheterization procedures.

METHOD AND MATERIALS

Patients scheduled for left and/or right heart catheterization procedures were recruited into this IRB-approved study. During the catheterization procedure, 15 patients received an infusion of Definity (2 activated vials mixed in 50 mL saline; 4-10 mL per minute) and 3 patients received a co-infusion of Sonazoid (infusion rate (mL/hour) = 0.18 x body weight in kg) and saline (120 mL/hour). During contrast infusion, the patients were scanned using a customized interface developed on a SonixTablet scanner (BK Ultrasound; interface developed using C/C++ and cross-platform Qt libraries (The Qt Company)) to determine optimum incident acoustic output (IAO; from a set of 16 pre-configured acoustic outputs coded from 0 or minimum to 15 or maximum) eliciting ambient pressure sensitive growth phase subharmonics for SHAPE, on a per-patient basis. Previously determined optimal parameters for Definity (ftransmit: 3.0 MHz; a chirp down pulse) and Sonazoid (ftransmit: 2.5 MHz; square wave pulse) were used for data acquisition. Correlation coefficient between the SHAPE and pressure catheter data was computed using MATLAB (2016A, The MathWorks, Inc.).

RESULTS

The IAO's at which the best correlation coefficient obtained between the SHAPE and pressure catheter data varied on a per-patient basis from coded values of 3 to 15 (patient BMI range: 22.7-64.6). Data with Definity infusion showed that the correlation coefficient between SHAPE and pressure catheter for the left ventricle (LV) was -0.8 ± 0.03 (mean ± standard deviation; n = 10) and for the right ventricle (RV) was -0.8 ± 0.08 (n = 12). Data with Sonazoid infusion showed the correlation coefficient between SHAPE and pressure catheter for the LV was -0.8 ± 0.04 (n = 2) and the RV was -0.8 (n = 1).

CONCLUSION

Preliminary results indicate a good correlation (correlation coefficient range: -0.7 to -0.9) between SHAPE and pressure-catheter based intra-cardiac pressures.

CLINICAL RELEVANCE/APPLICATION

Intra-cardiac SHAPE may become an effective noninvasive alternative to cardiac catheterization procedures.

SSE04-05 Transient Ischemic Dilation and Coronary Artery Disease Burden in Cardiac MRI

Monday, Nov. 26 3:40PM - 3:50PM Room: N226

Participants
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PURPOSE

Transient Ischemic Dilation (TID) is a well-established finding in nuclear myocardial perfusion imaging (MPI) and is a marker for coronary artery disease (CAD) severity. Stress perfusion cardiac MRI (CMR) offers significantly improved spatial and temporal resolution relative to MPI and allow for direct measurement of the LV wall cavity dimensions. Despite these advantages, CMR-derived TID ratios are not well established and thus not utilized in the clinical setting for CAD severity. The aim of this study was to confirm whether TID occurs during stress perfusion CMR and define a TID ratio that predict the presence and severity of CAD.

METHOD AND MATERIALS

Patients who underwent a complete stress CMR from 2012-2016 were included in the study. Imaging studies were analyzed and stress and rest left ventricular (LV) area at three myocardial cross-sections, basal, mid, and apex, was recorded. Coronary angiographic data for all patients with this information available was reviewed. TID ratio was calculated as the LV cavity area minus papillary muscles at stress versus rest. Global TID ratio was calculated by taking the mean of the segments (basal, mid, and apex) for each patient. Patients were classified into High Risk group if angiography results show >= 70% stenosis in the proximal LAD, >= 70% stenosis in the Left Main, >=90% lesion in more than 2 major vessels, or prior CABG with >=70% graft lesion. Unpaired t-test was used to compare mean values of High Risk and Low Risk groups and a ROC analysis was performed to determine the global TID ratio that differentiated patients with High Risk CAD versus Low Risk CAD.

RESULTS

One hundred forty three patients underwent stress CMR. Fourteen patients met criteria for High Risk CAD on coronary angiography, while the remainder had either negative stress or positive stress with low risk CAD. Mean Global TID ratio for high risk group was 1.18 vs 0.98 in the low risk group (p = 0.004). AUC in the ROC analysis was 0.734 (p=0.004). Associated criterion maximizing specificity revealed global TID ratio > 1.16 with a sensitivity of 57% and specificity of 85%.

CONCLUSION

Significant dilation in the LV area at stress occurs when severe CAD is present compared to rest.

CLINICAL RELEVANCE/APPLICATION

A global stress to rest ratio of 1.16 in cardiac stress MRI may provide an additional marker for identifying high-risk multi-vessel CAD.

SSE04-06 Is Cardiac MR Indispensable for Assessing the Cardiac Mass?: Based on the Review of 10-Years of Hospital Records

Monday, Nov. 26 3:50PM - 4:00PM Room: N226

Participants
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PURPOSE

Although cardiac magnetic resonance (MR) is useful for assessing cardiac mass, it has limited to use as the first modality because of high cost and long scan times. Therefore, we aimed to evaluate how MR is effective in assessing the cardiac mass based on the review of 10-years of hospital records.

METHOD AND MATERIALS

We hypothesized that cardiac mass is firstly detected with echocardiography, and further evaluated with CT and MR. On the basis of echocardiography from 2008 to 2017 in single tertiary hospital, we searched patients with cardiac mass using ICD code and keywords. Cardiac mass was classified by the location (intracardiac, valve and extracardiac) and evaluated the transferred ratio to next modality (CT or MR) from echocardiography according to mass location. Finally, we evaluated why the clinician performed MR and how successful that goal was achieved.

RESULTS

In a total of 718 adults (390 males, 62.6±18.7 years) with cardiac mass (282 intracardiac mass, 262 valve mass, 174 extracardiac mass) which detected on echocardiography, 406 patients (56.5%) were performed CT. Among them, CT performed ratio is highest for extracardiac mass (92.0%) followed by intracardiac mass (66.0%) and valve mass (22.9%), sequentially. MR was performed in 64 patients (8.9%); 16 patients with directly performed MR, 48 patients were performed MR after CT. Role of MR in assessing the cardiac mass was as follows; tissue characterization (n=36), differentiation of thrombus from tumor (n=15) and detection of invasiveness (n=25). After MR, the successful rate which met the goals of MR was highest for detection of invasiveness (92.0%), followed by differentiation of thrombus (80.0%) and tissue characterization (61.1%).

CONCLUSION

Valve mass may be sufficient with echocardiography, and extracardiac mass requires CT to assess the extent. CMR is useful for determine invasiveness and differentiate thrombus from tumor than tissue characteristics

CLINICAL RELEVANCE/APPLICATION

From this review of our data, the efficacy of CMR for assessing cardiac mass might be higher to determine the invasiveness and differentiate the thrombus from tumor than to detect tissue characteristics.

SSE05

Chest (Airway Disease)

Monday, Nov. 26 3:00PM - 4:00PM Room: N230B

BQ CH CT

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants

Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Moderator*) Research Grant, Canon Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Fuji Pharma Co, Ltd; Research Grant, Guerbet SA;
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Sub-Events

SSE05-01 Generation-Based Airway Remodeling in Smokers with Normal-Looking CT: After Normalization to Control Inter-Subject Variability

Monday, Nov. 26 3:00PM - 3:10PM Room: N230B

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PURPOSE

As the quantitative airway analysis has been evolved, the effect of smoking has been established. However, the generation-based smoking effect where inter-subject variabilities are normalized is rarely known. The purpose of this study is to evaluate a prediction model of airway parameters, and further to investigate generation-based structural and functional airway alterations in smokers with the derived normalization scheme.

METHOD AND MATERIALS

68 smokers and 174 nonsmokers with inspiratory/expiratory CT findings, and normal pulmonary function tests were included in the study. VIDA Apollo software (Coralville, IA) was used for the airway size analysis. To control inter-subject variability, multiple linear regressions of tracheal wall thickness (WT), diameter (D), and luminal area (LA) were used for the normalization of airway parameters considering the effects of age, sex and height. Using this scheme, each airway parameter was normalized by individual predicted values, and normalized WT (WT*), D (D*), LA (LA*) from the 1st to 8th generation of each lobe were compared between smokers and non-smokers.

RESULTS

LA* and D* decreased and WT* increased in the smokers after normalization ($p<0.05$), which was not observed before normalization. The wall thickness of the segmental airways in smokers was not changed between inspiration and expiration (WT*ins-WT*exp= 0.01±0.01), whereas that in non-smokers was thicker at expiration than inspiration (-0.02±0.01). Besides, airways at the 3rd generation showed significant wall thickening in smokers than nonsmokers ($p=0.003$).

CONCLUSION

Quantitative CT assessment using a normalization scheme suggest that smoking may induce airway wall thickening and reduce changes of wall thickening during respiration, which means a decrease in airway wall compliance. Generation-based analysis showed that the 3rd generation is most affected by smoking.

CLINICAL RELEVANCE/APPLICATION

When it comes to the effect of smoking, it is important to perform normalization and focus on wall thickening of segmental airways.

SSE05-02 Enhanced Evaluation of Tracheomalacia with Use of Cyclic Ultra-low Dose Dynamic Expiratory CT

Monday, Nov. 26 3:10PM - 3:20PM Room: N230B

Awards

Student Travel Stipend Award

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PURPOSE

The percent tracheal area narrowing (%TN) between paired inspiration CT and dynamic expiratory CT (DECT) is used to diagnose and grade tracheomalacia (TM). At our institution this is done clinically with the maximum %TN on either of two consecutive ultra low dose DECTs (mDECT). This study aims to evaluate the implications of mDECT vs. single DECT in TM diagnosis and grading.

METHOD AND MATERIALS

CT studies for evaluation of TM from 2017 performed at a single imaging site were retrospectively evaluated. CT protocol of one routine inspiratory chest CT and two consecutive ULD (100 kVp, fixed mA 10) DECT. The %TN for each DECT was obtained by comparing the greatest percent tracheal narrowing on anatomically matched expiration and inspiration CT, measured independently for DECT 1 and 2. Tracheal area was measured manually delineating the luminal contour of the trachea with the free-hand PACS ROI tool on 2.5 mm axial slices by a thoracic fellowship trained radiologist. The presence of TM (>70 %TN) and its severity (negative <70%, mild 70-80%, moderate 80-90%, severe >90%) were assessed. The mean %TN, percent of patients with TM diagnosis, and distribution of TM severity between DECT1, DECT2 and mDECT were analyzed using paired 2-tailed t-test, 2-tailed binomial proportions test, and chi-squared test, respectively.

RESULTS

184 patients (41% male) with mean age of 64 were analyzed. Mean radiation dose for each DECT phase was 0.07 mSv with all studies deemed diagnostic. mDECT demonstrated 57 mean %TN, 10% greater than DECT1 and 6% greater than DECT2 (each $p<0.001$), with DECT2 9% greater mean %TN than DECT1 ($p<0.05$). 40% Percentage of patients with TM diagnosis with mDECT (40%) was 10% greater than DECT1 or 2 (each 30%, $p<0.05$). mDECT (109 negative, 31 mild, 24 moderate, and 20 severe) had significantly greater number of patients diagnosed with TM with a significantly more severe distribution of disease than DECT1 (128, 27, 21, 12) or DECT2 (127, 21, 21, 15), (each $p<0.05$) without significant differences between DECT1 and 2.

CONCLUSION

For CT evaluation of TM, mDECT demonstrated low patient radiation dose with an increase in mean %TN, a higher rate of TM diagnosis and a more severe distribution of disease than a single DECT phase alone.

CLINICAL RELEVANCE/APPLICATION

CT evaluation of TM with two ultra low dose DECTs should be considered to diagnose and grade TM.

SSE05-04 Correlation of CT Small Airway Measurement with Clinical and Inflammation Factors in Asthma Patients

Monday, Nov. 26 3:30PM - 3:40PM Room: N230B

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PURPOSE

To evaluate the correlation of CT small airway measurement with clinical and inflammatory indicators in Asthma Patients.

METHOD AND MATERIALS

20 patients with asthma were enrolled, all received spiral CT, pulmonary function test, serum leptin, IgE and TGF-ß1, induced sputum cytology and MMP-9. Asthma Control Test (ACT) and smoking condition were recorded. At the end of 6th generation airway, adjusted by body surface area, Luminal diameter(LD), luminal area(Ai), wall thickness(WT) and wall area%(WA%)were measured. Inter-observer repeatability was estimated by intra-class correlation coefficients(ICC). Comparison of the CT airway indexes between groups of onset age<=12yrs and>12yrs, ACT well/partly controlled and poorly controlled, with and without smoking history, induced sputum Eos%<3% and >=3% were made. Correlations between CT airway measurements with clinical and inflammatory indicators were determined.

RESULTS

The ICC of LD, Ai , WT and WA% was 0.813, 0.923, 0.850, 0.958. In asthma patients, both LD and Ai were significantly lower in groups of onset age <=12yrs, patients with smoking history and induced sputum Eos%>=3% than corresponding groups(LD, t=-2.760, -2.459, -3.935, Ai, t=-2.851, -2.267, -4.492, all $P<0.05$). WA% was significantly higher in groups of induced sputum Eos%>=3% than the corresponding group($t=2.448$, $P<0.05$). LD and Ai had negative correlation with course of disease and induced sputum Eos%(LD, r=-0.512, -0.841, Ai, r=-0.489,-0.841, all $P<0.05$), and positive correlation with FEV1/FVC and serum leptin(LD, r=0.669, 0.533, Ai, r=0.681,0.552, all $P<0.05$). Ai also showed positive correlation with FEV1%($r=0.452$, $P<0.05$). WT and WA% were significantly negative correlated with FEV1/FVC and FEV1%(WT, r=-0.621, -0.483, WA% , r=-0.729, -0.548, all $P<0.05$). WA% also showed positive correlation with serum IgE and induced sputum MMP-9($r=0.509$, 0.636, all $P<0.05$).

CONCLUSION

CT airway indexes were found partially associated with asthma onset age, course of disease, smoking condition, serum leptin and IgE, induced sputum Eos% and MMP-9,. CT airway indexes showed correlation with FEV1/FVC and FEV1%.

CLINICAL RELEVANCE/APPLICATION

CT indexes of small airway were found associated with asthma onset age, course of disease, smoking condition, serum leptin and IgE, induced sputum Eos% and MMP-9, as well as FEV1/FVC and FEV1%.

SSE05-05 A Comparative Study of Performance Between Radiographers and Machine Learning Model (MLM) for Airway Measurement

Monday, Nov. 26 3:40PM - 3:50PM Room: N230B

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PURPOSE

The purpose of this study is to compare the performance between radiographers and machine learning model of analyzing airway.

METHOD AND MATERIALS

Total 182 patients' thin slice CT data of KOLD cohort was used and their all airway branches were semi-automatically segmented by AView software (Coreline Soft, Co., Ltd, South Korea). 46,436 airway axial images were used to train MLM using DenseNet 201 that we changed the last DenseLayer to binary classification. All airway axial images were colored using integral-based half-band method and they were labeled as accept or reject to clarify and precise airway results. In randomly selected 50 axial images, accuracy was compared among two radiographers with 4-year experience on airway measurement and MLM. Cohen's Kappa was used to assess the inter-observers agreement and elapsed time was measured. T-test, in addition, was performed to compare airway results on 182 patients of KOLD cohort between one blinded radiographer and MLM.

RESULTS

The ROC analysis of the test data sets showed 0.92 of area under curve. In the 50 randomly selected airway axial images, Sensitivity, specificity of MLM were 0.96, 0.88 and its accuracy was 0.92. In radiographers, respectively, 0.86, 0.7 and 0.78 were shown (Cohen's kappa = 0.62). Elapsed time between two control groups, two radiographers and MLM, showed statistically significant difference (190.3 and 1.8 seconds, $p < 0.05$). The mean airway pi-10 and wall area percent showed no statistically significant difference (radiographer, 4.12 ± 0.89 mm, 66.43 ± 7.56 %; MLM, 4.15 ± 0.88 mm, 66.66 ± 7.35 %, $p > 0.05$, respectively).

CONCLUSION

Trained MLM showed no differences comparing with skilled radiographers in the results of airway measurement with short elapsed time. Consequentially, MLM measures all airway branches fully automatically without expert interactions, if airway segmentation well performed.

CLINICAL RELEVANCE/APPLICATION

The airway is considered as an imperative index of lung. Fully automatic airway measurement of whole branch would be more efficient for imaging biomarker in COPD patients.

SSE05-06 Catheter-Based Endobronchial Navigation with a Novel Cone Beam CT Airway Segmentation Platform to Reach Peripheral Lung in a Swine Model Without Bronchoscopy

Monday, Nov. 26 3:50PM - 4:00PM Room: N230B

Participants
Quirina M. de Ruiter, PhD, Bethesda, MD (*Presenter*) Former Employee, Koninklijke Philips NV; ;
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Corporation

PURPOSE

To investigate the feasibility of catheter-based endobronchial navigation to peripheral lung without a bronchoscope using a novel Cone Beam CT (CBCT) image-guidance prototype in a swine model.

METHOD AND MATERIALS

All animal procedures were approved by the Animal Care and Use Committee. Swine (n=3) were placed under general anesthesia. Thoracic CBCT (FD20, Philips Healthcare) was imported into a workstation with prototype software (Philips) that provides for 3D airway segmentation, manual identification of targets and 3D navigation guidance superimposed on fluoroscopic imaging. Peripheral targets (bronchial subsegments) were identified. Catheter-based endobronchial navigation to targets was performed with 4 and 5 Fr catheters (Cook Medical) with varying shapes (e.g., C2, multipurpose, DAV) over 0.035' hydrophilic vascular guidewires of various curves and stiffness (Terumo). The primary endpoint was successful navigation of a catheter into a bronchial target. Success was assessed by catheter position on multiple X-ray images at preplanned C-arm angles and CBCT.

RESULTS

Catheter-based navigation to primarily 3rd and 4th order airway segments was successful in 11/13 tasks in the first two swine. Failure to navigate guidewires to distal targets occurred when the guide wire or catheter tip was too stiff with poor maneuverability or had a sub-optimal shape for the airway geometry. With optimization of device selection and imaging settings, catheter-based navigation to even more complex 4th and 5th order segments targets was successful in 8/11 tasks; navigation failures occurred due to suboptimal catheter or wire shape or stiffness for the target (n = 2) or suboptimal imaging settings (n=1). In these cases, operator adherence to predefined fluoroscopic imaging protocols also restricted identification of malposition and adjustments that might otherwise occur.

CONCLUSION

Catheter-based endobronchial navigation without a bronchoscope is feasible with CBCT 3D segmentation and image-guidance combined with fluoroscopy. Catheter and wire design, including size, shape and physical properties, are important predictors of navigation success, especially for more peripheral airway tasks.

CLINICAL RELEVANCE/APPLICATION

CBCT airway segmentation and guidance software may advance endobronchial catheter-based approaches for lung diagnostics and treatments beyond the reach of a bronchoscope. Catheter and wire selection impacts procedural success.

SSE06

Science Session with Keynote: Emergency Radiology (Forensic and Musculoskeletal Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: E353A

CT ER MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Scott D. Steenburg, MD, Zionsville, IN (*Moderator*) Research collaboration, IBM Corporation
Martin L. Gunn, MBChB, Seattle, WA (*Moderator*) Research Grant, Koninklijke Philips NV; Royalties, Cambridge University Press; Spouse, Consultant, Reed Elsevier; Spouse, Consultant, athenahealth, Inc

Sub-Events

SSE06-01 Emergency Radiology Keynote Speaker: Post-Mortem CT for Trauma

Monday, Nov. 26 3:00PM - 3:20PM Room: E353A

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

SSE06-03 Evaluation of Organ Density Values in Postmortem Computed Tomography (PMCT) in Correlation with Radiological Alteration Index (RAI) as Possible Surrogate for Postmortal Alteration in Human Cadavers

Monday, Nov. 26 3:20PM - 3:30PM Room: E353A

Participants
Judith Boven, Dusseldorf, Germany (*Presenter*) Nothing to Disclose
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Rotem S. Lanzman, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Patric Kroepil, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Christoph K. Thomas, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Gerald Antoch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Joel Aissa, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

We evaluated the correlation between organic parenchymal density in Hounsfield Units (HU) with the radiological alteration index (RAI) level as surrogate for postmortal alteration in postmortem computed tomography (PMCT).

METHOD AND MATERIALS

We retrospectively included 14 human cadavers (6 females, 8 males) undergoing whole body PMCT. RAI was assessed in 7 localizations reflecting the presence of gas. Based on the total RAI-score cadavers were divided into three groups. [Group 1: low RAI (total score: 0-30); Group 2: medium RAI (total score: 30-60) and Group 3: high RAI (total score: 60-100)]. Density values (HU) were measured in 8 different localizations (1. frontal lobe, 2. basal-ganglia, 3. myocardium, 4. pectoral muscle, 5. liver, 6. left kidney, 7. m. iliopsoas, 8. first lumbar vertebral body[L1]). Correlation between density values and RAI was tested.

RESULTS

7 cadavers were included in group 1 with a mean RAI-score of 8.9±9.8,4 cadavers in group 2 with a mean RAI-score of 36.5±6.7 and 3 cadavers in group 3 with a mean RAI-score of 83.7±14.8. Density measurements showed no significant difference between the three groups for all anatomic landmarks (frontal lobe: group 1: 43.4±6.5 HU vs. group 2: 46.1±5.8 HU vs. group 3: 46.4±6.4 HU; basal-ganglia: 43.7±5.3 vs. 41.8±4.8 vs. 44.7±6.8 HU; myocardium: 49.4±9.7 vs. 44.7±8.3 vs. 45.9±8.6 HU; pectoral muscle: 52.9±7.2 vs. 47,0±8.1 vs. 50.8±14.3; liver: 61.5±10.4 vs. 76.1±12.0 vs. 64.1±9.6; left kidney: 49.1±9.5 vs. 43.9±10.7 vs. 35.6±9.8; m. iliopsoas: 48.7±9.2 vs. 51.4±10.3 vs. 55.1±9.8; L1: 169.8±40.5 vs.165.8±46.8 vs. 141.9±30.0; $p > 0.05$ for all). There was no significant correlation between density measurements and RAI.

CONCLUSION

There was no correlation between RAI and density measurements in 8 evaluated organs irrespective of the patients' RAI index.

CLINICAL RELEVANCE/APPLICATION

CT organ density measurements cannot be reliably used to assess decay in postmortem CT.

SSE06-04 Diagnostic Value and Forensic Relevance of a Novel 3D-Reconstructions Method (Cinematic Rendering) in Postmortem Computed Tomography (PMCT)

Monday, Nov. 26 3:30PM - 3:40PM Room: E353A

Participants
Judith Boven, Dusseldorf, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate the radiologic performance and forensic relevance of novel photorealistic 3D reconstructions (Cinematic Rendering) of traumatic injuries in comparison to conventional postmortem computed tomography (PMCT).

METHOD AND MATERIALS

22 human cadavers undergoing whole body PMCT on 3 different CT-scanners (Definition Flash, Edge and AS+, Siemens, Germany) after traumatic death were retrospectively analyzed. A total of 38 pathologies were reconstructed with 3D Cinematic Rendering mode and conventional multiplanar CT in all 3 dimensions (bone and soft tissue window). 3D reconstructions of pathologies were performed with the preset gallery settings 'Patient Marking CT VRT' and 'Myocardium dark'.Two forensic pathologists evaluated the images according to their expressiveness and judicial relevance on a five-level scale (1: high expressiveness; 5: low expressiveness) and decided whether Cinematic Rendering reconstructions are suitable for judicial reviews or not. Two radiologists analyzed all images due to the detection rate of pathologies in both, Cinematic Rendering reconstructions and PMCT.

RESULTS

Forensic estimation: Mean value expressiveness of Cinematic rendering reconstructions: forensic Reader 1: 2.4±1.1 (range:1-5); forensic Reader 2: 1.9±1.2 (range: 1-5); total: 2.1±1.2 (range:1-5). Mean value expressiveness of conventional PMCT: forensic Reader 1: 4.1±1.1 (range: 2-5); forensic Reader 2: 3.7±1.1 (range: 1-5); total: 3.9±1.1 (range: 1-5). Concerning forensic interpretation and demonstration aspects results showed that Cinematic Rendering reconstructions were significantly more expressive than conventional PMCT images ($p<0.05$). Regarding the radiologic detection rate of all pathologies the evaluation of both radiologists lead to no significant difference between 3D reconstructions and original CT slices for all pathologies.

CONCLUSION

Cinematic Rendering reconstructions are more helpful for forensic pathologists than standard PMCT images. Concerning the detection of pathologies by radiologists, there is no significant difference between PMCT and Cinematic Rendering reconstructions. Essentially, Cinematic Rendering is suitable for demonstration and detection of relevant findings.

CLINICAL RELEVANCE/APPLICATION

Cinematic Rendering is a good method for visualizing pathologies,e.g. fractures or soft tissue injuries in judicial reviews and helps forensic pathologists correlate the findings with autopsy results.

SSE06-05 Utilizing the Broken Circle Sign: A New Method for Detecting a Hill-Sachs Lesion on an Internal Rotation Shoulder Radiograph

Monday, Nov. 26 3:40PM - 3:50PM Room: E353A

Participants
Sarah M. Yu, BS, Columbus, OH (*Presenter*) Nothing to Disclose
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Joseph S. Yu, MD, Columbus, OH (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

A Hill-Sachs (HS) lesion is a potential indicator of shoulder joint instability. Diagnosis is based on a flat or concave defect in the superior aspect of the humeral head on an internal rotation (IR) radiograph but the finding is often subtle. The purpose of this study was to describe a new method designed to increase the sensitivity for HS lesions.

METHOD AND MATERIALS

A retrospective search for patients who sustained a prior dislocation, were evaluated with x-rays, and had a HS lesion on MRI was performed for a 10-yr period. In Part 1, only the AP IR x-ray was utilized and these were randomized with controls. Three readers were asked to independently score all x-rays with 'yes' if they detected a HS lesion or 'no' if they did not or were unsure. One month later, the readers were taught the Broken Circle Sign, and re-scored the x-rays using the new technique. In Part 2, 15 MRI-confirmed cases of HS lesions that were missed on initial review were mixed with normal x-rays and shown to 17 residents individually before and after teaching the new method. A paired t-test was used to evaluate the differences in sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV).

RESULTS

A total of 256 patients met the selection criteria (199 men, 57 women; age range: 15-82 yrs, mean: 31.2 yrs). There were 127 right and 129 left shoulders. In Part 1, sensitivity for all 3 readers increased by an average of 20.6% (54.1% to 74.7%; p<0.02), accuracy increased by an average of 7.4% (69.1% to 76.5%; p<0.05), and NPV increased by an average of 10.8% (62.4% to 73.3%; p<0.005). In Part 2, sensitivity for the residents increased by an average of 20.4% (54.1% to 74.5%; p<0.0001), accuracy increased by an average of 14.6% (65.1% to 79.7%; p<0.0001), and NPV increased by an average of 15.3% (41.6% to 56.9%;p<0.001) independent of their level of training. Only 2 residents did not improve due to high initial scores in sensitivity and accuracy.

CONCLUSION

The Broken Circle Sign is a simple tool that helps to increase the conspicuity of a Hill-Sachs lesion on internal rotation shoulder radiographs. It appears to increase the sensitivity, accuracy, and NPV at all levels of training.

CLINICAL RELEVANCE/APPLICATION

The Hill-Sachs lesion occasionally is a difficult diagnosis to make on radiographs. The Broken Circle Sign is a simple method that can aid in increasing the diagnostic acumen for this abnormality.

SSE06-06 Radiology "Forensics": Determination of Age and Gender from Chest X-Rays Using Deep Learning

Monday, Nov. 26 3:50PM - 4:00PM Room: E353A

Participants
Paul H. Yi, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Tae Kyung Kim, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Jinchi Wei, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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Haris I. Sair, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Ferdinand K. Hui, MD, Richmond, VA (*Abstract Co-Author*) Speakers Bureau, Terumo Corporation Speakers Bureau, Penumbra, Inc Stockholder, Blockade Medical Inc
Cheng Ting Lin, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To develop and test the performance of deep convolutional neural networks (DCNNs) for the automated detection of 1) age and 2) gender on chest radiographs (CXRs).

METHOD AND MATERIALS

We obtained 112,120 frontal CXRs from the NIH ChestX-ray14 database performed in 48,780 females (44%) and 63,340 males (56%) ranging from 1 to 95 years old; amongst 5941 pediatric CXRs (5%), 2546 (43%) were female (p=0.3). The entire dataset was split into training (70%), validation (10%), and test (20%) datasets and used to train, validate, and test the ResNet-18 DCNN pretrained on ImageNet for: 1) determination of gender (using both entire dataset and only pediatric CXRs); 2) determination of age <18 years old or >=18 years old (using entire dataset); and 3) determination of age <11 years old or 11-18 years old (using only pediatric CXRs). During each training epoch, each image was augmented via random rotations, cropping, and flipping. We also tested the DCNNs on an external dataset of 662 CXRs performed in adults and children from China. Receiver operating characteristic (ROC) curves with area under the curve (AUC) and standard diagnostic measures (e.g, accuracy) were used to evaluate DCNN test performance with AUCs statistically compared between DCNNs.

RESULTS

The DCNNs trained to determine gender on the entire dataset and pediatric CXRs only had AUC of 1.0 and 0.91, respectively (p<0.0001) and accuracy of 98% and 83%, respectively. The DCNNs trained to determine age <18 years old or >=18 years old and <11 years old or 11-18 years old had AUCs of 0.99 and 0.96 (p<0.0001), respectively, with accuracy of 98% and 89%, respectively. On the external dataset, the DCNNs achieved AUC of 0.98 for gender (p=0.01) and 0.91 for determining age < or >=18 years old (p<0.001), with accuracy of 94% and 97%, respectively.

CONCLUSION

DCNNs can accurately predict gender from CXRs, as well as distinguish between adult and pediatric patients, in both American and Chinese populations, and between pre-pubescent and pubescent children in American populations. The ability to glean demographic information from CXRs may aid forensic investigations, as well as help identify novel anatomic landmarks for gender and age.

CLINICAL RELEVANCE/APPLICATION

Deep convolutional neural networks can accurately infer gender and age from chest radiographs from American and Chinese populations, which may be a useful tool in "forensic" radiology.

SSE07

Gastrointestinal (Advanced Liver Ultrasound Techniques)

Monday, Nov. 26 3:00PM - 4:00PM Room: S402AB

BQ GI US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Michael S. Gee, MD, PhD, Boston, MA (*Moderator*) Nothing to Disclose
Mark E. Lockhart, MD, Birmingham, AL (*Moderator*) Author, Oxford University Press; Author, JayPee Brothers Publishers; Editor, John Wiley & Sons, Inc; Deputy Editor, Journal of Ultrasound in Medicine

Sub-Events

SSE07-02 The Value of Portal Vein Pulsatility for Diagnosis of High Risk Nonalcoholic Steatohepatitis

Monday, Nov. 26 3:10PM - 3:20PM Room: S402AB

Awards
Trainee Research Prize - Fellow

Participants
Masoud Baikpour, MD, Boston, MA (*Presenter*) Nothing to Disclose
Arinc Ozturk, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Manish Dhyani, MBBS, Burlington, MA (*Abstract Co-Author*) Nothing to Disclose
Nathaniel D. Mercaldo, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Joseph R. Grajo, MD, Tampa, FL (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine the value of portal vein pulsatility for diagnosis of high risk nonalcoholic steatohepatitis (NASH).

METHOD AND MATERIALS

This IRB-approved HIPAA-compliant study included 123 consecutive subjects (54 males and 69 females, average age of 50.3±12.2 years) with a biopsy proven diagnosis of Nonalcoholic Fatty Liver Disease (NAFLD) who had undergone Duplex Doppler ultrasound assessment of their main portal vein within 1 year prior or after their liver biopsy, from January 2014 to February 2018. We reviewed the Doppler ultrasound images of these patients, used the spectral waveform to measure the maximum (Vmax) and minimum (Vmin) velocity of blood in their portal veins, and calculated the Venous Pulsatility Index (VPI) defined as (Vmax-Vmin)/Vmax. Area under the receiver operating characteristic curve (AUC) was measured to determine the value of this index for diagnosis of high risk NASH (hrNASH), which is defined as a NASH stage of equal or greater than F2 based on the extent of fibrosis on liver biopsy.

RESULTS

Of 123 study subjects, 33 (26.8%) had hrNASH. These patients had a significantly lower VPI than the other 90 subjects (0.19±0.08 vs. 0.32±0.11; $p<0.001$). The AUC of VPI for diagnosis of hrNASH was calculated to be 0.838 (95%CI: 0.757-0.920). Subgroup analysis in subjects whose Doppler ultrasound assessment was performed within 6 months of liver biopsy yielded a similar hrNASH diagnosis AUC of 0.830 (95%CI: 0.735-0.925). VPI analysis was demonstrated to be superior to commonly used hrNASH diagnosis serum tests in this cohort.

CONCLUSION

VPI analysis may be a useful non-invasive tool for hrNASH diagnosis.

CLINICAL RELEVANCE/APPLICATION

VPI analysis may be useful for high risk NASH diagnosis, which is important for liver-specific mortality NAFLD risk assessment.

SSE07-03 Viscoelasticity Measurement Using Shear Wave Elastography for the Evaluation of Allograft Rejection after Liver Transplantation

Monday, Nov. 26 3:20PM - 3:30PM Room: S402AB

Participants

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Jae Seok Bae, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate whether viscoelasticity measurement using shear wave elastography could help detect acute cellular rejection of allograft after liver transplantation

METHOD AND MATERIALS

Between Jan 2018 and March 2018, we prospectively enrolled 33 patients who underwent liver transplantation. Ultrasound (US) examination of allograft liver using shear wave elastography was done for all of 33 patients, and stiffness value (kilopascal, kPa) as well as shear wave dispersion slope ([m/s]/kHz) of allograft liver were measured and recorded. Percutaneous liver biopsy was performed to diagnose acute cellular rejection histopathologically using 18G automating cutting needle immediate after US evaluation. Relationship between US parameters obtained from shear wave elastography and presence of acute cellular rejection on histopathologic examination was evaluated using Mann-Whitney U test and receiver operating characteristic analysis.

RESULTS

Allograft liver stiffness value as well as shear wave dispersion slope were successfully measured in all of 33 patients. Acute cellular rejection was diagnosed in 12 patients out of 33 patients (12/33, 36.4%) on histopathologic examination. Mean allograft liver stiffness value was 8.04 ± 2.33 kPa in 12 patients with acute cellular rejection, and was not significantly different from that of 7.07 ± 3.62 kPa in 21 patients without acute cellular rejection (P=0.082). However, mean shear wave dispersion slope of allograft liver was 15.03 ± 2.85 [m/s]/kHz in 12 patients with acute cellular rejection, and significantly higher than that of 11.81 ± 4.10 [m/s]/kHz in 21 patients without (P=0.004). The area under the curve for the prediction of acute cellular rejection in allograft liver was 0.802 (P<0.001, 95% confidence interval; 0.626-0.919) for shear wave dispersion slope with a sensitivity of 100% (12/12) and specificity of 57.1% (12/21) when the cut-off value was set at 11.5 [m/s]/kHz.

CONCLUSION

Shear wave dispersion slope obtained from shear wave elastography could have a potential to predict the presence of acute cellular rejection in allograft liver after transplantation, and could help make decision regarding the treatment plan for liver transplantation recipients.

CLINICAL RELEVANCE/APPLICATION

Shear wave dispersion slope obtained from shear wave elastography could help make decision regarding the treatment plan for liver transplantation recipients.

SSE07-04 Role of Contrast-Enhanced Ultrasound for the Post-Treatment Evaluation of Hepatocellular Carcinoma

Monday, Nov. 26 3:30PM - 3:40PM Room: S402AB

Participants
Daniel Ohngemach, MD, Manhasset, NY (*Presenter*) Nothing to Disclose
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Fahim Hashmi, MD, Manhasset, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Minimally-invasive treatments for hepatocellular carcinoma (HCC) continue to rise in popularity. Monitoring treated lesions for residual tumor has been accomplished by contrast-enhanced CT or MR (CEMR); however, there is growing interest in the use of contrast-enhanced ultrasound (CEUS) to monitor treatment response following thermo-ablation and embolization of hepatocellular carcinoma. We sought to compare post-treatment findings at CEUS with findings at CEMR to evaluate the efficacy of monitoring treatment response with CEUS.

METHOD AND MATERIALS

We reviewed CEUS examinations performed for evaluation of hepatomas treated by thermo-ablation and/or embolization from April 2017 through March 2018. A positive CEUS or CEMR was defined as residual enhancing tumor within the treatment bed. CEUS examinations were compared with CEMR after treatment but before any further intervention on that lesion.

RESULTS

We identified 28 lesions in 24 patients that underwent CEUS for post-treatment evaluation. 22 lesions (79%) had CEMR for comparison. Mean time between CEMR and CEUS was 37.8 days (range: 0-112 d). CEUS identified enhancing tumor in 86.7% (13/15) lesions with positive CEMR, and did not demonstrate enhancement in any of 100% (5/5) of lesions with negative CEMR. While CEUS did not detect any CEMR-occult disease, it did confirm presence of enhancing tumor in 2 lesions with indeterminate CEMR. Finally, CEUS confirmed absence of tumor in a lesion characterized as negative at noncontrast MR, but which could not be confirmed by CEMR due to contraindication to gadolinium. Overall, CEUS had a 90% (18/20) agreement rate with diagnostically confirmed lesions on CEMR.

CONCLUSION

CEUS demonstrated high agreement rate with CEMR in our study population of ablated and embolized hepatic lesions. There were several cases for which contrast-enhanced ultrasound outperformed MRI or enabled evaluation in patients who could not undergo contrast-enhanced MR. These results suggest an ongoing role for CEUS as an adjunct to cross-sectional imaging in the monitoring of HCC following ablation or embolization.

CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced ultrasound may potentially add value in the evaluation of treated hepatic lesions, particularly in patients with contraindications to contrast-enhanced MR or in whom MRI findings are inconclusive.

SSE07-05 A Comparative Study of Shear Wave Elastography Measurement on Liver's Right Lobe and Left Lobe for diagnosis of Chronic Liver Disease using Liver Biopsy as 'Gold Standard'

Monday, Nov. 26 3:40PM - 3:50PM Room: S402AB

Participants
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Pavlos Zoumpoulis, MD, PhD, Athens, Greece (*Presenter*) Nothing to Disclose

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PURPOSE

Chronic Liver Disease (CLD) is one of the major causes of death nowadays 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 have emerged in order to avoid LB complications. Standard SWE examination protocol involves measurements on the Right Lobe (RL), but this is not always feasible since on CLD we observe liver's RL shrinkage and liver's Left Lobe (LL) widening. On the other hand, an alternative measurement on LL can be performed but has not been yet evaluated. The aim of this study is to compare the performance of SWE on liver's RL and LL in CLD diagnosis using LB as 'Gold Standard'.

METHOD AND MATERIALS

163 subjects, 56 normal (F0) and 107 with CLD (F1-F4), were included in the study. a B-Mode and Color/Power Doppler examination was performed on each patient. SWE measurements were performed on the RL and LL of each patient. SWE measurements on each lobe were compared to LB results that were classified according to the Metavir Classification System for fibrosis (F0-F4). Receiver Operating Characteristic analysis was then performed on each set of SWE measurements (RL and LL) to obtain best cut-off stiffness values.

RESULTS

ROC analysis was performed for each lobe (RL/LL) showing: AccuracyRL/AccuracyLL = 0.9448/0.9264 for F=F4, AccuracyRL/AccuracyLL = 0.9448/0.9509 for F>=F3, AccuracyRL/AccuracyLL = 0.9571/0.9387 for F>=F2, and AccuracyRL/AccuracyLL = 0.8589 /0.8957 for F>=F1. Best cut-off stiffness values calculated for each lobe (RL/LL) compared to Metavir fibrosis stages were: F=F4: 11.8/10.6 kPa, F>=F3: 9.7/9.8 kPa, F>=F2: 8.3/8.1 kPa, F>=F1: 6.3/5.9 kPa respectively.

CONCLUSION

This study shows that SWE measurements on the LL, when feasible, are reliable in CLD diagnosis and can be used alternatively when measurements on the RL are not possible.

CLINICAL RELEVANCE/APPLICATION

This study shows that SWE measurements on the LL, when feasible, are reliable in CLD diagnosis and can be used alternatively when measurements on the RL are not possible.

SSE07-06 SHI CEUS Signals in the Hepatic Vein are an Indirect Sign of Pathophysiology Changes Caused by Portal Hypertension

Monday, Nov. 26 3:50PM - 4:00PM Room: S402AB

Participants
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PURPOSE

To determine if the presence of SHI signals inside the hepatic vein can be used as an indirect qualitative sign of portal hypertension.

METHOD AND MATERIALS

Eighty-seven patients that were part of an IRB and FDA approved portal hypertension study underwent a subharmonic imaging (SHI) contrast US (CEUS) examination of their portal and hepatic veins using a modified Logiq 9 scanner (GE, Milwaukee, WI) with a 4C probe. SHI is a new CEUS imaging technique where the receive frequency is half of the fundamental (1.25 and 2.5 MHz, respectively) resulting in better tissue suppression. Images were acquired after infusion of the US contrast agent Sonazoid (GE Healthcare, Oslo, Norway) at a rate of 1.44μL of microbubbles/kg/hour and analyzed for the presence or absence of SHI signals in the hepatic vein; based on the assumption that in portal hypertensive patients SHI signals would be seen in the hepatic vein. These findings were compared to the hepatic venous pressure gradient (HVPG; i.e., the gold standard) obtained by transjugular liver biopsy as part of the subject's standard of care.

RESULTS

Out of the 87 cases, 10 cases were excluded, 5 cases because the HVPG values were clinically discordant and 5 cases because the ROI used was close to the IVC junction causing the physiologic reflux from the IVC to not permit a clear evaluation of the hepatic vein SHI signal. From the 77 patients that could have their data analyzed, 44 had increased HVPG values corresponding to subclinical and clinical portal hypertension (>5 and 10 mmHg, respectively) and 33 patients had normal HVPG values (< 5mmHg). Qualitative assessments of the digital clips acquired during the examinations showed that in all of the 44 cases with increased HVPG values a SHI signal was seen in the hepatic vein and from the 33 cases with normal HVPG values, 30 cases had no SHI signal in the hepatic vein. The overall accuracy was 96% (74/77) with a sensitivity of 100% (44/44) and specificity of 91% (30/33).

CONCLUSION

The presence of SHI signal inside the hepatic vein can be used as a qualitative indirect sign for portal hypertension.

CLINICAL RELEVANCE/APPLICATION

SHI CEUS evaluation of the hepatic vein is a non-invasive and safe method that can be used in as a new initial, qualitative sign of portal hypertension.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSE08

Gastrointestinal (Hepatocellular Carcinoma Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: S404AB

GI OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSE08-01 Imaging of Hepatocellular Carcinoma: A Preliminary International Survey

Monday, Nov. 26 3:00PM - 3:10PM Room: S404AB

Participants
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PURPOSE

To describe 2018 international current practices in imaging-based surveillance, diagnosis, staging, and treatment response assessment for hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

Institutional review board exemption was granted for this survey-based study. An electronic survey was sent to members of the LI-RADS International Working Group (94 liver imaging experts from 27 countries and 5 continents) and 40 additional abdominal radiologists identified by survey authors. The 42-item survey captured data on respondents' demographics and liver imaging expertise; local imaging practices for HCC screening, surveillance, diagnosis, staging, and treatment response assessment; and personal use of HCC diagnostic imaging systems.

RESULTS

Of 90 respondents (response rate, 55%), 21% were from Asia, 31% from Europe, 8% from North America, 36% from South America, and 4% from Australasia. Similar proportions of respondents were in academic (47%) and private or mixed practice (53%). Median respondents' experience was 16 years (interquartile range, 8-24 years). Noncontrast ultrasound was the most common modality for HCC screening and surveillance (89%). Multiphase computed tomography and MRI were used for HCC diagnosis by 96% and 83% of respondents, respectively. Biopsy was most commonly performed for lesions considered probably or definitely malignant but not meeting definitive HCC imaging criteria for HCC (89%). Extracellular contrast agents (72%) were the most commonly used MRI contrast agents and Lumason™/SonoVue™ (64%) the most commonly used CEUS contrast agent. A majority (95%) of respondents use ancillary in addition to major imaging features for liver lesions assessment. The use of HCC diagnostic imaging systems for HCC varied by region. Response Evaluation Criteria In Solid Tumors (RECIST) or mRECIST were most the common criteria for assessing HCC treatment response (53%). Usage of diagnostic systems varied from 0-81% depending on the system and region. Overall, the

most commonly used diagnostic systems were LI-RADS (64%), AASLD (33%), and EASL-EORTC (30%).

CONCLUSION

HCC imaging diagnostic systems vary geographically. Efforts to unify these diagnostic systems should rely on larger surveys to identify and address regional differences and potential barriers to adoption.

CLINICAL RELEVANCE/APPLICATION

Regional differences in imaging practices should be taken into account in developing a unified system for imaging of HCC.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ An Tang, MD - 2018 Honored Educator

SSE08-02 Add the Value of Gd-EOB-DTPA-Enhanced MRI in Characterizing Cirrhotic Nodules with Atypical Enhancement on CT Enhanced Images: Implications for CT/MRI LI-RADS V2017 Characterization of Hepatocellular Carcinoma

Monday, Nov. 26 3:10PM - 3:20PM Room: S404AB

Participants
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Zhao Liu, Lanzhou, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the value of Gd-EOB-DTPA-enhanced magnetic resonance imaging (MRI) in characterizing atypically enhanced nodules in high-risk patients detected on CT enhanced images for the detection of hepatocellular carcinoma (HCC) in reference to the CT/MRI LI-RADS v2017 classification system.

METHOD AND MATERIALS

Data of 43 patients consecutive patients with 50 atypical nodules seen on enhanced CT images who further underwent Gd-EOB-DTPA MRI between January 2016 and June 2017 were retrospectively analyzed. CT and MRI examination interval were range 1 to 52 days. Two experienced radiologist assigned LI-RADS scores with a blind method. The diagnostic accuracy of CT/MRI LI-RADS v2017 was assessed by comparing with pathological or clinical diagnosis, which as s reference standard.

RESULTS

Excellent agreement between readers were reached with CT ($K=0.806$, $P<0.001$) and MRI ($K=0.852$, $P<0.001$) , respectively. MRI can show more major and ancillary features than CT significantly ($P<0.05$). With LR-4, LR-5 regarded as HCC, the accuracy of CT and MRI in diagnosing HCC by comparing with the reference standard was 86.67% and 90.9%, respectively. There is no significant differences in statistic ($P>0.05$). However, 17 HCC lesions categorized as LR-3 with CT were classified as LR-4 or LR-5 with MRI, and 1 benign lesion was classified as LR-3 with CT and LR-2 with MRI.

CONCLUSION

With LI-RADS, Gd-EOB-DTPA MRI is more sensitive than CT for diagnosing HCC by providing more information. Thus, Gd-EOB-DTPA MRI can improve the accuracy for detecting HCC of atypical enhanced nodules on CT.

CLINICAL RELEVANCE/APPLICATION

Gd-EOB-DTPA MRI can improve the accuracy for detecting HCC of atypical enhanced nodules on CT with LI-RADS.

SSE08-03 Impact on Liver Imaging Reporting and Data System Categorization and Tumor Staging of the 2018 Change in the American Association for the Study of Liver Diseases Criteria for HCC

Monday, Nov. 26 3:20PM - 3:30PM Room: S404AB

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PURPOSE

The American Association for the Study of Liver Diseases (AASLD) in 2018 changed one of its criteria for the diagnosis of hepatocellular carcinoma (HCC). Previously, the AASLD counted 10-19 mm observations with arterial phase hyperenhancement (APHE) and "washout" (WO) as HCC only if they were visible at antecedent surveillance ultrasound (US). The latest AASLD guidance removed the requirement for US visibility so that all 10-19 mm observations with APHE and WO would count as HCC, regardless of US visibility. The aim of this study is to determine the impact on LI-RADS categorization and HCC staging if LI-RADS adopts the new AASLD criterion, causing a subset of LR-4 observations to be recategorized LR-5.

METHOD AND MATERIALS

All MRI and CT reports issued using a standardized LI-RADS template at one tertiary care center between 4/15-3/18 were identified. For each reported LR-3, LR-4, or LR-5 observation, the presence of each major feature (size, APHE, WO, 'capsule', threshold growth [TG]) and antecedent US visibility was extracted from the reports retrospectively. All observations were assigned a LI-RADS v2017 category based on the extracted features. Observations categorized LR-4 using v2017 were then recategorized by adopting the new AASLD criterion (modified LI-RADS). Patients were assigned a radiologic tumor stage (T-stage) based on the number and size of observations categorized LR-5, first using v2017 LI-RADS and then using modified LI-RADS.

RESULTS

Of the 672 reported observations in 411 patients reviewed for this study, 187 observations (28%) in 149 patients were categorized LR-4 using v2017 LI-RADS (median size 13 mm, IQR 10-19 mm). Of 187 LR-4 observations, 78 (42%) had APHE and WO only, without US visibility, 'capsule', or TG; these were re-categorized LR-5 using modified LI-RADS. 57 of 67 (85%) patients with re-categorized observations had a change in radiologic T-stage: 68% (39/57) from stage 0 to 1, 12% (7/57) from stage 0 to 2, 5% (3/57) from stage 1 to 2, 12% (7/57) from stage 2 to 3, and 2% (1/57) from stage 2 to 4a.

CONCLUSION

The proposed AASLD guideline change will cause 42% of LR-4 observations to be categorized LR-5 and 85% of affected patients to have an increase in radiologic T-stage.

CLINICAL RELEVANCE/APPLICATION

The revised AASLD criteria will cause substantial upgrading of observation and upstaging of patients; further studies are needed to assess how these changes affect accuracy and outcome.

SSE08-04 Comparison of Diagnostic Performance of Non-Contrast MRI and Abbreviated MRI in Initially Diagnosed Hepatocellular Carcinoma Patients: A Simulation Study of Surveillance for Hepatocellular Carcinomas

Monday, Nov. 26 3:30PM - 3:40PM Room: S404AB

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PURPOSE

To compare the diagnostic performance of non-contrast MRI and abbreviated MRI using gadoxetic acid for detecting hepatocellular carcinoma (HCC) in initially diagnosed, early stage HCC patients

METHOD AND MATERIALS

We identified 142 consecutive, initially diagnosed HCC patients within Milan criteria, who performed liver MRI between 2015 and 2016. For the control group, we enrolled 158 consecutive patients without HCC but had risk factors (liver cirrhosis, chronic hepatitis B or C) of HCC, who also performed liver MRI in the same period. Total number of HCCs was 177 and the number of HCCs smaller than 2 cm and 2 cm <= were 92 and 85, respectively. Two radiologists independently reviewed two MRI sets; non-contrast set and abbreviated set. Non-contrast set consists of T2 FSE/ssFSE with fat saturation, T1 in- and out-of-phase image, non-contrast 3D GRE T1 images, DWI (with b-value 500s/mm2) and ADC map. Abbreviated set consists of T2 FSE/ssFSE with fat saturation, 3D GRE T1 images at hepatobiliary phase 20 minutes after gadoxetic acid injection, DWI and ADC map. Both readers recorded the presence, size and location of HCCs.

RESULTS

In per-patient analysis, sensitivity of reader 1 of non-contrast and abbreviated set were 90.8% and 89.8%, respectively. Specificity of non-contrast and abbreviated set were 92.7% and 92.3%, respectively. For reader 2, sensitivity of both sets were 87.4% and 87.5%, and specificity were 90.3% and 91.7%, respectively. When comparing two image sets, there was no statistical difference in both readers (p=0.65 and 0.86 for reader 1 and 2, respectively, using MeNemar test). Kappa statistics showed excellent inter-observer agreement (0.86 for non-contrast and 0.84 for abbreviated set). In per-tumor analyses, sensitivity of reader 1 for non-contrast and abbreviated set were 81.9% and 83.1%, respectively. For reader 2, per-tumor sensitivity for both sets were 80.8% and 83.6%, respectively.

CONCLUSION

Non-contrast and abbreviated MRI using gadoxetic acid showed comparable diagnosing performance for detecting HCCs in early stage HCC patients.

CLINICAL RELEVANCE/APPLICATION

Ultrasonography is not sensitive enough for the surveillance of patients with very high risk of HCCs. Non-contrast MRI is cheaper

than abbreviated MRI using gadoxetic acid and can avoid the repeated usage of contrast media which can be accumulated in human brain. Non-contrast liver MRI can be a potential candidate for a surveillance tool of HCC.

SSE08-05 CT Findings on Hepatocellular Carcinoma in Patients with Hepatitis C Showing a Sustained Virologic Response after Interferon-Free Therapy: Comparison with that in Patients with Interferon-Based Therapy

Monday, Nov. 26 3:40PM - 3:50PM Room: S404AB

Participants
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PURPOSE

Hepatitis-C virus (HCV) infection is a common cause of chronic hepatitis and can lead to hepatocarcinogenesis. Antiviral therapy with interferon (IFN) can reduce the incidence of hepatocarcinogenesis especially in patients with a sustained virologic response (SVR). New direct-acting antiviral agents (DAA), approved in several countries for the treatment of chronic HCV infection, have markedly increased the SVR rate. However, it remains controversial whether IFN-free therapy such as DAA reduces hepatocarcinogenesis as same as IFN-based therapy. We compared the CT findings of hepatocellular carcinoma (HCC) in patients with HCV infection who manifested SVR after IFN-free and IFN-based therapy.

METHOD AND MATERIALS

We divided 43 patients with surgically resected solitary HCC that developed after achieving SVR for HCV infection into 2 groups. Group A (n=30) had received IFN-based- and group B (n=13) IFN-free therapy. We compared the patient- and the HCC characteristics (size and histological grade), serum tumor markers, and the tumor-liver contrast (TLC: difference in the CT value between the hepatic parenchyma and HCC) on arterial- and equilibrium-phase at dynamic CT scans between two groups using the Fisher exact- and the Mann-Whitney's U test.

RESULTS

There were no significant inter-group differences with respect to the patient- and the HCC characteristics and serum tumor markers. In the equilibrium phase, TLC was significantly higher in group B than group A (median 16.1 vs 9.2 Hounsfield units, $p<0.01$). In the arterial phase there was no significant difference in TLC between the two groups ($p=0.17$).

CONCLUSION

The CT features of HCC in patients who achieved SVR after treatment with IFN-free or IFN-based therapy were different.

CLINICAL RELEVANCE/APPLICATION

Differences in the CT imaging features of HCC that developed after achieving SVR in patients treated with IFN-based- or IFN-free therapy may suggest differences in the biological characteristics of their tumors.

SSE08-06 Negative Results at US-Guided Biopsy of Focal Liver Lesions: Conservative or Aggressive Management?

Monday, Nov. 26 3:50PM - 4:00PM Room: S404AB

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PURPOSE

In patients with suspicious malignant liver lesions, the management of a negative result at biopsy is challenging. Our purpose was to investigate patient- and procedure-related variables affecting the false-negative (FN) results of US-guided biopsy of focal liver lesions, and to develop a patient-specific predictive model for the management of negative biopsy results.

METHOD AND MATERIALS

In this retrospective IRB-approved, HIPAA-compliant study, we included 389 patients (mean age 62 years ± 12.1; 175 men, 214 women) who had undergone US-guided liver biopsy of suspicious malignant liver lesions between 2013-2015. A total of 405 lesions (mean diameter: 3.8 cm ±2.7) were analyzed. We collected multiple patient- and procedure- related variables, including gender, age, body mass index, history of malignancy, cirrhosis, lesion size and location and sample acquisition technique. By comparing pathology reports of biopsy and the reference standard (further histology or imaging follow-up>1 year), the results were categorized as true-positive (TP), true negative (TN), and FN. Diagnostic accuracy and diagnostic yield were measured. Univariate and multivariate analysis was performed to evaluate variables affecting FN results. Statistical significance was set at $p<0.05$. A

patient-specific predictive model of FN results based on decision tree was fit.

RESULTS

Diagnostic accuracy and diagnostic yield of US-guided liver biopsy were 93.8% (380 of 405) and 89.4% (362 of 405), respectively. The FN rate was 6.5% (25 of 387). Predictive variable of a FN result at univariate analysis included body mass index, lesion size and sample acquisition technique. The only independent predictors at multivariate analysis was patient age. By taking into account lesion size and location in combination with patient age and history of previous malignancy, we developed a decision tree model predictive of FN results with confidence up to 100%.

CONCLUSION

FN results are rare but not negligible at US-guided liver biopsy. Independent predictors of FN results are difficult to identify. Our decision tree predictive model suggests that patient age, history of malignancy, lesion size and location may predict FN results with high confidence.

CLINICAL RELEVANCE/APPLICATION

We developed a decision tree predictive model that allows to identify US-guided liver biopsy results with high probability of being false-negative, and thus could support personalized management.

SSE09

Gastrointestinal (Advanced Imaging Texture Analysis)

Monday, Nov. 26 3:00PM - 4:00PM Room: S404CD

CT GI MR 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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Alvin C. Silva, MD, Scottsdale, AZ (*Moderator*) Nothing to Disclose

Sub-Events

SSE09-01 Contrast-Enhanced MR Imaging Based 3D Texture Analysis as a Potential Tool for Preoperative Prediction of Microvascular Invasion in Hepatocellular Carcinoma

Monday, Nov. 26 3:00PM - 3:10PM Room: S404CD

Participants
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PURPOSE

To investigate the value of contrast enhanced MR imaging (CE-MRI) texture analysis in preoperative predicting the microvascular invasion (MVI) status of hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

A retrospective study of 142 pathologically confirmed cases were conducted. Studies were divided into two cohort: the training cohort (n=99) and validation cohort (n=43), including MVI positive group (n=53) and MVI negative group (n=89) based on pathology. 58 textural parameters were extracted in two cohort using baseline MRI on both arterial phase (AP) and portal phase (PP) by a 3D method. The clinical-radiological features were also included. Univariate logistic regression identified potentially predictive parameters, which were entered into the multivariate logistic regression to build the texture model and the combined model together with clinical features to predict development of MVI.

RESULTS

In the clinical features, significant difference was found in max tumor diameter (MTD) (P=0.002), tumor differentiation (P=0.026) and AFP (P=0.025) between the two groups in training cohort. Four MR texture features in AP and five in PP were used to build the texture model. The combined model in AP showed a better diagnostic performance than PP using ROC analysis in validation cohort, with area under the curve (AUC) 0.794 vs. 0.706, sensitivity 0.812 vs. 0.750 and specificity 0.852 vs. 0.704.

CONCLUSION

The CE-MRI 3D texture analysis can predict MVI of HCC preoperatively and noninvasively, and AP image showed better predictive efficiency than in PP image. Combined model with clinical-radiological features could improve MVI prediction ability to some extent.

CLINICAL RELEVANCE/APPLICATION

Preliminary studies had shown that MVI was a risk factor for the overall survival and recurrence rates of HCC patients. However, there was no accepted method for predicting MVI preoperativeIn this study, 3D CE-MRI texture analysis was used together with clinical-radiological features to build model to predict the MVI status in a training cohort preoperatively. A validation cohort was set to validating the model efficiency and stability. After multivariate logistic regression, our result revealed that the combined model in arterial phase showed a good performance to predicting MVI with AUC of 0.810. This is of great clinical significance for the surgical decision-making and treatment after surgery to avoid recurrence.

SSE09-02 Machine Learning Models for Prediction of Hepatocellular Carcinoma Response to Transcatheter Arterial Chemoembolization based on Baseline CT Image Texture Analysis and clinical Staging Data

Monday, Nov. 26 3:10PM - 3:20PM Room: S404CD

Participants
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PURPOSE

The purpose of this work is to develop a fully automated algorithm that uses pre-therapeutic quantitative image features and clinical data as inputs to predict HCC response to TACE.

METHOD AND MATERIALS

TACE outcome information on 113 HCCs in 105 patients receiving first-line treatment with TACE was obtained from a database. An automated segmentation program was developed using fully convolutional neural networks and random forest classification methods to parse out each HCC. The Dice similarity coefficient was calculated to compare the automated segmentation accuracy with that of a manually validated process. A boruta feature selection algorithm was used for data reduction for the quantitative image features considered. The response of HCC to TACE was predicted using a second random forest classifier with the inputs; 1) Barcelona clinic liver cancer (BCLC) stage alone 2) quantitative image features alone 3) BCLC stage plus quantitative image features. The primary clinical endpoint was time to progression (TTP) based on follow-up CT radiological criteria (mRECIST). TTP cutoff of 14 weeks was used to stratify patients as follows; TTP >= 14 wks as TACE susceptible and would benefit from further TACE sessions, TTP < 14 wks as TACE refractory and would be better suited for a change of treatment strategy.

RESULTS

The automated segmentation model had a Dice similarity coefficient scores at baseline of 0.65 ±0.048 and 0.64 ±0.081 for viable and necrotic tissue, respectively. The model's response prediction accuracy rate was 73.2% using a combination of the BCLC stage and quantitative image features (P-value= 0.0096, 95% CI=0.64-0.8, SN=0.83, SP=0.55) versus 62.9% using the BCLC stage alone. Shape image features of the viable, necrotic and background liver were the dominant features correlated to the TTP as selected by the Boruta method and were used to predict the outcome.

CONCLUSION

This preliminary study demonstrates the feasibility of improving the accuracy of predicting treatment response of HCC to TACE therapy using quantitative imaging feature obtained prior to therapy. The approach is likely to provide useful information for assisting in patient selection for the continuation of TACE therapy versus changing treatment strategy.

CLINICAL RELEVANCE/APPLICATION

TACE is recommended for unresectable BCLC stage B HCC. Tumor response to first TACE session affects the treatment strategy.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Khaled M. Elsayes, MD - 2014 Honored EducatorKhaled M. Elsayes, MD - 2017 Honored EducatorKhaled M. Elsayes, MD - 2018 Honored Educator

SSE09-03 CT-Textural Analysis for Discrimination Between Chronic Lymphocytic Leukemia (CLL) and CLL Transformed into Diffuse Large B-Cell Lymphoma (Richter's Syndrome)

Monday, Nov. 26 3:20PM - 3:30PM Room: S404CD

Participants
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PURPOSE

To find CT-texture analysis (CTTA) features for discrimination between chronic lymphocytic leukemia (CLL) including indolent and aggressive subtypes and diffuse large B cell lymphoma (DLBCL) caused by transformation (Richter's syndrome).

METHOD AND MATERIALS

We retrospectively identified 52 patients with indolent (26/52) or aggressive CLL (8/52) and DLBCL caused by Richter's syndrome (18/52) who underwent contrast-enhanced CT (CECT) between 03/2011 and 05/2017 using a standardized protocol (120 kV, 200-250 mAs, thin-collimation, weight-adapted i.v. contrast media in portal-venous phase). ROIs were set in the main lymphoma masses as large as possible avoiding partial volume averaging. CTTA evaluation included heterogeneity, intensity, average, deviation, skewness, entropy of co-occurrence matrix, number non-uniformity grey-level dependence matrix (NGLDM), mean contrast neighborhood grey-tone difference matrix (NGTDM) and entropy NGLDM. For each CTTA parameter the respective mean, entropy and uniformity were calculated. For final calculation a medium filter was used. We first grouped all CLLs and compared them with DLBCL and secondly compared both the indolent and aggressive CLL subtypes separately with DLBCL.

RESULTS

CTTA-values between the entire CLL-group and DLBCL significantly differed with respect to entropy (P<.002), uniformity of heterogeneity (P<.008), mean intensity (P<.0001), mean average (P<.007), entropy of co-occurrence matrix (P<.012) and number

non-uniformity (P<.03). Indolent CLLs significantly differed from DLBCL in terms of entropy (P<.007), uniformity of heterogeneity (P<.018), mean intensity (P<.001), mean average (P<.004) whereas aggressive CLLs were significantly different from DLBCL in terms of entropy (P<.03), uniformity of heterogeneity (P<.02), mean intensity (P<.02) and mean entropy of co-occurrence matrix (P<.04).

CONCLUSION

CTTA features significantly differ in subjects with CLL compared to DLBCL caused by Richter's syndrome and could therefore be implemented in the routine evaluation of patients suspected of CLL transformation into a DLBCL. Differences in CTTA-features represent ultrastructural characteristics like tissue heterogeneity and contrast-induced attenuation.

CLINICAL RELEVANCE/APPLICATION

Differentiation between CLL and DLBCL caused by Richter's syndrome has major therapeutic and prognostic implications.

SSE09-04 Correlation Between Whole-Tumor CT Texture Analysis and Pathological Findings in Resected Primary Colon Cancer: Preliminary Results

Monday, Nov. 26 3:30PM - 3:40PM Room: S404CD

Participants
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PURPOSE

to correlate tumor heterogeneity by using whole-tumor CT texture analysis with pathological findings in primary colon cancer.

METHOD AND MATERIALS

IRB-approved retrospective study; need for informed consent was waived. Thirty patients with resected primary colon cancer were included (21M, 9F; mean age 75y). Thirty-nine first, second and higher order texture features were obtained from preoperative CT portal-venous phase images using a dedicated software (LifEX, www.lifexsoft.org). The results were compared with 10 histopathological features from the specimen (histology, tumor grade, growth pattern, T status, N status, presence of ulceration, percentage of necrosis, presence of vascular and lymphatic invasion, presence of free nodules).

RESULTS

tumor histology, tumor grade, growth pattern, T and N status were significantly correlated with 20 different Grey-Level Co-occurrence Matrix (GLCM), Grey-Level Run-Length Matrix (GLRLM), Grey-Level Zone-Length Matrix (GLZLM) and Neighborhood Grey-Level Different Matrix (NGLDM) parameters (Mann-Whitney test; p<0.05). No differences were found between first order texture features and the considered pathological findings (p=ns).

CONCLUSION

CT second and higher order texture features correlate with tumor biology and with T/N status at pathology.

CLINICAL RELEVANCE/APPLICATION

Second and higher order texture features are a new promising tool for preoperative characterization of colon cancer.

SSE09-05 Performance of 3T-MRI-Derived Texture Analysis in Rectal Cancer: Predicting Tumoral Response to Therapy

Monday, Nov. 26 3:40PM - 3:50PM Room: S404CD

Participants
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PURPOSE

To determine the performance of texture analysis(TA) in predicting tumoral response to therapy in patients with rectal cancer.

METHOD AND MATERIALS

Forty consecutive patients with clinical suspicion of rectal cancer were prospectively enrolled and had undergone 3T-MRI examination pre- and post- chemo-radiotherapy(CRT). All patients underwent total mesorectal excision 6-8 weeks after the end of CRT. The gross specimens were analyzed by an expert gastrointestinal pathologist and the histological results were considered the reference standard. A region-of-interest was manually drawn around the largest tumour area on a single axial oblique T2-w slice. Slices were analyzed with a dedicated software(TextRad) and the following first order statistical TA parameters were computed: Skewness, Kurtosis, Entropy, and Mean Value of Positive Pixels[MPP]). Non-parametric Mann-Whitney U test was used to compare

TA parameters and the response rate among complete responders(CR), partial responders(PR), and non-responders(NR) before and after CRT. Receiver operating characteristic curves(ROC) were used to assess the discriminatory power of TA parameters to predict complete response to CRT.

RESULTS

Thirteen patients(32,5%) showed CR, twenty-two patients(55%) showed PR and five patients(12,5%) were classified as NR. After CRT, CR showed significant reduction of Entropy(6.17 ± 0.54 vs 6.49 ± 0.43), Kurtosis(0.72 ± 1.05 vs 2.60 ± 2.01) and MPP(306.33 ± 168.97 vs 414.24 ± 219.26); all P <= 0.002. After CRT, PR/NR showed significant reduction of Entropy(6.47 ± 0.57 vs 6.70± 0.50) and Skewness(0.53 ± 0.75 vs 0.35 ± 0.67); all P <= 0.029 . After CRT, CR showed significant lower Kurtosis(0.33 ± 0.65) and MPP(262.19 ± 135.28), compared to PR/NR(Kurtosis: 1.87 ± 1.85; MPP: 357.54 ± 155.07); all P <= 0.042.Entropy was the only TA parameter showing significance in the predicting CR(AUC 0.64 [95% CI: 0.57 - 0.71]), P < 0.001 with the best cut-off value of >= 6.68, with a sensitivity of 76.9% and a specificity of 38.46% in predicting CR.

CONCLUSION

Among TA parameters Entropy might be a good predictor of tumor response showing the best AUC in ROC curves with good sensitivity and specificity. Kurtosis and MPP showed a significant decrease in patients with CR.

CLINICAL RELEVANCE/APPLICATION

TA parameters derived from T2 images such as Kurtosis, Skewness and Entropy might potentially play an important role as imaging biomarkers of tumoral response to CRT in patients with rectal cancer.

SSE09-06 Texture Analysis of Pancreas MRI: Utility for Differentiating Pancreatic Head Cancer from Mass-Forming Chronic Pancreatitis at the Pancreatic Head

Monday, Nov. 26 3:50PM - 4:00PM Room: S404CD

Participants
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PURPOSE

To investigate Haralick texture analysis of pancreatic head mass MRI for differentiating pancreatic head cancer(PHC) from mass-forming chronic pancreatitis at the pancreatic head.

METHOD AND MATERIALS

58 PHC patients, 23 mass-forming chronic pancreatitis patients prior to pancreatoduodenectomy or biopsy and 30 healthy controls undergoing MRI were included. Whole-lesion volumes of interests were placed on T2WI, pre- and post-contrast T1WI, which based on pathological information. Histogram-based parameters and textural features extracted from VOIs were analyzed using generalized estimating equations. The resulting data were processed with Kruskal-Wallis test and binary logistic regression models. Diagnostic accuracy was assessed by area under the receiver operating characteristic curves.

RESULTS

For pre-contrast T1WI, significant differences were observed for 26 matrixes. At binary logistic regression, among the 17 matrixes (AUCs>0.8), significant independent predictors of PHC were Quantile95, Compactness1 with a combined AUC of 0.953 (P=0.000). Combining these two matrixes achieved sensitivity of 89.7% and specificity of 89.7%. On post-contrast T1WI, significant differences were observed for thirty-nine matrixes. At binary logistic regression, among the 18 matrixes (AUCs>0.8), significant independent predictors of PHC were RelativeDeviation, Uniformity, and Compactness1, with a combined AUC of 0.948 (P<0.0001). Combining these three matrixes achieved sensitivity of 86.2% and specificity of 84.9%. PHC has the highest degree of compactness, followed by chronic pancreatitis, and the lowest normal pancreas. PHC shows higher Relative Deviation and lower uniformity than chronic pancreatitis and normal pancreatic tissue. However, chronic pancreatitis and normal pancreas did not differ between these two matrixes. For T2WI significant differences were observed for Skewness, Haralick Correlation, and Inverse Difference Moment, but the AUCs of these parameters were not greater than 0.8.

CONCLUSION

Texture metrics obtained on various MRI sequences, post- contrast T1WI provided the highest, and T2WI the lowest performance for differentiating pancreatic head mass. Several Haralick-based texture features appear useful for distinguishing chronic inflammatory mass from PHC.

CLINICAL RELEVANCE/APPLICATION

Several Haralick-based texture features appear useful for distinguishing chronic inflammatory mass at the pancreatic head and PHC.

SSE10

Gastrointestinal (General Abdominal Oncology)

Monday, Nov. 26 3:00PM - 4:00PM Room: S403A

CT GI OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Lauren F. Alexander, MD, Jacksonville, FL (*Moderator*) Spouse, Stockholder, Abbott Laboratories; Spouse, Stockholder, AbbVie Inc; Spouse, Stockholder, General Electric Company

Sub-Events

SSE10-01 18F-FDG PET/MRI versus PET/CT in Staging of Gastro-Esophageal Junction Cancer

Monday, Nov. 26 3:00PM - 3:10PM Room: S403A

Participants
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PURPOSE

To compare F-18-Fluorodeoxyglucose (FDG)-positron-emission-tomography/magnetic-resonance-imaging (PET/MRI) and PET/computed-tomography (PET/CT) in staging of gastro-esophageal junction (GEJ) cancer.

METHOD AND MATERIALS

Following IRB approval and informed consent, 24 patients with histologically proven GEJ cancer were prospectively recruited; 4 patients were excluded for technical reasons (19 male, 1 female; mean 68.3+/-9.1 years). Patients were injected with 326+/-28 MBq FDG intravenously for the clinical PET/CT. Uptake time was 60 minutes. PET/MRI was acquired directly after the PET/CT. 2 experienced radiologists and nuclear physicians reviewed the images and defined the PET/MRI-TNM stage in consensus. PET/CT NM-stage was defined for clinical routine. Standard of reference was the multidisciplinary team meeting (MDT) stage, which was defined by contrast enhanced CT+/-endoscopic ultrasonography (EUS) and PET/CT. Sensitivity (SE), Specificity (SP), positive predictive value (PPV), negative predictive value (NPV) and accuracy (AC) were calculated. McNemar test was performed to assess differences between different modalities.

RESULTS

For PET/MRI T-stage was concordant with MDT stage in 14 (70%) of 20 patients. Differences in T-stages between PET/MRI and MDT were statistically significant (p=0.03) (Table 1). In our cohort, PET/MRI upstaged three T3 primary lesions as T4 and correctly assigned two T4 lesions. Both PET/MRI and PET/CT agreed in N-and M-staging in all patients. Differences in N-stage between hybrid modalities and MDT were significant (p=0.03) (6 of 20 patients) (Table 2). SE, SP, PPV, NPV and AC for detection of lymph node metastases were 94%, 100%, 100%, 67% and 95% for both imaging modalities.

CONCLUSION

PET/MRI and PET/CT performed similarly in N and M staging. PET/MRI has advantages over PET/CT in providing additional T-stage.

CLINICAL RELEVANCE/APPLICATION

PET/MRI might be used for staging of patients with GEJ cancer in the future.

SSE10-02 Arterial Enhancement Patterns on MR imaging as Preoperative Prognostic Markers of Intrahepatic Mass-forming Cholangiocarcinoma

Monday, Nov. 26 3:10PM - 3:20PM Room: S403A

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PURPOSE

This study aimed to evaluate the prognostic factors of intrahepatic mass-forming cholangiocarcinoma (IMCC) and to determine the relationship between the magnetic resonance imaging (MRI) features of IMCC including arterial enhancement pattern, the clinicopathologic factors, and the clinical outcomes.

METHOD AND MATERIALS

The institutional review board approved this retrospective study. The need for informed patient consent was waived. This stud included 134 patients who underwent curative hepatic resection and preoperative MRI for IMCCs (median size: 4.5 cm). The MRIs were reviewed for the IMCCs, which were classified according to the arterial enhancement pattern (diffuse hypoenhancement vs. peripheral rim enhancement vs. diffuse hyperenhancement). We performed survival analysis according to preoperative and postoperative clinicopathologic factors as well as imaging findings.

RESULTS

In multivariate analysis, the CA 19-9 level ($P = 0.010$), tumor size ($P = 0.001$), tumor number ($P = 0.008$), tumor differentiation ($P = 0.036$), vascular invasion ($P < 0.001$), and arterial enhancement pattern ($P < 0.001$) were significant prognostic factors for overall survival (OS). The CA 19-9 level ($P = 0.013$), tumor size ($P = 0.018$), T classification ($P = 0.013$), necrosis ($P = 0.019$), and arterial enhancement pattern ($P = 0.005$) were significant prognostic factors for recurrence-free survival (RFS). There were significant differences in clinicopathologic features among the three arterial enhancement groups. The OS and RFS of the diffuse hyperenhancement group were significantly better than those of the peripheral rim or diffuse hypoenhancement group ($P < 0.001$).

CONCLUSION

The arterial enhancement pattern on MRI, along with the CA 19-9 level and tumor size may be a useful prognostic marker in the preoperative evaluation of patients with IMCC.

CLINICAL RELEVANCE/APPLICATION

The arterial enhancement patterns on MRI are the potential prognostic marker in the preoperative evaluation of patients with IMCC. Patients with IMCC with diffuse hyperenhancement had significantly better clinical outcomes than those with peripheral rim enhancement or diffuse hypoenhancement.

SSE10-03 Clinical Value of Single-Source, Dual-Energy Spectral CT Imaging in Differentiating Small Liver Cyst from Micro-Metastatic Lesion

Monday, Nov. 26 3:20PM - 3:30PM Room: S403A

Participants
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PURPOSE

To evaluate the value of single-source, dual-energy CT in the differential diagnosis of small liver cysts from micro-metastatic lesions.

METHOD AND MATERIALS

From January 2014 to Oct 2016, 30 patients with 55 liver lesions underwent spectral CT scans. The lesions were divided into two groups: group A (micro-metastatic) and group B (small liver cysts) (all lesions were diagnosed by medical history and follow-up). The mean CT value of the 40-140keV monochromatic images, iodine (water) concentration and effective atomic number (eff-Z) for the lesions were measured on an AW 4.5 workstation The slope of the spectral curve (K) was measured in the two groups and were statistically compared. Receiver operating characteristic (ROC) curves were constructed to evaluate the effectiveness of each parameter.

RESULTS

The consistency of measurements between the observers was rated very well (ICC>0.75). In the unenhanced CT phase, there was no difference in all measurements between the 2 lesion groups ($P>0.05$). The CT values of the 40-70keV images in group A were significantly higher than those in group B in all three contrast-enhanced phases ($P<0.05$). Using the CT value of 79.06HU as a threshold for the 40keV images, one obtained an area-under-curve (AUC) for ROC study of 0.802 with sensitivity of 87.5% and specificity of 61.3% for differentiating small liver cysts from micro-metastatic lesions. The iodine concentration, eff-Z and K measurements were different between the two lesion groups only in the arterial phase ($P<0.05$) (AUC=0.747, 0.765, 0.753). Through combining the CT value at 40keV, iodine concentration, eff-Z and K values in the arterial phase, we could obtain an pooled sensitivity of 90.3%, specificity of 66.7% with a pooled AUC of0.856.

CONCLUSION

Single-source dual-energy CT provides multiple parameters for relatively high diagnostic accuracy in differentiating small liver cysts from micro-metastatic lesions.

CLINICAL RELEVANCE/APPLICATION

Single-source dual-energy CT has good clinical value in differentiating small liver cyst from micro-metastatic lesion.

SSE10-04 Volumetric Measurement of Split and Merged Target Lymph Nodes on CT in Clinical Trials, Compared with RECIST Version 1.1

Monday, Nov. 26 3:30PM - 3:40PM Room: S403A

Participants
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PURPOSE

To investigate the volumetric changes of split or merged target lymph node on CT scans compared with Response Evaluation Criteria in Solid Tumors (RECIST) version 1.1 measurements.

METHOD AND MATERIALS

Target lymph nodes (short axis diameter >= 1.5 cm) that separated from a conglomerate node (split node) or merged with other nodes (merged node) were retrospectively examined at multiple time points in a cohort of 182 patients with cancers enrolled in clinical trials. Each target node was measured in PACS (Carestream Health) based on RECIST 1.1 before and after splitting or merging, and percent size change was calculated. Volumetric changes of the nodes were also calculated using Vitrea Enterprise Suite V:6.8.0, with percent change recorded as the ground truth. RECIST and volumetric measurements were compared using a t-test. Our cohort was categorized into 3 groups: a conglomerate node splits, one target node merge with other nodes (one-target merged), and two neighboring target nodes merge (two-target merged) as RECIST allows a maximum of two target lymph nodes per patient.

RESULTS

Our cohort consisted of 20 split nodes and 30 merged nodes (19 were 1-target merged, and 11 were 2-target merged). A significant difference ($p<0.001$) was seen in all groups between RECIST and volumetric measurements. Mean percent change in size of split nodes was +1% range -48% to +52%) by RECIST and -66% (range from -98% to -13%) by volumetric method. Mean percent change in size of one-target merged nodes was 65% (range 29% to 107%) by RECIST and 210% (range 15% to 607%) by volumetric method. Mean percent change in size of two-target merged nodes was -15% (ranging from -31% to -4%) by RECIST and 110% (ranging from 15% to 234%) two-target merged. While volumetric measurements indicated a decrease in size of all split nodes, RECIST measurements indicated an increase in size in 60% of cases. In merged nodes, volumetric measurements indicated an increase in size for both merged groups, while RECIST measurement showed a decrease in size in all 2-target merged nodes (11 of 11).

CONCLUSION

RECIST 1.1 may not accurately represent the volumetric increase or decrease in size of target lymph nodes during merging or splitting events.

CLINICAL RELEVANCE/APPLICATION

Volumetric analysis of split and merged lymph nodes indicates a need for revision of target lymph node measurement methodologies of RECIST version 1.1.

SSE10-05 Is There a Direct Correlation Between Microvascular Wall Structure and K-Trans Values Obtained from Perfusion-CT Measurements in Lymphomas?

Monday, Nov. 26 3:40PM - 3:50PM Room: S403A

Participants
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PURPOSE

To test the hypothesis that ultrastructural wall abnormalities of lymphoma vessels correlate with CT perfusion kinetics.

METHOD AND MATERIALS

Our local institutional review board approved this prospective study. Between February 2013 and June 2016, we included 23 consecutive subjects with newly diagnosed lymphoma, who were referred for CT-guided biopsy (6 female, 17 male; mean age, 60.61±12.43years; range, 28-74 years) and additionally agreed to undergo perfusion-CT of the target lymphoma tissues. Perfusion-CT was obtained for 40 seconds using 80 kV, 120 mAs, 64 x 0.6 mm collimation, 6.9 cm z-axis coverage, and 26 volume measurements. Mean and maximum k-trans (ml/100ml/min), blood flow (BF; ml/100ml/min) and blood volume (BV) were quantified using the deconvolution and the maximum slope + Patlak calculation models. Immunohistiochemical staining was performed for microvessel density (MVD) quantification (vessels/m2) and electron microscopy was used to determine the presence or absence of tight junctions, endothelial fenestration, basement membrane, pericytes and for measurement of extracellular matrix thickness

RESULTS

Extracellular matrix thickness as well as the presence/absence of tight junctions, basal lamina and pericytes did not correlate with CT perfusion parameters. Endothelial fenestrations correlated significantly with mean BFdeconvolution ($p=0.047, r=0.418$), and additionally was significantly associated with higher mean BVdeconvolution ($p<0.005$). Mean k-transPatlak correlated strong with mean k-transdeconvolution ($r=0.939, p=0.001$), and both correlated with mean BFdeconvolution ($p=0.001, r=0.748$), max BFdeconvolution ($p=0.028, r=0.564$), mean BVdeconvolution ($p=0.001, r=0.752$) and max BVdeconvolution ($p=0.001, r=0.771$). MDV correlated with max k-transdeconvolution($r=0.564, p=0.023$).

CONCLUSION

K-trans values of perfusion CT do not correlate with ultrastructural microvessel features, whereas endothelial fenestrations correlate with increase intra-tumoral blood volumes.

CLINICAL RELEVANCE/APPLICATION

Numerous imaging studies have been conducted with the aim of non-invasively quantify tumor vascularization and vessel wall leakiness. However, to the best of our knowledge, an association between electron microscopy-based ultrastructural vessel wall features and PCT kinetics of lymphoma has not been investigated. Therefore, we tested the hypothesis that ultrastructural wall abnormalities of lymphoma vessels correlate with PCT kinetics.

SSE10-06 Nationwide, Longitudinal Trends in CT Colonography Usage: Cross Sectional Survey Results from the 2010 and 2015 National Health Interview Survey

Monday, Nov. 26 3:50PM - 4:00PM Room: S403A

Participants
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PURPOSE

Colorectal cancer screening reduces mortality however screening rates have plateaued. Prior studies have found that giving patients choices between different screening tests improves adherence. CT colonography is an emerging minimally invasive screening test that demonstrates high sensitivity for colonic polyps(>1 cm). With increasing health insurance coverage, there are limited national, population-based estimates of CT colonography utilization over time. Our purpose was to estimate longitudinal utilization of CT colonography among eligible participants using nationally representative cross sectional survey data.

METHOD AND MATERIALS

We used nationally representative cross sectional survey data from 2010 and 2015 National Health Interview Surveys including information about CT colonography usage. 2010 response rate was 77% and 2015 response rate was 80%. Participants between ages 50-75 without histories of colon cancer were included. Logistic regression analyses were used to evaluate longitudinal changes in the proportion of eligible individuals undergoing CT colonography, adjusted for potential confounders and stratified by type of health insurance and age category. Analyses were conducted taking into account complex survey design elements (adjusted weights, strata and sampling units).

RESULTS

8,965 survey respondents in 2010 and 12,721 survey respondents in 2015 were included. 1.2% reported usage of CT colonography in 2010 and 0.9% reported usage of CT colonography in 2015, a statistically significant decrease (Adjusted OR 0.92, 95% CI 0.86 - 0.99). Optical colonoscopy usage increased from 57.9 to 63.6% (Adjusted OR 1.04, 95% CI 1.02 - 1.06). In our stratified analyses, patients with private health insurance($p = 0.35$), patients below 65 (not Medicare eligible)($p = 0.07$) and patients who had heard of CT colonography($p = 0.28$), did not experience changes in CT colonography usage. Overall awareness of CT colonography decreased from 20.5% to 15.9%, a statistically significant decrease (Adjusted OR 0.94, 95% CI 0.92 - 0.96).

CONCLUSION

Despite increasing overall usage of optical colonoscopy from 2010 to 2015, CT colonography awareness(~16%) and utilization(~1%) remained low.

CLINICAL RELEVANCE/APPLICATION

Improved public awareness and coverage expansion to Medicare age populations will promote increased CT colonography utilization and improvements in overall colorectal cancer screening.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Debra A. Gervais, MD - 2012 Honored Educator

SSE11

Genitourinary (Imaging of Renal Stones)

Monday, Nov. 26 3:00PM - 4:00PM Room: S102CD

AI CT GU

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Mitchell E. Tublin, MD, Pittsburgh, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSE11-01 Three Dimensional Texture Analysis with Machine Learning Provides Incremental Predictive Information for Successful Shock Wave Lithotripsy in Patients with Kidney Stones

Monday, Nov. 26 3:00PM - 3:10PM Room: S102CD

Participants
Manoj Mannil, Zurich, Switzerland (*Presenter*) Nothing to Disclose
Jochen von Spiczak, MD,MSc, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Christian Fankhauser, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Thomas Hermanns, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Hatem Alkadhi, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To determine the predictive value of three-dimensional texture analysis (3D-TA) in computed tomography (CT) images for successful shock wave lithotripsy (SWL) in patients with kidney stones.

METHOD AND MATERIALS

Patients with pre and postoperative CT scans, previously untreated kidney stones and a stone diameter of 5-20 mm were included. A total of 224 3D-TA features of each kidney stone, including the attenuation measured in Hounsfield Units (HU), and the clinical variables body mass index (BMI), initial stone size, and skin-to-stone distance (SSD) were analyzed using five commonly used machine learning models. The data set was split in a ratio of 2/3 for model derivation and 1/3 for validation. Machine learning-based predictions for SWL success in the validation cohort were evaluated calculating sensitivity, specificity, and the area-under-the-curve (AUC).

RESULTS

For SWL success the three clinical variables BMI, initial stone size and SSD showed AUCs of 0.68, 0.58 and 0.63 respectively and no predictive information for HU could be noted. By use of a RandomForest classifier using three 3D-TA features an AUC of 0.79 could be observed. By combining 3D-TA features and clinical variables, the discriminatory accuracy improved further with an AUC of 0.85 for 3D-TA features and SSD, an AUC of 0.8 for 3D-TA features and BMI and an AUC of 0.81 for 3D-TA and stone size.

CONCLUSION

Our in-vivo study indicates the potential of 3DTA of urinary stone CT enabling the prediction of successful stone disintegration with SWL with high accuracy.

CLINICAL RELEVANCE/APPLICATION

Selected 3D-TA features provide incremental predictive value for successful SWL, which allows stratifying patients with symptomatic kidney stones to either primary SWL or Ureterorenoscopy.

SSE11-02 Usefulness of Computer Aided Detection of Urinary Stones in Computed Tomography Kidney Ureter Bladder using Convolutional Neural Networks: Preliminary Study

Monday, Nov. 26 3:10PM - 3:20PM Room: S102CD

Participants
Sung Bin Park, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

Computed tomography kidney ureter bladder (CTKUB) is the method of choice for diagnosing urinary stones. The purpose of this study is to develop a computer aided detection (CAD) algorithm for identifying a urinary stone in thin slice CTKUB.

METHOD AND MATERIALS

Thin slices (3 mm) CTKUB (120 kVp and 150 mAs) in patients with suspicious of stone disease were included in the study. The labeling of urinary stones or not in CTKUB as reference standard was performed by an expert radiologist. 5,268 urinary stones and 4,980 non-urinary stones on CTKUB images were evaluated for training dataset. 551 urinary stones and 528 non-urinary stones on CTKUB images were evaluated for validation dataset. The convolutional neural network was consisted of 8 convolution layers, 9 fully connected layers and softmax classifier. The diagnostic performance of CAD algorithm for identifying a urinary stone from combination of three different image planes (axial, coronal and sagittal) in thin slice CTKUB using convolutional neural network was analyzed.

RESULTS

In training dataset, the performance was almost perfect. In validation dataset, the CAD algorithm was classified all 551 urinary stones as stones. It was also classified 528 non-urinary stones as 527 non-urinary stones and 1 urinary stone. The sensitivity, specificity, accuracy, positive predictive value and negative predictive value of CAD algorithm were 100%, 99.8%, 99.9%, 99.8% and 100%, respectively.

CONCLUSION

CAD algorithm in thin slice CTKUB using convolutional neural network can have high diagnostic performance for urinary stone detection. Prospective further studies involving more participants and focusing on the factors affecting clinical practice such as stone size, location (ureter, kidney) are needed.

CLINICAL RELEVANCE/APPLICATION

In view of its high accuracy, we believe CAD algorithm in thin slice CTKUB using convolutional neural network can be used as an initial examination in patients with suspicious of stone disease.

SSE11-03 Efficacy of Single-Source Rapid kV-Switching Dual-Energy CT for Characterization of Non-Uric Acid Renal Stones: A Prospective Ex-Vivo Study Using Anthropomorphic Phantom

Monday, Nov. 26 3:20PM - 3:30PM Room: S102CD

Awards
Student Travel Stipend Award

Participants
Roberto Cannella, MD, Pittsburgh, PA (*Presenter*) Nothing to Disclose
Mohammed Shahait, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Alessandro Furlan, MD, Pittsburgh, PA (*Abstract Co-Author*) Book contract, Reed Elsevier; Research Grant, General Electric Company; Consultant, General Electric Company
Joel D. Bigley, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
Timothy Averch, Pittsburgh, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To investigate the accuracy of rapid kV-switching single-source dual-energy computer tomography for prediction of classes of non-uric acid stones.

METHOD AND MATERIALS

Non-uric-acid renal stones retrieved via percutaneous nephrolithotomy were prospectively collected between January 2017 and February 2018 in a single institution. Only stones >5mm and with pure composition (i.e. >80% composed of one element) were studied. Stone composition was determined using Fourier Transform Infrared Spectroscopy. The stones were scanned in 32 cm-wide anthropomorphic whole body phantom in a location mimicking the kidneys. Image acquisition was performed using a single-source rapid-kVp switching CT scanner. The effective atomic number (Zeff) and the attenuation (HU) at 40 kev, 70 kev, and 140 kev virtual monochromatic sets of images were extracted by placing a ROI at the largest cross-sectional areas. Ratios between the attenuations at different energy levels were calculated. Mean values of different stone classes were compared using ANOVA and student t-test. Difference between the actual class of stone and the predicted class of stone based on vendor-recommended Zeff thresholds were assessed. A p-value <0.05 was considered statistically significant. Receiver operating curves (ROC) and area under curve (AUC) with 95% confidence intervals were calculated to assess the efficacy of each parameter.

RESULTS

The final study sample included 31 stones from 31 patients consisting of 2 (6%) struvite, 4 (13%) cysteine and 25 (81%) calcium-based pure stones. The mean size of the stones was 9.9 ± 2.4 mm. The mean Zeff of the stones was 12.0±0.41 for calcium-based, 10.1 ± 0.14 for struvite, and 9.9 ± 0.57 for cysteine stones which were statistically different ($p<0.001$). In 16 cases (51.6%), there was discrepancy between the actual stone class and the predicted class based on vendor-recommended thresholds. Zeff had the best efficacy for differentiation of different stone classes. The calculated AUC was for 0.947 for Zeff; 0.833 for HU40; 0.880 for HU70 and 0.893 for HU140.

CONCLUSION

Zeff has superior performance to HU and attenuation ratios for differentiation of different classes of non-uric-acid stones.

CLINICAL RELEVANCE/APPLICATION

Non-invasive determination of composition of urinary stone has important clinical implication in guiding the decision making algorithm

for stone treatment.

SSE11-04 Dual-Energy Spectral CT Characterization of Urinary Calculi In Vivo

Monday, Nov. 26 3:30PM - 3:40PM Room: S102CD

Participants
Xiaohu Li, MD, Hefei, China (*Presenter*) Nothing to Disclose
Yongqiang Yu, MD, Hefei, China (*Abstract Co-Author*) Nothing to Disclose
Jianying Li, Beijing, China (*Abstract Co-Author*) Employee, General Electric Company

PURPOSE

To explore the feasibility of using dual-energy energy spectral CT to determine the components of urinary calculi in vivo

METHOD AND MATERIALS

Fifty-seven cases of patients with urinary calculi were included in the present eighty-nine stones,with GSI (gemstone spectral imaging) scan using AW4.6 workstation for image analysis indexes:GSI scan mode (Effective atomic number), the material (Materia Density) calcium water ratio (calcium water ratio, CWR),50keV and 70keV single energy CT value. The differences of 4 indexes were compared. According the infrared spectrum analysis results as the reference standard. Compared with spectrum diagnosis ,we can conclude that sensitivity, specificity and positive predictive value, negative predictive value of pure uric acid stones, pure non-uric acid stones, stones mixed . Retrospective study of involving 24 cases of single component calculi (11 pieces of uric acid stones, 9 pieces of calcium oxalate, 3 pieces of calcium phosphate stones) and 53 cases of mixed stones.Stones were respectively measuring the effective atomic number, CWR, 50ke V, 70keV single energy CT value and we can compare the indexes of different groups with the one way anova.

RESULTS

The infrared spectrum analysis results as the reference standard, the sensitivity for analysis pure uric acid calculi, pure non-uric acid stones and mixed stones were 100%, 91.7%, 97.0% ,respectively;with specificity of 100%, 97.4%, 95.7% ,respectively;with the positive predictive value of 100%, 84.6% 98.5% respectively and the negative predictive value were 100%, 98.7%, 91.7% ,respectively.

CLINICAL RELEVANCE/APPLICATION

It is useful to reduce the occurrence of complications if we can make a definite diagnosis of stone composition before surgery.

SSE11-05 Role of Single Source Dual Energy CT in Evaluation of Chemical Composition of Urinary Tract Calculi

Monday, Nov. 26 3:40PM - 3:50PM Room: S102CD

Participants
CHANDRESH O. KARNAVAT, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose
Niravkumar K. Kadavani, MBBS, Mumbai, India (*Presenter*) Nothing to Disclose
Ritu M. Kakkar, MBBS, DMRD, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose
Shrinivas B. Desai, MD, Mumbai, India (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the diagnostic accuracy of Single Source Dual Energy CT in characterisation of renal stones with biochemical analysis as reference

METHOD AND MATERIALS

This was a prospective study carried out at a tertiary care centre for a period of 3 years using Gemstone Spectral Imaging in single source dual energy CT scanner- GE Discovery CT750 HD. A total of 70 patients with renal calculi who underwent single source dual energy CT and subsequent surgery were included in the study. Both high and low energy data sets are acquired simultaneously for axial and helical acquisitions at the full 50 cm field of view. Dual-energy data were processed by the GSI general protocol on the CT workstation (Advantage Windows, version 4.2; GE Healthcare). A region of interest (ROI) was applied over the renal stone viewed on the bone window settings occupying approximately 50% of the stone area on axial images. Using GSI software effective atomic number of the ROI area Z (Zeff) was calculated and stones were characterised. Post surgery biochemical analyses of these stones were sent to a common laboratory. All results of dual energy CT were compared to the biochemical analysis by applying kappa statistics

RESULTS

Out of 70 patients, 43 were male and rest were female. The age group of patients ranged from 25 to 70 years (mean 47 years). Out of 48 calcium oxalate stones on dual energy CT, 47 were calcium oxalate and one was mixed. Out of 12 struvite stones on dual energy CT, 10 were struvite and 2 were mixed. Single cysteine stone detected on dual energy CT was found to be mixed stone on biochemistry. All 7 ammonium urate stones on dual energy were found to be same on biochemistry. Single mixed stone detected on dual energy CT showed similar result on biochemistry. Weighted kappa was found to be 0.835 which indicates very good agreement between two different diagnostic tests

CONCLUSION

Single Source Dual energy CT scan has a role in accurately assessing the chemical composition of the urinary tract calculi

CLINICAL RELEVANCE/APPLICATION

Chemical composition of the urinary tract calculi using Single Source Dual Energy CT has significant impact on medical management of patient with stone disease

SSE11-06 Comparison of CT-Index and Effective Z Analysis for Characterization of Urinary Stones with Dual-Energy CT: A Phantom Study

Monday, Nov. 26 3:50PM - 4:00PM Room: S102CD

Participants
Felice A. Burn, MD, Aarau, Switzerland (*Presenter*) Nothing to Disclose
Daniel Mueller, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Sebastian T. Schindera, MD, Aarau, Switzerland (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To assess the accuracy of CT-index and effective Z value (atomic number) derived from dual-energy CT for differentiation of uric acid from non-uric acid stones and to further characterize the subgroup of non-uric acid stones.

METHOD AND MATERIALS

Total of 64 urinary stones from humans (32 uric acid and 32 non-uric acid stones with subgroups of oxalate, struvite, brushite and apatite) were included in the study. The stones were placed in an anthropomorphic CT-phantom (diameter, 30 cm). All stones underwent an x-ray diffraction analysis representing the gold standard and they had a high purity and homogeneity of at least 90% in their compositions. The phantom was scanned on a 360-slice MDCT scanner (Aquilion ONE Vision, Canon Medical) with a dual-energy mode using tube voltages of 135 and 80 kVp. The acquired datasets were automatically segmented and postprocessed with commercially available software. The CT-index and the effective Z, which was derived from raw data-based dual-energy analysis, was assessed. A statistical receiver operating characteristics (ROC) analysis and multivarable discrimination analysis was performed.

RESULTS

The differentiation of uric acid stones from non-uric acid stones were significant, using the CT-index ($p < 0.001$) and the effective Z value ($p < 0.01$). The use of the effective Z and CT-index allow further separation in subcategories as uric acid, oxalat, apatit, brushit and struvit stones (Figure 1), whereas this separation is less accurate than for the differentiation of uric acid from non-uric acid stones. If the CT-index and the effective Z values were taken both in consideration a subgroup analysis shows. If the CT-index and the effective Z values were taken both in consideration a subgroup analysis shows more powerful options in differentiation.

CONCLUSION

CT-index and effective Z values, derived from dual-energy CT, allow very accurate differentiation of uric acid from non-uric acid stones. The differentiation of non-uric acid subgroups is not very reliable for both parameters separately. However, the combinations of both parameters in the evaluation of subgroups can improve the separation of non-uric acid stones.

CLINICAL RELEVANCE/APPLICATION

Improved characterization of renal stone compositions with dual-energy CT using CT index and effective Z value in combination has a direct impact on the clinical management and therefor may improve patient outcome and may reduce treatment costs.

SSE12

Science Session with Keynote: Genitourinary (Adrenal Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: S103AB

CT GU

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Elaine M. Caoili, MD, MS, Ann Arbor, MI (*Moderator*) Nothing to Disclose
Hebert Alberto Vargas, MD, Cambridge, United Kingdom (*Moderator*) Nothing to Disclose

Sub-Events

SSE12-01 Genitourinary Keynote Speaker: Imaging of the Adrenal Glands-What More Do We Need to Know?

Monday, Nov. 26 3:00PM - 3:10PM Room: S103AB

Participants
Michael T. Corwin, MD, Sacramento, CA (*Presenter*) Nothing to Disclose

SSE12-02 The Diagnostic Value of Modified Dixon Fat Quantification Technique in the Evaluation of Adrenal Masses

Monday, Nov. 26 3:10PM - 3:20PM Room: S103AB

Participants
Andreas Feist, Bonn, Germany (*Presenter*) Nothing to Disclose
Leonie Kramer, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose
Daniel Kuetting, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose
Frederic Carsten Schmeel, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose
Hans H. Schild, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose
Guido M. Kukuk, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the diagnostic value of six-echo modified Dixon (mDixon) fat quantification techniques in the differentiation between benign and malignant adrenal masses.

METHOD AND MATERIALS

All dedicated upper abdominal MRI examinations including proton density fat fraction (PDFF) maps of the year 2015 (n=535) were re-evaluated for the presence of adrenal incidentalomas. PDFF values acquired by placing one single ROI were compared to adrenal signal intensity index (ASII, [(signal intensity on in-phase imaging - signal intensity on opposed-phase imaging) / (signal intensity on in-phase imaging)] × 100%) and adrenal-to-spleen chemical-shift ratio (ASR, ([(signal intensity of lesion on opposed-phase imaging - signal intensity of spleen on opposed-phase imaging) / (signal intensity of lesion on in-phase imaging - signal intensity of spleen on opposed-phase imaging)]-1) × 100%) for all lesions by two independent readers. All lesions were interpreted in the clinical context including -if available- histological results, interdisciplinary tumor board decisions and follow-up examinations.

RESULTS

Fifty-five patients with 70 lesions were identified. 47 lesions (67.1%) were finally diagnosed as adenomas, 23 lesions (32.9%) were confirmed adrenal metastases. Applying PDFF maps a fat fraction of at least 8.3% was 100% sensitive and 91.7% specific for the diagnosis of adrenal adenoma (AUC: 0.996). A fat fraction of at least 12.25% showed a sensitivity of 91.5% and specificity of 100% in detecting adenomas ruling out all possible malignant adrenal masses. PDFF measurements were significantly more observer independent than calculations of ASII and ASR ($p < 0.05$).

CONCLUSION

Six-echo mDixon fat quantification technique provides a robust, fast and highly observer independent tool for the distinction between benign and malignant adrenal masses.

CLINICAL RELEVANCE/APPLICATION

Providing a high diagnostic accuracy and superior inter-rater variability compared to ASII and ASR PDFF maps might replace the established indices in the evaluation of adrenal masses.

SSE12-03 Adrenal Nodules Greater Than 10 Hounsfield Units (HU) on Non-Contrast CT: Still Indeterminate?

Monday, Nov. 26 3:20PM - 3:30PM Room: S103AB

Awards
Student Travel Stipend Award

Participants

Zi Jun Wu, MD, Seattle, WA (*Presenter*) Nothing to Disclose
Carolyn L. Wang, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Daniel S. Hippe, MS, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company; Research Grant, Canon Medical Systems Corporation; Research Grant, Siemens AG
Erik Soloff, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
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Larson Hsu, MD, Buffalo, NY (*Abstract Co-Author*) Nothing to Disclose
Toshimasa J. Clark, MD, Denver, CO (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To determine if a Gaussian-based algorithm (GA) analysis with and without noise correction can help characterize indeterminate adrenal nodules (> 10HU) on non-contrast CT as lipid poor adenomas.

METHOD AND MATERIALS

IRB-approved, HIPAA-compliant retrospective study evaluated adrenal nodules greater than 1 cm on non-contrast CT using the GA based region of interest histogram analysis with and without noise correction (normalization of mAs, kVp, and slice thickness to published data). Two independent readers evaluated the nodules and were blinded to final pathology. Lesions were characterized as malignant if pathology proven by biopsy or surgical resection or likely benign due to pathology or imaging features (stability > 1 year, adrenal CT washout, MRI signal loss, or negative FDG PET/CT with a FDG positive primary). Inter-reader agreement was assessed using intraclass correlation coefficient (ICC). Sensitivity, specificity and area under the curve (AUC) were derived.

RESULTS

There were 91 adrenal nodules in 83 patients that averaged 2.6 cm in size (±1.9 cm). 33 nodules were pathologically confirmed metastases most commonly lung cancer: average size 1.7 ± 0.7 cm, mean attenuation 23.8 ± 8.8 HU. 58 nodules were presumed to be adenomas based on imaging characteristics: average size 3.9 ± 2.6 cm, mean attenuation 32.2 ± 8.2 HU. Inter-reader agreement was excellent (ICC > 0.8) for multiple variables, including nodule size, mean attenuation, SD of attenuation, and G-index. The noise-corrected GA had significantly higher specificity (85% vs. 59%, p<0.001) and lower sensitivity (38% vs. 58%, p<0.001) for identifying adenoma than the uncorrected GA. The AUC for the corrected GA-index was 0.74, which was statistically improved compared to uncorrected GA-index (0.52, p=0.04) while being similar to the mean attenuation (0.78, p=0.1) and size (0.81, p=0.3).

CONCLUSION

A Gaussian-based algorithm based on histogram analysis can discriminate between lipid-poor adrenal adenomas and non-adenomas, although it performed no better than an alternative mean attenuation cutoff.

CLINICAL RELEVANCE/APPLICATION

Noise correction Gaussian based algorithm can be used to assess indeterminate adrenal nodules >10HU with high specificity, however further workup may still be needed in patients with a history of cancer.

SSE12-04 Correlation Between Subclinical Hypercortisolism and Adrenal Volumetry in Patients with Incidental Adrenal Adenoma

Monday, Nov. 26 3:30PM - 3:40PM Room: S103AB

Participants
Nicolas Mertens Folch, Santiago, Chile (*Presenter*) Nothing to Disclose
Roberto I. Olmos, MD, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose
Rene Baudrand, Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose
Alvaro Huete Garin, MD , Santiago, Chile (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To correlate lesion and contralateral adrenal gland volume (CLAV) measurements in asymptomatic patients with incidental adrenal adenoma (IAA) found on computed tomography (CT) with the presence of subclinical hypercortisolism (SCH).

METHOD AND MATERIALS

50 consecutive subjects with IAA were prospectively enrolled after obtaining informed consent between August 2016 and January 2018 according to local scientific ethics committee guidelines. Dexamethasone suppression test and ACTH quantification in peripheral blood was performed in all patients to diagnose SCH. All subjects underwent an adrenal protocol CT with iodinated intravenous contrast and lesion was confirmed as adenoma using known diagnostic criteria (non contrast density < 10 HU, relative washout > 40%, absolute washout > 60%). Volume of the IAA and the CLAV was calculated with Osirix® viewer software by 2 reviewers, with reproducibility evaluated using Bland-Altman analysis. Mann-Whitney U test was used for statistical correlation. Receiver operating characteristic (ROC) curves were obtained to determine the discrimination capabilities of each variable.

RESULTS

Subjects included had a mean age of 57.2 years, 82% (n=41) were female. 12 subjects (24%) from the group were diagnosed with SCH. Patients with SCH had larger IAA volumes (p<0.0001) and lower CLAV (p=0.005) than those without SCH. The Bland-Altman analysis showed acceptable inter-reader measurement agreement and moderate dispersion of the results, especially at higher IAA and CLAV volumes, with a mean difference of 0.09 cm3, 95% CI [-1.4, 1.58] for IAA volume and a mean difference of 0.42 cm3, 95% CI [-2.69, 3.53] for CLAV. Area under the ROC curve (AUC) for IAA volume and CLAV was 0.936, 95% CI [0.869, 1] and 0.822, 95% CI [0.668, 0.976] respectively.

CONCLUSION

IAA volume and CLAV appear to be useful and reproducible tools predicting the presence of SCH in asymptomatic patients with IAA.

CLINICAL RELEVANCE/APPLICATION

Endocrinologic work-up may be advised for patients with IAA and volumetric markers suggesting SCH.

SSE12-05 Hollowed Adrenal Gland Sign in Patients of Septic Shock: Incidence, CT Appearance and Prognosis

Monday, Nov. 26 3:40PM - 3:50PM Room: S103AB

Participants
Yang Peng, Guangzhou, China (*Presenter*) Nothing to Disclose
Qiuxia Xie, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Jian Guan, MD, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Fan Zhang, Guangzhou, China (*Abstract Co-Author*) Nothing to Disclose
Xuhui Zhou, MD, PhD, Shenzhen, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To investigate the incidence, CT appearance and prognosis of hollowed adrenal gland sign in septic shock patients.

METHOD AND MATERIALS

From January 2014 to May 2017, there were181 patients with septic shock in ICU (mean 60.7 years; range 19-89 years; 112 males, 69 females). All the patients received dual-phase enhanced CT scan in one week after diagnosis. CT findings and clinical records were reviewed retrospectively. When patients showed diffuse enlargement of bilateral adrenal glands on CT, and in arterial phase the central area of adrenal gland showed much lower attenuation while in venous phase the central "hollowed" area showed further enhancement and was similar to the peripheral area, they were defined as hollowed adrenal gland sign positive. Single factor analysis was performed.

RESULTS

59 patients showed hollowed adrenal gland sign (32.6%, 59/181) as positive group, while the remain 122 patients were negative. Total mortality rates of positive group and negative group were 81.3% (48/59) and 49.1% (60/122), respectively. According to the primary diseases causing septic shock, patients in both groups were divided into 4 subgroups (intestinal diseases, biliary and pancreatic diseases, postoperative infection and others). The mortality rates of 4 subgroups in positive group were 75.0% (12/16), 66.7% (10/15), 91.7% (22/24), and 100% (4/4), respectively. And the mortality rates of 4 subgroups in negative group were 43.8% (14/32), 28.6% (8/28), 64.3% (27/42) and 55.0% (11/20), respectively. There were significant difference of total mortality rates and mortality rates of matching subgroups between two groups ($P<0.01$). Single factor analysis of variance showed that the hollowed adrenal gland sign was an independent factor to predict a poor prognosis (death) for septic shock patients.

CONCLUSION

Hollowed adrenal gland sign is common on CT in septic shock patients and predicts a poor prognosis.

CLINICAL RELEVANCE/APPLICATION

Hollowed adrenal gland sign is a typical CT appearance of septic shock patient with relative adrenal insufficiency, and appears to be an independent adverse prognostic factor.

SSE12-06 Adrenal Incidentalomas: A New Risk Factor for Overall Mortality?

Monday, Nov. 26 3:50PM - 4:00PM Room: S103AB

Awards
Trainee Research Prize - Medical Student

Participants
Michio Taya, MD, Seattle, WA (*Presenter*) Nothing to Disclose
Viktoriya Paroder, MD,PhD, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose
Eran Bellin, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose
Linda B. Haramati, MD, MS, Bronx, NY (*Abstract Co-Author*) Spouse, Board Member, Kryon Systems Ltd

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PURPOSE

To determine the mortality risk of adrenal incidentaloma on abdominal CT.

METHOD AND MATERIALS

Retrospective cohort study at a multicenter academic medical center. Cohort was identified from patients with newly detected adrenal incidentaloma on CT abdomen report; the primary outcome was all-cause mortality. Study population was derived from patients >=18 years with CT abdomen within 24 hours of emergency department presentation 1/1/05-12/31/09 without history of adrenal disease, adrenal lab testing, or cancer. Incidentaloma cohort was identified by database query of CT reports, followed by manual review to exclude misclassifications. Confirmed incidentaloma cohort was matched to 'no nodule' controls at 3:1 on age ±1 year and exam date ±3 months. Mortality was ascertained by database query for in-hospital deaths and supplemented with National Death Index query for those lost to follow-up. Survival analysis performed with Kaplan-Meier curves and Cox proportional hazards model examining the effect of adrenal incidentaloma on all-cause mortality.

RESULTS

Initial query yielded a population of 42,575 adults with CT abdomen, mean age 50 ±19 years, 63% women. 969 (2.3%) patients had confirmed adrenal incidentalomas and were matched with 2,907 controls. These 3,876 individuals entered survival analysis with 31,182 total person-years follow-up, median follow-up 8.8 years (IQR 6.0-10.6) in the incidentaloma cohort and 9.0 years (IQR 7.1-

10.7) in the no nodule cohort. Mortality was 36.4% (353/969) in the incidentaloma cohort and 31.6% (919/2907) in the no nodule cohort for a rate difference of 7.6 deaths/1000 person-years (95% CI 2.1-13.0; p=0.005). Adrenal incidentaloma presence was associated with an unadjusted 19% increased risk of death (HR 1.19; 95% CI 1.05-1.36) and a 14% increased risk of death when adjusted for age, sex, race, and other significant predictors including diabetes (HR 1.14; 95% CI 1.01-1.29).

CONCLUSION

Incidentally discovered adrenal nodules are associated with a significant though small increased risk of all-cause mortality.

CLINICAL RELEVANCE/APPLICATION

The clinical significance of adrenal incidentalomas remain understudied; results of the present study suggest that incidentalomas may not be as harmless as previously thought.

SSE13

Health Service, Policy and Research (Trends and Utilization)

Monday, Nov. 26 3:00PM - 4:00PM Room: S403B

HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 0

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Jonathan James, BMBS, Nottingham, United Kingdom (*Moderator*) Nothing to Disclose

Sub-Events

SSE13-01 The Impact of a Program to Manage the Utilization of Advanced Diagnostic Imaging in Accord with Appropriateness Criteria: The Multi-Year Experience of Multiple States

Monday, Nov. 26 3:00PM - 3:10PM Room: S403B

Participants
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Kevin D. Hiatt, MD, Winston-Salem, NC (*Presenter*) Nothing to Disclose

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PURPOSE

In the context of recent concerns about inappropriate utilization of advanced diagnostic imaging (ADI) and the associated deleterious effects of excessive radiation exposure, a radiology benefit manager implemented a program to assist a multi-state health insurance plan manage the use of outpatient ADI, encouraging the withdrawal of inappropriate requests or change to a more appropriate modality (such as ultrasound or MRI in lieu of CT, when indicated). This study investigated the impact of this program.

METHOD AND MATERIALS

A utilization management program was instituted in the middle of 2009 in 2 states in the U.S., and in the middle of 2011 in 2 additional states, to manage the utilization of CT, MRI, PET, and cardiac nuclear medicine (CNM) in accord with appropriateness criteria for the 1.6 million commercial and Medicare members of a health insurance plan. Utilization for each modality was monitored via claims data for 1 year prior to implementation and during the program (through the end of 2015) and expressed in terms of units per 1,000 members (UPK).

RESULTS

Across all 4 states after implementation, utilization declined from 60.1 to 52.0 UPK for CT (-14%), 63.7 to 55.6 for MRI (-13%), 2.2 to 1.9 for PET (-15%), and 7.2 to 3.4 for CNM (-53%) in the commercial population and from 277.2 to 226.8 for CT (-18%), 152.5 to 132.4 for MRI (-13%), and 48.3 to 27.2 for CNM (-44%) in the Medicare population, but increased from 10.9 to 11.5 for PET (+5%) in the Medicare population.

CONCLUSION

After program implementation, utilization declined for all studied modalities in all states for all populations except for PET in the Medicare population.

CLINICAL RELEVANCE/APPLICATION

The imposition of appropriateness criteria in the ordering process through a radiology benefit management program may significantly alter the utilization of ADI for the modalities managed.

SSE13-02 Exploring CMS Quality Measure #405 for Small Incidental Abdominal Lesions

Monday, Nov. 26 3:10PM - 3:20PM Room: S403B

Participants
Bari Dane, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

One measure that CMS has adopted to evaluate and adjust Medicare payments for radiologists under the Merit-Based Incentive Payment System is measure #405, relating to appropriate follow-up imaging recommendations for incidental abdominal lesions. Measure #405 reflects the fraction of incidental <=0.5 cm liver, <1 cm cystic renal, and <=1 cm adrenal lesions detected on CT,

MRI, or ultrasound, for which radiologists recommend follow-up imaging (lesions excluded in presence of malignancy or other medical reason). A rate of 0% indicates perfect performance. We assessed outcomes of lesions encompassed by CMS quality measure #405.

METHOD AND MATERIALS

1,000 consecutive incidental lesions fulfilling measure #405 criteria were identified. Reports were reviewed for follow-up recommendations. Subsequent imaging, whether or not performed specifically for index lesion follow-up, was assessed for size increase or evidence of lesion malignancy.

RESULTS

The final cohort included 378 ultrasound, 313 CT, and 311 MRI exams, demonstrating 150 liver, 738 renal, and 112 adrenal lesions. Follow-up imaging was recommended in 3% (33) of patients, including 55% (18) of ultrasound exams. Follow-up imaging was obtained in 58% (19) of the 33 recommended cases, compared with at least one subsequent exam in 52% of lesions without a recommendation (p=0.560). Subsequent cross-sectional imaging occurred for a total of 517/1000 cases (>=6 months follow-up in 428 cases; >=1 year in 358). On subsequent imaging, one renal cyst detected on ultrasound showed low-level enhancement on MRI, and three simple renal cysts demonstrated slight size increase; no other lesion in the cohort showed a size increase or evidence of malignancy. No follow-up was recommended for any of these 4 lesions on the baseline exam.

CONCLUSION

Small incidental lesions encompassed by CMS quality measure #405 (most commonly renal cysts on ultrasound) have an extremely minimal risk of being clinically important. Radiologists' recommendations for follow-up did not seem to drive subsequent imaging rates nor detection of the very rare potentially relevant outcome for such lesions. The findings support the measures aim of avoiding follow-up recommendation for these lesions.

CLINICAL RELEVANCE/APPLICATION

The findings support CMS measure #405 that avoids follow-up recommendations for small incidental abdominal lesions. Radiologists should consider using the measure to optimize their MIPS performance.

SSE13-03 Vertebral Fracture Assessment (VFA) Utilization, 2005-2016: A COARDRI Study

Monday, Nov. 26 3:20PM - 3:30PM Room: S403B

Participants
Robert J. Ward, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

To characterize utilization of VFA since 2005 with emphasis on the impact of the 2007 DXA reimbursement cut.

METHOD AND MATERIALS

Data was derived from the CMS Medicare Part B Physicians/Supplier Procedure Summary Master Files from 2005 through 2016. Codes 76077, 77082, and 77085 were utilized.

RESULTS

1.713,443 VFA procedures were evaluated from 2005 to 2016. Over that period of time non radiologists billed 74.9% of the studies, 23.0% were billed by radiologists, and 2.1% were unknown. The overall trend in utilization over this period mirrors DXA utilization with decreased utilization (-44.8%) for non-imagers since the 2007 DXA reimbursement cut. Likewise, trending increases in radiologist utilization (+30.6) is noted over the same period. As VFA is performed concurrently with DXA we corrected for DXA trends by utilizing a VFA/DXA ratio. Non-radiologists demonstrated a increasing trend of VFA cases relative to DXA over 2005 to 2016 increasing from 5.8% to 9.2% in 2016. Radiologists in comparison ranged from 1.7% in 2005 to 2.7%. The top 5 specialties for utilization over the period are as follows: Internal Medicine (25.1%), Radiology (21.7%), Rheumatology (17.9%), Family Practice (10.1%), and Endocrinology (9.3%).

CONCLUSION

VFA trends somewhat mirror utilization of DXA since 2005 demonstrating decreasing volumes for most non imaging specialties and increasing volumes for radiology. From 2005 a small absolute increase in DXA study volume relative to VFA is identified.

CLINICAL RELEVANCE/APPLICATION

VFA utilization demonstrates a trend of shifting volumes from non-radiologists to radiologists. VFA aids in the detection of vertebral fractures, (osteoporosis) in patients who may not qualify for treatment based solely on DXA derived BMD/T-scores. It is of growing importance for radiologists to become familiar with VFA indications, reporting standards, and significance in the detection and treatment of osteoporosis.

SSE13-04 Show Me The Money: Practice Patterns of the Top 50 Highest Medicare-Reimbursed Diagnostic Radiologists

Monday, Nov. 26 3:30PM - 3:40PM Room: S403B

Participants
Paul H. Yi, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
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Nathan Y. Kim, MD , Madison, WI (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

With the advent of universal health care in the USA, demand for radiological services continue to rise while health care reimbursements decline. The purpose of this study was to examine the 50 diagnostic radiologists who received the most Medicare reimbursements in 2014 and their practice patterns to glean potential solutions for financial viability.

METHOD AND MATERIALS

The Medicare Provider Utilization and Payment Database was queried for the 50 diagnostic radiologists who received the most Medicare reimbursements in 2014. The following were recorded for these radiologists: total reimbursements, total number of patients treated, and distribution of reimbursements amongst types of services rendered. Chi-Squared tests were used to compare reimbursements between radiologists from different US regions.

RESULTS

In 2014, the top 50 Medicare-reimbursed radiologists were paid an average of $1,958,011 (range, $1,247,255 to $5,146,999) for treating an average of 2524 patients (range, 137 to 11,460) and average payment per patient of $3018 (range, $121 to $14,084). 40% of reimbursements came from procedures, 31% from imaging tests, 10% from radiation oncology procedures, and 19% from other services. 80% of radiologists focused the majority of their services to one type of service (e.g., primarily imaging studies), with the remaining 20% having a more balanced mix of imaging studies and procedures. There were even distributions of these radiologists from the Northeast (14; 28%), West (15; 30%), and South (18; 35%) with fewer from the Midwest (3; 6%), although all regions had an average total reimbursement of at least $1,900,000 ($p>0.05$).

CONCLUSION

Even amidst decreasing reimbursements, some radiologists are maintaining very high levels of Medicare payment. Although fewer of these highly-reimbursed radiologists are from the Midwest, overall reimbursements are similar between regions. How these radiologists achieve high levels of reimbursement vary, with most focusing on one service type, e.g., primarily procedures, suggesting that a focused practice may improve overall productivity. Radiologists should be reassured that it is possible to maintain high reimbursement levels in today's healthcare market.

CLINICAL RELEVANCE/APPLICATION

Amidst decreasing reimbursements, some radiologists are able to maintain very high levels of Medicare payment at an average of nearly $2 million.

SSE13-05 How Specialized are Radiologists Who Are Reading MRI Studies of the Brain?

Monday, Nov. 26 3:40PM - 3:50PM Room: S403B

Awards
Student Travel Stipend Award

Participants
Evan D. Calabrese, MD, PhD, San Francisco, CA (*Presenter*) Nothing to Disclose
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PURPOSE

To assess the degree of specialization in radiologists who are interpreting MRI studies of the brain.

METHOD AND MATERIALS

The IRB approved this study under exempt review. We accessed the Medicare Physician and Other Supplier Public Use File for calendar year 2015. We searched for all radiologists who interpreted MRI of the brain, neck, and spine (i.e. neuro MRI). Radiologists were sorted by the number of MRI studies interpreted and by percent of fee-for-service Medicare (FFSM) claims derived from interpretation of the associated CPT codes. Based upon the distribution of percent claims from neuro MRI, we sought to identify a group of radiologists who read the fewest numbers of neuro MRI, termed "low volume readers," and the associated percent of all FFSM MREx that are interpreted by these low volume readers. The database was queried with Python. Statistical analysis was performed with Python and Excel.

RESULTS

A total of 13,694 radiologists interpreted 4,066,887 neuro MRIs. Of the radiologists reading FFSM neuro MRI, the average number of studies read was 297 (10th-90th percentile, 46-690) and the average percent of claims dollars arising from neuro MRI was 23% (10th-90th percentile, 6%-56%). The distribution in numbers of MRI interpreted and in percent of claims dollars arising from neuro MRI is shown in Figure 1. Based upon the distributions of radiologist volume and percent revenue from neuro MRI, the threshold for low volume readers was set at 97 FFSM neuro MRI examinations. There were 3,674 radiologists in the low volume group (27% of radiologists interpreting neuro MRI), and these radiologists were responsible for interpreting 207,8144 of 4,066,887 neuro MRI (5% of all neuro MRI).

CONCLUSION

There are large numbers of radiologists who read small numbers of neuro MRI per year. Approximately 27% of radiologists interpreting neuro MRI read fewer than 97 neuro MRI per year, which corresponds to 5% of all neuro MRI studies being interpreted by a low volume radiologist. The composition of this low volume radiologist group, and whether there is a relationship between volume of neuro MRI interpreted and quality of those interpretations, are unknown; these questions should be further studied.

CLINICAL RELEVANCE/APPLICATION

We describe a method for assessing degree of specialization of the radiology workforce. The methods can be used to assess either individual radiology practices, or regional or national samples.

SSE13-06 Qualitative and Quantitative Analysis of Radiologists' Workload in an Academic Hospital Department

Monday, Nov. 26 3:50PM - 4:00PM Room: S403B

Participants
Ulrike Streit, MD, Goettingen, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

The role of today's hospital-based radiologists goes far beyond interpretation-related tasks. This observational study defines these types of activities, as well as quantifies the type of value-adding interactions radiologists experience on a daily basis with referring departments and other health personnel. The purpose of this study is to evaluate the quality and quantity of these value-adding non-image interpretation tasks in the daily routine of hospital-based resident and attending radiologists.

RESULTS

Five main categories of responsibilities for NITs were identified including teaching and education, clinical decision support, management and organizing, patient care, and other. For both cross-sectional imaging units, CT and MRI, NITs constituted 50% of the workday for attending radiologists and 48% for resident radiologists. Subcategories revealed heterogeneous results for attendings and residents for each category: teaching and education (14% / 18%), management and organizing (17% / 6%), patient care (7% / 25%), clinical decision support (44% / 24%), and other (18% / 27%).

CONCLUSION

NITs consumed a significant portion of a radiologist's workday, therefore, number of examinations performed is not a reliable surrogate for the daily workload of hospital-based radiologists especially in the cross-sectional imaging units. Though time consuming these non-image interpretation tasks contribute to the already perceived evolving role of a modern radiologist towards central figures in the process of managing patients and patient information, fulfilling a critical role, which surpasses image interpretation-related tasks towards a more integrative and consultative role. These findings will help to further define the changing role of the radiologist to other physicians, non-medical personnel, hospital administrators, as well as policy makers.

METHODS

A prospective, observational study was performed in the department of radiology of a German university hospital. Two experienced radiologists performed a two months observation of the entire medical staff. The observers followed the subject radiologists throughout the workday, recording activities using a time and motion methodology. An evaluation matrix was developed to characterize and quantify image interpretation tasks (IITs) and non-image interpretation tasks (NITs) for resident and attending radiologists.

PDF UPLOAD

http://abstract.rsna.org/uploads/2018/18019421/18019421_s1ez.pdf

SSE14

Informatics (Artificial Intelligence in Radiology: More Cutting-Edge Deep Learning)

Monday, Nov. 26 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.

Participants
Norio Nakata, MD, Tokyo, Japan (*Moderator*) Nothing to Disclose
Nabile M. Safdar, MD, Milton, GA (*Moderator*) Nothing to Disclose
Safwan Halabi, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Alexandre Cadrin-Chenevert, MD, St Charles Borromee, QC (*Moderator*) Nothing to Disclose

Sub-Events

SSE14-01 Machine Learning Fully Automatic Analysis of Vertebrae Trabecular Bone Mineral Density in 10,000 CTs: Groundwork for Opportunistic Osteoporosis Screening

Monday, Nov. 26 3:00PM - 3:10PM Room: E353C

Participants
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CONCLUSION

ML technology can be exploited to perform large-scale investigations of CT-tBMD on this and other large cohorts as groundwork for developing CT-based osteoporosis screening.

Background

Opportunistically CT measured vertebral trabecular bone mineral density (CT-tBMD) has been proposed as a possible alternative to DEXA measurements for assessing osteoporosis in cases where a body CT is performed for other motives (trauma, surgery, oncology, COPD, etc). Such an application will require better understanding of CT-tBMD ranges in health and pathology. Previous works, using traditional semi-automatic quantization methods, have been of limited cohort size. Recent developments in machine learning (ML) applied to analyze medical imaging data have increased robustness and accuracy enabling accurate automated segmentation of anatomic structures. We applied a ML pipeline to a large public cohort containing CT and correlated clinical data (COPDgene.org) to demonstrate the viability of using such technology for large-scale tBMD studies.

Evaluation

Deep Reinforcement Learning and Adversarial Deep Image-to-Image ML networks were trained with 4560 manually segmented vertebrae from 380 CTs. A pipeline incorporating this network and 5% erosion algorithm, for trabecular bone isolation, was developed. It showed a 4.5% prediction error when tested on another 834 manually segmented vertebrae. The pipeline was applied to 9554 chest CTs from the COPDGene cohort and correlated to available corresponding clinical data. Results demonstrate a downward trend of BMD with age with slightly more rapid decline in later years for women than men. The data demonstrated significantly lower BMD in subjects diagnosed with osteoporosis, with history of compression or hip fracture (p-values<0.01). Processing time was 5.9 sec per series on a 3 GPU workstation.

Discussion

These findings agree with previous ones obtained by traditional semi-automatic techniques on smaller cohorts. Novelty in this work is the use of an ML based and fully automatic pipeline which provides precision and scalability and permits rapid application to the current and other large cohorts.

SSE14-02 Towards Hierarchical Optimization of Pretrained Deep Learning Models for Tuberculosis Screening in Chest Radiograph

Monday, Nov. 26 3:10PM - 3:20PM Room: E353C

Participants
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CONCLUSION

We verified that hierarchical optimization process could assist to optimize the pretrained deep learning models by developing and incorporating hierarchical and structured feature information.

Background

Tuberculosis (TB) is a chronic infectious disease and thus early screening is critical in alleviating its transmission and reducing reproductive rate. While there are a few researches for the given task in chest radiograph through developing new deep learning models and simply using fixed pretrained models, there are very rare researches on further optimizing pretrained models to improve the performance.

Evaluation

We focused on optimizing pretrained models using hierarchical optimization process using iterative adaptive fixation and release operations and parallel model building. Based on the implications of high-level abstractions, lower layers in pretrained models will have more general feature information (e.g., edges) and upper layers keep domain-specific feature information (e.g., object parts or objects). The optimization is done by making a parallel pool consisting of 10 instances of a pretrained deep learning model and by bypassing through fixation/release of convolution layers with slightly perturbed feature information and then fine-tuning is repeatedly done until the gradient changes become negligible. Finally, the winner will be selected as the best model. We used 7,000 normal patients' chest radiograph images, and 7,000 TB patients' images for training using the hierarchical optimization. As the pretrained models, we used GoogLeNet, ResNet-152 and Inception-ResNet-V2. For validation and test, we used two independent datasets each consisting of 300 normal patients' images and 150 TB patients' images. Results showed that the area under the receiver operating characteristics curves (AUCs) of GoogLeNet, ResNet-152 and Inception-ResNet-V2 were 0.97, 0.99 and 0.99, respectively. For comparison, the AUCs of the models without such optimization process obtained 0.89, 0.93, 0.92, respectively.

Discussion

We proposed a method of optimizing pretrained deep learning models in a hierachical manner. Further study is required to deal with class-imbalanced dataset issues.

SSE14-03 Understanding Deep Learning: Insights from a Classifier Trained to Predict Contrast Enhanced Phase from Abdominal CT Imaging

Monday, Nov. 26 3:20PM - 3:30PM Room: E353C

Participants
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CONCLUSION

The data that we report here demonstrates that voxel level visualizations provide powerful insight into the precise anatomical regions of imaging which activate a network. Investigating the anatomical structures identified in these maps may provide key insight for systems (e.g., tumor) where well performing deep learning models exist but defining radiological signatures are unknown.

Background

The imaging features identified by deep learning classifiers are difficult to describe directly. Deep learning classifiers learn to identify images by optimizing a series of non-linear functions to activate on texture and shapes. The effect of this, is that for a given multi-layer network, multiple visually different inputs can act to strongly activate a network's output. Multiple techniques (attention maps, grad-cam maps, saliency maps, guided backpropagation maps, and saliency-attention maps) have been purported to provide insight as to the specific imaging features identified by a deep learning model. We directly investigated the utility of these methods in a radiology context.

Evaluation

Typical organ enhancement patterns that follow vascular contrast agent administration are well understood. We leveraged this and developed a deep learning classifier to identify contrast enhanced renal scan phase from whole slice CT data. The classifier exceeded 90% accuracy on the test set. We utilized this classifier to explore the utility of attention maps, grad-cam maps, saliency maps, guided backpropagation maps, and saliency-attention maps to identify the imaging features our model utilized to predict scan phase.

Discussion

Saliency maps and guided back propagation maps identify voxels in input imaging which promote model prediction. For most scans these visualizations identified similar anatomical regions which directly reflect renal scan phase (renal: cortex, medulla, artery, vein, aorta, and vene cava). Attention maps, grad-cam maps, and saliency-attention maps illustrate layer activations and indirectly identifed the anatomy responsible for these activations. As a whole, these maps indicated that the kidneys were responsible classification but could not clearly localize the features.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Naoki Takahashi, MD - 2012 Honored Educator

SSE14-04 Multi-Class Deep Learning for Classification of Thoracic Radiographs to Enable Accurate and Efficient Workflow

Monday, Nov. 26 3:30PM - 3:40PM Room: E353C

Participants
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PURPOSE

DICOM header information is frequently used to classify image types within the clinical radiological workflow, however, if a header contains incorrect or missing fields, it cannot be reliably used for classification. To expedite image transfer and interpretation, we trained a convolutional neural network in the task of classifying chest radiographs into 4 categories: AP/PA images, lateral images, soft tissue images and bone images (for dual energy studies).

METHOD AND MATERIALS

Our research included 5669 clinical thoracic radiographs. One set of 1911 radiographs, acquired Feb. 2006 to Feb. 2017, was manually sorted into the four categories. The manually sorted set consisted of 818 AP/PA images, 419 lateral images, 389 soft tissue images, and 285 bone images. Classifying the images using DICOM header information alone left 38% unclassified. Using TensorFlow (Google, 2015), an AlexNet architecture network was trained from scratch, in which 1242 images (65%) were used for training, 382 images (20%) for validation, and 287 images (15%) for testing. Next, the trained network was applied to an independent set of 3758 additional images yielding 68 (1.8%) images misclassified, 65% of which were soft tissue and AP/PA images.

RESULTS

The network classified Images with a high accuracy (98.19%). An important task for clinical workflow is the distinction between an AP/PA and its associated lateral view to ensure correct organization of the imaging sequence as well as appropriate image processing and CAD application. The AUC for distinguishing between AP/PA and lateral was 0.9998 ± 0.0002. Other results included AUC=0.9979 ± 0.0005 in distinguishing between soft tissue and AP/PA images and AUC=1 in distinguishing between soft tissue and bone images. In addition to high performance, the rapid classification of images could be applied in a hospital setting without disruption of clinical workflow. The model was trained in 5 min and classified 3758 images in 3 min. By comparison, an experienced human sorter took about 11.6 hours to classify the test set.

CONCLUSION

A trained convolutional neural network can classify different radiographic projections from the same study, most notably AP/PA vs. lateral, with high speed and accuracy.

CLINICAL RELEVANCE/APPLICATION

A trained neural network can be used in a clinical setting to quickly and accurately classify radiographs by image type to ensure correct organization of the study sequence.

SSE14-05 Deep-Learning Renal Segmentation for Fully Automated Radiation Dose Estimation in Radionuclide Therapy

Monday, Nov. 26 3:40PM - 3:50PM Room: E353C

Participants
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PURPOSE

Convolutional neural networks have been shown to be powerful tools to assist with object detection and, like a human observer, may be trained based on a relatively small cohort of reference subjects. Rapid, accurate organ recognition in medical imaging permits a variety of new quantitative diagnostic techniques. In the case of therapy with targeted radionuclides, it may permit

comprehensive radiation dose analysis in a manner that would often be prohibitively time-consuming using conventional methods.

METHOD AND MATERIALS

An automated image segmentation tool was developed based on 3-dimensional convolutional neural networks to detect right and left kidney contours on low-dose, non-contrast CT images. The model training set involved 89 manually-contoured cases and was then tested on a cohort of 24 patients receiving therapy with 177Lu-PSMA-617 for metastatic prostate cancer. Automatically generated contours were compared with those drawn by expert and assessed for similarity based on dice score, mean distance-to-agreement and total segmented volume. Further, the contours were applied to voxel dose maps computed from post-treatment quantitative SPECT imaging and renal dose estimates using automated and manual means were evaluated for statistical bias.

RESULTS

Neural network segmentation was able to identify right and left kidneys in all patients with a high degree of accuracy. Mean dice score was 0.91±0.05 and 0.86±0.18 for right and left kidneys, respectively, with associated mean distances-to-agreement of 2.0±1.0 and 4.0±7.5 millimetres. The system was integrated into the hospital image database, returning contours for a selected study in approximately 90 seconds. Poor performance was observed in 3 patients with cystic kidneys of which only few were included in the training data. Mean radiation absorbed dose based on automated contours was within 4.0% of that computed with manual segmentation.

CONCLUSION

Automated contouring using convolutional neural networks shows promise in providing quantitative assessment of functional SPECT and PET images; in this case demonstrating comparable accuracy for radiation dose interpretation in radionuclide therapy relative to a human observer.

CLINICAL RELEVANCE/APPLICATION

The primary application of this research is quantitative diagnosis and improved nuclear medicine treatment personalisation.

SSE14-06 Using Active Learning and Domain Adaptation to Train a 3D-Unet for Liver Segmentation at a High Volume Liver Transplant Center

Monday, Nov. 26 3:50PM - 4:00PM Room: E353C

Participants
Brett Marinelli, MD,MS, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To demonstrate the ability of a deep learning model to automatically assess liver volume utilizing publicly available data and active learning that successfully transfers to an external cohort at a high volume transplant center.

METHOD AND MATERIALS

131 CTs and liver segmentations were used from the MICCAI Grand Challenge LiTS dataset. 257 clinically acquired CTs (CACs) were collected from an institution's PACs where liver volumetry was recorded. CACs are from between 1/2014 - 12/2016 and include145 pre-transplant evaluations (56%), 159 cirrhotics (62%), 92 hepatocellular carcinoma cases (36%), and 18 prospective living liver transplant donors (7.0%). A preprocessing pipeline standardized all images to 128x128x128 voxels. As a benchmark, a 3D-UNet convolutional neural network (CNN) was trained on an 80/20 train/validation split of the LiTS dataset. Then, a 3D-UNet was fit to a training set composed of the LiTS dataset augmented by six copies of five CACs in an active learning framework. A semi-automatic GrowCut method was used for segmentation of active learning cases with Slicer3D. The CAC dataset excluding active learning scans was used as the comparative test set. Dice similarity validation scores were recorded. Successful volume measurement was defined as a difference within 200cc. Median and 1st-3rd interquartile range (IQR) were reported for both tested models. A paired student's t-test compared performance before and after implementation of active learning.

RESULTS

The benchmark model demonstrated a 0.90 Dice on the LiTS validation set, successful volume measurements in 139/257 livers and median absolute difference of 180 mL (IQR 80-311 mL) in the test set. The active learning approach demonstrated a 0.84 Dice on the LiTS validation cohort, successful volume measurements in 150/252 livers and a median absolute difference of 160 mL (IQR 67-313mL). The active learning approach yielded superior results (P=0.04).

CONCLUSION

Combining active learning and domain adaptation for liver segmentation can significantly improve model performance at capturing liver volumes utilizing publicly available datasets while deploying the model at a high volume liver transplant center.

CLINICAL RELEVANCE/APPLICATION

We describe methods that use a deep learning model for automatically assessing liver volume with publicly available data and active learning that successfully transfers to an external cohort at a high volume transplant center.

SSE15

Musculoskeletal (Upper Extremity)

Monday, Nov. 26 3:00PM - 4:00PM Room: N228

MR MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSE15-01 Dynamic MRI of the Midcarpal Compartment in 20 Seconds: Normal Motion Pattern Analysis and Reader Reliability

Monday, Nov. 26 3:00PM - 3:10PM Room: N228

Participants
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PURPOSE

To describe the normal motion pattern of the scaphotrapezial joint (STJ) and capitate-triquetrum interval (CTI) during active radial and ulnar deviation of the wrist during dynamic MRI, and to determine the observer performance of measurements in asymptomatic volunteers.

METHOD AND MATERIALS

In this prospective study, real-time 3T MRI examinations were performed in 35 wrists (19 asymptomatic volunteers; age mean: 30.5 yrs [range: 20-55]; M/F:10/9). Using a radial fast-GRE coronal sequence with 315 ms temporal resolution and a total acquisition time of ~ 20 seconds, 60 images were acquired during continuous imaging of the moving wrist through the full range of motion from radial to ulnar deviation. Two independent readers measured 1) the transverse translation of the trapezium at the STJ and 2) the CTI. A two-sample Kolmogorov-Smirnov goodness-of-fit hypothesis test was performed to evaluate the relationship between these measurements with laterality (right vs. left), sex, lunate type, and wrist kinematic pattern (row vs. column kinematics). Intra-observer and inter-observer correlation coefficients were determined.

RESULTS

Translation of the trapezium at the STJ in neutral, radial, and ulnar deviation averaged 0.3±0.8 mm, 1.9±1.2 mm, and -0.4±1.0 mm, respectively. There was no significant difference in trapezium translation with wrist laterality, sex, lunate type, or wrist kinematic pattern. The CTI in neutral, radial, and ulnar deviation averaged 5.3±1.4 mm, 3.6±1.1 mm, and 6.0±1.4 mm, respectively. The mean CTI was greater in men than women in the neutral position only (p=0.019). The mean CTI was increased in wrists with type II lunates compared to type I lunates during radial (p=0.001) and ulnar deviation (p=0.014). There was no difference in CTI with wrist laterality or wrist kinematic pattern. Mean intraobserver and interobserver correlation coefficient was 0.79 and 0.77, respectively.

CONCLUSION

Using dynamic MRI, this study provides a normal range of expected STJ and CTI measurements in asymptomatic wrists. Dynamic MRI with a short acquisition time may be used as a supplement to conventional static MRI in the diagnostic evaluation of the midcarpal compartment.

CLINICAL RELEVANCE/APPLICATION

Understanding midcarpal motion patterns is a key step in efforts to establish an accurate diagnosis and promote optimized treatment regimes including nonoperative rehabilitation and surgical planning.

SSE15-02 Distal Radioulnar Joint MR Arthrography for Diagnosing Foveal Tear of Triangular Fibrocartilage: Comparison of MR imaging and MR Arthrography with Arthroscopic Correlation

Monday, Nov. 26 3:10PM - 3:20PM Room: N228

Participants
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PURPOSE

To evaluate the value of distal radioulnar joint (DRUJ) MR arthrography for diagnosing foveal tear of triangular fibrocartilage (TFC).

METHOD AND MATERIALS

A total of 83 patients (54 men, 29 women; mean age, 32.7 years) who underwent DRUJ MR arthrography and arthroscopy were retrospectively reviewed. MR protocol includes pre-injection T2- and T1-weighted coronal images and post-injection T2-weighted coronal and T1-weighted fat suppressed coronal, sagittal, and axial images. Two radiologists graded the foveal lamina of the TFC as normal, partial tear, or complete tear after the review of pre-injection image sets and post-injection image sets separately. Diagnostic performance of MR imaging and MR arthrography was assessed based on the arthroscopic findings and compared by using McNemar test.

RESULTS

On arthroscopy, 71 of 83 patients had foveal tear of TFC; 51 cases were isolated foveal tear and 20 cases were combined foveal and styloid tear. On the review of MR images, the sensitivity, specificity, and accuracy for diagnosing foveal tear were 62.0%, 41.7%, and 59.0%. In MR arthrography, the values were 94.4%, 41.7%, and 86.7%, respectively. Sensitivity was significantly higher in DRUJ MR arthrography ($P < .001$).

CONCLUSION

DRUJ MR arthrography increase the accuracy for diagnosing foveal tear of TFC compared to standard MR imaging. The benefit of pre-injection images was minimal in diagnosing foveal tear of TFC.

CLINICAL RELEVANCE/APPLICATION

DRUJ MR arthrography increase the accuracy for diagnosing foveal tear of TFC compared to standard MR imaging.

SSE15-03 Bennett Lesions in Overhead Throwers and Associated Shoulder Abnormalities on MRI

Monday, Nov. 26 3:20PM - 3:30PM Room: N228

Participants
Jenika Karcich, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

To determine if the presence of a Bennett lesion in overhead throwers is associated with additional shoulder abnormalities on MRI.

METHOD AND MATERIALS

An IRB approved retrospective review of our database from 1/2012 to 4/2018 identified 35 overhead throwers with a Bennett lesion on MRI. An additional control group consisting of 35 overhead throwers without a Bennett lesion were matched for age, level of play (professional vs. non-professional), and type of study (arthrogram vs. non-arthrogram). Each study was assessed independently by 2 MSK fellowship trained radiologists. The sizes of the Bennett lesions were measured. Each MRI was assessed for the presence of a labral tear, posterior glenoid cartilage deficiency, humeral head notching/cysts, and posterior supraspinatus/infraspinatus tendon fraying or tear. Discrepancies were adjudicated by a third MSK fellowship trained radiologist. Statistical analysis was performed with a chi-squared test.

RESULTS

Average Bennett lesion volume in a professional vs. non-professional overhead thrower: 708 mm3 vs. 545 mm3 (p=0.43). Total Bennett lesions resected: 6% (2/35) Associated MRI abnormalities in Bennett vs. Non-Bennett overhead throwers: SLAP tear: 51% vs. 31% (p = 0.09) Posterior labral tear: 51% vs. 31% (p=0.09) Anteroinferior labral tear: 26% vs. 17% (p=0.38) Posterior glenoid cartilage abnormality (fissure, delamination, partial/full thickness): 23% vs. 3% (p = 0.01) Humeral head notching/cysts: 77% vs. 63% (p = 0.19) Articular surface rotator cuff fraying/tear: 26% vs. 17% (p = 0.38)

CONCLUSION

Overhead throwers with Bennett lesions have an increased frequency of posterior glenoid cartilage abnormalities, but not labral tears or findings of internal impingement.

CLINICAL RELEVANCE/APPLICATION

The presence of a Bennett lesion in an overhead thrower warrants close examination for an adjacent posterior glenoid cartilage abnormality.

SSE15-04 Comparison Between High-Resolution Isotropic Three-Dimensional Cube FS PD and Conventional Two-Dimensional FS PD MR Images of the TFCC at 3 Tesla

Monday, Nov. 26 3:30PM - 3:40PM Room: N228

Participants

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PURPOSE

To compare a newly developed high-resolution isotropic 3D Cube FS PD sequence with conventional high-resolution sequences in assessing TFCC of the wrist in term of image quality and diagnostic performance.

METHOD AND MATERIALS

12 volunteers were enrolled in the study with an average age 22.7 years (range 22-27 years). All the sequences were carried out on all volunteers at 3.0T MR scanner (Signa HDxt, GE Healthcare, Milwaukee, WI) and a Wrist Array coil. Each imaging was performed with 2D PD FS(coronal,axial and sagittal:TR=2900ms,,TE=32.0ms,Matrix=320×256, FOV=10×7cm2, Slicethickness =2.0mm,gap=0.3mm,NEX=2,acquisition,time=99s)and 3D isotropic PD FS (coronal:TR=1400ms, TE=36.4,Matrix=256×256, FOV=10×9cm2, Slicethickness=0.4mm, gap=-0.2mm, NEX=0.5, acquisition time=279s).Delineation of anatomic structures of the wrist, amount of artifact, effect of fat suppression, image blur, and overall quality were qualitatively evaluated using the 5-point scoring system(5: excellent, 4: good,3: satisfactory, 2: poor, and 1: nonidentified.Signal-to-noise-ratios (SNR) of each structure and contrast-to-noise ratios(CNR)between structures of the TFCC were quantitatively measured using vendor supplied software (AW4.6work station, GE).

RESULTS

The 2D MRI demonstrated higher scores than 3D in anatomic structure of the SL ligament(P=0.043), the LT ligament(P=0.022),cartilage(P=0.043),artifact(p=0.007)and image blur(p=0.015).However,there were no statistical significance between 2D and 3D MRI in disc and overall quality. Higher SNR values were found for in the 2D sequence (6.32±3.32)than the 3D(4.20±1.66),The corresponding CNR values were(4.87±3.10) for the 2D and(3.45±1.97) for the 3D.To better control for voxel size, we also measured the SNR and CNR values in the reconstructed 2-mm images from original 3D isotropic images and obtained similar values as in the 2D (5.86±3.05 and 3.01±0.86, respectively), indicating that reconstruction with larger slice thickness improved SNR and CNR.

CONCLUSION

Although,Isotropic 3D Cube FS PD sequence may enhance standard wrist MRI by increased visualization of multiplanar and post processing capabilities, however,the 3D Cube image quality was lower.

CLINICAL RELEVANCE/APPLICATION

With regard to clinical applications,3D Cube image of the wrist has almost equal potential to 2D MRI.

SSE15-05 Correlation Between Fat Fraction, Cross Sectional Area of Rotator Cuff and Muscle Strength: Using MRI DIXON Sequence and Biodex Isokinetic Test

Monday, Nov. 26 3:40PM - 3:50PM Room: N228

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PURPOSE

To evaluate the correlation between fat fraction (FF), cross sectional area (CSA) of rotator cuff and muscle strength using T2-weighted Dixon Spin-Echo Fat image and biodex isokinetic test.

METHOD AND MATERIALS

37 patients (13 men, 24 women; age range, 45-78 years) undergoing shoulder MR imaging with concomitant biodex isokinetic test were enrolled in this study. Quantitative fat analysis and CSA measurement of rotator cuff (supraspinatus [SS], infraspinatus [IS], teres minor [TM]) in the image plane of scapular Y-shape were performed by one musculoskeletal radiologist using a post-processing software (Syngo via, Siemens healthineers, Erlangen, Germany) for T2-weighted Dixon Spin-Echo fat image. Multivariate regression and multiple linear regression analysis were used to investigate the relationship between 4 biodex isokinetic test parameters (peak torque [PT], peak torque/body weight [BW], torque at 30° [T30], total work [TW]) for 8 shoulder movements (60°, 180° flexion [FL] and extension [EX], 60°, 180° internal rotation [IR] and external rotation [ER]) and FF and CSA of the rotator cuff.

RESULTS

Multiple linear regression analysis shows significant correlation between CSA of SS and T30, TW of 180° ER; PT, T30, TW of 60° IR; PT, T30, TW of 180° IR, and between CSA of IS and T30 of 60° IR; PT, BW, TW of 180° ER (all $p<=0.04$). A significant correlation between FF of IS with all parameters of 180° IR and 180° ER, and between CSA of IS with all parameters of 180° IR was found on multivariate regression analysis (all $p<=0.04$). FF of TM was significantly associated with PT, T30, TW of 60° IR ($p<=0.03$). There was no significant correlation between CSA and FF of rotator cuff and parameters of FL and EX, whereas age and sex were significantly associated with parameters of FL and EX, as well as with some parameters of ER and IR (all $p<=0.05$).

CONCLUSION

CSA and FF of SS and IS measured on T2-weighted Dixon Spin-Echo Fat image correlated with the strength of shoulder movements, especially IR and ER. Therefore, the strength of rotator cuff could be more elaborately evaluated by measuring both FF and CSA of the muscles.

CLINICAL RELEVANCE/APPLICATION

CSA measurements and fat quantification using DIXON have the potential to become an important clinical resource when evaluating the muscles of the rotator cuff.

SSE15-06 Intra and Inter Observer Variability among Different Methods of Measuring Carpal Collapse

Monday, Nov. 26 3:50PM - 4:00PM Room: N228

Awards
Student Travel Stipend Award

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PURPOSE

To find out that the method with least intraobserver and interobserver variability among different methods used for determining carpal collapse.

METHOD AND MATERIALS

Retrospective radiographic evaluation of 50 normal wrist PA radiographs were done by 3 observers, measuring normitative values of Carpal height ratio (CHR), Revised Carpal Height Ratio (RCH ratio), Capitate radius (CR index). 1) Carpal Height Ratio (CHR) measured by carpal height divided by the length of 3rd metacarpal. 2) Revised Carpal Height Ratio (RCH ratio) measured by dividing the carpal height by the length of capitate. 3) Capitate radius (CR index) measured by closest distance between the distal edge of radius and the proximal edge of capitate. The measurements were repeated after one month by all the observers. Data was collected and statistical analysis was done by using SPSS 21 version. Data from all the observers were was described in descriptive terms with mean and standard deviation. For intra observer variability, correlation coefficient was calculated for every individual observer. For inter observer variability intraclass correlation coefficient was calculated and presented with r and p value.

RESULTS

Total of 50 normal wrist PA radiographs (17 females and 33 males) were studied between the age 13 to 71 years with mean age of 37.52 years. The mean range of values in our study for CHR was 0.49 ± .03to .51 ±.03; RCHR 1.51 ± .077 to 1.57 ± .059 and CRI 0.972 ± .09 to 1.06 ± .12. The r value was close to 0.91 and p value was <0.001 in all the three observers in CR Index meaning that the intra observer variability was least in CR Index. For the inter observer variability Intra Class Coefficient of 0.9 indicates that the CR Index has the least variability. RCH Ratio has the maximum variability in both inter and intra observer comparisions

CONCLUSION

We conclude that CR Index is the best method to measure carpal collapse in terms of reproducibility of the results.

CLINICAL RELEVANCE/APPLICATION

With regard to intra and inter observervariability, CR Index was most reliable measurement for carpal collapse, as only one measurement is taken in CR index and the measurement points are well defined.

SSE16

Musculoskeletal (Metal Artifact Reduction Techniques)

Monday, Nov. 26 3:00PM - 4:00PM Room: N227B

CT MK MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (*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

SSE16-01 Metal Artifact Reduction MRI of Patients with Painful Hip Arthroplasty Implants: Fully Sampled SEMAC versus Vastly Undersampled Compressed Sensing SEMAC

Monday, Nov. 26 3:00PM - 3:10PM Room: N227B

Participants
Benjamin Fritz, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose
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PURPOSE

To compare fully sampled slice-encoding for metal artifact correction (SEMAC) and vastly undersampled compresses sensing-(CS)-SEMAC sequences for metal artifact reduction MRI in patients with total hip arthroplasty (THA).

METHOD AND MATERIALS

Following internal review board approval and informed consent, 30 patients with pain and dysfunction following THA underwent prospectively 1.5 T MRI, including coronal intermediated-weighted (IW)- and short tau inversion recovery (STIR) SEMAC (22:39 min) and CS-SEMAC (9:55 min) pulse sequences with otherwise identical parameters. Following anonymization and randomization, two fellowship-trained musculoskeletal radiologists independently evaluated the datasets. Outcome variables included image quality parameters, bone implant interface visibility, overall reader satisfaction, detection rate of abnormalities of the hip joint. Statistical analysis included kappa statistics and paired rank sum tests. P-values <= 0.05 were considered significant.

RESULTS

The inter-observer agreements were at least adequate for all categories (kappa > 0.58). There was no significant difference for the technical parameters, including motion (p = 0.69), blur (p = 0.37), noise (p = 0.06), metal artifact reduction (p = 0.46), tissue contrast (p = 0.81), and fat-suppression (p > 0.99). The visibility of bone implant interface of the acetabular and femoral component was rated on average as "good" indicting minimal impairment with preservation of all structural details without significant differences between SEMAC and CS-SEMAC (p = 0.51). The overall reader satisfaction was "good" for both SEMAC and CS-SEMAC (p=0.85). For SEMAC versus CS-SEMAC, readers found an average of 18 versus 18 osteolyses (p = 0.87), 15 versus 17 cases of synovitis (p = 0.38), 23 versus 21 peritorchanteric fluid accumulations (p = 0.55) and 23 versus 19 abductor tendon tears (p = 0.34), respectively.

CONCLUSION

In patients with painful hip arthroplasty implants, fully sampled and vastly undersampled SEMAC pulse sequences produce similar image quality and afford similar detection rates of abnormalities.

CLINICAL RELEVANCE/APPLICATION

The vastly undersampled CS-SEMAC technique allows for 55% faster MRI of THA implants, thereby preserving the detection rates of abnormalities, when compared to fully sampled SEMAC technique.

SSE16-02 SEMAC-VAT MR Imaging at 1.5 T in Patients with Pedicle Screw Fixation: Is It Superior to Standard MR Imaging for the Detection of Postoperative Complications?

Monday, Nov. 26 3:10PM - 3:20PM Room: N227B

Participants

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PURPOSE

To compare the Slice-encoding metal artifact correction (SEMAC)-View-angle tilting (VAT) sequence with the standard turbo-spin echo (TSE) MR sequence for image quality, visibility of periprosthetic structures, and diagnostic confidence for detection of postoperative complications in patients with pedicle screw fixation at 1.5 T.

METHOD AND MATERIALS

Seventy patients with pedicle screw fixation between the thoracic vertebrae and the sacrum were included. SEMAC-VAT imaging were compared with standard TSE images. The MR imaging were retrospectively evaluated by two radiologists for SNR (signal-to-noise ratio) of anatomical structures and size of artifacts, visibility of periprosthetic anatomical structures, and diagnostic confidence for detection of postoperative complications. Paired t-tests and Wilcoxon signed-rank tests were used for comparisons, and intra-class correlation and kappa values were used for inter-observer agreement.

RESULTS

For all anatomical structures, the signal-to-noise ratio was significantly lower for SEMAC-VAT than for TSE images ($p < 0.001$). SEMAC-VAT images demonstrated effective artifact reduction compared to TSE images ($p < 0.001$). The visibility of most periprosthetic anatomical structures, and diagnostic confidence for detection of postoperative complications, were better for SEMAC-VAT than for TSE imaging ($p < 0.001$). For the spinal canal, however, TSE was better ($p < 0.001$).

CONCLUSION

MR images with SEMAC-VAT can significantly reduce metal artifact, providing improved delineation of periprosthetic anatomical structures and diagnostic confidence for detection of postoperative complication compared with standard TSE images. For the spinal canal, however, TSE was better.

CLINICAL RELEVANCE/APPLICATION

Taking into account the results of our own, we propose the following guidelines for performing SEMAC-VAT image on patients with pedicle screw fixation.

SSE16-03 Metal Artifact Reduction on Photon-Counting-Detector CT Using Tin Filtration and Detection of High-Energy Photons

Monday, Nov. 26 3:20PM - 3:30PM Room: N227B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To evaluate the use of photon-counting-detector CT with tin filtration (PCD-CT Sn) to improve diagnosis in patients with orthopedic metal implants.

METHOD AND MATERIALS

Adult patients with orthopedic metal implants underwent CT using commercial energy-integrating-detector CT (EID-CT) followed by PCD-CT Sn (140 kV, 0.4 mm Sn, energy thresholds of 25 and 75 keV). EID-CT and PCT-CT Sn Bin 2 (75 - 140 keV) 2-mm images were reconstructed. Three radiologists blindly evaluated images in a side-by-side fashion, comparing predefined anatomic structures using a 6-point scale (0 = critical structures totally obscured to 5 = anatomic recognition with high confidence in diagnosis). Preference for PCD-CT Sn was assessed using a 5 point scale (-2= decline in confidence; 0= no difference; +2= improvement in diagnostic confidence). The effect of artifact on the ability to make a diagnosis was also graded (1= artifact has no/minimal effect to 3= artifact impedes diagnosis), with quantitative analysis measuring the width of most prominent artifact at the axial plane. Statistical analysis was performed using the Wilcoxon signed rank test, where $p<0.05$ was considered statistically significant.

RESULTS

20 patients with orthopedic metal implants were included in the study, with hardware in the spine in 12 patients, shoulder in 3, and extremities in 5. The mean overall visualization scores of the cortex, trabeculae, and implant-trabecular interface were significantly better for PCT-CT Sn (4.4. vs. 3.3, $p<0.0001$). For spinal hardware, PCD-CT Sn showed improved image quality score for the central canal (3.3 v 0.9, $p<0.0001$), with similar findings for neural foramina. The mean overall preference score for PCT-CT Sn was $+1.6 \pm 0.7$ compared to EID ($p<.0001$), indicating improved diagnostic confidence. The effects of metal artifact on diagnosis were

less at PCD-CT Sn (1.9 v 2.6, p<0.0001), and the width of the metal artifact was substantially reduced (from 1.1 ± 1.4 cm to 0.5 ± 0.5 cm, p<0.0001).

CONCLUSION

Selection of high-energy photons using a Sn filter and PCD-CT bin 2 images markedly improves visualization of key anatomic structures and improves diagnostic confidence by reducing the size of metal-related artifacts.

CLINICAL RELEVANCE/APPLICATION

PCD-CT with tin filtration and reconstruction of images obtained using high-energy photons provides additional critical diagnostic information compared to commercial EID-CT systems to patients with metal implants.

SSE16-04 Utility of CT Metal Artifact Reduction Algorithms for Intervertebral Devices: Experimental Study in Ex Vivo Bovine Coccyx Using Micro-CT as the Reference Standard

Monday, Nov. 26 3:30PM - 3:40PM Room: N227B

Participants
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PURPOSE

The accuracy of radiological assessments of bony fusion following spinal fusion is affected by radiographic interference from metallic components of the intervertebral devices. Therefore, this study evaluated the utility of dedicated CT metal artifact reduction algorithms (SEMAR and MAR) for measuring trabecular bone microarchitecture in a comparison using micro-CT as the gold standard.

METHOD AND MATERIALS

Twenty bovine coccyges with and without titanium or poly-ether-ether-ketone (PEEK) interbody devices were scanned by ultra-high resolution MDCT (Aquilion Precision, SEMAR), 256-MDCT (Revolution CT, MAR), and micro-CT as the gold standard. The quality of the MDCT images was evaluated in terms of the visibility of trabecular bone using a 3-point Likert scale. Trabecular thickness (Tb.Th), trabecular number (Tb.N), trabecular separation (Tb.Sp), fractal dimension (FD), and volumetric bone mineral density (vBMD) of the same 10-mm-thick portion of coccyx including a metal artifact were obtained for MDCTs and micro-CT. Relationships between MDCT- and micro-CT-derived trabecular bone indices were compared.

RESULTS

The mean reduction in the width of the artifact was 48.7% for SEMAR/titanium, 20.6% for SEMAR/PEEK, 15.8% for MAR/titanium, and 18.9% for MAR/PEEK. The image quality analysis revealed that the artifact was removed from the trabecular bone space in 72.7% of the SEMAR/titanium images and 18.2% of the images obtained using the three other combinations. FD, Tb.Th, Tb.Sp, and vBMD measured by ultra-high resolution MDCT were found to be significantly correlated with micro-CT values (ρ=0.486~0.499, p=<0.001~0.05) while no significant correlation was observed between 256-MDCT- and micro-CT values. For coccyx with titanium, the correlations of Tb.Th, Tb.Sp, and vBMD with micro-CT values were improved by SEMAR (ρ=0.491~0.489, p=<0.001~0.05). For coccyx with PEEK, correlations of FD, Tb.Sp, and vBMD with micro-CT values were improved by SEMAR (ρ=0.502~0.525, p=<0.001~0.05).

CONCLUSION

SEMAR combined with ultra-high resolution MDCT objectively and subjectively decreases metal artifacts when compared to 256-MDCT with MAR. Correlations of trabecular indices and vBMD with micro-CT values were improved with SEMAR.

CLINICAL RELEVANCE/APPLICATION

Trabecular bone architecture can be assessed using ultra-high resolution MDCT with a metal artifact reduction algorithm, suggesting that it is possible to evaluate bony fusion after spinal fusion.

SSE16-05 Combined Iterative Metal Artifact Reduction Reconstruction and Virtual Monoenergetic Extrapolation at Higher Photon Energies in CT Imaging of Ankle Arthroplasty Implants

Monday, Nov. 26 3:40PM - 3:50PM Room: N227B

Awards
Student Travel Stipend Award

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PURPOSE

To compare the effects of combined virtual monoenergetic extrapolation (VME) and iterative metal artifact reduction (iMAR) at higher photon energies on low and high-density metal artifacts and overall image quality.

METHOD AND MATERIALS

Six total ankle arthroplasties were implanted into human cadaveric ankles and underwent computed tomography with a dual-source scanner at tube voltages of 80 and tin-filtered 150 kVp to produce mixed 120 kVp equivalent polychromatic images. Image datasets were created with six protocols including polychromatic weighted filtered back projection (WFBP), polychromatic iMAR, monoenergetic WFBP at 150 and 190 keV, and monoenergetic iMAR at 150 and 190 keV. High- and low-density artifacts were separately quantified with a threshold-based MATLAB script. After anonymization and randomization, two observers independently ranked the datasets for overall image quality. A conservative p-value of less than 0.001 was considered significant for all statistical analyses.

RESULTS

Least amount of high-density artifacts were visualized with iMAR 190 keV and iMAR 150 keV (all p-values < 0.001), whereas polychromatic iMAR was the most effective method of mitigating low-density streaks (p-values < 0.001). For both low and high-density artifacts, polychromatic iMAR acquisition was superior to WFBP 150 keV and WFBP 190 keV (p-values < 0.001). Readers ranked the overall image quality of polychromatic iMAR images highest on sharp kernel reconstructions (p-values < 0.001). Similarly, on soft tissue kernel reconstructions, the polychromatic iMAR images were ranked the highest with a statistically significant difference over other techniques (p-values < 0.001), except for iMAR 150 keV (p = 0.356).

CONCLUSION

iMAR with polychromatic spectra and VME result in fewer metal artifacts and better image quality than WFBP with polychromatic spectra and VME. The combination of iMAR and VME at higher photon energies results in mixed effects on implant-induced metal artifacts, including decreasing high-density artifacts and increasing low-density artifacts, which in combination may not improve image quality for a particular implant when compared to polychromatic iMAR images at lower photon energies.

CLINICAL RELEVANCE/APPLICATION

Combined iMAR and VME at higher photon energies results in mixed effects on metal-related artifacts, which overall may not improve image quality for a particular implant.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Elliot K. Fishman, MD - 2012 Honored EducatorElliot K. Fishman, MD - 2014 Honored EducatorElliot K. Fishman, MD - 2016 Honored EducatorElliot K. Fishman, MD - 2018 Honored Educator

SSE16-06 Improved Visualization of Juxtaprosthetic Tissue Using Metal Artifact Reduction MRI: Experimental and Clinical Optimization of Compressed Sensing SEMAC

Monday, Nov. 26 3:50PM - 4:00PM Room: N227B

Participants
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PURPOSE

To identify an optimal imaging protocol for metal artifact reduced MRI by application of different post-processing parameters in compressed sensing slice-encoding for metal artifact correction (CS-SEMAC).

METHOD AND MATERIALS

In an experimental setup, a total hip arthroplasty (THA) embedded in gadolinium containing agarose was scanned at 1.5T. Pulse sequences included coronal STIR, T1w and T2w CS-SEMAC sequences. All pulse sequences were acquired with 11, 19 and 27 slice-encoding steps (SES). Post-processing was performed with variations of the parameters (i) number of iterations (5, 10, 20, 30, 50) and (ii) normalization factor (0.0005, 0.001, 0.002, 0.003, 0.005). Following, identical STIR, T1w and T2w pulse sequences with 11 and 19 SES were acquired in patients with THA. Semi-quantitative outcome measures were assessed on a five-point scale (1=best, 5=worst). The overall best image quality was determined. Statistical analyses included descriptive statistics, t-tests, multivariate regression models and partial Spearman correlations.

RESULTS

Scan times varied between 2:24 and 8:49 minutes. Reconstruction times varied between 3:14 and 85:00 minutes. Artifact reduction was optimal with an intermediate normalization factor (0.001) and improved with higher SES and iterations. Iterations >20 did not improve artifact reduction or image quality further. Ripple artifacts increased with higher SES and iterations. A normalization factor of 0.001 or 0.002 was best for reduction of blurring, while the soft tissue contrast was better and the distortion of soft tissue was less severe with lower normalization factors. Overall best soft tissue image quality was found for STIR and T1w images with 19 SES, 10 iterations and a normalization factor of 0.001 and for T2w images with 11 SES, 10 iterations and a normalization factor of 0.0005.

CONCLUSION

For the advanced acceleration and reconstruction algorithms of CS-SEMAC, optimal SES, iterations and normalization factors could

be identified. 19 SES and 20 iterations were sufficient for optimal artifact reduction, enabling an imaging protocol with clinically feasible acquisition and reconstruction times.

CLINICAL RELEVANCE/APPLICATION

Identified optimal CS-SEMAC MRI parameters may be applied in clinical practice and allow for improved evaluation of juxtaprosthetic tissue in patients with THA due to excellent artifact reduction.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSE17

Nuclear Medicine (Central Nervous System Nuclear Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: S505AB

NR NM

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

SSE17-01 18F-Fluciclovine PET Evaluation of Recurrent High-Grade Glioma

Monday, Nov. 26 3:00PM - 3:10PM Room: S505AB

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PURPOSE

18F-Fluciclovine has shown promise in the detection and diagnosis of high-grade gliomas (HGG) due to minimal uptake in normal brain parenchyma and increased uptake in neoplastic tissue. The goal of this study is to evaluate 18F-fluciclovine PET uptake in patients with suspected recurrent HGG previously treated with chemotherapy and/or radiotherapy and correlate with overall survival.

METHOD AND MATERIALS

Nine patients with suspected recurrent HGG (WHO grade III, IV) previously treated with surgical resection followed by either chemotherapy and/or radiotherapy underwent dynamic 18F-fluciclovine brain PET. Average 18F-fluciclovine dose was 10.5 ± 0.41 mCi (390 ± 15 MBq). Semi-quantitative PET analysis (SUVmax, SUVmean) was performed for each lesion identified on standard of care MRI and compared to normal brain parenchyma and venous blood at all time points to obtain time activity curves. Metabolic tumor volume of each lesion was measured at each time point using a threshold of 1.6* normal brain parenchyma. True recurrence was confirmed with histopathological confirmation in 5 patients and subsequent serial MRI examinations.

RESULTS

18F-Fluciclovine uptake greater than background was visually identified in 6 of 9 patients. Average SUVmax and SUVmean of identifiable lesions were 5.7±1.2 and 1.4±0.5 at 60 minutes respectively. Average SUVmax and SUVmean for normal brain uptake were 1.8±0.6 and 0.5±0.2 respectively. Range of glioma SUVmax/normal SUVmean was 32.5 - 6.6 with an average ratio of 15.1±10.4. 18F-Fluciclovine PET identified a new distinct local metastasis in a patient that was confirmed on subsequent MRI examinations. Recurrent gliomas that were not visually identified by 18F-fluciclovine PET had an average SUVmax of 2.1±0.6 with a glioma SUVmax/normal SUVmean average of 6.1±1.7. The mean time of survival from the 18F-fluciclovine PET with identifiable recurrent HGG was 14.9 months vs 24.1 months for those lesions not visually identified on PET.

CONCLUSION

18F-fluciclovine PET/CT is a promising diagnostic tool for identifying recurrent HGG and may be a valuable tool for survival prognostication although more work is needed to verify these results.

CLINICAL RELEVANCE/APPLICATION

18F-fluciclovine PET/CT is a promising diagnostic tool for identifying recurrent HGG and may be a valuable tool for survival

prognostication.

SSE17-02 PET-MR Imaging Biomarkers Improving Differential Diagnosis Between Progression and Radionecrosis of Brain Tumors

Monday, Nov. 26 3:10PM - 3:20PM Room: S505AB

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PURPOSE

Follow-up under treatment of patients with high grade glioma is essential, the MRI being the modality of choice. However, anatomical MRI may not be always reliable after radiation or chemotherapy. Advanced MRI techniques as well as PET were proposed for improving the diagnostic accuracy, that remains still moderate and variable across studies. Our purpose was to evaluate the diagnostic accuracy of PET-MRI for differential diagnosis between tumor progression and radionecrosis.

METHOD AND MATERIALS

Between December 2015 and September 2017, patients followed for primary malignant brain tumors underwent FDOPA PET-MRI. The acquisitions were performed with a 3T PET-MR system (SIGNA, GE Healthcare). The MRI acquisition included SE 3D T1-weighted images without and after contrast injection, 3D FLAIR imaging, DWI, pseudo-continuous arterial spin labeling (pCASL) and dynamic susceptibility-contrast (DSC) perfusion. The SUVmax, SUVmean, and SUVpeak were measured in each lesion with Volume of Interest (VOI). A region of interest was drawn in each lesion and the mean rADC, rCBV, and rCBF for both DSC and pCASL perfusion were calculated. In addition, the visual analysis was performed.

RESULTS

Forty-four patients were included. ROC analysis showed good discrimination between progression and radionecrosis with a good diagnostic accuracy for SUVmax (0.82), for SUVpeak (0.9) and for ASL rCBF (0.86). It was fair for rADC (0.63) and rCBV (0.75). A logistic regression model found among predictor variables, the combination of these SUVpeak and pCASL rCBF variables improved sensitivity (0.94), specificity (0.83), the AUC (0.97, 95% CI=[0.93,0.99]) and the accuracy (0.94). Visual analysis allowed a diagnostic accuracy of 0.77 for PET reading only, of 0.89 for PET reading with morphological MRI and of 0.98 for PET-MRI combined reading.

CONCLUSION

We have observed an increase in diagnostic accuracy for combined analysis of PET and MRI biomarkers for both qualititative and qualitative biomarkers, SUVpeak and pCASL rCBF being the most significant quantitative biomarkers. Combined PET-MR imaging allows to increase the diagnostic accuracy for differential diagnosis between tumor progression and radionecrosis in neuro-oncology.

CLINICAL RELEVANCE/APPLICATION

The combined analysis of imaging morphological, functional and metabolic markers on PET-MRI is helpful in differential diagnosis between tumor progression and radionecrosis in neuro-oncology.

SSE17-03 Detection of Abnormal Brain FDG-PET Images With Deep Learning

Monday, Nov. 26 3:20PM - 3:30PM Room: S505AB

Participants
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PURPOSE

FDG-PET/CT is widely used in routine clinical practice and its utilization is projected to increase. The brain is often included as part of the study; however, due to its background physiological FDG uptake, the sensitivity for abnormality detection in this region is usually low. By utilizing a deep learning algorithm to aid radiologists detect abnormalities, clinical management and outcomes could be improved. The aim of this study was to evaluate the ability of a new deep learning framework to discern between normal and abnormal FDG uptake in the brain.

METHOD AND MATERIALS

285 FDG-PETs acquired between 2007 and 2017 were retrospectively reviewed. A deep learning framework was trained using 110 normal and 110 abnormal brain studies, including 10 studies for testing in each category. The remaining 36 normal and 29 abnormal studies were used for validation of the resulting inference model and its sensitivity and specificity were analyzed. DICOM studies were anonymized, appropriately windowed and converted into portable network graphics format. A network architecture that uses a time distributed 2D convolutional neural network with 100 epochs was generated. A classification was performed based on the probability of an individual FDG-PET scan being normal or abnormal. Various models were derived.

RESULTS

Accuracy and loss function of the optimal trained model were calculated at 0.761 and 0.462, respectively. Receiver operating characteristic (ROC) curve demonstrated an area under the curve of 0.832 (Figure 1). According to ROC curve, the optimal probability threshold to detect abnormal Brain FDG-PET scans was 0.661. Validation test characteristics resulted in sensitivity of 80.6% and specificity of 75.9%.

CONCLUSION

Preliminary results of a novel deep learning model showed promising capability in detecting brain abnormalities on FDG-PET images which could aid radiologists and improve clinical outcomes.

CLINICAL RELEVANCE/APPLICATION

Improving detection of brain FDG-PET abnormalities in daily clinical practice with the aid of a deep learning method that could help improve clinical management and outcomes.

SSE17-04 Posterior Cortical Variant Alzheimer's Disease and Lew Body Dementia: Similarities and Differences on FDG PET Scan

Monday, Nov. 26 3:30PM - 3:40PM Room: S505AB

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PURPOSE

Posterior cortical atrophy (PCA) is a form of dementia considered to be an atypical variant of Alzheimer's disease (AD) and Dementia with Lewy bodies (DLB) is a type of posterior dementia characterized by fluctuating levels of cognition, changes in behavior, visual hallucinations with accompanying extrapyamidal motor symptoms. We attempt to identify specific core areas on FDG PET imaging which are common to both and also establish the differences which may be helpful to differentiating the two.

METHOD AND MATERIALS

We retrospectively analysed of 30 patients with clinically suspected posterior dementia. All the subjects underwent F-18 FDG PET CT scan of the brain and the studies were analyzed both qualitatively (visually) and semi-quantitatively. The subjects had undergone dopamine transporter imaging with Tc 99 m TRODAT 1 on a prior date. The subjects were divided into possible PCA with TRODAT scan normal (n=10) and possible DLB with abnormal (n=20). The FDG uptake patterns were recorded and areas of cortical hypometabolism in the cerebral cortex that were two standard deviations from the mean were considered as abnormal.

RESULTS

All the subjects had an abnormal pattern of F-18 FDG uptake on PET scan, both on visual inspection and semiquantitative analysis. Bilateral parieto-occipital hypometabolism was consistently found in all the subjects. Hypometabolism in precuneus, posterior cingulate and the cortex around the angular gyrus was present in all the subjects of PCA with relative sparing of the medial occipital cortices. DLB subjects showed variable degrees of involvement of the medial occipital cortices with relative sparing of posterior cingulate and precuneus.

CONCLUSION

FDG PET scan can act as a non-invasive diagnostic modality in differentiating the two posterior cortical dementias despite significant clinical and imaging overlap.

CLINICAL RELEVANCE/APPLICATION

We present features based on which FDG-PET can be used to diagnose and differentiate Posterior Cortical Atrophy (PCA) and Dementia with Lewy Bodies (DLB) in the clinical practice.

SSE17-05 Correlation of 4´-[methyl-11C]-thiothymidine Uptake with Human Nucleoside Transporter and Thymidine Kinase-1 Expressions in Patients with Newly Diagnosed Gliomas

Monday, Nov. 26 3:40PM - 3:50PM Room: S505AB

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PURPOSE

We examined expressions of four human nucleoside transporters including: human equilibrative nucleoside transporters (hENT1 and hENT2); and human concentrative nucleoside transporters (hCNT1 and hCNT3), and thymidine kinase-1 (TK1), the key enzyme in 4'-[methyl-11C]-thiothymidine (4DST) phosphorylation, to elucidate the mechanism of 4DST uptake in patients with newly diagnosed gliomas.

METHOD AND MATERIALS

A total of 19 patients with newly diagnosed gliomas were examined with 4DST PET. Tumor lesions were identified as areas of focally increased uptake, exceeding that of normal brain background. For semi-quantitative analysis, tumor-to-contralateral normal brain tissue (T/N) ratio was determined by dividing the maximal standardized uptake value (SUV) for tumor by that of the mean SUV for reference tissue. The expressions of hENT1, hENT2, hCNT1, hCNT3, and TK1 in tumor specimens were examined by immunohistochemistry and compared with 4DST T/N ratio.

RESULTS

All but two gliomas showed focally increased 4DST uptake. All but one grade II glioma that was not visualized with 4DST PET showed hENT1 staining. Of the gliomas, hENT2 and hCNT3 staining was observed in 11 and 16 gliomas, respectively. No hCNT1 staining was observed in any of the gliomas. All but two gliomas that were not visualized with 4DST PET showed TK1 staining. A significant correlation was observed between T/N ratio and hENT1 score ($r = 0.75$, $p < 0.001$). There was no significant correlation between T/N ratio and hENT2 score or hCNT3 score. There was a significant strong correlation between T/N ratio and TK1 score ($r = 0.92$, $p < 0.001$). It is likely that expression of TK1 might be more important than expression of hENT1 for uptake of 4DST.

CONCLUSION

Results of this preliminary study indicate that expressions of hENT1 and TK1 appear to be important determinants of 4DST uptake in newly diagnosed gliomas.

CLINICAL RELEVANCE/APPLICATION

Expressions of hENT1 and TK1 appear to be important determinants of 4DST uptake in newly diagnosed gliomas.

SSE17-06 A Novel Clustering Approach in Brain Tumors Using Dynamic 18F-FET PET/MRI

Monday, Nov. 26 3:50PM - 4:00PM Room: S505AB

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PURPOSE

Purpose of the present study is to present a user-independent, quantitative approach to easily classify brain areas on the base of uptake temporal evolution using dynamic 18F-FET PET/MRI.

METHOD AND MATERIALS

O-(2-18F-fluoroethyl)-L-tyrosine (18F-FET) PET/MRI performed at out Institution in brain tumors were retrospectively analyzed using a clustering technique in order to differentiate areas using uptake dynamics: time activity curves (TACs) were considered for each voxel in the brain volume and an unsupervised clustering algorithm was applied. This algorithm provides as output an automatic grouping of TACs and hence of voxels they are associated to. Therefore, it is possible to create parametric images, representing the different behavior over time of the tissues.

RESULTS

We were able to automatically identify brain areas grouped by dynamic similarities using 18F-FET uptake and produce parametric images (see Figure 1, panel (a)) and associated mean time-activity curves obtained averaging the TACs of voxels belonging to the same group (see Figure 1, panel (b)).

CONCLUSION

The proposed approach allows to exploit dynamic 18F-FET PET data: the automatic nature of the method removes the user-dependent ROI drawing step, the clustered data can be further analyzed to extract representative features of the average TACs and intuitive parametric images are produced. Moreover the method could be easily employed with other tracers.

CLINICAL RELEVANCE/APPLICATION

Validation of the method against pathological data is ongoing and seems to provide encouraging results. The method could then be used to plan areas for radiotherapy clustering areas with similar dynamic characteristics.

SSE18

Neuroradiology/Head and Neck (Thyroid and Parathyroid Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: E351

AI CT HN NR US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSE18-01 Thyroid Nodules on Ultrasound: Effect of Computer-Aided Diagnosis (CAD) on Radiologists' Performance with a Large Clinical Diagnostic Population

Monday, Nov. 26 3:00PM - 3:10PM Room: E351

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PURPOSE

To evaluate the effect of computer-aided diagnosis (CAD) on different level radiologists' performance for discriminating malignant from benign thyroid nodules on US images.

METHOD AND MATERIALS

From January 2013 to December 2017, thyroid nodules with decisive diagnosis on the basis of pathologic results were consecutively enrolled. The observer study was conducted with four experienced radiologists and four radiology fellows, all of whom analyzed the thyroid nodules using 2017 ACR TIRADS first without and subsequently with CAD software. The performance of each observer without and with the CAD was assessed by measuring the area under the receiver operating characteristics curve (Az), sensitivity, specificity, PPV and NPV. To quantify the changes in clinical management decisions with the CAD aid, we computed for each radiologist the number of malignant and benign nodules for which the clinical management decision was changed. Concordance between observers in classing the thyroid nodules was measured in without and with CAD conditions.

RESULTS

In total, 1065 thyroid nodules from 1035 patients were included; 382 (35.87%) were benign and 683 (64.13%) were malignant. Use of the CAD resulted in an improvement of the average performance of the 8 observers, as measured by means of a statistically significant increase in Az value (0.840-0.853; $p < .000$) , sensitivity (86.44%-87.52%; $p < .000$) and inter-observer agreements(0.744-0.769; $p < .05$) A statistically significant difference was not found in the specificity without and with the computer aid (38.74%-38.55%; $p = .20$). On the basis of TI-RADS assessments, it was estimated that with CAD, each observer, on average, correctly recommended 1.02% (7/683) of additional biopsies and also increased 0.37% (1.4/382) of unnecessary biopsies.

CONCLUSION

Computer-aided diagnosis can help radiologists improve their sensitivity in detection of thyroid malignancies and also increased the rate of unnecessary biopsies.

CLINICAL RELEVANCE/APPLICATION

To aid diagnosis for inexperienced radiologists and decrease workload

SSE18-02 Comparision of Morphology and Enhancement Characteristics of Ectopic and Eutopic Parathyroid Adenomas.

Monday, Nov. 26 3:10PM - 3:20PM Room: E351

Participants
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PURPOSE

4D-CT is a novel technique for pre-surgical localization of parathyroid adenomas (PA). PA can be eutopic or ectopic. Detection of ectopic PA is crucial for surgical success especially if patient has multigland disease with both eutopic and ectopic PA. Purpose of our study is to determine the differences in morphology and enhancement characteristics between eutopic and ectopicPA which will help in increasing the confidence of radiologist for suggesting high probability.

METHOD AND MATERIALS

This is an IRB approved retrospective study of 232 patients with surgically proven PA who underwent 4D CT imaging for pre surgical localization of PA between 2014 and 2017. All 4D CT scans were performed with initial noncontrast followed by 30 sec and 90 sec postcontrast images on 64 slice MDCT scanner. Contrast washout ratios (CWR) were calculated by measuring Hounsfield units (HU) of PA on the noncontrast, 30 second post contrast early arterial exam (30A) and on the 90 second post contrast delayed exam (90D). CWR = [100 x (HU on 30A - HU on 90D)/HU on 30A].

RESULTS

Out of 232 patients, 186 patients - 1 gland, 37 patients - 2 gland, 6 patients - 3 gland and 3 patients- 4 gland adenomas constituting a total of 290 radiologically diagnosed lesions. Out of these, 25 (6M, 17F) PA were in ectopic and 265 (37M, 228F) PA were eutopic. Out of 290 radiologically reported lesions, 242 lesions (21 Ectopic and 221 Eutopic) matched to the adenomas found on surgery and pathology constituting to 242 radiological-surgical-pathology matched lesions. 48 lesions were false positive, which did not correlate with the location on surgical pathology. Morphological characteristics like shape, size, heterogeneity were studied and compared between eutopic and ectopic adenomas. Enhancement characteristics of eutopic and ectopic adenomas were compared and were categorized at 10% washout intervals, for example: 1-10%, 11-20% and so on.

CONCLUSION

1. 217 out of 265 eutopic adenomas and 20 out of 25 ectopic adenomas demonstrated contrast washout ratios between 31%-80% and did not demonstrate significant difference in washout characteristics. 2. Size and shape of ectopic PA did not show significant influence on washout characteristics. 3. Measurement of contrast enhancement and washout dynamics is limited in lesions with large cystic areas.

CLINICAL RELEVANCE/APPLICATION

Detection of ectopic PA is crucial for surgical success especially in the setting of multigland disease.

SSE18-03 The Assessment of Cervical Lymph Node Metastasis from Thyroid Cancers: A Quantitative Analysis on Multiphasic CT

Monday, Nov. 26 3:20PM - 3:30PM Room: E351

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PURPOSE

Purpose: The purpose of this study was to evaluate the diagnostic performance of multiphasic CT in the discrimination of metastatic lymph nodes of papillary (PTC) and medullary (MTC) thyroid cancers from non-metastatic ones with the use of quantitative parameters.

METHOD AND MATERIALS

Materials-methods: This study enrolled 62 pathologically proven metastatic and 62 benign lymph nodes from 23 thyroid cancer patients (19 PTC and 4 MTC). Multiphasic CT was utilized by using non-enhanced, arterial (25-second delay) and venous (80-second delay) phases. Two readers independently measured mean tissue attenuation values (MAV) of metastatic and benign lymph nodes. The relative wash in and wash out percentages were calculated and were defined as: arterial MAV-nonenhanced MAV/nonenhanced MAV, venous MAV- arterial MAV/arterial MAVx100; respectively.

RESULTS

Results: The difference in MAV between metastatic and benign lymph nodes for the PTC were maximum in the arterial phase ($p<0.001$). The arterial phase showed the highest diagnostic performance compared with other phases for the PTC (AUC±SE:0.98±0.01; %95 CI: 0.96-1). A cutoff value of 97.5 HU for the arterial phase had a sensitivity of 96.3% (%95 CI: 87.5-99%) and specificity of 94.4% (%95 CI: 84.8-98.1%), positive predictive value (PPV) of 97.2% and negative predictive value (NPV) of 92.6% in the discrimination of metastatic lymph nodes from PTC ($p<0.001$). Metastatic lymph nodes from MTC showed progressive enhancement compared to benign lymph nodes and the venous phase showed the highest diagnostic performance in discrimination between metastatic and benign lymph nodes ($p<0.05$). A MAV cutoff of 112.5 HU in the venous phase predicted metastatic lymph nodes from MTC with a sensitivity of 87.5%, specificity of 75%, ($p=0.015$).

CONCLUSION

The detection of metastatic lymph nodes from thyroid cancers can be achievable with the use of quantitative parameters in

multiphasic CT. Metastatic lymph nodes from PTC show strong uptake of contrast in the arterial phase and wash out of contrast in the venous phase. Whereas, metastatic lymph nodes from MTC show progressive enhancement in the venous phase.

CLINICAL RELEVANCE/APPLICATION

Determination of metastatic lymph nodes is an important problem in thyroid cancers. Complete resection of the primary disease and metastases is the one of the important factor in the survival.

SSE18-04 Retrospective Analysis of Thyroid Ultrasound Recommendations Using Thyroid Imaging Reporting and Data System (TI-RADS) Scoring

Monday, Nov. 26 3:30PM - 3:40PM Room: E351

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Breast Imaging, Reporting, and Data System (BI-RADS) has been used to standardize mammogram reports and recommendations; Thyroid Imaging, Reporting, and Data System (TI-RADS) seeks to do the same. We compared our institution's prior biopsy recommendations on ultrasound reports to what the recommendations would have been using TI-RADS.

METHOD AND MATERIALS

Our study was a retrospective review of 449 thyroid nodules which were assessed by ultrasound and subsequently biopsied. We collected the description of the lesion and the original recommendations from the radiology report. Pathology results were collected. Three radiologists then performed blinded and independent evaluations of each exam; a TI-RADS score was assigned to each thyroid nodule. Recommendations based on TI-RADS were compared with prior recommendations and biopsy results.

RESULTS

449 thyroid nodules were identified by review of biopsies. Had we implemented TI-RADS, we would have recommended 102 fewer biopsies (23%). No nodules for which a biopsy was initially recommended but not recommended by TI-RADS criteria demonstrated a clinically significant malignancy at biopsy. Incidental foci of papillary carcinoma found within benign follicular nodules less than 0.5cm were considered not clinically relevant, as studies have shown that 5-30% of autopsies have found occult papillary carcinoma in patients who died of unrelated causes. Our positive predictive value before implementing TI-RADS was 8.2%. Utilizing TI-RADS, our positive predictive value is 10.5%, a ~25% difference.

CONCLUSION

There was a decrease in the number of thyroid biopsies that would have been recommended when using TI-RADS. We demonstrated a 23% decrease in the number of recommended biopsies without decreasing our ability to identify clinically significant malignancies. Findings suggest that implementing TI-RADS will decrease the number of negative biopsies performed, which will decrease patient risk and worry as well as save the health system from the cost of these additional procedures. Our study is limited by only selecting patients who underwent biopsy. Due to our inclusion criteria, we did not assess for any missed malignancies in nodules presumed to be benign on prior ultrasound reports.

CLINICAL RELEVANCE/APPLICATION

Use of TI-RADS for thyroid nodule biopsy recommendations can greatly reduce the number of biopsies recommended without missing a clinically significant malignancy.

SSE18-05 Machine Learning Optimization of 4D-CT and 99m-Technetium Sestamibi for Preoperative Localization in Patients with Primary Hyperparathyroidism

Monday, Nov. 26 3:40PM - 3:50PM Room: E351

Participants
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PURPOSE

The purpose of this study is to apply machine learning to 4D-CT and 99mTechnetium sestamibi (MIBI) for preoperative localization of hyperfunctioning parathyroid glands in patients with primary hyperparathyroidism (PHPT). Our aim is to develop a model and decision tree algorithm to maximize diagnostic accuracy.

METHOD AND MATERIALS

A retrospective study of 400 patients who underwent combined imaging protocol of 4D-CT and MIBI SPECT/CT and subsequent parathyroidectomy was performed. Four parathyroid glands were assumed for each patient (n=1600). Reference standard was surgical pathology. Both 4D-CT and MIBI were interpreted by two nuclear radiologists. Using machine learning, a random-forest tree

algorithm using 3-fold cross validation was trained and validated to predict the probability of a parathyroid gland as positive hyperfunctioning gland on pathology (adenoma or hyperplasia). A total of 17 variables were used, including 4 clinical, 10 biological, and 3 imaging variables. Imaging variables included 4D-CT, MIBI, and combined 4D-CT+MIBI.

RESULTS

Of 1600 parathyroid glands, 521 were abnormal on surgical pathology. The model output was probability of a gland as positive on pathology. The final model selected variables of combined 4D-CT+MIBI and preoperative serum PTH and Calcium crossproduct (PTH*Ca). The AUC of the model was 0.99 (95 CI: .984-.996) and outperformed AUC of radiologist interpretation of 4D-CT and MIBI, alone and in combination. When both 4D-CT and MIBI are positive, the probability of a true positive is 97% (n=305) and when either test is positive, the probability is 75% (n=164). When both tests are negative, the gland is a true negative in 96% of cases if PTH*Ca is > 1232 (n=333), 92% of cases if PTH*Ca>675 and <1232 (n=563) and 81% of cases if PTH*Ca<675 (n=297).

CONCLUSION

Diagnostic accuracy of preoperative 4D-CT and MIBI is improved with machine learning compared with radiologist interpretation. A decision tree algorithm simplified into three variables selected by machine learning can provide probability of correct classification of each parathyroid gland as normal or abnormal and guide the surgeon to pursue minimally invasive parathyroidectomy or 4-gland exploration.

CLINICAL RELEVANCE/APPLICATION

Machine learning-derived model and decision tree algorithm can improve diagnostic accuracy of preoperative localization of 4D-CT and 99mTechnetium Sestamibi for patients with primary hyperparathyroidism.

SSE18-06 Utility of Ultrasound Elastography (Acoustic Radiation Force Impulse Imaging) in the Diagnosis of Parathyroid Adenoma in Correlation with Sestamibi Scan

Monday, Nov. 26 3:50PM - 4:00PM Room: E351

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PURPOSE

In this study we consider applying the technique of ARFI with Virtual Touch Quantification (a type of quantitative elastography) in diagnosis of parathyroid adenomas(most common cause of primary hyperparathyroidism), to prospectively assess whether this technique can increase the diagnostic value of ultrasound approaching nearer to or more than the sensitivity and specificity of sestamibi scan.

METHOD AND MATERIALS

This was a prospective observational study conducted in the department of radiodiagnosis of our institution from October 2016 to December 2017. The study population consisted of 36 patients(n=36) with clinical suspicion of primary hyperparathyroidism with positive Sestamibi scan for parathyroid adenoma irrespective of ultrasound results(done prior to the Sestamibi scan). The parathyroid adenoma was first identified by grey scale imaging features and then a region of interest for elastography was placed within the lesion and the stiffness of the lesion using ARFI-VTQ values were obtained. Five successful measurements were taken for ARFI -VTQ(measured in meters per second) and the median value was calculated.

RESULTS

Ultrasound elastography was performed on all the 36 cases of adenomas and the median ARFI-VTQ values were calculated. The mean ARFI values of the corresponding adjacent thyroid tissue were also calculated.The mean ARFI-VTQ values of adenomas was (1.72±0.45m/s).The mean ARFI-VTQ values of normal thyroid tissue was (2.66±0.38m/s).There was a statistically significant difference between the two variables with [p <0.0001]. The study shows a consistently low elastography values for adenomas than adjacent thyroid tissue and other lesions which mimic adenomas like lymph nodes . Thus ultrasound along with ARFI-VTQ values has high accuracy in diagnosing adenomas.

CONCLUSION

Ultrasound elastography(withARFI-VTQ)is an excellent tool which enhances the diagnostic value of ultrasound in parathyroid adenomas when used along with B-mode ultrasound and doppler.

CLINICAL RELEVANCE/APPLICATION

In clinically diagnosed patients of hyperparathyroidism ultrasound ARFI-VTQ can be applied as a solitary imaging modality(in place of sestamibi), since it is an excellent diagnostic imaging tool in the diagnosis of normally located parathyroid adenomas with high accuracy.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSE19

Neuroradiology (Epilepsy Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: E352

MR 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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Sub-Events

SSE19-01 7T MRI of Hippocampal Internal Architecture in Medial Temporal Lobe Epilepsy Compared with that in 3T MRI

Monday, Nov. 26 3:00PM - 3:10PM Room: E352

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PURPOSE

Asymmetry of hippocampal internal architecture (HIA) clarity has been regarded as a sign of hippocampal sclerosis (HS). The aim of this work was to compare HIA in patients with medial temporal lobe epilepsy (MTLE) in 3T and 7T MRI in lateralizing epileptic side and its relationship with postoperative seizure outcome

METHOD AND MATERIALS

39 patients with MTLE were recruited, and MRI at 3 T and 7T were obtained respectively (GE Discovery MR750 3T and Siemens Investigational Device 7T) for semi-quantitative assessment of the HIA by visual scoring system (Ver Hoef et al., 2013). The values of the average HIA scores of 3T and 7T MRI in the epileptogenic and non-epileptogenic hippocampi were compared with Kruskal-Wallis H test. Pair-wise differences between groups were evaluated with Mann-Whitney U test. A logistic regression model examined the utility of average HIA asymmetry score in lateralizing seizure onset determined by video-EEG. 25 patients underwent amygdalohippocampectomy and received postoperative follow up. The relationship between HIA and postoperative seizure freedom was investigated

RESULTS

HIA scores of the epileptogenic hippocampi were lower than that of non-epileptogenic hippocampi either in 3TMRI (P=0.0166) or 7TMRI (P=0.0014). The HIA scores of either side of hippocampi in 7T MRI were higher than that of 3T MRI (Contralateral P < 0,0001, Ipsilateral P=0.0002). Logistic regression analysis showed that the HIA asymmetry score either in 3T MRI or 7T MRI was the strong predictor of epileptic laterality (3T MRI: B = 1.504, P = 0.033; 7T MRI: B = 1.705, P = 0.019). However, there were no significant differences in HIA asymmetry score between patients rendered seizure free (ILAE 1) compared to those continuing to experience seizures (ILAE 2-5) either in 3T MRI or 7T MRI.

CONCLUSION

7T MRI was relatively superior to 3TMRI in displaying the subtle hippocampal internal architecture for its higher HIA scores. HIA asymmetry is a significant predictor in lateralizing epileptic side of MTLE patients either in 3T MRI or 7T MRI, but not in the surgical outcomes of the patients

CLINICAL RELEVANCE/APPLICATION

The superiority of 7T MRI in presenting subtle hippocampal internal architecture may help lateralize epileptic side of temporal lobe epilepsy on early side or without evident hippocampal sclerosis in 3T MRI

SSE19-02 Detecting Mesial Temporal Sclerosis on 3D T1 Weighted MRIs Using Deep Learning

Monday, Nov. 26 3:10PM - 3:20PM Room: E352

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PURPOSE

Mesial temporal sclerosis (MTS) is a common cause of surgically treatable epilepsy in adults. MTS is frequently, but not always, detectable on MRI. The purpose of this project was to determine if deep learning using a convolutional neural network can be used to detect MTS on MRI.

METHOD AND MATERIALS

Anonymized volumetric T1 weighted MRIs were retrospectively obtained from 88 normal controls and 119 patients with a clinical and EEG consensus diagnosis of MTS. Of the MTS patients, 39 were read as no MTS on MRI and 80 were read as having MTS during routine clinical interpretation. These studies were divided into training(173), validation (17) and test(17) groups each with a similar distribution of MRI types. The images were bias corrected and the hippocampi were segmented using FSL(Analysis Group, FMRIB, Oxford, UK). The hippocamal segmentations were used to construct bounding boxes around each hippocampus which was utilized during model training. Using TensorFlow, a 3D convolutional neural network modeled after the VGG architecture was constructed and trained to predict normal vs MTS and to locate a bounding box around each hippocampus.

RESULTS

During training, the maximum accuracy achieved on the validation set was 100%. Using the model weights from that epoch, an accuracy of 88% was achieved on the test set with a sensitivity of 89% and a specificity of 88%. For comparison, the sensitivity of the human interpretation for detection of MTS in this cohort of patients with clinical and EEG consensus diagnosis of MTS was 67%.

CONCLUSION

On this small sample, deep learning methods show potential utility for automating the detection of MTS on MRI, warranting further investigation.

CLINICAL RELEVANCE/APPLICATION

Deep learning has the potential to aid in detecting MTS in epilepsy patients

SSE19-03 In Vivo Measurements of GABA and Glutamate-Glutamine in Nocturnal Frontal Lobe Epilepsy

Monday, Nov. 26 3:20PM - 3:30PM Room: E352

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PURPOSE

Nocturnal frontal lobe epilepsy (NFLE) is a focal epilepsy with seizures arising mainly during sleep and characterized by violent limb movement or tonic-dystonic postures. The major inhibitory and excitatory neurotransmitters, γ-aminobutyric acid (GABA) and glutamate, respectively, are implicated in the pathophysiology of NFLE. This study aimed to compare the measurements of GABA, and glutamate-glutamine (Glx) levels in NFLE subjects.

METHOD AND MATERIALS

Study participants were recruited at the seizure disorders outpatient clinic from November 2013 to July 2017. T1-weighted images were acquired and reconstructed for the spectral voxels using a 3T system. Proton magnetic resonance spectroscopy was used to measure GABA and Glx levels in the bilateral dorsolateral prefrontal cortex (DLPFC) regions with a voxel size of 4.0 × 2.0 × 1.5 cm3. Figure 1 illustrates voxels position. Spectra were analyzed using 'Gannet'. The GABA and Glx levels were expressed in 'institutional units' as ratios of peak areas relative to the Cr signal. Only spectra with a relative fitting error generated by GannetFit below 15%, and FWHM below11 Hz were included.

RESULTS

Demographic information is provided in table 1. Thirty-nine subjects with NFLE and 63 controls participated in this study with well-matched for age and gender. As shown in Figure 2, Glx level in the right DLPFC region was higher in NFLE compared with controls (P=0.020). We did not find any GABA level alterations in the current study. In NFLE patients there was significant positive correlations between illness duration and right DLPFC glx level (R2=0.514, P=0.05).

CONCLUSION

In patients with seizures characterized by complex motor behaviors, the region of seizure onset may involve the DLPFC. In line with our finding, elevations in Glx were also observed in idiopathic generalized epilepsy, which may imply increased neuronal excitability. A significant positive correlation was found in NFLE subjects between Glx levels and illness duration, indicating that the longer illness duration may due to severer hyperactivity. These findings are interpreted in terms of a pathophysiological model of NFLE in which excitatory neurotransmission abundance in right DLPFC could lead to hyperexcitability and, potentially seizures-related neuronal dysfunction.

CLINICAL RELEVANCE/APPLICATION

(dealing with MRS) 'MRS exam in possible focus region is recommended in epilepsy patients.'

SSE19-04 White Matter Regional Based Analysis Using Diffusion Tensor Tractography in Patients with Temporal Lobe Epilepsy and Correlation with Patient Outcomes

Monday, Nov. 26 3:30PM - 3:40PM Room: E352

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PURPOSE

In this study, we aim to evaluate the use of diffusion tensor tractography (DTT) as a predictive model of temporal lobe epilepsy (TLE) and correlate their clinical significance with respect to postsurgical outcome. Automated regional based white matter analysis was used to compare the tract density in two groups of TLE patients: responders and non-responders to the surgical treatments.

METHOD AND MATERIALS

A total of 19 patients with TLE underwent either a craniotomy anterior temporal lobectomy (ATL) or a Selective Laser Amygdalohippocampectomy (SLAH) and were imaged using 3.0T Philips Achieva MR scanner. DTI images were acquired axially in the same anatomical location prescribed for the T1-weighted images. The raw data set of the diffusion volumes were first corrected for eddy current distortions and motion artifacts. Track density imaging (TDI) of 68 white matter parcels were generated using fiber orientation distribution (FOD) based deterministic fiber tracking and compared between responders (10) and non-responders (n=9) to the surgical treatments.

RESULTS

looking at tract density of white matter parcels, significant increases have been observed in five distinct white matter parcels (Table 1) in non-responders. These regions are included ipsilateral lingual (p=0.04), ipsilateral temporal pole (p=0.007), ipsilateral pars opercularis (p=0.03), ipsilateral inferior parietal (p=0.04) and contralateral frontal pole (p=0.04).

CONCLUSION

The significant decreases exhibited in tractography on the ipsilateral hemisphere as the pathological process are likely attributed to direct effects of the sclerotic disease such as the ipsilateral temporal pole in TLE patients [9]. These findings may also be attributed to extensions of the disease process/disruptions in connections to adjacent structures, for instance, the ipsilateral lingual gyrus which joins the parahippocampal gyrus and is a continuation of the tentorial surface of the temporal lobe.

CLINICAL RELEVANCE/APPLICATION

These results may have the potential to be developed into imaging prognostic markers of postoperative outcomes and provide new insights for why some patients with TLE continue to experience postoperative seizures if pathological/clinical correlates are further confirmed. On the contrary, arears predicting unfavorable postsurgical outcome were distinct, suggesting different configuration of epileptogenic networks between responders and non-responders.

SSE19-05 Assessment of ASL Perfusion MRI as an Imaging Biomarker in Seizure: Imaging Timing and Perfusion Pattern Analysis

Monday, Nov. 26 3:40PM - 3:50PM Room: E352

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PURPOSE

The aim of the study is to identify time-related perfusion change after seizure by ASL-PWI, and to evaluate additional values of ASL-PWI in seizure patients.

METHOD AND MATERIALS

The ASL-PWI and EEG were performed on 61 patients who suspected seizures. The electronic medical records of the patients were reviewed to record the time intervals between seizure and MR imaging, seizure semiology, multiplexity and suspected seizure etiology. And we analyzed perfusion abnormality on ASL-PWI in each patient by pattern of perfusion maps (increase/decrease) and location of the abnormality. Then the concordance of location which showed abnormality between ASL-PWI and EEG was scored from 0 to 4 and compared ASL-PWI findings with conventional MRI findings.

RESULTS

The time interval between seizure attack and ASL-PWI ranged from 0.5 ~ 121.5 hrs (mean period, 31.6 hr). 5 patients (8.2%) were performed MR imaging shorter than 6 hours, 9 (14.8%) were 6-12 hours, 27 (29.5%) were 6-24 hours and 29 (47.5%) were longer than 24 hours. There was a negative linear correlation between time interval and concordance of location with statistically significant (p=0.040). In single seizure group, the first hypoperfusion was 13 hours and the last hyperperfusion was 26 hours. Delayed hyperperfusion (>24hrs) seems to be related with multiple seizures. In normal routine MRI group, 56.8% (21/37) showed abnormal ASL-PWI results. In abnormal routine MRI group, 29.1% (7/24) showed perilesional perfusion change.

CONCLUSION

ASL-PWI findings after seizure, although are time-dependent and challenging to analysis, but since abnormal perfusion findings on ASL-PWI is observed in many seizure patients and have added values, ASL-PWI is recommended in a routine seizure protocol

CLINICAL RELEVANCE/APPLICATION

By adding ASL-PWI in seizure protocol, the accuracy of the seizure diagnosis can be improved and the estimation of epileptogenic foci can be assisted.

SSE19-06 Interhemispheric White Matter Asymmetries Are Distinctly Affected in Left and Right Medial Temporal Lobe Epilepsy with Hippocampal Sclerosis

Monday, Nov. 26 3:50PM - 4:00PM Room: E352

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PURPOSE

Many past studies reported the asymmetrical structural and/or functional changes of mesial temporal lobe epilepsy (MTLE), that is, the abnormalities in the ipsilateral were more obvious than the contralateral hemisphere in both left MTLE (LMTLE) and right MTLE (RMTLE).However, none of these studies compared the left hemisphere to right hemisphere directly and the asymmetry traits of MTLE remain largely unconfirmed. Thus, this study aims to investigate the white matter microstructure asymmetries of MTLE by compare the two hemispheres directly.

METHOD AND MATERIALS

25 MTLE patients with unilateral hippocampal sclerosis (HS) (LMTLE-HS group, n=13; RMTLE-HS group, n=12) and 26 health controls (HC) were enrolled. Diffusion tensor imaging (DTI) data were analyzed by tract-based spatial statistics (TBSS) to test the hemispheric differences across the entire white matter skeleton. We also conducted two-sample paired t-test for 21 paired-ROIs parceled on the basis of ICBM-DTI-81 white-matter labels atlas of bilateral hemispheres. An asymmetry index (AI) was calculated using the formula AI=100*[Right-Left]/[(Right+Left)/2] to further quantify the differences between the left and right paired-ROIs mentioned above.

RESULTS

The asymmetries across a large number of white matter skeletons were significantly reduced in LMTLE-HS group and RMTLE-HS group compared to HC. ROI-based quantitative analysis of FA/MD showed the asymmetry traits of fornix (FORX), cingulum (hippocampus), cingulum (cingulus gyrus), uncinate fasciculus (UF),superior longitudinal fasciculus (SLF) and superior fronto-occipital fasciculus (SFOF) were disappeared in LMTLE-HS and/or RMTLE-HS group. Apart from that, the intergroup analysis of AI revealed no significant difference between LMTLE-HS group and HC, but some differences were showed when compared RMTLE-HS with LMTLE-HS or RMTLE-HS with HC.

CONCLUSION

The asymmetry traits of MTLE patients were reduced compared to HC. The AI between LMTLE-HS and HS did not show any significant difference indicated that LMTLE-HS might impair the two hemispheres equally. The differences of AI between RMTLE-HS and LMTLE-HS indicated that they might have different mechanisms.

CLINICAL RELEVANCE/APPLICATION

The different asymmetry traits among LMTLE-HS, RMTLE-HS and HC may be able to differentiate LMTLE-HS from RMTLE-HS and thus may be useful for locating side of seizure lesions in MTLE patients.

SSE20

Neuroradiology (Young Brain, Old Brain)

Monday, Nov. 26 3:00PM - 4:00PM Room: E350

NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Margaret N. Chapman, MD, Boston, MA (*Moderator*) Nothing to Disclose
Leo J. Wolansky, MD, Farmington, CT (*Moderator*) Institutional Grant, Guerbet SA

Sub-Events

SSE20-01 Neuroimaging Evidence of Structural and Functional Brain Plasticity After Sight Onset Late in Childhood

Monday, Nov. 26 3:00PM - 3:10PM Room: E350

Participants
Tapan Gandhi, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Direct data from human subjects on the validity of the "critical period" of brain development and the permanent detrimental impact of sensory deprivation during this period is lacking. We present evidence for neural plasticity in congenitally blind children following sight restoration.

METHOD AND MATERIALS

Pre- and post-treatment scans of 15 participants (8 to 24 years) who had been treated for bilateral congenital blindness were done on a 3.0T MRI (750w, GE Healthcare) using a 32 channel brain coil. A high-resolution T1-weighted fast spoiled gradient echo anatomical scan was acquired for each participant. To measure blood oxygen level dependent (BOLD) contrast, 35 slices parallel to the AC/PC were acquired using standard T2 weighted gradient-echo echoplanar imaging. A diffusion-weighted scan (40 direction + 5 b0; 74.4 ms TE; 13.7s TR; 2x0.86x0.86 mm3; FOV: 256 x 256 x 72; b = 1000 nm/s2) was performed for diffusion tensor tractography.

RESULTS

Using functional connectivity analyses, we find marked changes in the functional organization of the visual cortex. There is a significant enhancement of cortical decorrelation as a function of time following sight onset. The fusiform facial area (FFA) and occipital facial area (OFA) develop rapidly. Structural imaging demonstrates increase in both volume and thickness of grey matter compared to controls, especially in the fusiform. Analysis of the optic tract in the same participants revealed no change in mean diffusivity (MD) and fractional anisotropy (FA) during the post-treatment period, while the FA of the optic radiation decreased steeply over 2 years.

CONCLUSION

Contrary to our expectation of limited neural plasticity late in the developmental timeline, we find strong evidence of brain malleability using both functional and structural imaging. Our findings help explain the behaviourally observed gains in visual proficiency congenitally blind individuals exhibit as a function of time after sight restoring surgery.

CLINICAL RELEVANCE/APPLICATION

Our study presents evidence for brain plasticity and hence opens up treatment avenues for conditions such as late-diagnosed congenital blindness.

SSE20-02 Evolution of Brain Dynamics in the First 2 Years of Life

Monday, Nov. 26 3:10PM - 3:20PM Room: E350

Participants
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Han Zhang, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
Weili Lin, PhD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

Dinggang Shen, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Brain is a dynamic system with its state varying all the time. Increasing evidences have indicated that the brain dynamics may evolve in early development and contribute to the cognitive development. This study uses resting-state fMRI and dynamic graph analysis to delineate how such dynamics develop in the first 2 years of life.

METHOD AND MATERIALS

Seventy-two normal infants at 0-, 1- and 2-years old were recruited. After data preprocessing, we extracted regional mean BOLD time series (140 TRs) from 116 pre-defined regions based on AAL atlas and constructed a temporal adjacency network by treating each TR as a node and the similarity (measured by inverse Euclidean distance) in brain states between two different TRs as an edge. Here, each brain state is a momentary (single TR) pattern of the BOLD activities at the 116 brain regions. We performed a subject-level clustering on the temporal adjacency network to divide the brain states into several groups. For each group, we generated a representative state by averaging all time series with the same state. To identify the common states in age groups, we used a second-level clustering over the subject-level state network, where nodes are identified as brain states of the subjects and edges are the similarity between pairs of brain states.

RESULTS

We observed three major brain states that frequently occurred across almost all ages (see histograms in Fig.1). We found these three states could be one-to-one matched across age groups. The first state displays high activities in the sensorimotor cortex, while the second state shows high activities in the visual cortex. In the third state, high activities in the higher-order cognition-related areas are prominent. The first state is highly consistent across all age groups. The second state has a higher similarity between 0- and 1-year-old. For the third state, the later two age groups are much more similar.

CONCLUSION

In closing, three common brain states were identified from 0- to 2-years-old, but showing different similarities across age groups. Such state-level differences may be due to the brain evolution in the first 2 years of life to support the development of the cognitive function.

CLINICAL RELEVANCE/APPLICATION

This study is helpful to better understand the infancy normal neurodevelopment and provides a baseline for the disease diagnosis in early ages.

SSE20-03 Evaluating Normal Fetal Brain Development in 25-39 Weeks Gestational Age Using IVIM-DWI: A Preliminary Study

Monday, Nov. 26 3:20PM - 3:30PM Room: E350

Participants
Yuan Xiao, Xi'an, China (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate the age-related normal changes of water diffusivity and perfusion in the fetal brain using intravoxel incoherent motion diffusion weighted imaging (IVIM-DWI).

METHOD AND MATERIALS

This study was approved by the local Ethics Committee and informed consents were obtained. Seventy nine normal singleton fetuses between 25-39 weeks of gestation were scanned without sedation of healthy pregnant women. The multi-b DWI with 9 b-values (0 - 800 sec/mm2) was performed using a 1.5-Tesla MR scanner. Pure diffusion coefficient (D), pseudo-diffusion coefficient (D*) and perfusion fraction (f) values were measured in white matter (frontal, parietal, temporal and occipital lobe), cerebral hemisphere (CH), thalamus (TH), basal ganglia region (BGR) and pons using an IVIM model. D, D* and f values were compared among different brain regions with one-way ANOVA. Correlation between IVIM parameters and gestational age (GA) was assessed with quadratic polynomial regression.

RESULTS

Statistical difference in D and f values were found among the different right brain regions (D values, $F = 96.644$, $P < 0.0001$; f values, $F = 105.598$, $P < 0.0001$). Mean D values in supratentorial deep white matter areas were higher than those in other regions ($P < 0.0001$). There were significant negative correlation between GA and D values in CH, BGR, TH and pons (CH, $R2 = 0.49$, $p < 0.0001$; BGR, $R2 = 0.33$, $P < 0.0001$; TH, $R2 = 0.12$, $p = 0.0014$; pons, $R2 = 0.22$, $p < 0.0001$). D values in supratentorial regions gradually increased before 29th GA and then decreased. The f values in the pons were positively related with GA ($R 2 = 0.23$, $p = 0.0325$). The f value was higher at 32-36 GA in other brain regions.

CONCLUSION

These results suggested that IVIM-DWI parameters is promising in evaluating the fetal brain development.

CLINICAL RELEVANCE/APPLICATION

no

SSE20-04 Associations Between Age-Related Neuropathology and Magnetic Susceptibility of the Human Brain

Monday, Nov. 26 3:30PM - 3:40PM Room: E350

Participants
Arnold M. Evia Jr, PhD, Chicago, IL (*Presenter*) Nothing to Disclose
Ashish A. Tamhane, MS, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Studies suggest that quantitative susceptibility mapping (QSM) may be sensitive to brain changes related to Alzheimer's disease (AD) and vascular dementia. However, these studies are typically performed with clinical diagnosis, and are susceptible to contributions from unidentified pathology. In contrast, measuring the underlying neuropathology through histology allows for an accurate assessment of neuropathologic burden. Therefore, this work investigated the associations of magnetic susceptibility with multiple age-related neuropathologies by combining ex-vivo QSM and histology in a large community cohort of older adults.

METHOD AND MATERIALS

Postmortem cerebral hemispheres were obtained from 223 participants of two longitudinal cohort studies of aging. Each hemisphere was imaged on a 3T MR scanner with 3D gradient-echo and 2D spin-echo sequences. Ex-vivo magnetic susceptibility maps were generated using the MEDI toolbox and spatially transferred to a template constructed by applying the "unbiased atlas construction via group-wise DRAMMS registration" tool to the spin-echo data. A board-certified neuropathologist, who was blinded to age and clinical diagnoses, evaluated each hemisphere for neurodegenerative and vascular pathologies: AD, Lewy bodies, hippocampal sclerosis (HS), TDP-43, arteriolosclerosis, atherosclerosis, cerebral amyloid angiopathy, gross and microscopic infarcts. Voxelwise linear regression of the participants' magnetic susceptibility values was conducted with the neuropathologies and demographics as independent variables. Statistical significance was achieved at $p<0.05$ for the FDR-adjusted p-values.

RESULTS

Significant associations were discovered between magnetic susceptibility and measures of AD, HS, arteriolosclerosis, gross and microscopic infarcts.

CONCLUSION

This work demonstrated that magnetic susceptibility shifts linked to age-related neuropathologies can be detected by QSM. Both neurodegenerative and vascular pathologies were linked to magnetic susceptibility. These findings are expected to translate well to in-vivo QSM, as it was recently shown that ex-vivo magnetic susceptibility can be linked to in-vivo magnetic susceptibility for this work's experimental setup.

CLINICAL RELEVANCE/APPLICATION

Quantitative susceptibility mapping can detect brain changes linked to age-related neuropathology, and may be a valuable diagnostic tool for age-related brain diseases.

SSE20-06 Whole Brain Structural Health in Relation to Cardiovascular Risk Factors: An Evaluation Using the Brain Atrophy and Lesion Index

Monday, Nov. 26 3:50PM - 4:00PM Room: E350

Participants
Tao Gu, MD, PhD, Beijing, China (*Presenter*) Nothing to Disclose
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Xiaowei Song, PhD,MSc, Surrey, BC (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Multiple structural changes on MRI in the brain can have interactive and additive impacts on aging and dementia. These changes can be collectively assessed using a semi-quantitative brain atrophy and lesion index (BALI). Previous studies have been focused on using the BALI to understand brain health of older adults, while it is not known how age and cardiovascular risk factors affect the accumulation of these various changes. In the present study, we address the question using a sample containing younger and middle-aged adults.

METHOD AND MATERIALS

Data of 239 subjects (men=71%; age range=20-80 years) who underwent regular health check and a routine anatomical MRI

examination in Beijing Hospital of China were analyzed. Basic demographics and traditional cardiovascular risk factors (CVRF) of the subjects were reviewed. A BALI score was generated for each subject by evaluating T2 weighted MRI at 1.5T and 3T. Mean difference in BALI total and subcategory scores between subjects of difference age and CVRF conditions were examined using t-test and ANOVA, while associations between the BALI score and age or CVFR was evaluated by correlation and regression analyses.

RESULTS

Over 89% of these subjects had at least one CVRF, while respectively 29%, 18%, 11%, 1% had two to five CVRFs. On average, older subjects had more CVRF. The BALI total score and subcategory scores were closely related to age (r's=0.41-0.69, p's<0.001). The BALI total and the categorical scores differed significantly by the number of CVRF (t's=4.16-14.83, p's<0.05). Subjects with a higher BALI score were more likely to be associated with at least one CVRF (X2's=6.9-43.9, p's<0.05). Multivariate analyses adjusting for various possible confounders demonstrated a strong impact of the CVRF on whole structural brain health as evaluated using BALI (Odds Ratio = 1.676, 95% CI=1.207-2.325), especially hypertension (OR=2.455, 95% CI=1.126-5.353), independent of the effect of age.

CONCLUSION

The accumulation of deficits in brain structure can start at a younger age. Cardiovascular risk factors play a key role in affecting such accumulation. The data emphasize the importance of early control of cardiovascular risk factors on promoting brain health in aging-and dementia.

CLINICAL RELEVANCE/APPLICATION

understand the relationship between age and whole brain structural health and how cardiovascular risk factors affect the accumulation of deficits in the brain over time using BALI

SSE21

Pediatrics (Oncology and Nuclear Medicine)

Monday, Nov. 26 3:00PM - 4:00PM Room: E353B

MR NM OI PD

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Heike E. Daldrup-Link, MD, Palo Alto, CA (*Moderator*) Nothing to Disclose
Ethan A. Smith, MD, Cincinnati, OH (*Moderator*) Travel support, Koninklijke Philips NV

Sub-Events

SSE21-01 Whole-Body Magnetic Resonance Imaging in Newly Diagnosed Langerhans Cell Histiocytosis Patients: Lesion Detectability and Risk Stratification

Monday, Nov. 26 3:00PM - 3:10PM Room: E353B

Participants
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PURPOSE

To compare lesion detectability and the accuracy of risk stratification of skeletal survey, bone scan, and whole-body magnetic resonance imaging (WB-MRI) in patients with newly-diagnosed Langerhans cell histiocytosis (LCH).

METHOD AND MATERIALS

Patients who presented with newly-diagnosed LCH and who underwent skeletal survey, bone scan, and WB-MRI (n=46) between June 2011 and April 2017 were retrospectively included. The sensitivity and mean number of false-positives per patient in the three whole-body imaging modalities (skeletal survey, bone scan, and WB-MRI) were assessed. Risk stratification was performed in each patient for each whole-body imaging modality. The reference standard for LCH lesions was histopathologic findings or clinical and imaging follow-up. The ability to detect LCH lesions and the accuracy of the initial risk stratification were compared between the three whole-body imaging modalities.

RESULTS

WB-MRI had significantly higher sensitivity (99.0%; 95% confidence interval [CI], 93.2-99.9%) than skeletal survey (56.6%; 95% CI, 46.7-66.0%; p<0.0001) and bone scan (38.4%; 95% CI, 29.4-48.3%; p<0.0001) in the detection of LCH lesions, and there were no significant differences in the number of false-positives per patient (p>0.017 for all comparisons). WB-MRI tended to have higher accuracy for the risk stratification than skeletal survey and bone scan (concordance rate of 0.98, 0.91, and 0.83, respectively), although the differences between imaging modalities were not statistically significant (overall p-value 0.066).

CONCLUSION

WB-MRI had higher detectability for LCH lesions than skeletal survey and bone scan, while the three whole-body imaging modalities had comparable accuracy in the initial risk stratification of LCH.

CLINICAL RELEVANCE/APPLICATION

WB-MRI might serve as a primary imaging modality for risk stratification in patients with initially diagnosed LCH.

SSE21-02 The Complementary Role of Early Interim PET Semi-Quantitative Metrics to Lugano Criteria in Predicting Treatment Response in Children with Hodgkin Lymphoma

Monday, Nov. 26 3:10PM - 3:20PM Room: E353B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To evaluate if adding iPET semiquantitative metrics to Lugano criteria will increase its predictability for response to therapy.

METHOD AND MATERIALS

112 children with newly diagnosed Hodgkin lymphoma between January 1, 2007 and January 1, 2017 underwent PET before treatment, after 2 cycles, and at the end of first line treatment. The diagnostic test accuracy of semi-quantitative metrics results were compared to Lugano criteria for assessment of treatment response at iPET time point to predict the final response to treatment. The standard of reference for treatment response was based on clinical assessment, imaging results at end of first line of treatment, and histopathological confirmation of residual masses. The group of patients with positive iPET as per Lugano criteria had been re-classified into positive and negative iPET as per semiquantitative metrics cut offs.

RESULTS

Using the Lugano criteria, 41 patients were positive and 71 were negative at iPET with accuracy of 70 %.Using semi-quantitative metrics, the number of positive cases decreased to 34 cases with a higher accuracy of 75%. On further analysis of the 41 positive iPET patients detected by Lugano classification, the number of positive cases decreased to 23 after applying our proposed cut offs for each of the semi-quantitative metrics. Thus,18 patients were reclassified as good responders according to semiquantitative analysis.

CONCLUSION

Semiquantitative metrics proved to be more accurate than Lugano criteria in prediction of treatment response at interim timepoint. Patients with positive iPET results according to Lugano classification may require additional evaluation using semi-quantitative metrics that classify the patients into groups with different outcomes. Larger prospective cohort and longer duration follow up is needed to support our claim.

CLINICAL RELEVANCE/APPLICATION

Therapeutic protocols for Hodgkin lymphoma have recently employed a response adapted approach with de-escalation of therapy for those patients with adequate interim response to avoid late effects of therapy. Definitions of adequate response have tended to be conservative to avoid undertreatment for a disease with excellent cure rates. The addition of semi-quantitative analysis may be helpful in therapy planning by identifying a larger pool of patients that may be eligible for de-escalation compared to the Lugano criteria.

SSE21-03 Value of Superb Microvascular Imaging in Biopsy Site Selection of Pediatric Solid Tumor

Monday, Nov. 26 3:20PM - 3:30PM Room: E353B

Participants
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PURPOSE

To investigate the value of superb microvascular imaging (SMI) in biopsy site selection in children with solid tumor.

METHOD AND MATERIALS

A total of 48 children with solid tumors scheduled for biopsy were recruited in this retrospective study with mean age 4.58±3.62y (0.08-15y). All patients underwent CDFI/ CDE and SMI to image tumor vascularity using Adler criteria for biopsy site selection. Ultrasound guided biopsy was performed targeting hyper-vascularity region on SMI within 3 days following ultrasound evaluation. Another 35 patients with mean age 5.6±3.2y (1.6-15y) underwent CDFI/ CDE targeted biopsy between July 2012 and March 2015 were served as historical control. The sample adequacy of these two groups was compared retrospectively.

RESULTS

The Adler grade of 48 solid tumors using CDFI/ CDE was as follows: 2 tumors with grade 0 (4.2%, 2/48); 16 with grade I (33.3%, 16/48); 16 with grade II (33.3%, 16/48) and 14 with grade III(29.2%,14/48). By applying SMI technology, no tumor was scored with grade 0, one patient with grade I (2.1%, 1/48), 8 with grade II (16.7%, 8/48) and 39 with grade III (81.3%, 39/48). SMI was more sensitive in imaging tumor vascularity than CDFI/ CDE ($P<0.001$). The pathologic diagnosis was confirmed in all 48 tumors evaluated with SMI technology with sample adequacy of 100% (48/48). In comparison, the pathologic diagnosis was confirmed in 31 tumors in control group with sample adequacy of 88.6% (31/35, $P=0.025$). The biopsy was sampled in necrosis regions in 4 tumors in control group, and the final pathologic diagnosis was then confirmed by further surgery.

CONCLUSION

By increasing micro vessel display, SMI technology provides a practical solution to the problem of biopsy site selection in children with solid tumor. The biopsy site selected by SMI can avoid sampling necrosis or fibrotic regions and thus improve sample adequacy.

CLINICAL RELEVANCE/APPLICATION

For children with unresectable solid tumor, biopsy pathology is the standard approach for further treatment decision. The biopsy guided by SMI can avoid sampling necrosis or fibrotic regions, and thus reduce false negative results.

SSE21-04 Does Ferumoxytol Detect Joint Infiltration of Pediatric Cancer Patients?

Monday, Nov. 26 3:30PM - 3:40PM Room: E353B

Participants
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PURPOSE

During our MR imaging evaluations of pediatric cancer patients with the iron oxide nanoparticle compound ferumoxytol (Feraheme), we observed a surprising marked T1-enhancement of the joint effusion in some patients and not others. The purpose of this study was to elucidate the underlying pathological mechanisms that lead to the observed ferumoxytol-induced indirect arthrography effect.

METHOD AND MATERIALS

We retrospectively identified 13 pediatric cancer patients and young adults (mean age 17.1 ± 4.1, 8 males, 5 females) with bone sarcomas (n=12) and desmoid tumor (n=1) who had undergone MRI scans at 1 hour (n=8), 24 hours (n=6) or 48-120 hours (n=1) after intravenous injection of ferumoxytol at a dose of 5 mg Fe/kg body weight. The patients received a whole-body MRI with T1-weighted LAVA sequences, followed by a local MRI with T1-SE, T2-FSE and LAVA sequences. 6 of the 13 patients had also received a gadobutrol (Gadavist)-enhanced MRI. 8 of the 13 tumors were resected and underwent surgical and/or histopathological evaluation of joint invasion. The signal-to-noise ratio (SNR) of tumors with and without joint invasion was compared using a t-test and a $p<0.05$.

RESULTS

At 1 hour after ferumoxytol infusion, we did not observe enhancement of joint effusions and no significant difference in SNR ($p>0.05$), regardless of tumor infiltration status. At >24 hours post-contrast, four patients showed significantly increased SNR values ($p=0.002$) of the effusion compared to muscle as an internal standard on T1-weighted images. Two of these patients were diagnosed with joint infiltration histologically while two others who did not undergo resection showed signs of joint infiltration on imaging. The other three > 24-hour scans did not show significant enhancement of the effusion and showed no joint infiltration on histology. Standard gadobutrol-enhanced MR images did not show this differential signal effect.

CONCLUSION

This pilot study suggests that ferumoxytol leak into a joint effusion might serve as an indirect indicator for joint infiltration in pediatric cancer patients. Further studies have to prove this finding in a larger cohort of patients.

CLINICAL RELEVANCE/APPLICATION

Ferumoxytol-enhanced MRI can detect joint infiltration in pediatric cancer patients.

SSE21-05 Ferumoxytol Does Not Impact SUV Values on PET/MR Scans

Monday, Nov. 26 3:40PM - 3:50PM Room: E353B

Awards
Student Travel Stipend Award

Participants
Anne M. Muehe, MD , Stanford, CA (*Presenter*) Nothing to Disclose
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Heike E. Daldrup-Link, MD, Palo Alto, CA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Accurate measurement of standardized uptake values (SUV) of tumors and normal organs in positron emission tomography (PET) is crucial for treatment response assessment of pediatric cancer patients. The iron oxide nanoparticle compound ferumoxytol can be used "off label" as a contrast agent for integrated PET/MR scans. However, ferumoxytol accumulation in the reticuloendethelial system (RES) could affect MR-based attenuation corrections of PET data. The purpose of our study was to compare SUV values of normal organs on ferumoxytol-enhanced and unenhanced 18F-FDG PET/MR scans.

METHOD AND MATERIALS

In this IRB approved prospective study, 16 children (2-18 years) with malignant tumors underwent 18F-FDG PET/MR scans (dose 3 MBq/kg) before chemotherapy with (n=8) or without (n=8) intravenous injection of ferumoxytol (5 mg Fe/kg). Patients who received ferumoxytol were age- and sex-matched with patients who received unenhanced scans. MR attenuation correction was obtained by a four-point Dixon LAVA sequence accounting for fat, air, water, and soft tissue (TR 4.2 ms, TE 1.1, 1.7, 2.3 ms, FA 5). Anatomical correlation was obtained with a high-resolution LAVA (TR 4.4 ms, TE 1.1, 1.7, 2.2 ms, FA 15). For SUV mean values of normal organs three dimensional spherical region of interests were placed with MIM software over specified regions of the brain,

parotid gland, larynx, mediastinal blood pool, thymus, myocardium, liver, spleen, bone marrow, kidney and muscle and compared with a t-test.

RESULTS

The SUV mean values of patients with and without ferumoxytol-enhanced PET/MR scans were for brain (6.5 vs 6.4, p=0.96), parotid gland (1.3 vs 1.5, p=0.49), larynx (1.4 vs 1.6, p=0.14), mediastinal blood pool (1.4 vs 1.2, p=0.33), thymus (2.0 vs 2.0, p=0.76), myocardium (1.8 vs 1.7, p=0.44), liver (1.4 vs 1.6, p=0.67), spleen (1.7 vs 1.7, p=0.92), bone marrow (1.5 vs 1.8, p=0.12), kidney (2.0 vs 1.7, p=0.34), and muscle (0.5 vs 0.7, p=0.23). None of the organs or tissues showed a statistical significant difference.

CONCLUSION

Ferumoxytol at a dose of 5 mg Fe/kg has no impact on the SUV mean values of normal organs on PET/MR.

CLINICAL RELEVANCE/APPLICATION

Ferumoxytol can be used as a contrast agent in pediatric whole body PET/MR scans without impacting the SUV values of normal tissues.

SSE21-06 Voxel-Based Volumetric Analysis of Cortical Asymmetry in Glucose Metabolism in the Developing Human Brain

Monday, Nov. 26 3:50PM - 4:00PM Room: E353B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Clinical interpretation of cerebral positron emission tomography with 2-deoxy-2[F-18] fluoro-D-glucose (FDG-PET) images often relies on evaluation of regional asymmetries. This study was designed to establish age-related variations in regional cortical glucose metabolism asymmetries in the developing human brain.

METHOD AND MATERIALS

FDG-PET scans of 58 children (age 1-18 years) were selected from a tertiary care single center pediatric PET database. All children had a history of epilepsy, normal MRI, and normal pattern of PET glucose metabolism on careful visual evaluation. PET images were analyzed objectively by statistical parametric mapping with the use of age-specific FDG-PET templates. Regional FDG uptake was measured in 35 cortical regions in both hemispheres using an automated anatomical labeling atlas, and left-to-right metabolic ratios of homotopic regions were correlated with age, gender, and epilepsy variables.

RESULTS

Regional cortical glucose metabolism was mostly symmetric in young children and became increasingly asymmetric in older subjects. Specifically, several frontal cortical regions showed an age-related increase of left>right asymmetries, while right>left asymmetries emerged in posterior cortex (including portions of the occipital, parietal and temporal lobe) in older children. Similar trends were seen in a subgroup of 39 children with known right-handedness. Age-related correlations of regional metabolic asymmetries showed no robust gender differences and were not affected by epilepsy variables.

CONCLUSION

These data demonstrate a region-specific emergence of cortical metabolic asymmetries between age 1-18 years, with left>right asymmetry in frontal and right>left asymmetry in posterior regions. These findings can facilitate correct interpretation of cortical regional asymmetries on pediatric FDG-PET images across a wide age range.

CLINICAL RELEVANCE/APPLICATION

Our findings will help in understanding the regional neurometabolic evolution and its relationship with neurocognitive development and its impairment in various neurological conditions.

SSE22

Physics (CT: QA and Protocols)

Monday, Nov. 26 3:00PM - 4:00PM Room: S504AB

CT PH SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Frank N. Ranallo, PhD, Madison, WI (*Moderator*) Grant, General Electric Company
Bob Liu, PhD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSE22-01 Improving Computed Tomography (CT) Scanning Practices in the Era of Automation

Monday, Nov. 26 3:00PM - 3:10PM Room: S504AB

Participants
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CONCLUSION

This study showed widespread vertical off-centering across all sites and for all CT protocols. The effectiveness of individualized training of technologists is demonstrated by the significant ($p < 0.0001$) reduction in cases where patients were placed vertically off-center, as compared to the insignificant reduction following the classroom style annual training.

Background

Due to technological innovations, many aspects of CT systems have become automated to optimize patient dose and image quality. However, for some CT vendors, patient centering, which is critical for the proper performance of automatic exposure control, still remains a manual task. We sought to assess the frequency of patient vertical off-centering across the institution. We also investigated the effectiveness of methods used to re-educate technologists on optimal CT imaging practices.

Evaluation

Using a commercially available automated dose monitoring system (ADMS) (Dose Watch, GE), CT scan acquisition data for all protocols was collected from 12 CT scanners beginning in January 2017. The scanners were located at the main cancer hospital (n=3) and at 6 affiliated outpatient locations (OPL)(n=9). Data on vertical centering within the CT gantry were sorted by scanner location and operator. Comparisons of vertical off-centering were made across all locations. Re-education about optimal CT imaging practices was performed with each technologist at 1 OPL. The staff at the main cancer hospital and 6 other OPL received classroom-style annual training on optimal CT imaging practices.

Discussion

During the 2nd quarter of 2017, out of a total of n = 22708 patients, 50.5% percent of patients (n=11469) undergoing CT scans were positioned vertically off-center by a range of -11.8 cm to 10.9 cm, with a median (interquartile range) of 0.818 cm (-0.491 to 2.13 cm). Of these, 34.9% (n=7921) were scanned at OPLs. After individualized re-education with technologists at one OPL, patient vertical off-centering at that site decreased by 31.8% in the 3rd quarter. For all other locations where a classroom style annual training was delivered, a reduction of 1% in vertical off-centering was observed.

SSE22-02 Optimizing CT Image Characteristics Using a Large Data Set from Annual Medical Physics Performance Evaluations

Monday, Nov. 26 3:10PM - 3:20PM Room: S504AB

Participants
Christopher Smitherman, MS, Staten Island, NY (*Presenter*) Nothing to Disclose
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PURPOSE

This work determines typical image reconstruction and display settings for CT imaging and compares them to the reference values published by the AAPM.

METHOD AND MATERIALS

Scan protocol parameters were collected from reports of 100 annual CT scanner medical physics surveys in two states for adult head and abdomen and pediatric head and abdomen protocols per the ACR accreditation procedures. Data collection spanned academic and community hospitals and freestanding imaging centers; the data set includes pooled data collected by academic and consulting medical physicists. Reconstruction kernel/algorithm, image thickness, and image interval were tabulated for four protocols for all scanners; subgroups were analyzed to compare scanner manufacturers and different types of imaging facilities. Values were compared to reference protocols published by AAPM and recommended and required parameters given in the ACR CT Accreditation Clinical Image Quality Guide.

RESULTS

Protocols for CT scanners at ACR-accredited facilities adhered to the maximum slice width values specified by the ACR accreditation program. There was variability in adherence to AAPM-recommended reference parameters, ranging from 80% agreement for adult head protocols to 44% agreement for pediatric abdomen protocols. There was wide variation in the chosen reconstruction algorithm; subgroups were used to compare protocols within each manufacturer since direct comparison between different manufacturers' proprietary algorithms was not possible within the scope of this work.

CONCLUSION

There is substantial variation in image reconstruction parameters among ACR-accredited CT facilities that conform to ACR requirements. These parameters impact key image quality characteristics and radiation doses used for imaging, so appropriate choices are crucial to achieving optimization of imaging. Further work is needed to understand the nature of the deviation between the data collected at clinical sites and the AAPM reference protocols; while the AAPM protocols were published relatively recently, it is not clear whether the standard practice reflects changes that run ahead of updates to the AAPM protocols or whether the community is lagging in adopting the AAPM recommendations.

CLINICAL RELEVANCE/APPLICATION

This work validates reference CT protocols against protocols used in real imaging departments. Deviations from reference protocol can be used in troubleshooting image quality.

SSE22-03 CT Resolution, Noise, and Dose Reference Levels Across a Multi-Center Patient Population

Monday, Nov. 26 3:20PM - 3:30PM Room: S504AB

Participants
Taylor Smith, Durham, NC (*Presenter*) Nothing to Disclose
Francesco Ria, DMP, Durham, NC (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The diagnostic reference level (DRL) is useful as a first-order tool to compare radiation exposures of one's imaging clinic against those of one's peers in computed tomography. Ria et al. have advocated for the addition of a Noise Reference Level (NRL), Noise Reference Range (NRR), a Dose Reference Level (DoRL) and a Dose Reference Range (DoRR) as a means of extending the first steps of optimization of clinical operation to image quality in addition to radiation exposure (ICRP 135). In this work, we investigate and establish another reference level, for the case of resolution, called the Resolution Reference Level (RRL) and Resolution Reference Range (RRR).

METHOD AND MATERIALS

Over 10000 anonymized scans were sampled from 109 institutions in the United States which represented 13 large (estim. > 36,000 scans/yr), 32 medium (6000 - 36,000), 64 small (< 6000) imaging centers. CTDIvol, Noise and resolution (MTF) were measured for chest and abdominopelvic (AP) helical single-acquisitions of the trunk (extremity/head scans, multiple reconstructions excluded). Noise was taken as a modified version of the Global Noise Level measured in air. MTFs were measured from the air-skin interface. Patients were binned by their effective diameter. DoRL, NRL, and RRLs were measured for each size bin. Reference Levels for each were defined as the median values. Reference Ranges were defined as interquartile intervals.

RESULTS

Measurements of the f50 MTF in AP exams in all sizes had RRR lower bounds from 0.33 - 0.42 mm^{-1}. The RRR upper bounds for these exams ranged from 0.38 - 0.46 mm^{-1}. In chest exams these ranges were from 0.39 - 0.42 mm^{-1} and 0.45 - 0.46 mm^{-1} respectively. The lower bound of DoRR in the AP exams in all sizes ranged from 5.3 - 11.2 mGy. The upper bounds of DoRR ranged from 7.4 - 16.5 mGy. In chest exams these lower and upper bounds of the DoRR ranged from 5.4 - 11.5 mGy and 7.5 - 14.4 mGy.

CONCLUSION

An extension to the reference level methodology has been proposed. With this new RRL and RRR, and existing NRL, NRR, DoRL, and DoRR, a clinic can begin to make holistic decisions regarding population-based imaging-protocol adjustments with consideration to dose, noise, and resolution.

CLINICAL RELEVANCE/APPLICATION

This work extends the notion of NRL to the assessment of resolution. It represents a more generalizable sampling, with more vendors and kernels, and an order of magnitude increase in population.

SSE22-04 Image Quality Metric Extraction Based on Machine Learning Techniques for Clinical CT Protocol Optimization

Monday, Nov. 26 3:30PM - 3:40PM Room: S504AB

Participants
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PURPOSE

To extract standard image quality metrics (image noise and spatial resolution) directly from clinical CT images using machine learning techniques. This capability is desired to guide optimization and customization of clinical protocols to achieve desired diagnostic image quality and clinical task performance.

METHOD AND MATERIALS

For training and testing of the machine learning networks, we acquire a series of clinical datasets and use post-processing techniques to generate datasets with various noise levels and various spatial resolution levels. We use the full-width-at-half-maximum (FWHM) of the point spread function (PSF) as spatial resolution metric and the standard deviation of the noise as image noise metric. 9 cardiac acquisitions with 224 images are post-processed to create various (5) levels of blurring, resulting in a combined training and test set of 10,080 images. We use both feature-based machine learning techniques and deep convolution neural networks (CNN) to execute supervised learning to estimate traditional analytic IQ metrics such as noise and spatial resolution. For example, to demonstrate the feasibility of the framework, we selected and implemented random forest regression approach for the supervised learning task. 7 features are extracted from the raw image and 8 features are extracted from the edge map. We extend this framework to deep convolution neural network (CNN) based machine learning method using Keras

RESULTS

Mean and standard deviation of estimation error is (0.0003mm, 0.0352mm) where true FWHM was emulated at [0.66mm, 1.174mm]. The figure below shows two example results: (a) an emulated image with a FWHM of 0.77 mm and the corresponding estimated FWHM has an error of 1.6%; (b) an emulated image with a FWHM of 1.02 mm and the corresponding estimated FWHM has an error of 4.7%.

CONCLUSION

It is feasible to extract image quality directly from clinical images. Both feature-based machine learning techniques and deep learning techniques are implemented and evaluated. Preliminary results show an accurate estimation of image quality with average errors of 3%.

CLINICAL RELEVANCE/APPLICATION

IQ estimation directly from clinical images is a critical enabler to guide optimization and customization of clinical protocols to achieve desired diagnostic image quality and clinical task performance.

SSE22-05 Predicting Major CT Scanner Failures Using Routine Quality Control Data

Monday, Nov. 26 3:40PM - 3:50PM Room: S504AB

Participants
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PURPOSE

Data collected for daily equipment quality control (QC) on computed tomography (CT) scanners contain patterns that may predict near term failure of major scanner components. Such defects are usually time consuming and hamper significantly the clinical workflow. The purpose of this study is to identify, from determinable QC parameters, the key performance values that can predict scanner hardware failure.

METHOD AND MATERIALS

Our retrospective review included 37 CT scanners from four different manufacturers. Available QC data for all CT scanners included the daily records of mean and standard deviation (SD) of the CT number (HU) using the manufacturer's factory water phantom and a custom scan protocol. Data was stored in a cloud-based compliance solution and monitored using statistical process control according to our institution protocol. We identified two identical clinical CT units that had tube replacement within the last year. We collected the SD values over three month period before and after the replacement date. We then calculated the mean SD values before and after the repair for both units. We also determined pre- and post-repair cumulative SD and cumulative SD error relatively to each scanner mean SD.

RESULTS

The mean SD of the CT numbers (HU) before and after the tube replacement for CT1 were respectively 5.75 and 5.33 (Ratio=1.078) and for CT2 5.92 and 5.48 (Ratio=1.080). Pre-repair cumulative SD and cumulative SD error for CT1 were 517 and 745% and for CT2 538.9 and 842%. Post-repair cumulative SD and cumulative SD error for CT1 were 463.5 and 271% and for CT2

460.5 and 277%. The pre- and post-repair cumulative SD and SD error satisfy a linear model curve that correlates the QC measurements with the tube defect of both CT units.

CONCLUSION

Daily scanner HU noise values are insufficient to anticipate a major defect. However, a three-month cumulative SD and SD error above 500 and 700% respectively can predict failure of the tube component. Future studies are needed to highlight the possible use of such observed trends to predict impending failures. Thus, collection of data in an electronic database for a large scanner fleet would allow early intervention ultimately improving patient care.

CLINICAL RELEVANCE/APPLICATION

To our knowledge, this study is the first to introduce the cumulative SD and cumulative SD error as a predictive tool of a major CT performance failure.

SSE22-06 Realism and Potential of Population-Based Virtual Clinical Trials in Computed Tomography: Are We There Yet?

Monday, Nov. 26 3:50PM - 4:00PM Room: S504AB

Participants
Ehsan Abadi, Durham, NC (*Presenter*) Nothing to Disclose
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PURPOSE

Medical imaging systems are currently evaluated using either physical phantoms or patient images, both with limitations. Physical phantoms are generally simplistic, not representative of a human population, and thus limited to fully reflect task-based or patient-specific assessments. Patient images are ground truth-limited, expensive, and ethically unattainable in repetitive studies. Virtual clinical trial (VCT), defined as conducting clinical experiments using realistic simulations, can overcome these challenges. This work aimed to develop a comprehensive package to conduct realistic VCT using realistic human models with known ground truth and representative CT imaging conditions.

METHOD AND MATERIALS

A realistic VCT requires two main toolsets: computational anthropomorphic phantoms and scanner simulators. We developed a series of high-resolution phantoms including highly detailed intra-organ anatomies. We also developed a rapid, realistic, and scanner-specific CT simulator to image the phantoms. Our simulator included geometry and physics (spectrum and bowtie filter) of commercial scanners, axial/helical trajectories, focal spot wobbling, poly/monochromacity, noise and detector response characteristics, scatter, tube current modulation, beam hardening correction, and a commercial processing box for scanner-specific reconstructions. Two pilot VCTs were performed: characterizing noise across reconstruction algorithms, and quantifying information loss as a function of beam collimation and pitch values.

RESULTS

Our simulator produced CT images with NPS, MTF, and HU values close to real CT scans of same physical phantoms, under different acquisition settings and reconstruction kernels. The pilot VCT showed that iterative images have non-stationary noise texture with higher noise magnitude in the edges.

CONCLUSION

We developed a package that conducts VCTs in the context of CT imaging and demonstrated its applicability in clinical studies where those studies need realistic heterogeneous models and repetitive measurements and therefore unattainable using physical phantoms or patient images. Our tool enables the imaging scientists and clinicians to explore and optimize the imaging systems more comprehensively.

CLINICAL RELEVANCE/APPLICATION

A realistic virtual clinical trial enables the medical imaging community to conduct clinically-relevant experiments that are impossible to perform using patient images or physical phantoms.

SSE23

Physics (Breast X-Ray Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: S502AB

AI BR PH SQ

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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Hilde Bosmans, PhD, Leuven, Belgium (*Moderator*) Co-founder, Qaelum NV Research Grant, Siemens AG

Sub-Events

SSE23-01 Radiation Dose Reduction in Digital Breast Tomosynthesis (DBT) by Means of Neural Network Convolution (NNC) Deep Learning

Monday, Nov. 26 3:00PM - 3:10PM Room: S502AB

Participants
Junchi Liu, MS, Chicago, IL (*Abstract Submitter*) Nothing to Disclose
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PURPOSE

To reduce cumulative radiation exposure and lifetime risks for radiation-induced cancer from breast cancer screening, we developed novel NNC deep learning for radiation dose reduction in DBT.

METHOD AND MATERIALS

Our original NNC deep learning employed patched-based neural network regression in a convolutional manner to convert lower-dose (LD) to higher-dose (HD) tomosynthesis images. We trained NNC with quarter-dose (25% of the standard dose: 12mAs at 32kVp) raw-projection images and corresponding "teaching" higher-dose (HD) images (200% of the standard dose: 99mAs at 32kVp) of a breast cadaver phantom acquired with a DBT system (Selenia Dimensions, Hologic). Once trained, NNC no longer requires HD images. It converts new LD images to images that look like HD images; thus the term "virtual" HD (VHD) images. We reconstructed tomosynthesis slices on a research DBT system. To determine a dose reduction rate, we acquired 4 studies of another test phantom at 4 different doses (1.35, 2.7, 4.04, and 5.39mGy entrance dose). Structural SIMilarity(SSIM) index was used to evaluate the image quality. For further testing, we collected half-dose (50% of the standard dose: 32±14 mAs at 33±5 kVp) and full-dose (100% of the standard dose: 68±23mAs at 33±5kvp) images of 51 clinical cases with the DBT system at Univ. of Iowa Hospitals & Clinics. We evaluated resulting images in a blinded observer study with 35 breast radiologists to rate and distinguish blinded VHD and real full-dose DBT images.

RESULTS

NNC converted quarter-dose images (1.35mGy; SSIM: 0.88) of the testing cadaver phantom to VHD images with image quality (SSIM:0.97) equivalent to 119% dose images (6.41mGy), achieving 79% dose reduction. In our blinded observer study, 21(60%) of 35 breast radiologists either preferred VHD images over real full-dose images or could not distinguish between the two. The difference in image quality between the two was not statistically significant (P=0.37). The time required to process each study was 0.48 sec. on a GPU (GTX Titan Z, Nvidia).

CONCLUSION

Blinded observer study with 35 radiologists demonstrated that VHD images converted by our deep-learning technology were equivalent to full-dose DBT images. Our cadaver phantom experiment demonstrated 79% dose reduction.

CLINICAL RELEVANCE/APPLICATION

Substantial radiation dose reduction would benefit patients by reducing the lifetime risk of radiation-induced cancer from DBT screening.

SSE23-02 Centralized Physics QC Program for the ECOG-ACRIN TMIST Trial of Breast Tomosynthesis

Monday, Nov. 26 3:10PM - 3:20PM Room: S502AB

Participants
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PURPOSE

To describe and provide preliminary results from a remote-monitoring QC program developed to provide assessment of quality and rapid feedback in a screening trial. The program is being used in the randomized TMIST trial of screening with breast tomosynthesis versus digital mammography. TMIST is expected to include 125 sites in the US and Canada and will recruit 164,986 women who will be imaged up to 5 times over 4 years.

METHOD AND MATERIALS

The QC program is based on imaging of phantoms by the technologist at each site and digital transmission to a central analysis server. Phantoms assess signal and noise properties, artifacts, spatial resolution and geometric fidelity of the imaging system. The analysis is performed automatically with results made available to technologists on a password protected web site. Technical information from the DICOM header, stripped of personal identifiers, from every clinical image is available for analysis of doses, exposure factors and compression parameters..

RESULTS

As of April 2018, initial QC data from 87 units at the first 29 TMIST sites were available, including de-identified screening mammogram header data from 60 units at the first 25 sites. The most frequent technical problems were due to electronic interference, dustlike artifacts and the compression force being reported in the header as '0. Problems were also noted due to duplication of image submission from the same individual as separate cases and noncompliance with the QC protocol. In addition, it was noted that digital detectors were occasionally replaced without technical documentation. This was accompanied by changes in signal-to-noise performance. Based on 881 examinations, the mean dose (CC + MLO) was 4.2 mGy for 2D digital mammograms and 8.2 mGy for tomosynthesis. The presentation will report on results up to November, 2018.

CONCLUSION

Use of a centralized remote data collection QC system reduces technologist labor at the site and reduces subjectivity in testing. This approach enables consistent analysis and rapid reporting of QC results.

CLINICAL RELEVANCE/APPLICATION

Sensitivity and specificity of breast cancer detection depend critically on the technical image quality. The credibility of the results from the TMIST trial requires that the image quality of both modalities is verified. In addition, experience from this trial will provide data to help define the essential elements of the standard QC program for tomosynthesis.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ruth C. Carlos, MD, MS - 2015 Honored EducatorRuth C. Carlos, MD, MS - 2018 Honored Educator

SSE23-03 Visual Grading Characteristics Analysis of Propagation-Based X-Ray Phase Contrast Mammography

Monday, Nov. 26 3:20PM - 3:30PM Room: S502AB

Participants
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PURPOSE

While all current x-ray based breast imaging modalities rely on minimal differences in soft tissue x-ray attenuation (absorption contrast), phase-contrast imaging has the capacity to also visualise variations in x-ray refraction (phase contrast). For x-ray energies typically used in breast imaging, the phase contrast can be substantially larger than the absorption contrast, presenting an opportunity to improve soft tissue visualisation especially in mammographically dense breasts. The goal of this study was to evaluate the radiological quality of images produced by the x-ray propagation-based phase-contrast computed tomography (PB-CT) technique at two different x-ray energies in comparison to absorption-based CT images collected at the same radiation dose (4 mGy).

METHOD AND MATERIALS

Twenty-seven synchrotron-based CT images of a full-size breast mastectomy specimen were reconstructed. Nine images were absorption-based CT at 32 KeV, nine images were PB-CT at 32 KeV and nine were PB-CT at 38 KeV. A group of breast specialist radiologists and medical imaging experts compared the radiological quality of the three sets of images based on various image quality criteria. Visual grading characteristics (VGC) analysis was conducted and VGC curves were obtained. The area under the VGC curve (0<=AUCVGC<=1) was calculated as the measure of the difference in image quality between two compared sets of images.

RESULTS

The results show that the radiological quality ratings of PB-CT 32 KeV images were significantly higher than absorption-based CT images (AUCVGC=0.879, p<=.001) and PB-CT 38 KeV images (AUCVGC=0.795, p<=.001). The image quality ratings were not significantly different between PB-CT 38 KeV images and absorption-based CT images (AUCVGC=0.567, p=.076).

CONCLUSION

Phase-contrast PB-CT mammography can be used to produce images with substantially higher radiological quality compared to conventional absorption-based images, but this advantage appears to be dependent on beam energy. The results from this study should provide a strong basis for future experimental and clinical protocols for further optimisation of this novel and promising approach to breast imaging.

CLINICAL RELEVANCE/APPLICATION

PB-CT of the breast is expected to deliver improved image quality compared to current x-ray modalities and become a viable method for early diagnosis of breast cancer in the future.

SSE23-04 Evaluation of American College of Radiology (ACR) Mammography Accreditation Phantom Image Quality of a Grid-Less and Software-Based Scatter Correction Technology

Monday, Nov. 26 3:30PM - 3:40PM Room: S502AB

Participants
Anzi Zhao, MS, Cleveland, OH (*Presenter*) Nothing to Disclose
Katie Hulme, MS, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the quality of ACR mammography accreditation phantom images acquired with a grid-less and software-based scatter correction technology - Progressive Reconstruction Intelligently Minimizing Exposure (PRIME).

METHOD AND MATERIALS

3 Siemens Mammomat Inspiration units with PRIME were utilized in this study. The same ACR phantom was imaged on all units. 20 2D phantom images were acquired on each unit using a phototimed technique (W/Rh, 28kVp, AEC segmentation off, dose level 'normal', exam tag 'QC RAW'), of which 10 were acquired with grid in position and 10 were acquired with PRIME. Mode of acquisition was varied in a random order. 10 additional PRIME images were acquired on one unit with a resolution test pattern to assess spatial resolution. Contrast-to-noise ratio (CNR), signal-to-noise ratio (SNR), and standard deviation (SD) of phantom images were evaluated using the method in Siemens quality control manual. Incident air kerma and average glandular dose (AGD) were measured and calculated for each exposure. A total of 60 phantom images were scored by 4 qualified medical physicists and 2 experienced mammography technologists on a diagnostic workstation in clinical viewing conditions, and using ACR phantom evaluation guidelines with demographics hidden.

RESULTS

With PRIME, all images failed CNR criteria (>=2) with significantly lower CNR and higher SD than grid-based images by as much as 43% and 23%, respectively; SNR was reduced by 2-4%; spatial resolution was unaffected at 7 mm/lp; AGD was reduced by up to 16%. Visual scoring by 6 viewers resulted in no significant difference between the two types of images. Minor degradation on average score of masses on PRIME images compared to grid-based images (4.1 vs 4.2) was noted on one unit. All viewers agreed on the notable difference in image appearance and noise texture when PRIME was employed.

CONCLUSION

PRIME didn't penalize ACR phantom scoring, although there was a significant degradation of CNR on PRIME images because of the increased noise. The clinical implications of differences in noise texture warrant further investigation. Although PRIME offers moderate dose savings, clinicians should still be aware of potential effects on image appearance.

CLINICAL RELEVANCE/APPLICATION

PRIME technology corrects scatter radiation and enables grid-less full-field digital mammography at lower patient average glandular

PRIME technology corrects scatter radiation and enables grid-less full field digital mammography at lower patient average glandular dose, with comparable image quality.

SSE23-05 Mammographic Compression Variability Increased after Removing Real-Time Pressure Indicator

Monday, Nov. 26 3:40PM - 3:50PM Room: S502AB

Participants
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CONCLUSION

When replacing a paddle with a pressure indicator, in a group of technicians familiar with the indicator, by a conventional paddle, the variability increased significantly leading to more unfavorable over- and under-compression.

Background

A certain level of breast flattening in mammography is needed to obtain a high quality image. Generally accepted and quantifiable standards do not exists. Recent studies show that the level of compression pressure at exposure influences screening performance. Attempts are made to standardize the compression procedure by introducing pressure-based compression using a paddle equipped with a real-time pressure indicator. We aimed to study the impact on compression practice when replacing the pressure-based paddle with a conventional paddle without pressure indication in group experienced technicians.

Evaluation

Mammographic compression pressure was retrospectively obtained from mammographic images (VolparaAnalytics) and evaluated in two datasets from the same radiology department with the same technician team. The first dataset (4 years, n=11.561 compressions) was collected when using a compression paddle equipped with a real-time pressure indicator aiming for a 10kPa (75mmHg) compression pressure. The second dataset (3 months, n=1331 compressions) was collected 4 months after the mammography system with pressure indicator was replaced by a system without pressure indicator. The average compression pressure and variance significantly ($P<0.001$) increased from 11.23 ± 0.04 kPa to 11.60 ± 0.14 kPa (mean ± SEM) after removal of the pressure indicator. The proportion of compressions in the pressure range 5-15 kPa decreased from 87.4% to 77.9%. The proportion of high pressures (>15kPa) almost doubled (11.0% to 18.8%) and low pressures (<5kPa) more than doubled (1.6% to 3.3%).

Discussion

When removing the pressure indicator, the initially low variability is increasing rapidly, indicating that an indicator is needed to remain high compression reproducibility. An increase in over- and under-compression can ultimately lead to decreased mammographic performance.

SSE23-06 Development of Low Dose Digital Mammography Platform by Image Reconstruction Using Deep Learning Algorithm: A Preliminary Study

Monday, Nov. 26 3:50PM - 4:00PM Room: S502AB

Participants
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PURPOSE

To investigate whether low dose mammography can be reconstructed to standard dose mammography using the new deep learning algorithm.

METHOD AND MATERIALS

14 specimens from 14 patients who underwent total mastectomy for primary breast cancer were included. Specimen mammograms were obtained with standard routine dose and reduced sequential doses; 80% of routine dose, 60%, 40%, 20% and 10%. The proposed de-noising method is designed based on semi-supervised learning with cycle consistency loss. Most of the mammography has Automatic Exposure Control (AEC) system which chooses an appropriate current X-ray source. The routine dose and 20% dose level images were selected as training dataset. Since the noise levels between two images are different and unavoidable slight mismatch due to potential deformation between multiple acquisitions, we developed the semi-supervised learning using cyclic consistency. We trained two generators (network G and F) and two discriminators (network Dx and Dy). Since we had 14 datasets, we performed cross-validation. Last, image quality of reconstructed low dose image was compared with the standard full dose image and was qualitatively rates as follows; 1= poor, 2= fair, 3= equal, 4=better.

RESULTS

As more radiation dose was decreased, noise was increased and contrast resolution was decreased accordingly. However, in the reconstructed images, noise was decreased and contrast resolution was rather improved. Overall, when we evaluated the lesions according to Breast imaging-reporting and data system lexicon, and with consideration of underlying breast parenchyma density,

the reduced dose of 20% cut-off of standard full dose showed no significant difference in image quality compared with standard dose mammography.

CONCLUSION

The image quality of reconstructed low dose mammography using the new deep learning algorithm is comparable with standard dose mammography until dose reduction cut-off 20% of standard full dose. Therefore, the radiation dose of mammography could be considerably reduced using this deep learning algorithm.

CLINICAL RELEVANCE/APPLICATION

Image reconstruction using the new deep learning algorithm is effective in dose reduction of mammography, especially in young women with high risk who are routinely examined with mammography for screening.

SSE24

Physics (MR: Diffusion and Susceptibility Imaging)

Monday, Nov. 26 3:00PM - 4:00PM Room: S504CD

MR 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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Sub-Events

SSE24-01 A Preliminary Study of Incoherent Motion Diffusion Weighted Imaging (IVIM) in the Curative Effect Evaluation of Diabetic Nephropathy

Monday, Nov. 26 3:00PM - 3:10PM Room: S504CD

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PURPOSE

To investigate the change of IVIM quantitative parameters before and after clinical treatment of patients with diabetic nephropathy, and objectively evaluate the clinical therapeutic effects of patients with diabetic nephropathy.

METHOD AND MATERIALS

20 patients(average age 56.60±9.38)with diabetic nephropathy who were diagnosed with diabetic nephropathy and received systemic hospitalization were selected. The clinical symptoms of the patients after treatment were significantly improved. The IVIM(b=0,50,100,150,200,400,600,800sec/mm²) and Diffusion weighted imaging(DWI,b=50,800 sec/mm²) sequence were obtained on a 3T scanner(Skyra, Siemens Healthineers). A total of 12 regions of interest were mapped in the cortex and medulla region of the upper pole, the renal hilum and the lower pole of the kidneys, and the results were averaged to obtain the measurement results.ADC map was automatically generated on the Siemens MRWP workstation after DWI sequence executed. IVIM parameters(ADC,D,f, and D* values) were generated by using a prototype software body diffusion toolbox(Siemens healthineers).Paired-sample t-test was used to compare changes in renal cortex and medulla ADC, D, f, and D* values before and after treatment in patients with diabetic nephropathy.

RESULTS

Compared to pre-treatment, ADC, D, f, and D* values of both kidney and medulla in patients with diabetic nephropathy were significantly higher ($p < 0.0001$) (Figure 1,Table 1).

CONCLUSION

IVIM is feasible for the evaluation of the efficacy of diabetic nephropathy, and it is helpful for the monitoring of clinical efficacy.

CLINICAL RELEVANCE/APPLICATION

IVIM responds to changes in the microstructure of the tissue, more scientific and objective assessment of clinical efficacy of diabetic nephropathy, with potential clinical application value.

SSE24-02 Diffusion-Weighted Imaging and Diffusion Kurtosis Imaging in the Diagnosis of Prostate Cancer: A Preliminary Retrospective Study

Monday, Nov. 26 3:10PM - 3:20PM Room: S504CD

Participants
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PURPOSE

This study explored and compared the value of DKI with DWI in distinguishing prostate cancer from non-cancer tissues and compared their performances in the peripheral zone and the central lobe.

METHOD AND MATERIALS

A retrospective review was performed in 212 consecutive patients who underwent examination on a clinical 3T MR scanner , and all patients were confirmed by pathology. A multi-b DWI sequence was performed with the following parameters: TR/TE = 5100/89ms, FOV = 280x224 mm2, scan,slice thickness = 4mm, slice number = 20, bandwidth = 1755Hz/Px, iPAT factor = 2, b-values =0, 500, 1000, 1500, 2000 mm2/s, scan time = 4min10s. Mean kurtosis (MK), mean diffusivity (MD) derived from DKI and apparent diffusion coefficient (ADC) derived from conventional DWI were calculated and analyzed by using an in-house-developed software based on MATLAB (Mathworks, Natick MA). The diagnostic accuracy of MK, MD and ADC values was evaluated with sensitivity, specificity, and area under receiver operating characteristic (ROC) curve (AUC). Student's t-test and ROC curves were used for statistical analysis.

RESULTS

There was a significant difference between non-cancerous tissues in the peripheral zone and central lobe (P <0.001) for MK, MD and ADC; while these parameters show no significant difference between prostate cancers in the peripheral zone and the central lobe (p>0.05). For the peripheral zone, MK, MD and ADC had sensitivities of 0.980, 0.983, 0.993, specificities of 0.994, 0.988, 0.993, and AUCs of 0.9996, 0.9993, 0.9998 when using cutoff values of 0.701, 1.693x10-3mm2/s, and 1.141x10-3mm2/s, respectively. While for the central lobe, the diagnostic performance of MK, MD and ADC dropped and got sensitivities of 0.785, 0.843, 0.855, specificities of 0.983, 0.978, 0.981, and AUCs of 0.9430, 0.9571, 0.9569, when the cut-off points were 0.829, 1.527x10-3mm2/s, 0.997x10-3mm2/s, respectively.

CONCLUSION

DKI and DWI may depict microstructure changes of prostate cancer, and can potentially provide quantitative information for the prostate tissue and have similar good diagnostic performance to distinguish prostate cancer from non-cancer tissues. the diagnosis values in the peripheral zone were slightly better than in the central lobe.

CLINICAL RELEVANCE/APPLICATION

DKI and DWI both could be used in clinical for distinguishing prostate cancer from non-cancer tissues, and would lead to a substantial improvement in the diagnosis of prostate cancer.

SSE24-03 The Susceptibility of Thrombus in Middle Cerebral Artery Predicts Prognosis by Quantitative Susceptibility Mapping

Monday, Nov. 26 3:20PM - 3:30PM Room: S504CD

Participants
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CONCLUSION

The susceptibility remained consistent regardless the location, thrombus length and onset time, which indicated that the thrombus composition was similar when detected on SWI. Susceptibility, thrombus length and CBS could predict clinical severity and short-term clinical prognosis.

Background

The quantitative susceptibility mapping(QSM) is used to evaluate susceptibility, length of thrombus and clot burden score (CBS) in the middle cerebral arterial.

Evaluation

To explore the relationship between thrombus and cerebral infarction and to early clinically prognose patients with acute cerebral infarction by QSM. We analyzed the data of 73 patients with acute cerebral infarction who had unilateral middle cerebral arterial occlusion on time of flight magnetic resonance angiography (TOF-MRA), and had the corresponding susceptibility vessel sign (SVS) on susceptibility weighted imaging (SWI). Susceptibility, length of CBS were evaluated based on QSM. The relationships between susceptibility and thrombus length, CBS, DWI-ASPECTS, admission and discharge National Institutes of Health stroke scale (NIHSS) were analyzed. The susceptibility among different locations and different segments of the thrombi did not achieve statistically difference(All p>0.05). The susceptibility and length were negatively correlated with DWI-ASPECTS (R2=0.045,0.186, p=0.034,0.000) and positively correlated with admission NIHSS(R2=0.058,0.067, p=0.014,0.015). The susceptibility was positively correlated with discharge NIHSS(R2=0.096, p=0.036). CBS was negatively correlated with thrombus length, admission and discharged NIHSS (R2=0.177,0.133,0.042, p=0.000,0.006,0.019) and positively correlated with DWI-ASPECTS(R2=0.107, p=0.002).

Discussion

There were two main findings in this study. First, all the susceptibility remained consistent regardless of the different segments, locations and onset time. Second, susceptibility, length of thrombus and CBS correlated to the extent of cerebral infarction, and they could all independently predict clinical severity and short-term clinical prognosis apart from the effect of length of MCA thrombus to the discharge NIHSS.

SSE24-04 Optimization and Clinical Evaluation of Wave-CAIPI Susceptibility-Weighted Imaging (SWI) for Detection of Intracranial Hemorrhage

Monday, Nov. 26 3:30PM - 3:40PM Room: S504CD

Awards
Student Travel Stipend Award

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PURPOSE

To characterize image quality and accuracy of highly accelerated Wave-CAIPI SWI compared to standard 3D SWI and 2D gradient-echo (GRE) for detection of intracranial hemorrhage.

METHOD AND MATERIALS

Optimization: Wave-CAIPI SWI was evaluated on a 3T Prisma MR scanner (Siemens, Erlangen) using 6-fold (acquisition time TA=1.5 min) and 9-fold (TA=1 min) acceleration on commercially available 20-channel and 32-channel RF coils. SNR was evaluated as a function of acceleration factor and head position in a healthy subject using the multiple acquisition method (NEX=10). *Clinical evaluation:* Wave-CAIPI SWI was prospectively compared to standard 3D SWI (TA=4.5 min) or 2D GRE (TA=2.3 min) for 63 consecutive patients undergoing clinical brain MRI. Two radiologists evaluated all images for the presence of hemorrhage, number of hemorrhagic foci, motion artifacts, and subjective image quality.

RESULTS

Adequate SNR (>30) was achieved in the central brain using 9-fold acceleration on the 32-channel coil and 6-fold acceleration on the 20-channel coil. Wave-CAIPI SWI was compared to standard SWI for 33 patients and 2D GRE for 30 patients. Inter-rater reliability was almost perfect for presence of hemorrhage (κ=0.92) and number of hemorrhages (κ= 0.89), substantial for motion artifact (κ=0.69), and modest for subjective image quality (κ=0.50). Motion artifacts in Wave-CAIPI SWI were less severe than standard SWI (p<0.01). Wave-CAIPI and standard SWI provided 100% agreement for presence of hemorrhage (13 of 33 patients). In two cases, additional hemorrhagic foci were detected on Wave-CAIPI SWI which were obscured by motion on the standard SWI. Wave-CAIPI SWI identified presence of hemorrhage in 13 of 30 patients compared to 11 of 30 patients for 2D GRE. In 6 cases, additional hemorrhagic foci were identified on Wave-CAIPI SWI that were not seen on the 2D GRE sequence. Subjective image quality was higher for Wave-CAIPI SWI than 2D GRE (p<0.01), and was not significantly different between Wave-CAIPI and standard SWI.

CONCLUSION

A 1 minute Wave-CAIPI SWI acquisition is comparable to a 4.5 minute resolution-matched standard SWI sequence and superior to a 2.3 minute 2D GRE sequence for detection of intracranial hemorrhage.

CLINICAL RELEVANCE/APPLICATION

Wave-CAIPI SWI may be useful to shorten clinical brain MR protocols, especially in motion prone populations. Acceleration should balance scan time with acceptable SNR for a given hardware configuration.

SSE24-05 5D Relaxation-Diffusion Tensor Correlation MRI for Model-Free Quantification of Microscopic Heterogeneity of Brain Tissue

Monday, Nov. 26 3:40PM - 3:50PM Room: S504CD

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PURPOSE

Conventional quantitative MRI yields voxel-average relaxation rates and diffusion tensors that are difficult to interpret in terms of chemical composition and microstructure whenever the voxels contain more than one tissue type such as white matter (WM), gray matter (GM), cerebrospinal fluid (CSF), and tumor. Here we introduce a method to quantify per-voxel heterogeneity as joint relaxation and diffusion tensor distributions.

METHOD AND MATERIALS

We propose a data acquisition protocol and inversion procedure to estimate nonparametric 5D joint distributions with the dimensions transverse relaxation rate R2, isotropic diffusivity, normalized diffusion anisotropy, and diffusion tensor orientation (two dimensions). A healthy volunteer was scanned on a Siemens Prisma 3T system using a diffusion-weighted EPI sequence customized for variable echo times and tensor-valued diffusion encoding, giving a 5D acquisition space with dimensions directly corresponding to the ones of the sought-for distributions. A total of 852 images were acquired at 2x2x6 millimeter spatial resolution, 110x110 matrix size, 11 slices, and a total scan time of 45 min without using simultaneous multislice. Per-voxel distributions were obtained by unconstrained Monte Carlo inversion including uncertainty estimation.

RESULTS

Voxels containing pure WM, GM, or CSF give nearly single-mode distributions (WM: high R2, low diffusivity, high anisotropy; GM: high R2, low diffusivity, low anisotropy; CSF: low R2, high diffusivity, low anisotropy), while voxels with binary mixtures yield the corresponding bimodal distributions. Component-resolved maps of signal amplitude, R2, diffusivity, anisotropy, and orientation for the WM, GM, and CSF fractions are obtained by binning and parameter calculation in the 5D distribution space.

CONCLUSION

Our image acquisition protocol and model-free data inversion procedure yields per-voxel quantification of distinct tissue types without relying on assumptions about the number or properties of the individual components.

CLINICAL RELEVANCE/APPLICATION

The new method is expected to be useful for pathological conditions associated with sub-voxel tissue heterogeneity, e.g. tumor infiltration in surrounding brain tissue or replacement of myelin with free water.

SSE24-06 Susceptibility Artifact on Diffusion-Weighted Imaging for 3T Prostate MR: Effect of Rectal Gel on Image Quality

Monday, Nov. 26 3:50PM - 4:00PM Room: S504CD

Participants
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CONCLUSION

Our preliminary data suggests that for patients undergoing 3T surface coil prostate MR, instilling rectal gel can successfully decrease susceptibility artifact from excess gas, resulting in improved visualization of the PZ and increased diagnostic confidence.

Background

While use of 3T surface coil examinations has led to increased patient comfort for prostate MR, elimination of the endorectal coil has resulted in new challenges. Susceptibility artifact from rectal gas can significantly limit visualization of the peripheral zone (PZ) on diffusion-weighted (DWI) images, potentially risking the detection of clinically significant cancers. Few studies have evaluated strategies to reduce this artifact, so we have piloted a method of instilling rectal gel in an attempt to displace excess gas.

Evaluation

We introduced a new workflow for real-time monitoring of prostate MR studies. If a marked amount of rectal gas or DWI susceptibility artifact was noted, 60 mL of ultrasound gel was administered per rectum, and images repeated. Between July 2017 and February 2018, 149 evaluations were performed at our institution, of which 26 cases with both pre- and post-gel DWI series were identified for retrospective analysis. Two subspecialty abdominal radiologists assigned 5-point scale values to assess the amount of PZ visualized (1=low, 5=high), PZ distortion by susceptibility artifact (1=low, 5=high), degree of rectal distention (1=none, 5=high), and overall diagnostic confidence (1=none, 5=without limitation). Both paired t-test and Wilcoxon rank-sum tests were performed to assess the effectiveness of the intervention. Rectal gas volumetry was also performed with segmentation of the estimated intraluminal space on T2-weighted images from the level of the prostatic base to the anorectal junction.

Discussion

PZ visualization and overall diagnostic confidence were increased for both readers to a statistically significant level ($p<0.05$). A corresponding decrease in perception of gas volume and decreased PZ distortion was also achieved to a statistically significant level ($p<0.05$). The administration of gel on average decreased rectal gas volume by 2-fold. Gel injection was well tolerated by all patients.

SSE25

Science Session with Keynote: Radiation Oncology (Gynecologic Cancers)

Monday, Nov. 26 3:00PM - 4:00PM Room: S104B

MR OI RO

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

SSE25-03 The Value of K-trans in DCE-MRI in the Diagnosis of Pathological Grade of Cervical Cancer

Monday, Nov. 26 3:20PM - 3:30PM Room: S104B

Participants
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PURPOSE

The value of Ktrans in DCE-MRI in the diagnosis of pathological grade of cervical cancer

METHOD AND MATERIALS

Retrospective analysis of 19 patients with poorly differentiated and 15 moderately well-differentiated cervical cancers who were confirmed by surgery and pathology from September 2015 to February 2017 and preoperatively performed 1.5T MRT1WI, T2WI, DCE-MRI, DWI, and other MR examinations. DCE-MRI images were analyzed and measured by two observers using the GenIQ software on the ADW4.6 workstation. The consistency of the data was evaluated by using ICC. An independent sample t test was used to compare the difference in Ktrans values in DCE-MRI between poorly differentiated and moderately differentiated cervical cancers. The ROC curve was used to analyze the Ktrans value to identify the diagnostic efficiency of poorly differentiated and moderately differentiated.

RESULTS

The parameters measured by the two observers were in good agreement (ICC values >0.75). The Ktrans value of the poorly differentiated group was greater than the moderately high differentiated group (0.70±0.21 vs 0.52±0.20), and the difference was statistically significant (P<0.05). The Ktrans value >=0.68 is a diagnostic threshold for the diagnosis of poorly differentiated and moderately differentiated, corresponding sensitivity and specificity of 52.6% and 81.2%, and AUC is 0.717.

CONCLUSION

The value of Ktrans in DCE-MRI has a certain value in the differential diagnosis of poorly differentiated and moderately differentiated cervical cancer.

CLINICAL RELEVANCE/APPLICATION

The prognosis of poorly differentiated and moderately differentiated cervical cancer is completely different, and differential diagnosis is extremely important.

SSE25-04 Radiologic Assessment of Inguinal Lymph Nodes in Pelvic Malignancies

Monday, Nov. 26 3:30PM - 3:40PM Room: S104B

Awards
Student Travel Stipend Award

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PURPOSE

Metastatic involvement of inguinal lymph nodes can alter radiation therapy (RT) planning for pelvic tumors. 18F-FDG PET/CT can identify metastatic nodes; however, inguinal nodes are commonly abnormal due to non-malignant processes such as infection or inflammation, complicating interpretation. We evaluated quantitative PET metrics to improve identification of metastatic inguinal nodes in patients with pelvic tumors compared to standard clinical interpretation.

METHOD AND MATERIALS

We identified 36 patients with vulvar cancer, 4 with vaginal cancer, and 14 with anal cancer who underwent 18F-FDG PET/CT prior to pathologic evaluation of inguinal nodes. For each groin evaluated pathologically, we analyzed the following values on the node with highest FDG uptake: maximum, peak and mean standardized uptake values (SUVmax, SUVpeak, SUVmean, respectively), total lesion glycolysis (TLG) and metabolic tumor volume (MTV). SUVmean, TLG and MTV were determined for volumes defined by thresholds of 42% and 50% of SUVmax, and for SUV >= 2.5. CT images were used to measure volume, short and long axes of each lymph node. Multivariate logistic regression identified predictive metrics for pathologic positive nodes and generated a probabilistic model. The AUCs of ROC curves for the model were compared to the standard clinical interpretation from the diagnostic report using adjacent pairwise differences.

RESULTS

Of 54 patients identified, 75 groins were evaluated pathologically resulting in 75 nodes for analysis (35 were positive for malignancy). Logistic regression identified SUVmean (50% threshold) and short axis length as most predictive for metastatic nodes. The model was better able to predict pathologic involvement compared to standard clinical interpretation (AUC: 0.91 [95%CI: 0.84 - 0.97] vs 0.80 [95%CI: 0.71 - 0.90], P<0.01).

CONCLUSION

18F-FDG PET/CT diagnostic accuracy for metastatic inguinal nodes in pelvic tumors may be improved with use of quantitative PET metrics and warrants further validation. Improving prediction of metastatic nodes can aid with appropriate selection of patients for pathologic node evaluation and guide RT volumes and doses.

CLINICAL RELEVANCE/APPLICATION

18F-FDG PET/CT accuracy for inguinal metastases may be improved with quantitative metrics for patients with pelvic malignancies and aid with radiation treatment planning.

SSE25-05 Assessment of MR Compatibility of Novel Needle Placement Template and Collets for Intraperitoneal Interstitial Gynecological Brachytherapy Application

Monday, Nov. 26 3:40PM - 3:50PM Room: S104B

Participants
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PURPOSE

A supplemental template kit was obtained to aid intraperitoneal needle implant geometry for MR-guided interstitial cervical brachytherapy. This product is in final stages of FDA approval and has not yet received MR-conditional designation. Therefore, our institution independently evaluated the MR compatibility using ASTM International guidelines and report our results.

METHOD AND MATERIALS

The supplemental kit consisted of the template (made of PEEK material with 40 6-Fr diameter holes) and 25 titanium collets. In the proposed clinical kit, the template and collets would be added to existing equipment including the cylindrical obdurator, tandem, and PEEK needles, which have been deemed MR-conditional previously. The planned fully-assembled applicator set is shown in Figure 1. A 3.0 T magnet was used to represent the most challenging MR environment as our institutional policy for MR-guided treatment planning is 1.5 T. Magnetically-induced effects of displacement force and torque were evaluated using ASTM F2052-15 and F2213-06 standard test methods, respectively. RadioFrequency (RF)-induced heating was evaluated using ASTM F2182-11a standard test methods. Final assessment for MR-conditional status was defined using ASTM F2503 requirements.

RESULTS

For the template and collets, the mean measured displacement was undetectable, there was no observed translation, no observed deflection, and no observed torque when placed at the strongest point of the magnet. Neither template nor collets were deemed candidates for RF-induced heating. The template was exempted based on its composition of 100% PEEK material. The collets were exempted as literature has repeatedly shown that devices smaller than one-tenth of the electromagnetic field (i.e. 5 cm for 1.5 T and 2.4 cm for 3.0 T) will not have a measurable rise in temperature.

CONCLUSION

ASTM International standards and guidelines were newly-acquired equipment. Standard test methods showed absence of any movement or torque, and complied with exemptions for RF-induced heating tests. Following ASTM F2503 guidelines, the equipment

is MR-conditional for 3 T, and thus is MR-conditional for 1.5 T.

CLINICAL RELEVANCE/APPLICATION

Novel brachytherapy applicator designed for MR-guided radiation therapy was tested internally by our institution to ensure MR compatibility and was deemed MR-conditional.

SSE25-06 3D MRI-Based Brachytherapy for Cervical Cancer: Can Dose Escalation Improve Survival?

Monday, Nov. 26 3:50PM - 4:00PM Room: S104B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Brachytherapy is an essential component of the treatment of locally advanced cervical cancer; recent GEC-ESTRO guidelines recommend that the dose to 90% (D90) of the high-risk clinical target volume (HRCTV) be at least 85Gy with even higher doses recommended to improve outcomes

METHOD AND MATERIALS

A retrospective review of brachytherapy plans delivered at a single institution were evaluated for dose parameters and local control following treatment. The HRCTV D90 was retrieved from all plans. Survival was defined as the interval between last brachytherapy fraction to time of death or last follow up. Significance of tumor parameters on survival was evaluated with uni- and multivariable Cox regression analysis.

RESULTS

A total of 250 women underwent high dose-rate brachytherapy for cervical cancer between 2007 and 2017 with evaluable dosimetry. Median follow up was 27.5 months. The median prescribed dose was 27.5Gy/5fx with a median HRCTV D90 of 83.9Gy (IQR: 81.9-85.7Gy), HRCTV volume of 31cc (IQR: 25.9-39.9cc), and treatment time of 7.3 weeks. Overall survival at 2 and 5 years was 84.9% and 72.4%. Factors which correlated with survival included age, initial tumor size, HRCTV D90, treatment time and HRCTV volume. On multivariable analysis, only HRCTV volume (HR 1.039 [95%CI 1.017-1.062], p=0.001), prolonged treatment time (HR 1.439 [HR 1.176-1.762], p<0.001), initial tumor size (HR 1.184 [95%CI 1.010-1.389], p=0.037), and age (HR 1.038 [95%CI 1.016-1.060], p<0.001) correlated with survival. HRCTV D90 approached significance with a higher D90 per Gy: HR 0.901 [95%CI 0.808-1.005], p=0.061. Survival at 2 and 5 years for women with tumors 31cc and less at the time of BT were 91.6% and 78.5% vs 78.3% and 66.0% for women with tumors greater than 31cc (p=0.026).

CONCLUSION

Survival is excellent with MRI-based planning in the entire cohort of patients. Our data suggests that adverse factors such as adenocarcinoma histology, large tumor, and poor response to chemoradiation cannot be overcome with dose escalation. The prospective EMBRACE II trial will further help us clarify the impact of dose escalation in poor responders.

CLINICAL RELEVANCE/APPLICATION

This suggests that different methods of therapeutic intervention are required for high-risk and poor-responding cervical cancer patients.

SSE26

Vascular Interventional (Education)

Monday, Nov. 26 3:00PM - 4:00PM Room: S104A

ED IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: .25

Participants
Nikunj R. Chauhan, MD, Cleveland, OH (*Moderator*) Nothing to Disclose
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Sub-Events

SSE26-01 Has Black Trainee Representation Improved in Interventional Radiology Fellowship from 1995 to 2015? A Comparative Study with Other Related Fields

Monday, Nov. 26 3:00PM - 3:10PM Room: S104A

Participants
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PURPOSE

Prior studies have shown underrepresentation of people of African-American descent within multiple medical specialties. Interventional Radiology (IR) has traditionally been a white male-predominate field and it is unknown if race diversity in IR has improved over time. The purpose of this study was to analyze trends in representation of black trainees in IR in comparison with other related fields over the past 20 years.

METHOD AND MATERIALS

We reviewed data from the American Association of Medical Colleges reported in annual issues on medical education in JAMA for the years 1995-2015. We assessed the percentages of black trainees in IR fellowships and other training programs, including Diagnostic Radiology residency, Radiation Oncology residency, Pediatric Radiology fellowship, and Neuroradiology Fellowship, as well of Residents from all specialties. Changes in the percentages of black residents/fellows from 1995 to 2015 were calculated for each group using Chi-Square tests.

RESULTS

From 1995 to 2015, the percentage of black trianees in IR fellowship increased from 0% to 4% ($p=0.03$). Similarly, from 1995 to 2015, the percentage of black trainees in every other training program studied increased significantly; for example, black representation in residency (all specialties) improved from 5% to 6% ($p<0.0001$) [Image 1]. In 2015, IR had no significant difference in black trainee representation compared to the other training programs studied.

CONCLUSION

Although the percentage of black trainees in IR fellowship has significantly increased over the past 20 years and is commensurate with the general residency population, black trainees are under-represented compared to the general USA population (18%). We recommend increased recruitment efforts towards black trainees at different levels of training both during and after medical school to improve the diversity within IR and other fields.

CLINICAL RELEVANCE/APPLICATION

Although the percentage of black trainees in IR fellowship has significantly increased over the past 20 years, black trainees are under-represented compared to the general USA population.

SSE26-02 An Analysis of the Patient Population Seen in a Newly Established Interventional Radiology Ambulatory Clinic

Monday, Nov. 26 3:10PM - 3:20PM Room: S104A

Participants
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PURPOSE

To analyze the types of patients seen in a newly established interventional radiology (IR) ambulatory clinic with an assessment of changes in that population over the clinic's first eight months of existence.

METHOD AND MATERIALS

A retrospective review of the clinic appointments that occurred in the first eight months was performed. Patient demographics, diagnosis, type of IR procedure for which they were being seen, and the type of visit (i.e new vs. return patient) were collected. Data points from the first four months (group 1) and second four months (group 2) of the clinic were analyzed separately to assess for any changes over time. A p value of <= 0.05 was considered statistically significant.

RESULTS

There were a total of 1,489 clinic visits in the first eight months (739 males; 750 females; mean age: 57.3 years). Overall, the three most common diagnoses were hepatocellular carcinoma (HCC) (14.3%, n=214), abscess (9.8%, n=146), and oropharyngeal cancer (8%, n=119). HCC, abscess, and oropharyngeal cancer were the three most common diagnoses for both groups 1 and 2 without a significant difference between groups. The three most common procedures performed on patients overall were chest port (24.9%, n=371), gastrostomy/gastrojejunostomy (20.6%, n=307), and chemoembolization (15.4%, n=229). Chest ports, gastrostomy/gastrojejunostomy, and chemoembolization were the three most common types of procedures performed on these patients in both groups 1 and 2 without any significant difference between the groups. There was also no significant difference between the groups for any other procedures performed, including: primary biliary drainage, IVC filter placement/retrieval, abscess drainage, uterine fibroid embolization, radioembolization, renal cryoablation, liver ablation, TIPS, kyphoplasty/vertebroplasty, or percutaneous sclerotherapy. Overall, 283 visits (19%) were "new" patient appointments. There was no significant difference between the groups in number of new patients seen (group 1: 18.4%, group 2: 19.4%; p=0.6).

CONCLUSION

IR sees a wide variety of patients in ambulatory clinic but the population did not change significantly during the sampling period.

CLINICAL RELEVANCE/APPLICATION

Ambulatory clinics can help IR establish itself as a clinical service. Information about the types of patients seen in these clinics can inform quality improvement and practice-building initiatives.

SSE26-03 Trends in Imaging Guidance for Percutaneous Procedures in the Medicare Population, 2007-2016

Monday, Nov. 26 3:20PM - 3:30PM Room: S104A

Participants
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PURPOSE

Imaging guidance has driven the rapid growth of percutaneous procedures. Our purpose was to assess utilization trends in imaging guidance for percutaneous procedures in recent years.

METHOD AND MATERIALS

The nationwide Medicare Part B databases for 2004-2016 were utilized. We selected the current procedural terminology (CPT) codes for CT, ultrasound (US), fluoroscopy (FL), and MRI guided procedures. CT, MRI, and FL codes were first introduced in 2007. The database provides volumes for each code. Medicare specialty codes were used to identify the specialty of the billing provider. Trend lines were plotted for total volume per year as well as for radiology and other major specialties per year. Because these databases represent a full population, sample statistics are not required.

RESULTS

US is the most common imaging modality used for guidance, followed by FL, then CT, and lastly MRI. Total volume of US guided procedures increased steadily from 864,008 in 2007 to 2,144,285 in 2016 (+148%). Orthopedic surgeons perform the highest proportion of US procedures (20% - mostly joint injections and aspirations), followed by anesthesia (19%) and then radiologists (9%). FL guidance has increased from 150,165 in 2007 to 495,273 in 2016 (+230%). Radiologists perform the highest proportion of these procedures (26%) among the individual specialties. CT guidance has remained relatively constant from 2007-2016 (196,473 to 204,063), with radiologists performing 98% of these procedures. MRI guidance volumes were very low, with radiologists performing 44%, followed by urologists at 39%. Total imaging-based guidance procedures (all modalities) increased from 1,220,749 in 2007 to 2,847,651 in 2016 (+133%).

CONCLUSION

Image guidance for procedures has grown since 2007. Radiologists perform more image-guided procedures than any other single specialty, although their overall share is only 19%. Ultrasound is the modality of choice for most procedures, accounting for over 75% of the image guidance for percutaneous procedures performed in 2016. Other specialties have increased their share of image-guided procedures since 2007, particularly of procedures with US and FL guidance.

CLINICAL RELEVANCE/APPLICATION

Radiologists perform the greatest proportion of image guided procedures, predominantly with US guidance, although other specialties have increased their usage of image guidance in recent years.

SSE26-04 Show Me the Money: Comparison of Political Action Committee Funding and Physician Compensation

Monday, Nov. 26 3:30PM - 3:40PM Room: S104A

Participants
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PURPOSE

To compare physician compensation of specialties with a political action committee (PAC) to those who do not.

METHOD AND MATERIALS

Physician specialties were identified through the AAMC 2015 physician workforce survey as well as the Medscape 2017 physician compensation report. Compensation data was collected via Medscape compensation surveys from the years of 2011-2017, American Medical Group Association (AMGA), Pinnacle Group, and Doximity. All PAC related data was collected via opensecrets.org. Statistics were performed with SPSS (IBM).

RESULTS

A total of 31 physician specialties were included in the analysis. Nearly 90% (n=28) had a PAC,10% (n=3) did not. Averages of the following were calculated for each specialty from 2010-2016: physician compensation, PAC donation, and PAC expenditure. Average PAC donation and PAC expenditure per capita was also calculated. A direct linear correlation was found between average PAC donation and average PAC expenditure for all the physician specialties (R2 of 0.999). Specialties with a PAC demonstrated higher average compensation than those without a PAC ($328,700 vs. $211,500) with a mean difference of $117,000 (p=0.04). SIR has one of the most underfunded PACs. For comparison,vascular surgery PAC contributions is 1.5x that of SIR's and cardiology PAC boasts a 9x financial advantage over our own.

CONCLUSION

Advocacy is not just about compensation but the reality is that being paid what you deserve is important. Our analysis reveals that over the past decade, specialties with higher physician compensation tend to have larger, more well funded PACs. A well funded PAC allows for more PAC expenditure which grants better access to members of Congress. Considering IR has recently separated from diagnostic radiology, which boasts one of the most robust PACs on our list, the impact of having an underfunded political action committee is unknown but worrisome considering our direct competitors (cardiology and vascular surgery) dwarf us in comparison. Policy drives practice, if we are to be true competitors then awareness and support of our PAC is critical.

CLINICAL RELEVANCE/APPLICATION

Political awareness and activisim is critical to the success of a specialty and those with political action committees lobbying on their behalf earn substantially more than those who do not.

SSE26-05 Training by the Numbers: A Survey-Based Analysis of the Number of Positions Available in New Interventional Radiology Training Pathways

Monday, Nov. 26 3:40PM - 3:50PM Room: S104A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The number and types of training pathways in interventional radiology (IR) have undergone a fundamental change, yet little is

known about the number of Independent IR (IndIR) positions relative to the number of positions in the Early Specialization in IR (ESIR) pathway. Thus, we investigate whether the number of available ESIR positions is aligned with the number of IIR positions.

METHOD AND MATERIALS

A three-question survey was conducted over e-mail and telephone to residency program directors and coordinators (Figure). Data collected included the number of ESIR, IntIR (Integrated IR), and IndIR positions, and number of current IR fellows accepted per year. Information was also obtained from publicly available databases on the SIR, ACGME, and ERAS websites. Analysis of results was performed using Microsoft Excel (Microsoft, Redmond, VA).

RESULTS

Ninety-nine of 113 ESIR programs (87.6% response rate) reported a total of 176 approved ESIR positions. Based on this average of 1.78 positions per program, the actual number of ESIR positions in the U.S. is likely more than 200. While 111 fellowship programs in the U.S. currently offer a total of 331 positions, current new training pathways include 77 IntIR programs and 48 IndIR programs with 150 and 133 positions, respectively. As the Integrated IR programs matched at 100% in the same time frame, thus have no open positions, this leaves substantially more ESIR positions that must feed into Independent IR training programs than are currently available.

CONCLUSION

A substantial discrepancy currently exists with IR training pathways, as the number of available ESIR positions far outnumbers the available Independent IR pathway positions.

CLINICAL RELEVANCE/APPLICATION

Given that the Integrated IR Residency was the most competitive match in 2018 (100% of positions filled with more than 250 applicants not matching into IR), it is expected that the ESIR program will become increasingly utilized. However, if the number of ESIR positions far outnumbers the Independent IR residency positions, these trainees will be expecting to train in IR but may not find out until the end of their PGY-4 year (and after other specialties have matched) that they have no advanced training position.

SSE26-06 Fundamentals of Interventional Radiology Skills Training: The FIRST Curriculum

Monday, Nov. 26 3:50PM - 4:00PM Room: S104A

Participants
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PURPOSE

There has been a paradigm shift in medical education, transitioning from an apprenticeship model to one centered on more directed skills training. There is a unique opportunity to embrace this changing landscape of medical education via usage of simulation-based training for interventional radiology. This is a preliminary study examining the efficacy of modules to be utilized in a forthcoming curriculum entitled, The Fundamentals of Interventional Radiology Skills Training (FIRST).

METHOD AND MATERIALS

A procedural checklist was generated from a core task analysis of two attendings performing each skill: venous access, biopsy, and interventional suturing. This checklist was then used to teach first year diagnostic radiology residents (n=7). A jugular venous access phantom was formed in realistic polycarbonate molds with a mixture of gelatin (7.4% by weight) and sugar-free psyllium fiber (4.6% by weight) combined with silicone tubing. This same gelatin and psyllium fiber mixture was also used for an ultrasound-guided liver biopsy phantom, with several targets at variable depths. Ultrasound (US) was performed with a portable GE VScan Dual Probe device. A high-fidelity suturing pad was also constructed from platinum-catalyzed silicone gels reinforced with power mesh. Pre- and post-session surveys utilizing a Likert scale were administered to quantify effectiveness of the teaching session with regard to (i) ability to perform skills and (ii) knowledge of procedural steps and equipment. Statistical analysis was performed using Mann-Whitney U Test.

RESULTS

On the pre-session survey, 100% of residents reported being uncomfortable with IR procedures. After the session, 100% of residents agreed simulation-based education would be invaluable prior to IR rotations. Compared to pre-session responses, there were significant differences in ability to perform a dermal stitch and drain knot ($p=0.0023$ for both), describe the steps in US-guided biopsy ($p<0.001$), and identify vascular access components ($p= 0.0017$).

CONCLUSION

These preliminary data demonstrate efficacy of dedicated IR skills teaching sessions and simulation using constructed phantoms. Our experience will inform future module development, including use of 3D printed vessels and a fluoroscopic trainer.

CLINICAL RELEVANCE/APPLICATION

A standardized simulation-based curriculum would be indespensible to IR trainee education to enable deliberate practice in a risk-free environment.

SSG01

Breast Imaging (Ultrasound Screening and Diagnostic Indications)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S406A

BR US

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

Participants
Donna M. Plecha, MD, Strongsville, OH (*Moderator*) Research Grant, Hologic, Inc
Jessica W. Leung, MD, Houston, TX (*Moderator*) Scientific Advisory Board, Hologic, Inc; Speakers Bureau, Hologic, Inc; Speakers Bureau, FUJIFILM Holdings Corporation

Sub-Events

SSG01-01 Performance of Screening Breast Ultrasound Over 5-Year Period

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S406A

Participants
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PURPOSE

To review and compare performance of screening ultrasound in women with dense breast tissue post adoption of state breast density mandate.

METHOD AND MATERIALS

Through a retrospective chart review, data was collected on 23,878 screening ultrasound exams performed from 2013-2017 in patients with heterogeneously dense or extremely dense breast tissue. We stratified the data by year to compare screening ultrasound performance over time. Cancer detection rate (CDR), PPV and biopsy rate were calculated for US only findings (mammographically normal). Data was collected on patient demographics, number of DBT exams performed, BI-RADS score, pathology, tumor size, and lymph node status.

RESULTS

A total of 23,878 screening ultrasound exams were performed; 691 (2.9%) in 2013, 1700 (7.1%) in 2014, 4767 (20.0%) in 2015, 7389 (30.9%) in 2016, 9339 (39.1%) in 2017. Use of BI-RADS 1 and 2 remained stable; ranging from 95.0% in 2013 to 97.1% in 2017. The use of DBT increased in the population increased, from 18.7% in 2013 to 99.3% in 2017. Cancer detection rate increased in the first 3 years, from 1.4/1000 (2013) to 3.6/1000 (2015) then decreased in 2016 to 2.4/1000, and again in 2017 to 2.2/1000. Biopsy rate steadily decreased since 2013, from 2.9% to 1.0% in 2017. PPV for biopsy initially increased substantially (5% in 2013 to 20% in 2014) and then slightly declined; 18.8% in 2015, 16.2% in 2016, and increased again to 22.3% in 2017. The assignment of BIRADS 3 decreased over time; from 2.5% of exams in 2013, to .76% in 2017.

CONCLUSION

Screening ultrasound continues to detect mammographically occult malignancy, though the rate can vary substantially, as we saw an initial increase, followed by a decrease to 2.2/1000 in 2017. This decrease could be due to the increase in use of DBT, which increases the visibility of malignancies on mammography. The biopsy rate consistently decreased, from 2.9% to 1.0%, as did assignment of BI-RADS category 3. PPV varied over time, with the highest rate over the period in 2017 (22.3%), potentially suggesting more appropriate use of biopsy in this population.

CLINICAL RELEVANCE/APPLICATION

There are 30 states with breast density legislation. As policies continue to change and center around individualized medicine, understanding the performance and value of US will be helpful for facilities as they continue to adopt improved screening practices and modalities for women with dense breast tissue.

SSG01-02 Non-Mass Lesion Detected by Breast US: Stratification of Cancer Risk for Clinical Management

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S406A

Participants
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PURPOSE

To develop a practical diagnostic prediction model by using imaging features of breast non-mass lesion (NML) detected by B-mode ultrasonography (US).

METHOD AND MATERIALS

From Dec 2011 to March 2016, B-mode US was performed in 777 NMLs in consecutive 828 patients. This retrospective study consecutively included 669 breast NMLs in 669 patients for which final diagnoses were established and mammographies obtained at the time of US examination. For each lesion, radiologists assessed BI-RADS category. For developing a diagnostic prediction model to estimate malignant risk of NMLs using a scoring, univariate and multivariate logistic regression analyses were performed to find US or mammographic features associated with malignancy in a developmental dataset (n=460). A score for each significant imaging feature was assigned and multiplied by the regression coefficient, and the risk score of malignancy for each NML was defined as the sum of individual scores. Based on area under the receiver operating characteristic curve (AUC), diagnostic performance of the prediction model was compared to the radiologist's BI-RADS classification. Later, we verified the usefulness of developed scoring model by applying into the remaining validation dataset (n=209).

RESULTS

Among 669 NMLs, 354 (52.9%) were benign and 315 (47.1%) were malignant. In the developmental dataset, the following US features, within or around the main lesion, showed significant association with malignancy: the presence of calcifications, architectural distortion, posterior acoustic shadowing or abnormal ductal change, and absence of microcysts. The following mammographic features also showed significant association with malignancy: the presence of calcifications or focal asymmetry. The predictive model's AUC was higher than the radiologist's BI-RADS classification (0.952 vs. 0.930). In the validation dataset, AUC of our prediction model was 0.961.

CONCLUSION

The prediction model using features of US and mammography may be useful in stratification of cancer risk of breast non-mass lesions.

CLINICAL RELEVANCE/APPLICATION

Cancer risk stratification for breast non-mass lesions using features of US and mammography may be useful in managing breast non-mass lesions detected by US.

SSG01-03 Decreasing Short-Term Follow-Up and Biopsies by Following BI-RADS 3 Lesions at 1 Year: A Prospective Study

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S406A

Participants
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Carmine Tinelli, MD, MSC, Pavia, Italy (*Abstract Co-Author*) Nothing to Disclose
Annalisa DeSilvestri, PhD, Pavia, Italy (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Supplemental US is know to detect node negative cancers not identified on screening mammography. However the large number of short-term follow-ups and low positive biopsy rate make this technique not cost effective. The majority of these are due to BI-RADS 3 lesions (B3), with an incidence of cancer in < 1%. This prospective study evaluates the effect of following B3 detected on supplemental ultrasound at 1 year.

METHOD AND MATERIALS

This HIPPA compliant, IRB approved with written informed consent study invited patients receiving a B1 or B2 screening mammogram with density 3 or 4 breast of any risk to receive a free automated volume whole breast (ABVS) ultrasound. The ABVS was performed on a Siemens S2000 using a 15cm L14-5 transducer. ABVS were read by radiologist with 20 year experience as BI-RADS category 1, 2, 3, or 0. Category 0 patients received a hand held ultrasound (HH). Patients were followed for 2 years.

RESULTS

Of 23426 screening patients, 8542(36.5%) had density 3 or 4 and were asked to participate. 2257 (26.4%) agreed to participate (50 yo mean age, range 31 to 90) (<10% high risk). The ABVS was interpreted as B1 in 1186 (52.5%), B2 in 591 (26.2%), B3 in 395 (17.5%) and B0 in 85 (3.8%). Of the 395 B3 patients, 310 had 1-year follow-up and were cancer free, 0%, 254 had 2-year follow-up and were cancer free, 0%. Of the 85 B0 patients, (recall rate of 3.8%) on HH 8 (11.3%) were B1, 51 (71.8%) were B2, 2 (2.8%) were B3, 6 (8.5%) were B4, and 4(5.6%) were B5. The B4 and 5 lesions were 2 B4A lesions were fibroadenomas,2 B4A were fibrocystic change, 2 category 4C lesions were IDC, and 4 category 5 lesions were IDC. The biopsy rate was 0.4% (10/2257) with a positive biopsy rate (PPV3) of 60.0% (6/10). The supplemental ultrasound detected 2.8/1000 additional cancers (4/1412). 5 cancers (0.28%, 5/1777) were detected in 3 yr f/u in B1 and B2 and 1 IDC (0.25%, 1/395) was identified in B3 in the contralateral breast.

CONCLUSION

Following B3 at 1 year interval decreases the recall rate (8.8% (233/2637) ACRIN 6666 to 3.8% (54/1412)) (p<0.001) and increases the PPV3 (8.9% (21/235)ACRIN 6666 to 60.0% (6/10))(p=0.001) without substantial node positive cancer misses. With these improved screening characteristic, supplemental ultrasound could be cost effective.

CLINICAL RELEVANCE/APPLICATION

Following B3 at 1 year markedly reduces the recall rate and increases the PPV3 making supplemental screening more cost effective.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Richard G. Barr, MD, PhD - 2017 Honored Educator

SSG01-04 A Preliminary Study of Predicting Molecular Subtypes of Breast Cancer by the Radiomics Features of Contrast-Enhanced Ultrasound

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S406A

Participants
Lei Tang, Shanghai, China (*Presenter*) Nothing to Disclose
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PURPOSE

The aim was to analyze the quantitative features of contrast-enhanced ultrasound(CEUS) imaging of breast cancer through computer image extraction, and to explore the preoperative prognosis of the different molecular subtypes of breast cancer.

METHOD AND MATERIALS

CEUS images of 189 patients were collected from our hospital. Everyone signed informed consent before CEUS. Surgical pathology and molecular typing results were obtained in all patients. Through mapping the borders of breast cancers on the images, the entire internal area of the tumor was determined. The lesions were divided into four quadrants(Fig 1). The high perfusion within the lesion area was defined as a high brightness area. The temporal and special features of the images in different areas were extracted by the computer in a dynamic CEUS file and the time intensity curves(TIC) were drawn. From the TIC curve, the features were extracted such as wash in rate(WiR), wash out rate(WoR), rise time(RT), base intensity(BI) and peak intensity(PI) and EI(=PI-BI), so on. The parameters of the curve in each area were calculated in different molecular typing groups.

RESULTS

The patient' numbers of Luminal A, Luminal B, HER2+, and triple negative breast cancer (TNBC) of each molecular subtypes were 46, 75, 37, and 31, respectively. The extracted effective features included EI of the internal bright area, WoR of internal bright area, WoR of the internal overall area, RT of the internal overall area, and so on. The cutoff value 1.566 of WoR in the internal bright area might help to find Luminal A, with a specificity of 82.61%. When to find TNBC, the cutoff value of EI at the internal bright area was 0.3494, the sensitivity was 64.52%, and the specificity was 68.99%. When distinguishing between Her2+ and TNBC, WOR of the internal overall had a cutoff of 5.7496 and a sensitivity of 74.19%.

CONCLUSION

The radiomics features of contrast-enhanced ultrasound could contribute to preoperative prediction of breast cancer molecular subtypes. Further research needed to be larger sample, multi-center expansion.

CLINICAL RELEVANCE/APPLICATION

The radiomics features of contrast-enhanced ultrasound could contribute to preoperative prediction of breast cancer molecular subtypes, which may help to predict efficacy and to select treatment options.

SSG01-05 Sonographic Features of Radial Scars and Complex Sclerosing Lesions

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S406A

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PURPOSE

To assess the morphologic characteristics of radial scars (RS) and complex sclerosing lesions (CSL) when they are visualized with ultrasound (US)

METHOD AND MATERIALS

A HIPAA-compliant, IRB-approved retrospective review of core needle biopsies (CNB) performed between 1/1/2007 and 12/31/2017 was performed and filtered for RS or CSL as the primary diagnosis. Patients with a concurrent diagnosis of malignancy or with only a microscopic incidental RS were excluded. The method of detection, mammographic and sonographic features, histology at CNB and at surgical excision, if performed, were recorded for all lesions visualized with US.

RESULTS

190 lesions with a CNB diagnosis of RS or CSL were identified. 57.4% (109/190) were visible on US. Most [75.2% (82/109)] US-visible lesions were initially detected on screening mammography, followed by screening US [19.3% (21/109)], diagnostic US [2.8% (3/109)], diagnostic mammography [1.8% (2/109)], and screening MRI [0.9% (1/109)]. Among US-visible lesions, 53.2% (58/109) appeared as non-mass areas of abnormal echogenicity, 44.0% (48/109) as masses, 1.8% (2/109) as architectural distortion only, and 0.9% (1/109) as dilated hypoechoic ducts. More lesions were anti-parallel [58.7% (64/109)] compared to parallel [41.3% (45/109)]. While most were hypoechoic [64.2% (70/109)], others were isoechoic [14.7% (16/109)], hyperechoic [3.7% (4/109)], or mixed [17.4% (19/109)]. Posterior acoustic features were most often none [58.7% (64/109)], followed by shadowing [28.4% (31/109)] and enhancement [12.8% (14/109)]. Color Doppler images, available in 87 lesions, showed no vascular flow in 34.5% (30/87), adjacent flow in 34.5% (30/87), and internal flow in 31.0% (27/87). Lesions presenting as architectural distortion on mammography [50.4% (55/109)] most often appeared as non-mass areas of variable echogenicity on US [89.1% (49/55)] rather than masses [10.9% (6/55)].

CONCLUSION

RS and CSL sonographic features are variable and include non-mass areas of abnormal echogenicity. While not strictly part of the BI-RADS lexicon, subtle 'nonmass' findings may be the only US correlate in some mammographically-detected lesions, especially those presenting as architectural distortion.

CLINICAL RELEVANCE/APPLICATION

As the incidence of RS and CSL increases with tomosynthesis utilization, understanding the variety of US appearances may increase the likelihood of detecting an US correlate and facilitate biopsy.

SSG01-06 Shear-Wave Elastography of the Breast: Value of a Novel 5-Point Technical Quality Score

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S406A

Participants
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PURPOSE

To determine the value of a novel 5-point technical quality score on the diagnostic performance of shear-wave elastography (SWE) of the breast.

METHOD AND MATERIALS

This IRB-approved HIPAA-compliant study included 110 consecutive women (mean age 55.1 + 15.3 years) with 122 breast lesions who underwent SWE and ultrasound-guided biopsy from Oct. 2017 to Jan. 2018. We recorded the maximum (Emax), mean (Emean), and standard deviation (Esd) elasticity measurements for each lesion. We defined five specific SWE technical quality parameters: (1) lesion visibility on B-mode image panel, (2) red pattern (high stiffness) in the near field of the field-of-view (FOV), (3) size and location of FOV box relative to lesion, (4) heterogeneity, vertical streaks, and absence of color in tissue surrounding the lesion, (5) size and location of the region-of-interest circle on the lesion for elasticity measurements. Three blinded readers independently assessed each SWE parameter as low (score=0) or high (score=1) quality. SWE total quality score < 3.3 was classified as low and > 3.3 as high. Intra-class correlation coefficient (ICC) was used to measure inter-observer agreement for the total score and the Hanley and McNeil's method was used to compare areas under the receiver operating characteristic curve (AUC) of SWE in low vs. high-quality images.

RESULTS

Mean size of the 122 lesions was 13.9 + 10.4 mm; 64 (52%) were benign and 58 (48%) were malignant. Inter-observer agreement was good among readers (ICC 0.805). AUCs were significantly improved in the high-quality group compared to the low-quality group for Emean (0.858 vs. 0.631, p=0.009; AUC difference=0.227, 95%CI [0.056, 0.398]) and Esd (0.816 vs. 0.629, p=0.040; AUC difference=0.187, 95%CI [0.008, 0.366]). AUC for Emax also increased to 0.861 in the high-quality group compared to 0.714 in the low-quality group but without statistical significance (p=0.077; AUC difference=0.147, 95%CI [-0.015, 0.309]).

CONCLUSION

Incorporating our novel 5-point technical quality score can improve the diagnostic performance of SWE in differentiating malignant from benign breast lesions.

CLINICAL RELEVANCE/APPLICATION

A simple 5-point technical quality metric provides guidance to users during real-time acquisition and improves diagnostic performance of SWE in differentiating malignant from benign breast lesions.

SSG01-08 Can Mid-Treatment Ultrasound in Triple Negative Breast Cancer Patients Predict Residual Pathologic Disease in the Axillary Nodes?

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S406A

Participants
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PURPOSE

To determine if the number of abnormal lymph nodes visualized on mid-treatment ultrasound in triple negative breast cancer (TNBC) patients who are undergoing neoadjuvant chemotherapy associates with residual nodal disease on surgical pathology

METHOD AND MATERIALS

As part of an on-going single-institution, clinical trial of stage I-III TNBC patients, the first 106 patients who underwent surgery were included in this interim analysis. Mid-treatment was defined as the period following completion of four cycles of AC (Adriamycin and cyclophosphamide) chemotherapy and before initiating either anticipated Taxol chemotherapy or an investigational therapy. The number of abnormal nodes at mid-treatment was assessed and recorded by experienced, fellowship-trained breast radiologists. These radiologists empirically categorized lymph nodes using a binary approach of sonographically abnormal versus normal. Pathologic lymph node positive was defined as the presence of macrometastasis and micrometastasis in at least one axillary node from sentinel lymph node biopsy and/or axillary lymph node dissection as stated in the surgical pathology reports. Wilcoxon rank sum test and Fisher's exact test were used to determine statistical significance.

RESULTS

There were 26 of 106 patients (25%) who had residual nodal disease at surgery and 80 of 106 patients (75%) who had nodal pathologic complete response. The median number of abnormal nodes at mid-treatment was 3 (range 0-16 nodes) for patients who had residual nodal disease compared to 0 (range 0-12 nodes) for patients who had nodal pathologic complete response. TNBC patients with residual nodal disease on surgical pathology had significantly more abnormal nodes at mid-treatment ($p<0.0001$). More specifically, TNBC patients with at least 2 abnormal lymph nodes at mid-treatment ultrasound had a significantly higher chance of being pathologic lymph node positive at surgery ($p<0.0001$).

CONCLUSION

There is a highly significant association between the number of abnormal lymph nodes identified at mid-treatment ultrasound and the presence of residual metastatic axillary nodes at surgery in triple negative breast cancer patients.

CLINICAL RELEVANCE/APPLICATION

The number of abnormal lymph nodes at mid-treatment may be an independent predictor of residual disease in TNBC patients and may assist in identifying chemoresistant patients who could benefit from investigational therapies.

SSG01-09 Is a BI-RADS 4 or 5 Assessment Reasonable on Screening Ultrasound?

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S406A

Participants
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PURPOSE

For participants recalled for further testing, to determine the utility of a BI-RADS final assessment in determining management based on technologist-performed screening ultrasound.

METHOD AND MATERIALS

5689 women in three centers (1 academic and 2 private practice) were enrolled in an IRB-approved study of screening tomosynthesis (DBT) and technologist-performed handheld screening ultrasound (US, with orthogonal views of each finding other than simple cysts) and underwent 8151 screens (5689 yr1, 2462 yr2). Two experienced breast-imaging specialized radiologists prospectively reviewed each DBT-US set independently and in opposing order. Whenever additional imaging was recommended prior to the next annual screening, readers recorded a "final" assessment: BI-RADS 3, 4A, 4B, 4C or 5, together with recommendations, which could include immediate additional imaging and/or possible biopsy, or six-month follow-up. When US was read first and still resulted in a recall after integration with the DBT, we compared subsequent management and outcomes with the original BI-RADS assessments. We excluded technical recalls. At least targeted prior sonograms were available for 980 participants in year 1.

RESULTS

24 women were ultimately diagnosed with cancer after US recall, median patient age 55 (range 40-75). A total of 455 (5.6%) US exams prompted recall: 348/5689 (6.1%) in year 1 and 107/2462 (4.3%) in year 2. Of 209 women scored BI-RADS 3, 114 had immediate additional evaluation and 95 had 6-month follow-up; 20 (9.6%) ultimately had biopsy with 2 (1.0%) found to have cancer. Of 153 rated BI-RADS 4A on screening, 86 (56.2%) had biopsy and 2 (1.3%) proved malignant. Of 60 BI-RADS 4B, 40 (66.7%) had biopsy and 4 (6.7%) had cancer. Of 11 BI-RADS 4C, 11 (100%) had biopsy and 7 (63.6%) had cancer. Of 9 BI-RADS 5, 9 (100%) had biopsy and 9 (100%) were found to have cancer.

CONCLUSION

Malignancy and biopsy rates were lower than expected for a BI-RADS 4A or 4B assessment on technologist-performed screening US, but were reasonable for a BI-RADS 4C or 5 assessment.

CLINICAL RELEVANCE/APPLICATION

Directly scheduling biopsy based on screening US was appropriate for BI-RADS 4C and 5 assessments; 56% of 4A and 67% of 4B assessments resulted in biopsy after physician-targeted evaluation.

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104th Scientific Assembly and Annual Meeting
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SSG02

Cardiac (Coronary Atherosclerosis)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S104B

CA CT VA AI

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

Participants
James C. Carr, MD, Chicago, IL (*Moderator*) Research Grant, Astellas Group; Research support, Siemens AG; Speaker, Siemens AG; Advisory Board, Guerbet SA
Konstantin Nikolaou, MD, Tuebingen, Germany (*Moderator*) Advisory Panel, Siemens AG; Speakers Bureau, Siemens AG; Speaker Bureau, Bayer AG
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Sub-Events

SSG02-01 Incremental Prognostic Value of Coronary Artery Disease-Reporting and Data System (CAD-RADS) Scores Over Coronary Artery Calcium Scores (CACS) for Major Adverse Cardiovascular Event in Stroke Patients Without Chest Pain

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S104B

Participants
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PURPOSE

The aim of this study was to investigate the prognostic value of coronary artery disease-reporting and data system (CAD-RADS) scores and determine the additional risk stratification benefit of CAD-RADS scores compared to coronary artery calcium score (CACS) and coronary artery disease (CAD) extent classifications in ischemic stroke patients without cardiac symptoms.

METHOD AND MATERIALS

From January 2013 to August 2014, 615 ischemic stroke patients who had at least one risk factor for CAD without chest pain underwent coronary computed tomography angiography (CCTA) and were included for final analysis. CT images were evaluated for CACS, extent of CAD and CAD-RADS scores. The primary endpoint was major adverse cardiovascular events (MACEs) defined as cardiovascular death, nonfatal myocardial infarction, unstable angina (UA) requiring hospitalization, revascularization and recurrent ischemic stroke event. Cox regression analyses were used to identify associations between CAD-RADS results and MACEs. C-statistics were calculated to compare discriminatory values of each model.

RESULTS

During the median follow-up period of 3.11 years, there were a total of 78 MACEs. Of 615 patients, 24.7% were classified as CAD-RADS 0, 19.3% as CAD-RADS 1, 17.6% as CAD-RADS 2, 18.5% as CAD-RADS 3, 15.6% as CAD-RADS 4A, 2.1% as CAD-RADS 4B, and 2.1% as CAD-RADS 5. CACS, CAD extent classification and CAD-RADS scores independently stratified risk of future MACEs (all $p < 0.05$). C-statistics revealed that both CAD extent classification and CAD-RADS scores improved risk stratification beyond CACS (C-index: 0.753 vs 0.698, $p < 0.001$ and 0.726 vs 0.698, $p = 0.041$, respectively).

CONCLUSION

In ischemic stroke patients without chest pain, CAD-RADS score had prognostic value for future MACE. In addition, CAD-RADS score provide additional risk-discrimination over CACS.

CLINICAL RELEVANCE/APPLICATION

CAD-RADS score provides additional risk-discrimination over CACS for the future major adverse cardiovascular events and can be recommended in the assessment of cardiovascular risk of stroke patient without chest pain.

SSG02-02 Machine Learning Outperforms CAD-RADS in Finding Optimal Prognostic Plaque Characteristics on Coronary CT Angiograms

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S104B

Participants
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PURPOSE

To use machine learning to find an optimal combination of coronary artery imaging features on CT angiography for the prediction of all cause mortality and coronary deaths, myocardial infarction and revascularization

METHOD AND MATERIALS

CT angiography was performed and risk factor data collected. Arteries were scored using CAD-RADS and 4 other published methods and compared to a score derived using machine learning. Causes of death were determined using the National Death Index. Myocardial infarction and revascularizations were discovered by follow-up letters. Prognostic results were compared using the area under the receiver operating characteristic curves.

RESULTS

7117 patients were imaged and followed for a mean of 9.0 years. There were 414 deaths from all causes, 79 attributed to coronary artery disease as the underlying or contributing cause, 51 myocardial infarctions (MI) and 231 revascularizations. The two best machine learning models were linear discriminant with diagonal covariance matrix and a classification neural network. Respective areas under the ROC curve were 0.76 and 0.77 for all cause mortality, 0.82 and 0.82 for coronary deaths or MI, and 0.87 and 0.88 for CHD or MI or revascularization. The corresponding CAD-RADS results were 0.71, 0.79 and 0.86.

CONCLUSION

Machine learning outperformed CAD-RADS for prediction of death and coronary events.

CLINICAL RELEVANCE/APPLICATION

Machine learning can be used to provide a prognostic score on coronary CT angiography that is comparable to or better than CAD-RADS.

SSG02-03 Development of a Deep Learning Algorithm for Predicting the Coronary Artery Calcium Score Using Retinal Images

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S104B

Participants
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PURPOSE

To determine if deep learning networks could be trained to estimate coronary artery calcium score (CACS) in heart CT scan from retinal images.

METHOD AND MATERIALS

All patients who obtained both ophthalmic examination and heart CT angiography at the tertiary center. Automated extraction of an OCT and retinal images was performed and linked to clinical end points from the electronic medical records. A deep neural network was trained to categorize images as either CACS<=10 (normal) or CACS>=100 (abnormal). We used the Modified VGG 11 model. We inserted one global average pooling layer instead of 2 fully-connected layers. To avoid overfitting, we had the data augmentation. At the SoftMax layer, the image that passed over the network was shown normal or abnormal binary probability value. Accuracy and Area under the receiver operating characteristic was estimated.

RESULTS

A total of 23,177 retinal images based on 15,056 examinations from 2,419 patients, who have received heart CT angiography including CACS, were extracted. At the examination level, we achieved an area under the ROC curve of 78.43% with an accuracy of 70%. At a patient level, we achieved an area under the ROC curve of 85.53% with an accuracy of 77.9%.

CONCLUSION

Using the non-invasive retinal examination including fundus photographs and OCT, deep learning networks show an impressive ability to predict the CACS, which is one of most important marker of heart disease.

CLINICAL RELEVANCE/APPLICATION

Deep-learning based screening of fundus photographs and OCT may have potential for a surrogate marker without radiation

exposure for high-risk patients with high coronary artery calcium score.

SSG02-04 Coronary Calcium Content Extracted by Machine Learning Methods from Incidental CT Scans Improves Coronary Heart Disease Prediction Accuracy

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S104B

Participants
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PURPOSE

Despite significant reductions in the last few decades, coronary heart disease (CHD) remains a significant cause of mortality. Many risk factors for CHD can be mitigated by lifestyle changes and pharmacological interventions, making risk calculation for individuals an important part of prevention. Accordingly, quantification of risk is integrated into prevailing management guidelines. Determination of coronary calcium content has been shown to allow improvement in risk calculation, but requires specialized tests that are not often performed. We present a novel algorithmic method that allows for the extraction of coronary calcium scores from incidental chest CTs performed for other indications, and demonstrate its utility in improving prediction accuracy over the American Heart Association (AHA) 2013 pooled risk model in a retrospective cohort study.

METHOD AND MATERIALS

There were 14,866 patients aged 30-74 with no prior CHD diagnosis included. CT scans and different covariates for the model were extracted in the two years prior to the index date (1 June 2012). Patients were followed-up for five years. Prediction performance results were compared between the AHA 2013 model (base model) and the same model with the novel coronary calcium score inserted as an additional predictor (augmented model). Both were logistic regression models and were trained on the sample population to allow comparison. For measures requiring a threshold, 3.5% risk over 5 years was chosen.

RESULTS

Based on the likelihood ratio test, the augmented model was superior to the base model (p-value <0.001). Similarly, the augmented model achieved superior performance for all performance measures: sensitivity increased 0.85%, specificity increased 4.9%, area under the ROC curve increased by 2.2% and there was a 4.5% categorical net reclassification improvement.

CONCLUSION

In this study, use of a novel biomarker extracted using a machine learning algorithm from incidental CT scans improves predictive accuracy compared to the commonly used model. This improvement occurs both in theoretical and practical measurements of model utility; in actual use it would translate into better clinical decisions.

CLINICAL RELEVANCE/APPLICATION

Coronary calcium content extracted via novel machine learning methods from incidental CTs significantly improves coronary heart disease prediction.

SSG02-05 Radiomics of Coronary Artery Calcium in the Framingham Heart Study

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S104B

Awards
Student Travel Stipend Award

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PURPOSE

To assess whether detailed coronary artery calcium (CAC) characterization based on radiomic feature extraction followed by machine learning improves prediction of cardiovascular (CV) events.

METHOD AND MATERIALS

Participants from the Offspring and third Generation cohorts of the community-based Framingham Heart Study who underwent chest CT between 2002 and 2005 were followed over a median of 9.1 years for cardiovascular events (CV) events (myocardial infarction, stroke, or death). Of those, 624 participants who had excellent image quality and CAC (Agatston score (AS)> 0) were randomly divided into discovery (n=318) and validation cohorts (n=306). CAC was segmented manually using 3DSlicer, and about 2000 radiomic features (based on intensity, shape, and texture of CAC) were extracted using pyRadiomics software. In the derivation cohort, we used an internal minimum redundancy maximum relevancy algorithm (without knowledge of events) to identify the 20 highest ranked features. Finally, a random forest classifier was used to optimize decision trees for prediction for CV events. The weighted predictive probabilty of events for each of the 20 features was summarized into a radiomic score. The performance of this score was tested independent in the validation cohort.

RESULTS

The discovery (66.1% men, 58.1±11.1 age) and validation cohorts (61.4% men, 59.3±11.2 age) had similar CV risk profile, median AS, and CV event rates (30/318 =9.7% and 29/306=9.5%, respectively). In adjusted multivariate analysis (for Framingham risk factors and AS), participants in the validation cohort, who had radiomic scores in the mid and upper tertiles had significantly higher risk for events as compared to the lower tertile (mid: HR= 9.3, p=0.03, upper: HR=16.5, p=0.007). The area under the curve (AUC) was higher for AS, radiomic score (RS), and combined AS/RS were 0.73, 0.76 and 0.79; respectively in the overall population. Performance was best in the subgroup with AS <300 (n=250, Figure)

CONCLUSION

This proof-of-concept study demonstrates that detailed CAC characterization based on radiomic feature extraction predicts CV events independent of traditional risk factors and AS. Further validation is necessary to determine clinical impact.

CLINICAL RELEVANCE/APPLICATION

Artificial intelligence may identify a prognostically important radiomic signature of CAC.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Udo Hoffmann, MD - 2015 Honored Educator

SSG02-06 Identification of Invasive and Radionuclide Imaging Markers of Plaque Vulnerability Using Computed Tomography Radiomics

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S104B

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PURPOSE

Several invasive and radionuclide imaging markers of coronary plaque vulnerability have been described. Identification of these imaging biomarkers by a single, widely available non-invasive technique may provide an opportunity to identify vulnerable plaques and vulnerable patients in daily clinical practice. Therefore, our aim was to assess the diagnostic accuracy of coronary computed tomography angiography (CTA) derived radiomic features to identify attenuated plaque using intravascular ultrasound (IVUS), thin-cap fibroatheroma per optical coherence tomography and radionucleide uptake using sodium fluoride positron emission tomography morphologic (NaF18-PET) as compared to conventional qualitative and quantitative CT metrics.

METHOD AND MATERIALS

We analyzed 44 plaques in 25 patients using IVUS, OCT, NaF18-PET and coronary CTA. We assessed 7 conventional qualitative and quantitative plaque characteristics and calculated 935 radiomic parameters. We calculated receiver operating characteristics area under the curve (AUC) values using a 5-fold cross validation with 1000 repeats to assess diagnostic accuracy. We used the Kolmogorov-Smirnov test to compare the distribution of AUC values resulting from the cross-validations.

RESULTS

Radiomics outperformed conventional metrics to identify attenuated plaque per intravascular ultrasound, thin-cap fibroatheroma by optical coherence tomography and metabolically active plaques per sodium fluoride positron emission tomography in CT images (AUC: 0.72 vs 0.59; 0.80vs 0.66; 0.87 vs 0.65; p<0.001 all; respectively).

CONCLUSION

Computed tomography radiomics may allow the non-invasive identification of invasive and radionuclide imaging biomarkers.

CLINICAL RELEVANCE/APPLICATION

Radiomics is able to identify morphologic and metabolic high-risk plaque features currently olny identifiable using invasive and radionucleide imaging, which are both important components of plaque instability.

SSG02-07 Epicardial Fat is Increased in the HIV Population and Associated to Coronary Artery Plaque Burden

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S104B

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PURPOSE

HIV patients are exposed to a higher risk of coronary artery disease (CAD) compared to non-infected patients. The exact mechanism responsible for this increased risk is not well understood. HIV individuals are also exposed to changes in body fat distribution characterized by greater ectopic fat. These changes may play a role in promoting atherosclerosis. Epicardial fat, which is the ectopic fat related to the heart, may play a unique role because of its location near to the coronary arteries. We hypothesize that epicardial fat volume is increased in the HIV patients and correlates with total coronary plaque volume, and with low attenuation plaque volume, which is a marker of plaque vulnerability.

METHOD AND MATERIALS

This is a cross sectional study, nested in the Canadian HIV and Aging Cohort Study (CHACS), a large prospective cohort following more than 800 HIV+ and HIV- patients. Consecutive CHACS participants with low to intermediate cardiovascular risk without symptoms or past CAD were invited to undergo cardiac computed tomography (CT) and coronary plaque imaging with CT angiography. Volume measurement of epicardial fat, total atherosclerotic plaque and low-attenuation plaque were performed. Association between epicardial fat volume, coronary plaque volume and low attenuation plaque volume was assessed using multivariate linear regression.

RESULTS

A total of 246 participants underwent cardiac CT scans. 173 were HIV+ and 73 were HIV-. HIV+ patients had greater epicardial fat volume indexed to body mass index (BMI) than HIV- patients ($p = 0.03$). In the HIV infected group, epicardial fat volume was associated with duration of antiretroviral therapy use ($ß = 1.45$, $p = 0.004$). After adjustment for traditional cardiovascular risk factors, BMI and waist circumference, epicardial fat volume was significantly associated with total plaque volume ($ß = 1.99$, $p = 0.04$) and low attenuation plaque volume ($ß = 0.86$, $p = 0.01$).

CONCLUSION

Epicardial fat volume is increased in the HIV participants . The association of epicardial fat volume with antiretroviral therapy duration and subclinical coronary artery plaque may suggest a potential mechanism that could explain the increased risk for CAD in the HIV population.

CLINICAL RELEVANCE/APPLICATION

Epicardial fat is increased in HIV patients and correlates with total coronary plaque volume and low attenuation plaque volume, a CT marker of plaque vulnerability.

SSG02-08 Subclinical Coronary Atherosclerosis among Individuals with HIV on Antiretroviral Therapy

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S104B

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PURPOSE

To compare coronary plaque burden and characteristics between HIV-infected and non-HIV-infected participants

METHOD AND MATERIALS

This cross-sectional study nested in a large prospective cohort was approved by the local Institutional Review Board. All subjects provided written consent. Consecutive HIV+ and HIV- participants were prospectively recruited for cardiac computed tomography (CT). Eligibility criteria were males/females, no known coronary artery disease, low/intermediate 10-yr Framingham risk score (FRS, 5-20%), no CT contraindication. Coronary calcium scoring was done with non-contrast CT, and contrast-enhanced CT for plaque (calcified vs noncalcified, volume) and lumen assessment. Imaging assessors were blinded to HIV status. Analyses used multivariate multiple linear and logistic regression models.

RESULTS

A total of 246 participants (173 HIV+ (93% males), 73 HIV- (81 % males)) were included, with similar age (mean 55 yo, p=0.69) and FRS (median 11 %, p=0.53). Diabetes (10% vs 1.4 %, p=0.01) and smoking (28% vs 14 %, p=0.02) were more frequent in HIV+ than HIV- participants, and elevated LDL cholesterol less frequent in HIV+ participants (20% vs 32%, p=0.07). Median duration of HIV infection in HIV+ participants was 18 yrs. All were on antiretroviral therapy (median 15 yrs). After adjusting for diabetes, smoking and LDL cholesterol, prevalence and plaque extent was similar between HIV+ and HIV- participants (72 % vs 69 %, p= 0.37; 2.9 ± 3.0 vs 2.7 ± 3.8 plaques/participant, p= 0.53). HIV+ participants showed more frequent noncalcified and less frequent calcified plaques than HIV- participants (0.3 ± 0.7 vs 0.1 ± 0.5, p=0.01; 1.4 ± 2.4 vs 2.0 ± 2.0 plaques/participants, p=0.006). Number of mixed plaques (1.0 ± 1.4 vs 0.6 ± 1.4 plaques/participant, p= 0.27), mean calcium score (148 vs 141, p=0.81), plaque volume (273 vs 218 mm3, p=0.91) and prevalence of >= 70% stenosis (10% vs 6%, p=0.40) were similar between HIV+ and HIV- participants.

CONCLUSION

Noncalcified plaques are more frequent in asymptomatic HIV+ individuals under antiretroviral therapy, while calcified plaques are less frequent, in comparison to HIV- individuals, after adjustment of cardiovascular risk factors.

CLINICAL RELEVANCE/APPLICATION

Noncalcified plaques are usually considered more vulnerable plaques. Our findings suggest one anatomic substrate that could explain the increased risk of myocardial infarction in the HIV population.

SSG02-09 Atherosclerosis of Coronary Arteries in HIV Patients on Routine Non-Gated CT Chest: Incidence, Characteristics, and Risk Factors

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S104B

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PURPOSE

To evaluate the incidence and risk factors of subclinical coronary artery calcification (CAC) in patients with Human Immunodeficiency Virus (HIV) infection.

METHOD AND MATERIALS

We retrospectively reviewed 143 HIV patients (M:F = 119:24; mean age, 46.4) who underwent routine non-gated CT of thorax, from May 2010 to November 2015. Each of the four main coronary arteries was identified-left main stem (LMS), left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA)- on CT images. Calcification in each artery was categorized as absent, mild, moderate, or severe by a radiologist. A multivariate logistic regression was performed to find independent risk factors for positive CAC. Clinical and laboratory parameters reflecting the status of HIV infection, including CD4 count, viral load, duration since HIV diagnosis, and status of antiretroviral treatment.

RESULTS

Forty-one patients (28.7%) showed calcifications in one or more coronary arteries. LAD (n=38, 92.7%) was most commonly affected, followed by LCX (n=18, 43.9%) and RCA (n=13, 31.7%). CAC deposited at the proximal portion in LAD and LCX (76.3%, 77.7%, respectively) while at the mid to distal portion in RCA (61.5%). Age of CAC+ group (53.9 years) was significantly higher than that (43.4 years) of CAC- group (p < 0.001). Minimum age of HIV patient with positive CAC was 24yrs. Duration of HIV infection in CAC+ group (12.3 years) was significantly higher than that (8.6 years) in CAC- group (p<0.0344). The mean viral load was significantly lower value in CAC+ group compared to that in CAC- group (76K versus 414K, p=0.02). CAC+ group showed significantly higher CD4 cell counts than CAC- group (mean=355.9 versus 175.3, p= 0.0053). There was no significant difference in HAART status between the two groups (current HAART receivers 84.4% versus 85.7%, p=0.539). On multivariate logistic regression, age, HIV duration, and CD4 were significantly associated with CAC+ (p-values<.05)

CONCLUSION

Patients with HIV showed early onset and increased incidence of CAC and associated with higher CD4 cell counts. Duration of HIV is an independent risk factor for coronary artery calcification, in addition to age of patients.

CLINICAL RELEVANCE/APPLICATION

Awareness of increased risk of atherosclerosis development in young-age HIV-infected patients is crucial for primary prevention of future cardiovascular events.

SSG03

Chest (Lung Nodule)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S504AB

AI CH CT

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

SSG03-01 Deep Learning-Based Computer-Aided Detection System for Multiclass Multiple Lesions on Chest Radiographs: Observers' Performance Study

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the added value of a deep-learning based computer-aided detection (CAD) system for multiclass multiple lesions on radiographs when radiologists read chest radiographs.

METHOD AND MATERIALS

We developed new CAD system using deep learning for detecting multiple lesions with 4 different patterns (nodule/mass, interstitial opacity, pleural effusion, and pneumothorax) on chest radiograph. To train the deep learning network, 17917 images were collected in two tertiary hospitals. Numbers of normal and abnormal patients are 11000 and 6917, respectively. We labeled disease type and delineate region of interests (ROI) drawn as ground truths by two thoracic radiologists with consensus. To validate the effect of the developed CAD on observer's performance, 9 observers including 7 board-certified radiologists and two radiology residents reviewed 200 chest radiographs twice with two weeks interval. 200 chest radiographs consists of 100 normal and 100 abnormal (nodule/mass: 60, interstitial opacity: 10, pleural effusion: 10, pneumothorax: 10) chest radiographs. The diagnostic performance of the developed CAD, observers with and without CAD were evaluated and compared using jackknife free-response receiver operating characteristic (JAFROC) figure of merits (FOMs) on a per-lesion basis. The reading time for review was recorded.

RESULTS

The developed CAD showed FOMs of 0.931 for nodule/mass, 0.900 for interstitial opacity, 1 for pleural effusion, and 1 for pneumothorax. The mean FOMs of 9 observers without CAD were 0.916 for nodule/mass, 0.922 for interstitial opacity, 0.944 for pleural effusion, and 0.978 for pneumothorax. After applying the CAD, the mean FOMs of 9 observers were 0.942 for nodule/mass, 0.900 for interstitial opacity, 0.967 for pleural effusion, and 1 for pneumothorax. Except for interstitial opacity, the accuracy of three patterns with CAD increased. The mean reading time was 91.5 minutes ± 53.2 without CAD and 79.1 minutes ± 28.2 with CAD.

CONCLUSION

The deep-learning based CAD may help improve observer performance for reading chest radiograph as well as reducing reading time.

CLINICAL RELEVANCE/APPLICATION

The deep-learning based CAD has the potential to improve observer efficiency in terms of accuracy and reading and may provide preliminary interpretation for chest radiographs.

SSG03-02 A Retrospective, Multi-Center Clinical Study for Validating Increased Lesion Detection Accuracy of Radiologists When Using Computer-Aided Detection System in Reading Digital Chest X-Ray Images

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S504AB

Awards
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PURPOSE

To evaluate performance of radiologists detecting pulmonary malignant nodules assisted by deep-learning based computer-aided detection (CAD) software, compared with performance of radiologist or CAD alone.

METHOD AND MATERIALS

Each of four participating centers in three countries retrospectively collected 150 lung cancer radiographs and 50 normal radiographs. Normal x-ray images are from healthy adults, confirmed by a CT scan taken within 14 days. Each cancer x-ray image has 1 to 3 pathologically confirmed nodule(s), whose sizes are between 1 and 3 centimeters. The estimated location of each nodule was marked on x-ray image referring to the CT scan. 12 radiologists from 4 institutions with various experiences independently analyzed a set of x-ray images and marked region of interests (ROIs) on each radiograph in suspicion of a nodule. Deep learning-based computer-aided detection (CAD) software was applied to find suspicious nodules on chest radiographs. Finally, 12 radiologists reviewed whole set of images with assistance of CAD, accepting or dismissing ROIs suggested by CAD. Sensitivity and false negative per image (FPPI) of radiologist alone, CAD alone and radiologist with CAD were statistically analyzed.

RESULTS

The overall sensitivity and FPPI of the CAD system were 63.75% and 0.20, which was not statistically distinct from those of radiologists. The average sensitivity of radiologists appeared to increase significantly from 65.1% to 70.3%, after aided by the CAD software ($p<0.0001$). The average FPPI was 0.2 and 0.18, without and with CAD, respectively. The decline of FPPI was significant ($p=0.0006$). On subgroup analysis, incremental effects of CAD on nodule detection sensitivity were not affected by radiologists' experience, size, location, type (primary or metastatic) of nodules and modality of acquisition.

CONCLUSION

The average sensitivity and FPPI of our CAD system were not statically different from those of radiologists. When radiologists were assisted by the CAD, overall sensitivity increased significantly while FPPI seemed to decrease. Incremental effect of the CAD system was not affected by radiologist's experience, characteristics of a nodule or modality, which can support the potential general use of this software.

CLINICAL RELEVANCE/APPLICATION

Radiologists' performance in lung cancer nodule detection can be improved with a deep learning-based CAD system regarding both sensitivity and false positive rate.

SSG03-03 Nodule Size Measurement: Automatic or Human-Which is Better for Predicting Lung Cancer in a Brock Model?

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S504AB

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PURPOSE

To assess the impact of automated segmentation of pulmonary nodules by measuring the accuracy of the prediction of malignancy

using the Brock University Cancer Prediction Model.

METHOD AND MATERIALS

Retrospective analysis was carried out of 7927 nodules (of which 314 were malignant) from 5394 patients who were scanned as part of the US NLST (mean age 62±5 years; of which 3192 were male). Following BTS guidelines, nodules <5mm in size were excluded, but all other nodules were included regardless of type, attenuation, and margin. Automatic 3D nodule segmentations were generated via a deep learned model and initiated with a single click point inside the nodule. We used the following methods for measuring nodule size: the NSLT radiologist measurements, D2D, the long axis from the automatic segmentations, D3D, and in order to characterize the nodule volumes more accurately, the volumes of the automatic segmentations, V, were converted to an equivalent linear size using the equation for a sphere. Each was tested as the size term in the standard Brock model to generate a malignancy risk and Area-Under-the-Receiver-Operating-Characteristics (AUC-ROC) curve calculated.

RESULTS

The AUC-ROC was 85.96% (95% confidence interval (CI): 84.33, 87.76) for D2D, 86.64 (95% CI: 85.04, 88.19) for D3D, and 88.17 (95% CI: 86.71, 89.82) for Dsph. The expected increase in AUC Dsph offers over D2D is 2.21 (95% CI: 1.28, 3.12).

CONCLUSION

The automatic nodule size measurements outperformed the manual radiologist measurements in predicting lung cancer as an input to the Brock model. The non-axial Dsph, which is derived from the volumetric segmentation outperforms both long axis-based methods. Assessing nodule segmentation by measuring prediction efficacy is a viable alternative to overlap measures such as DICE.

CLINICAL RELEVANCE/APPLICATION

Automatic segmentation removes the need for manual extraction of axial diameters of lung nodules. It is not subject to intra- and inter-radiologist variation thereby improving consistency.

SSG03-04 Effect of Artificial Intelligence Based Vessel Suppression and Automatic Detection of Part-Solid and Ground-Glass Nodules on Low-Dose Chest CT

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

Most studies with CAD and artificial intelligence (AI) software have focused on solid lung nodules. We assessed the effect of AI-based vessel suppression (AI-VS) and automatic detection (AI-AD) on ground glass (GGN) and part-solid lung nodules (PSN) in low-dose CT (LDCT).

METHOD AND MATERIALS

Our study included 100 LDCT examinations with mixed attenuation pulmonary nodules (average diameter>5mm) identified from the National Lung Cancer Screening Trial (NLST). These exams were not used in training or validation of the AI software (ClearRead CT, Riverain Inc.). All 100 LDCT were processed to generate three image series per case - unprocessed, AI-VS, and AI-AD series with annotated lung nodules. Two thoracic radiologists (R1: 3-year experience, R2: 27-year experience) independently assessed the unprocessed images alone, then together with AI-VS series, and finally with AI-AD. For each assessment, number of all > 5mm with location & size of dominant GGN and PSN were recorded. Descriptive statistics and student t tests were performed for data analysis.

RESULTS

On unprocessed images, R1 and R2 detected 278 nodules (123 PSN, 155 GGN) and 269 (117 PSN, 152 GGN), respectively (p>0.05). With addition of AI-VS images, R1 and R2 detected 290 nodules (126 PSN, 164 SSN) and 293 (132 PSN, 161 GGN), respectively, which were significantly greater than those detected without the AI-VS (p= 0.004). AI-VS aided in detection of solid component in 22 PSN which were deemed SSN by both readers. Conversely, AI-AD annotated only 75 PSN and 54 GGN (total 129 nodules). In 21 patients, AI-AD did not detect the dominant PSN or SSN; it detected 14 false positive nodules (vessels, atelectasis, anterior junctional line). Average respective sizes of 69-matched and detected PSN on unprocessed and AI-AD series were 15 ±7 mm and 13 ± 6 mm (p =0.07).

CONCLUSION

AI-VS improves detection and characterization of GGN and PSN on LDCT of the chest. Specifically, improved and easier detection of the solid component in non-solid nodules with AI-VS can avoid false down-grading of Lung-RADS category, and thus help in appropriate patient management.

CLINICAL RELEVANCE/APPLICATION

AI software can aid in improved detection and confident detection of ground-glass and part-solid lung nodules on low dose chest CT.

Honored Educators

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SSG03-05 Evaluation of Lung Nodules with FDG PET-CT: The Value of MIP Reconstructions in Conventional Thoracic CT Images During Shallow Breathing versus Images in Deep Inspiration

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S504AB

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PURPOSE

Detection of small lung nodules is important for apropiate staging of cancer. There is controversy in literature about the value of adding a separate CT of the lungs in deep inspiration. Radiation dose is no longer an issue with the use of modern equipment because only aproximately 3 mSv are added to the usual dose. The purpose of this study was to assess the value of additional thoracic CT in deep inspiration and the use of maximum intensity projection (MIP) reconstructions in PET-CT of oncologic patients.

METHOD AND MATERIALS

186 consecutive patients (99 male and 89 female; mean age,72 years; range: 26-93 y) underwent FDG PET-CT for one of the following indications: characterization of a new detected lung nodule/mass (n=101), staging of cancer (n=31), therapy respons monitoring (n=33), suspicion of tumor relapse (n=19) and cancer of unknown origin (n=2). After PET-CT acquisition with shallow breathing, a thoracic CT in deep inspiration was performed to all patients (slide thickness: 1.25 mm). MIP of the two sets of lung images were performed. Two experienced radiologist analyzed the 4 sets of CT studies. The number of lung nodules was recorded. Lung nodule was defined as a rounded opacity smaller than 10 mm completely surrounded by lung parenchyma. The clinical relevance of the eventual discrepancies between CT studies was analized (i.e. upstaging).

RESULTS

120/186 patients presented with nodules. PET-CT with shallow breathing detected 393 nodules, and 578 when MIP images were analized. Thoracic CT with deep inspiration found 534 nodules and 905 when MIP was used. The number of detected nodules increased from free breathing to breathe hold CT in 42 patients. The detected number of nodules with breath hold technique compared with free breathing increased increased in 51 patients when MIP was used. The extradetected nodules were considered clinical relevant in 7/120 (6%) of patients because they influence patient management for example by increasing TNM staging.

CONCLUSION

According to our results the addition of deep inspiration thoracic CT with MIP reconstructions can be recommended in clinical practice because this approach yields better performance in TNM staging in oncologic patients.

CLINICAL RELEVANCE/APPLICATION

Addition of deep inspiration CT with MIP reconstructions to conventional FDG PET-CT in oncologic patients yields better performance in TNM staging.

SSG03-06 Deep Learning for Rule-Out of Unnecessary Follow-Up in Patients with Incidentally Detected, Indeterminate Pulmonary Nodules: Results on an Independent Dataset

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S504AB

Participants
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PURPOSE

To assess the follow-up rule-out accuracy of a convolutional neural network (CNN) in patients with incidentally detected, indeterminate pulmonary nodules in a multi-site, heterogeneous population.

METHOD AND MATERIALS

The US National Lung Screening Trial (NLST) dataset was manually curated and used to create a training set: each reported nodule and cancer was located, contoured and diagnostically characterised (9310 benign nodule patients; 1058 cancer patients). All patients with solid and semi-solid nodules of 6mm and above, where benign nodules and cancers could be confidently identified by clinicians (5972 patients, of which 575 were cancer patients), were selected. A CNN was trained using Deep Learning and three thresholds for benign rule-out were calculated at three levels of sensitivity: 100%, 99.5% and 99%. An independent dataset of patients with incidentally detected indeterminate pulmonary nodules was retrospectively collected from a tertiary referral centre and surrounding hospitals in the UK with a heterogeneous mix of scan parameters, manufacturers and clinical indications (610 patients, 698 nodules, 5-15mm). Diagnosis was established according to British Thoracic Society guidelines (2015). The dataset contained 50 cancers from 47 patients (7% of all nodules). Performance was evaluated by measuring the specificity at the three benign rule-out thresholds; i.e. to measure the proportion of benign nodules correctly stratified while missing no or few cancers. Overall Area-Under-the-ROC-Curve analysis (AUC) was also calculated.

RESULTS

The specificity (sensitivity) was 24% (100%), 24% (100%) and 48.6% (100%) at the three thresholds respectively. AUC was 0.93 (95%CI = 0.90-0.96).

CONCLUSION

On this independent dataset, the CNN was able to correctly classify just under half of the benign nodules whilst not misclassifying any cancers.

CLINICAL RELEVANCE/APPLICATION

Our work shows the potential of CNNs in ruling out benign pulmonary nodules and therefore reducing the need for follow up scans in a large number of patients.

SSG03-07 A Decision Analysis of Follow-Up and Treatment Algorithms for Subsolid Pulmonary Nodules

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S504AB

Participants
Mark M. Hammer, MD, Saint Louis, MO (*Presenter*) Nothing to Disclose
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PURPOSE

To use simulation modeling based on evidence from the literature to evaluate several management strategies and treatment options for patients with ground glass nodules (GGNs).

METHOD AND MATERIALS

We developed a Monte Carlo model for patients with GGNs as they underwent follow-up per Lung-RADS for up to ten years. Nodules could grow and develop solid components over time. Rates of clinically-significant malignancy were calibrated to data from the National Lung Cancer Screening Trial. We investigated modifications to the follow-up schedule and tested different treatment strategies, specifically lobectomy, radiation therapy, and no therapy.

RESULTS

Overall, 2.3% of nodules represented clinically significant malignancies, and 6.3% of nodules were treated. Only 29.8% of Lung-RADS 4B/4X nodules were clinically-significant malignancies. We compared outcomes of patients with Lung-RADS 2 nodules followed at 1-, 2-, and 3-year intervals; overall survival at 10 years of follow-up was similar, ranging from 74.7% (annual) to 73.5% (triennial). We also evaluated 10-year outcomes from Lung-RADS 4B/4X non-solid nodules treated with different modalities; at 10 years, overall survival was highest in the radiation therapy arm, at 83.9%, and lowest in the no treatment arm, at 78.1%.

CONCLUSION

Our results suggest a conservative approach to the follow-up and treatment of GGNs. The follow-up interval for GGNs can be increased to 3 years with minimal change in outcomes. Our results also favor the use of radiation therapy when a nodule has met criteria for treatment. Prospective randomized trials are needed to evaluate thresholds for management and different treatment modalities for GGNs.

CLINICAL RELEVANCE/APPLICATION

Conservative management strategies for non-solid nodules, such as triennial follow-up for Lung-RADS 2 nodules and radiation therapy instead of lobectomy for Lung-RADS 4B/4X nodules, are preferable to more aggressive treatment.

SSG03-08 A Robust Model for Prediction of Pulmonary Nodule Malignancy with CT Scans

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S504AB

Participants
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Shiyuan Liu, PhD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Pulmonary nodules could be early manifestations of lung cancer, but the morphological complexity makes it difficult to differentiate benign and malignant nodules. This paper proposes two deep learning models aiming to accurately determine the malignancy of pulmonary nodules from CT images.

METHOD AND MATERIALS

Model-1 was adapted from the winning model in Data Science Bowl 2017.. We chose ResNet as its backbone and integrated U-Net and Capsule Network architectures to enable the model to comprehensively capture multiscale features of pulmonary nodules. Model-2 took extracted features from Model-1 as input to a random forest classifier to further predict nodule malignancy, as inspired from the NoduleX model. Two datasets were adopted to validate the performance of the proposed two models. Dataset 1 contains 1061 samples (benign/malignant: 703/353) from Lung Image Database Consortium and Image Database Resource Initiative (LIDC-IDRI), and Dataset 2 consists of 1117 samples (benign/malignant: 354/763) provided by collaborating hospitals. Nodules in both datasets were biopsy or surgery proven, and pathology diagnoses were used as gold standard. We randomly selected 20% from each dataset as the testing set and used the rest 80% as the training set. We trained and tested our two models on the above two datasets respectively.

RESULTS

On Dataset 1 (LIDC-IDRI), Model-1 achieved an AUC of 0.91 in the prediction of pulmonary nodule malignancy while Model-2 achieved an AUC of 0.96. On Dataset 2, Model-1 again reached a high AUC of 0.90, which significantly outperformed the Model-2 with AUC=0.80.

CONCLUSION

Model-1 showed consistently high accuracy in pulmonary nodule malignancy prediction on both the LIDC dataset and CT scans collected from collaborating hospitals. Our two models achieved comparable results with NoduleX model which had got the state-of-the-art performance in LIDC dataset. The experimental results demonstrated that Model-1 showed more stable performance across datasets and had better model robustness. The strength of Model-1 may lie in its Capsule Network structure that could extract more universally informative features and the end-to-end deep learning architecture.

CLINICAL RELEVANCE/APPLICATION

Our proposed model can serve as a useful tool for early diagnosis of lung cancer and has the potential to be applied in clinical treatment planning.

SSG03-09 External Validation of the McWilliams Model to Predict Probability of Cancer in Pulmonary Nodules using NLST Data

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S504AB

Participants
Audrey Winter, PhD, Los Angeles, CA (*Presenter*) Nothing to Disclose
William Hsu, PhD, Los Angeles, CA (*Abstract Co-Author*) Research Grant, Siemens AG

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PURPOSE

Lung cancer screening results in the discovery of an estimated 1.57 million screen- and incidentally-detected pulmonary nodules. Prediction models, which estimates the probability of lung cancer in pulmonary nodules detected on computed tomography (CT) can potentially aid in manage patients and minimize overdiagnosis. Thus, we performed an external validation of an existing model developed by McWilliams et al (doi:10.1056/NEJMoa1214726).

METHOD AND MATERIALS

Based on the inclusion/exclusion criteria stated by McWilliams, we identified 7,879 non-calcified nodules greater than 4 mm discovered at the baseline CT screening with at least 2 years of follow-up using data from the CT arm of the National Lung Screening Trial (NLST). We assessed model discrimination (the ability to distinguish between cancer/not cancer) and calibration (the agreement between predicted and observed probabilities). We identified differences between PanCan, the derivation dataset, and NLST. The regression coefficient and the intercept coefficient were estimated by fitting a logistic regression on NLST. We also attempted to update and recalibrate the model. Finally, we evaluated whether the addition of new covariates such as body mass index, smoking status, pack-years and asbestos improved performance.

RESULTS

While the AUC of the model was good 0.905 [0.882-0.928]), the histogram plot showed that whether a nodule was cancer/not cancer could not be well-separate (see Figure, left). The calibration plot showed that the model tended to overestimate the probability of cancer. Following methods in Steyerberg et al (doi: 10.1002/sim.1844), the updated model achieved an AUC of 0.914 [0.892-0.936] and a better calibration (see Figure, right). Emphysema ($p=0.03$) and nodule spiculation ($p<0.01$) had a significantly different effect in the NLST cohort compared to the PanCan. Among the new covariates, only the pack-year history was found to be significant ($p<0.01$).

CONCLUSION

While the model achieved high AUC, discrimination and calibration remain suboptimal, motivating our efforts to improve additional clinical, imaging, and the evolution of covariates over time that could influence performance.

CLINICAL RELEVANCE/APPLICATION

External validation is necessary to assess generalizability of a prediction model to new patients. We show how discrimination and

External validation is necessary to assess generalizability of a prediction model to new patients. We show how discrimination and calibration can be examined to assess how models can likely enter in clinical practice.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSG04

Emergency Radiology (Brain, Head, Neck and Spine)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S403A

CT ER HN NR

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

Participants
Christopher A. Potter, MD, Boston, MA (*Moderator*) Nothing to Disclose
Savvas Nicolaou, MD, Vancouver, BC (*Moderator*) Institutional research agreement, Siemens AG

Sub-Events

SSG04-01 Spectrum of Diagnostic Errors in Cervical Spine Trauma Imaging and Their Clinical Significance

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S403A

Participants
Francesco Alessandrino, MD, Boston, MA (*Presenter*) Nothing to Disclose
Christopher M. Bono, MD, Boston, MA (*Abstract Co-Author*) Advisory Panel, UnitedHealth Group Royalties, Wolters Kluwer nv
Christopher A. Potter, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Mitchel B. Harris, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purpose of our study was to describe and categorize diagnostic errors in cervical spine CT interpretation (CsCT) performed for trauma and to assess their clinical significance.

METHOD AND MATERIALS

All CsCT studies with diagnostic errors that came to our attention based on clinical or imaging follow up from 2004 to 2017 were analyzed. Errors were categorized as extraspinal or spinal, osseous or soft tissue finding, according to anatomical site and level for each spinal finding. All images were reviewed by a musculoskeletal fellowship trained emergency radiologist and a spine surgeon. For each error, the spine surgeon assessed the need for 1) surgery, 2) immobilization and 3) MRI. Findings were considered clinically significant if the answer to any of the three questions was positive.

RESULTS

56 patients with CsCTs and reports containing diagnostic errors were reviewed. 12 patients (21.5%) had missed or misinterpreted finding in extraspinal location. 44 patients (78.5%) had errors localized to spine (28 fractures/dislocations, 15 intervertebral disc protrusions, 1 lytic bone lesion). The locations of missed/misinterpreted fractures were: transverse (n=8), spinous process (n=6), facet (n=4), lamina (n=2), vertebral body (n=11), C1 (n=3), occipital bone (n=1). Two dislocations were at the atlantoaxial articulation (n=2). 4 patients had missed fractures encompassing more than one anatomical location. The most common spinal fracture levels were C5 (n=7) and C7 (n=6). In 4 patients, additional contiguous (n=2) or noncontiguous (n=2) fractures were missed. Responses to the three questions were positive in 3, 25, and 16 patients, respectively. All fractures were considered clinically significant, including 3 patients who would have required surgical stabilization (2 atlantoaxial dislocations and 1 facet fracture). None of the intervertebral disc protrusions were reported to alter the management by the surgeon.

CONCLUSION

65.9% of our patients in our series with diagnostic errors localized to spine on CsCTs were considered clinically significant, potentially altering therapeutic and diagnostic management. Transverse process fractures were the most common clinically significant missed/misinterpreted finding.

CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware of commonly missed injuries on CsCT and their clinical significance so they can adjust their search pattern and improve the accuracy of their reports.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Bharti Khurana, MD - 2014 Honored EducatorBharti Khurana, MD - 2018 Honored EducatorAaron D. Sodickson, MD,PhD - 2014 Honored EducatorAaron D. Sodickson, MD,PhD - 2017 Honored EducatorAaron D. Sodickson, MD,PhD - 2018 Honored Educator

SSG04-02 Diagnostic Value of Prevertebral Soft Tissue Thickening on Cervical Spine CT in Acute Trauma, Using MRI as the Reference Standard

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S403A

Participants
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PURPOSE

Population normal values of prevertebral soft tissue (PVST) thickness on CT have been established but there is little previously published research examining whether an abnormal PVST thickness on CT has diagnostic value as a sign of cervical spine injury. This study aims to evaluate whether an abnormal PVST on CT is a predictor of anterior column soft tissue injury on cervical spine MRI.

METHOD AND MATERIALS

The radiology information system(RIS) at a tertiary trauma centre was searched for Emergency Department patients over 18 years of age who had a CT of the cervical spine for trauma from 1st January 2017 onwards, which was followed by a cervical spine MRI within 7 days. Exclusion criteria include previous spinal surgery and intubated patients. 40 consecutive patients meeting inclusion and exclusion criteria were selected. For each CT study, PVST thickness on CT at levels C1 to C7 were measured, and the PVST thickness was categorised as normal or abnormal based on previously published normal values by Rojas et al in 2009. The corresponding MRI images and reports were reviewed for anterior column soft tissue injury (prevertebral haematoma or anterior longitudinal ligament injury). The performance of abnormal PVST thickness on CT as a predictor of MRI findings of anterior column soft tissue injury was evaluated and diagnostic odds ratio, sensitivity and specificity were calculated.

RESULTS

Prevertebral soft tissue thickening on CT is strongly associated with findings of anterior column soft tissue injury on MRI ($p = 0.0002$), with a diagnostic odds ratio of 32.7, specificity of 93% and sensitivity of 70%.

CONCLUSION

Prevertebral soft tissue thickness should be evaluated on cervical spine CTs as it is a useful radiological sign of anterior column soft tissue injury.

CLINICAL RELEVANCE/APPLICATION

When reporting cervical spine CTs, anterior column soft tissue injury should be strongly suspected if there is prevertebral soft tissue thickening.

SSG04-03 Spinal Trauma in DISH: Is MRI Essential After the Detection of Vertebral Fractures on CT?

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S403A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

1. To assess the incidence of posterior column involvement on CT and MRI in patients with diffuse idiopathic skeletal hyperostosis (DISH) and known anterior/middle column injury on CT. 2. To evaluate the utility of performing MRI in DISH patients with isolated anterior/middle column fractures and no neurological deficit.

METHOD AND MATERIALS

Records of 177 consecutive patients older than 50 years of age admitted between 2008 and 2017 for a traumatic spinal fracture and a diagnosis of DISH were reviewed. Only fractures involving an ankylosed region of the spine were included. Patients with fractures involving a non-ankylosed spine segment and history of prior spine surgery were excluded. Age, gender, mechanism of trauma, fracture type, spine CT and MRI imaging findings, surgical intervention, neurologic deficit, complications, and in-hospital mortality were collected from the medical records.

RESULTS

26% (47/177) of patients had hyperextension injuries; overall, 59% (106/177) had either non-displaced or minimally displaced fractures. 116/177 (66%) patients had fractures isolated to the anterior/middle column. 22/177 patients had fractures isolated to the posterior column only and 39/117 patients had fractures involving both the anterior/middle and posterior columns. 97 patients in our cohort underwent MRI after a fracture was detected on CT. 75 of the 97 patients had fractures isolated to the anterior/middle column. Of these 75, 26 had disruption of the posterior ligamentous complex (PLC), and only 4 of the 26 patients had no neurologic deficit. 28 of the 97 patients had either spinal cord injury or epidural hematoma and 27/28 of these patients presented with neurological deficit. The one patient that did not present with neurologic deficit had a tiny dorsal epidural hematoma without spinal

cord injury or disruption of the PLC and was managed conservatively.

CONCLUSION

1. 49% of patients in our cohort (87/177) had either a posterior column fracture on CT or disruption of the PLC on MRI. 2. In DISH patients with isolated anterior/middle column fractures and no neurologic deficit, MRI did not provide additional information that would change management in most cases (85%).

CLINICAL RELEVANCE/APPLICATION

In most DISH patients with anterior/middle column fractures only and no neurologic deficit, spine CT alone is sufficient for management without the additional time and money spent on MRI.

Honored Educators

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SSG04-04 Incidence and Patterns of Cervical Spine Injuries on CT: A Study in a Level I Trauma Center

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S403A

Participants
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Roy Riascos, MD, Houston, TX (*Presenter*) Nothing to Disclose

PURPOSE

Though spinal fractures constitute a minority of all trauma, the financial burden imposed is very significant especially cervical spine trauma. The pattern of cervical spine injuries in the setting of trauma in general population is unknown at the moment in United States with very few papers addressing the issue. We reviewed entire spectrum of cervical spine injuries and demonstrated correlation between various demographics, clinical presentation with radiological appearance of the injury.

METHOD AND MATERIALS

We performed retrospective analysis of 13,500 patients who underwent imaging for cervical spine trauma at a level I trauma center. Out of this database we selected 934 patients who had a positive CT scan. Each patient was then analyzed by reviewing the medical records and correlation was sought between demographic, clinical and imaging features.

RESULTS

In our study, the peak incidence of cervical spine trauma was in the age group of 21-30 years followed by 31-40 years with a male:female ratio of 2.1. Major cause of injury in the study population was motor vehicle accidents (66.1%), followed by fall from height of less than 8 feet (12.2%). For fractures of vertebral bodies, we identified 440 injury levels, with C1 and C2 being the most frequent fractured as compared to the subaxial spine. Incidence of C2 fractures (40.9%) was higher as compared to C1 (23.2%). Body and lateral mass fracture incidence was marginally higher as compared to odontoid fractures. C7 (11.3%) was the most fractured vertebral body in the subaxial spine followed by C6 (8%) and C5. Highest number of vertebral body fractures were due to compression injury. 924 injury levels were identified for vertebral body process with transverse process fractures (38.6%) being the most common.

CONCLUSION

Spinal trauma is on the rise and it helps to understand the frequency and pattern of injuries in cervical spine to guide us for better management of these patients.

CLINICAL RELEVANCE/APPLICATION

To understand the distribution and pattern of injuries in cervical spine on a plain CT in the setting of trauma to improve delivery of healthcare.

SSG04-05 The Combination of SWI and DTI in Evaluating the Severity of Traumatic Brain Injury

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S403A

Participants
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PURPOSE

To explore the diagnostic value of SWI and DTI on different severity's traumatic brain injury(TBI).

METHOD AND MATERIALS

Totally 60 TBI patients (including 20 mild TBI patients, 20 moderate TBI patients and 20 severe TBI patients) and 20 health volunteer underwent SWI, DTI and conventional MRI examination. The numbers of involving regions, numbers and areas of

hemorrhagic lesions detected by SWI, and FA values of 37 brain regions (including knee, body, splenium of corpus callosum, cingulate bundle, et al.) were compared between each two groups. The correlation analysis between GCS scores and the number of involving regions, number of hemorrhagic lesions, areas of hemorrhagic lesions detected by SWI, and FA values of each region were performed.

RESULTS

The differences of involving regions' number, lesions' number, lesion's areas detected by SWI between each two groups were statistically significant (P<0.05). Severe TBI group got the maximum number of involving regions, lesions, and the largest areas. Followed by moderate group and mild group. Among the 37 regions, totally 30 regions differ in FA values between the four groups (P<0.05). And among these 30 regions, 18 regions' FA values, for example corpus callosum region, gradually reduce as the severity of TBI aggravate. The GCS scores are highly negatively correlated with the number of involving regions, number of lesions, areas of lesions detected by SWI, but are positively correlated with 30 regions' FA values. The descending order of relevance is hemorrhagic lesions' areas(r=-0.932), lesions' number(r=-0.911), involving regions' number(r=-0.900), FA values of right cingulum(r=0.872), right anterior limb of internal capsule(r=0.801), left cingulum (r=0.787), the splenium of corpus callosum(r=0.775), the body of corpus callosum (r=0.765), et al.

CONCLUSION

The clinical applications of SWI and DTI is valuable in diagnosing different severity's TBI.

CLINICAL RELEVANCE/APPLICATION

SWI and DTI are effective in evaluating the severity of traumatic brain injury

SSG04-06 Iodine Maps on Follow-Up DECT: Prognostic Value in Patients with Cerebral Hemorrhagic Contusions in Moderate to Severe Head Trauma

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S403A

Participants
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PURPOSE

We aimed to retrospectively determine if the quantitative data derived from Iodine Maps of follow-up head DECT can predict the 6-month mortality and unfavorable outcome scores in patients with cerebral contusions as derived from IMPACT model.

METHOD AND MATERIALS

This study was HIPAA compliant and institutional review board approved. Informed consent was waived. We retrospectively analyzed admission and 6-hour follow-up CT studies in 69 patients with hemorrhagic contusion(s). We incorporated the previously described powerful conventional CT outcome predictors related to the dominant lesion and new variables derived from Iodine Maps in our evaluation. After performing univariate analysis, the independent predictors were determined by using regression analysis.

RESULTS

CT variables with significance on univariate analysis were, hematoma volume at admission (Spearman's rho=0.38, p=0.03 for mortality; Spearman's rho=0.36, p=0.04 for unfavorable outcome), hematoma volume on follow-up (Spearman's rho=0.42, p=0.001 for mortality; Spearman's rho=0.38, p=0.004 for unfavorable outcome), enhancing penumbra volume (Spearman's rho=0.47, p=0.0003 for mortality; Spearman's rho=0.43, p=0.001 for unfavorable outcome), iodine concentration (Spearman's rho=0.32, p=0.02 for mortality; Spearman's rho=0.3, p=0.03 for unfavorable outcome), iodine content in penumbra (Spearman's rho=0.5, p=0.0002 for mortality; Spearman's rho=0.45, p=0.001 for unfavorable outcome), iodine content in contusion (Spearman's rho=0.5, p = 0.0002 for mortality; Spearman's rho=0.44, p=0.001 for unfavorable outcome). There was no correlation between the fractional hemorrhagic progression of contusion (%HPC) and the outcomes. Enhancing penumbra volume, and iodine content in penumbra were the independent predictors of both the outcome scores on regression analysis (B=10.9, p=0.002; B=9.22, p=0.02 for mortality; B=13.1, p=0.003; B=11.4, p=0.02 for unfavorable outcome).

CONCLUSION

Enhancing penumbra volume, and iodine content in penumbra may be more accurate for predicting outcomes in patients with cerebral contusions, than the previously identified predictor variables of hematoma volumes and %HPC.

CLINICAL RELEVANCE/APPLICATION

Quantitative iodine based CT variables derived from extravasated iodine into the contusions may improve the accuracy of the existing prediction models.

SSG04-07 Supplementing Screening Criteria Yields Increased BCVI Incidence, with Subsequent Imaging Showing Markedly Increased Risk for Ischemic Stroke

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S403A

Participants
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PURPOSE

Blunt cerebrovascular injuries (BCVI) are uncommon, but can have severe consequences such as ischemic stroke. Detection of BCVI requires an angiogram of the cervical arteries, commonly by CT angiography (CTA). CTA screening criteria for BCVI based on clinical findings and trauma mechanism have improved detection. Denver criteria for screening are most commonly used in absence of a clear consensus. Since clinical findings are often inconclusive, many patients do not meet any of these criteria. The aim of this study was to analyze the effect of augmented Denver criteria on BCVI incidence, as well as to determine the relative risk for ischemic stroke.

METHOD AND MATERIALS

For a single level one trauma center, Denver screening criteria for BCVI were augmented by including any high-energy trauma, cervical spine fracture, and major chest injury. All acute blunt trauma WBCT studies over a period of 38 months were reviewed retrospectively for distribution and grade of BCVI by two board-certified radiologists blinded to initial results. Non-CTA studies were excluded and any disagreements settled by consensus. Any subsequent cerebral imaging studies were reviewed for ischemic lesions appearing at a later phase.

RESULTS

1544 WBCT studies included 374 CTA (m/f=271/103; mean age 41.5 years). Most common mechanisms of injury were MVA (51.5%) and fall from a height (22.3%). We found 72 BCVI in 56 patients (15.0%), with 13 (23.2%) multiple lesions. The internal carotid artery (ICA) was affected in 49 (68.1%) and the vertebral artery (VA) in 23 (31.9%) of cases. Most common injury grades were Biffl I and II in both ICA and VA, with C2 as the most common level. Gender (p=0.1482) and age (p=0.611) had no impact on BCVI incidence. Interobserver agreement was substantial (Kappa=0.674). Subsequent imaging of 215 patients revealed cerebral ischemic stroke in 19.6% of BCVI and 3.5% of the remaining cases. Fisher's exact test shows this difference to be highly significant (p<.0001) with an OR of 9.77 (95% CI; 3.3-28.7).

CONCLUSION

Augmenting Denver screening criteria yielded an almost threefold incidence for BCVI in blunt trauma than expected (15.0%), which emphasizes the need for more liberal screening protocols. The markedly elevated relative risk for ischemic stroke following BCVI with an OR of 9.77 underlines the urgency of this proposal.

CLINICAL RELEVANCE/APPLICATION

Supplementing screening criteria for BCVI might markedly improve patient outcome.

SSG04-08 Frequency of Acute Findings in Head CT Scans Performed in the Emergency Department

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S403A

Participants
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Eyal Zimlichman, Ramat Gan, Israel (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Head CT is the most common CT scan conducted in the ED. The aims of this study were to evaluate the frequency of acute findings on head CTs conducted in the ED in different age groups, and to analyze head CT referral indications.

METHOD AND MATERIALS

Institutional review board (IRB) approval was granted for this study. Informed consent was waived by the IRB committee. The records of one tertiary care hospital's ED were retrospectively reviewed for consecutive adult patients who underwent head CT during a time frame of 40 days from January 1st 2017. CT interpretations were obtained and checked for demographics, referral indications and CT findings. Findings were divided into three groups: Acute findings, chronic findings and normal head CT. The cohort was divided into groups according to age: young adults (aged 19-40), adults (aged 41-65) and elderly (over 65 years old). Associations between referral indications and acute findings were calculated.

RESULTS

During the study's time frame, 12,958 adult patients presented to our ED. 1,621 of them (12.5%) underwent a head CT (young adults 221/1621=14.4%, adults 404/1,621= 26.3%, and elderly 913/1,621=59.4%). Acute findings were found in 15% of the patients and the frequency increased with age (young adults 12.2%, adults 13.6%, elderly 17.2%, p=0.027). Chronic findings were found in 24% of the patients (young adults 5.9%, adults 18.3%, elderly 30.6%, p<0.001). The distribution of acute findings for the entire cohort was: brain hemorrhage 32.6%, brain infarct 27.6%, SOL 23.0%, fractures 8.4%, sinusitis 11.3% and hydrocephalus 9.2%. Brain hemorrhage was the most common finding in young adults (29.2%) and in the elderly (36.3%), while SOL was the most common in the adult group (36.4%). The top three referral indications were neurological signs (19.7%), trauma (15.6%) and headache (12.3%). Headache was the most common indication in young adults (25.1%) and neurological signs were the most common in the adults and elderly groups (20.6%, 20.0%, respectively). Seizures were associated with acute findings (p=0.024, OR=1.917) and dizziness with absence of acute findings (p=0.022, OR=0.528).

CONCLUSION

Acute findings are found in 15% of head CT scans performed in the ED. The frequency of acute and chronic findings increases with age.

CLINICAL RELEVANCE/APPLICATION

The increasing amount of head CTs and the relatively low yield of this test, requires the implementation of decision protocols.

SSG04-09 Evaluation of the Big-5 CT-Protocol: Diagnostic of Ischemic Stroke Including Origins

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S403A

Participants
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Ulf K. Teichgraeber, MD, Jena, Germany (*Abstract Co-Author*) Research Consultant, W. L. Gore & Associates, Inc Research Consultant, Siemens AG Research Consultant, CeloNova BioSciences, Inc Research Consultant, General Electric Company

PURPOSE

Approximately 20-40% of ischemic strokes are caused by a cardio genetic embolic disease. Evidence of the embolic origin cannot become clearly defined. The goal of this study was the implementation of an extended stroke protocol (Big-5, see Fig. 1) for evaluation of thrombo-embolic sources, detection of pulmonary artery embolism, carotid artery stenosis and acute aortic syndrome in one initial exam.

METHOD AND MATERIALS

Imaging was performed using a high-end CT in the ER (Revolution CT, GE Healthcare). All patients (n=208) received an unenhanced brain scan for hemorrhage exclusion. Subsequently a combined ECG-gated/non-ECG-gated scan (caudo-cranial) for the assessment of heart, aortic arch, carotid arteries and brain vessels. Consecutively 40 s after CM injection another ECG-gated acquisition in diastolic phase covering the left atrial appendage and left atrium. Finally, a dynamic neuro perfusion scan was performed. All patients had no contraindication for CM or any known iodine allergy. Image quality of left atrium appendage was scaled with a 5-tier Likert-scale by 2 radiologists.

RESULTS

Excluded were 48 patients due to external causes (motion artifacts, IC, etc.). In 60/160 patients a pathological finding, in 54 (34%) patients morphological change consistent with acute stroke was detected. Cardiogenic thrombus sources could be found in 8/160 cases, 6 in the left atrial appendage and 2 on the aortic valve. One type A aortic dissection was documented. In 3/54 patients with acute stroke a cardiac source of thrombus, in 18 cases a severe stenosis or occlusion of carotid vessels and in 20 cases extensive thrombotic plaques of aortic arch or carotids and in 13 patients an intracranial arterial thrombus could be found. Image quality of left atrium appendage was significantly better in venous phase compared with CTA arterial phase (141 vs. 107 cases as good or very good, $p<0.001$).

CONCLUSION

Big5 provides extensional clinical information for patients with acute ischemic stroke compared to the traditional CT stroke examination protocol.

CLINICAL RELEVANCE/APPLICATION

Concomitant pathologies including pulmonary artery embolism, carotid artery stenosis and acute aortic syndrome could make the initial clinical assessment difficult and can be excluded. There is higher prevalence of pathologic findings in carotid vessels than in detection of intracardial thrombus.

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SSG05

Gastrointestinal (Advanced Liver MR Imaging Techniques)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S503AB

GI MR

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

FDA Discussions may include off-label uses.

Participants
Kathryn J. Fowler, MD, San Diego, CA (*Moderator*) Nothing to Disclose
Elmar M. Merkle, MD, Basel, Switzerland (*Moderator*) Speakers Bureau, Siemens AG Research Grant, Bayer AG Research Grant, Guerbet SA Research Grant, Bracco Group Research Grant, Siemens AG
Victoria Chernyak, MD,MS, Bronx, NY (*Moderator*) Nothing to Disclose
Myeong-Jin Kim, MD, PhD, Seoul, Korea, Republic Of (*Moderator*) Nothing to Disclose

Sub-Events

SSG05-01 Correcting for Tumor Volume-Related Statistical Measurement Error in Motion Corrected Image Sets, Improves Sensitivity of the ADC to Detect Significant Changes in a Multicenter Study of Colorectal Liver Metastases

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S503AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

We compare reproducibility (CoV) of the Apparent Diffusion Coefficient (ADC) histogram for a standard Diffusion Weighted Imging (DWI) protocol against methods that correct for respiratory motion artifact and account for tumour volume, in order to assess the feasability of such methods to improve sensitivity of ADC in a multicentre setting.

METHOD AND MATERIALS

Data was acquired from 2 different 1.5 Tesla (T) vendors located at 3 centres. Test and retest images were acquired within 7 days. Two DWI acquisition protocols were used, A (standard) and B (allows for retrospective motion correction). Protocol B data was motion corrected using a previously published retrospective method. Similarly, a previously published model that estimates tumor volume related statistical error was applied (defined as S). The suitability of the model to describe this data set distribution was tested using Chi-squared ($\chi 2$) goodness of fit. Histogram analysis of reproducibility was calculated with a 5% level of significance for each method, A, B and S. The within-patient coefficient of variance (CoV) compared ADC reproducibility between methods for all the chosen histogram metrics (mean, median, 5th, 20th, 95th percentiles). Upper 95% limits of agreement (LoA) were calculated to define thresholds for detecting a statistically significant percentage change in ADC (ΔADC%).

RESULTS

15 patients (5 per site) were scanned. Although an improvement in sensitivity (CoV) was observed after motion correction (4.4% (A) vs. 3.2% (B) for mean ADC), no significant improvement was observed for the ADC histogram. Correcting for tumour size (S) in motion corrected data (B) significantly ($p<0.05$) improved CoV estimates (1.5% for mean ADC). The 95% LoA for ΔADC% narrowed from 12.7% (A) to 8.9% (B) to 1.9% (S). Sensitivity for the 20th percentile improved the most (20% to 2.4% 95% LoA)

CONCLUSION

This study demonstrates the feasibility of applying methods to improve ADC histogram sensitivity in a multicentre setting. Accounting for tumour volume and motion artifact improves estimates of reproducibility to within 1.5% (CoV for mean ADC),The 20th percentile demonstrated the largest improvement in sensitivity.

CLINICAL RELEVANCE/APPLICATION

Considering statistical error related to individual tumour volumes, and correcting for motion artifact, improves the sensitivity of the ADC to detect a significant post treatment response, in patients with colorectal liver metastases.

SSG05-02 Impact of Gadoxetate-Disodium vs. Gadoterate-Meglumine on Quantitative Respiratory and Hemodynamic Metrics Viewed through the Lens of a Compressed-Sensed MR Imaging Sequence

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S503AB

Participants
Carl Glessgen, MD, Basel, Switzerland (*Presenter*) Nothing to Disclose
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PURPOSE

To primarily test whether any contrast administration leads to respiratory irregularities. Secondarily, to quantify respiratory anomalies during the injection cycle comparing gadoxetate with gadoterate meglumine, and to assess whether utilization of free-breathing acquisition schemes using compressed sensing, parallel imaging and golden-angle radial sampling (GRASP) may yield additional quantitative information helpful in correcting imaging anomalies through respiratory gating.

METHOD AND MATERIALS

This prospective, IRB approved study examined a population of 497 patients; 338 received gadoxetate, 159 received gadoterate. All underwent GRASP imaging (TR/TE=4/2ms,ST=3.5, 0.56x0.56cm, temporal resolution=10s). Consecutive acquisitions during 250sec allowed dynamic imaging; each imaging was initiated 20 seconds prior to injection. Quantitative assessment evaluated (1)aortic enhancement (ROI in abdominal aorta), (2)respiratory translation of liver (ROI in liver dome) and (3)K-space based detection of plethysmographic excursion of diaphragm. (1)allows determination of individual contrast phases and hemodynamic metrics. (2)enables quantification of respiratory dynamics through changes in hepatic intensity; (3) enables extraction of plethysmographic signal strength curves and calculation of individual respiratory parameters.

RESULTS

Hemodynamic metrics did not differ between the 2 administered contrast agents ($p>0.05$). Both agents showed a mean signal drop of the hepatic ROI, with significantly higher (-52,3%vs-37,2%, $p=0.003$) and steeper (-.0211vs-.0165 ; $p< 0.001$) values for gadoxetate. Patients receiving gadoxetate had decreased breathing amplitude during entire examination (0.37 vs. 0.43, $p<0.001$), and specifically during pre-bolus and early arterial phases (0.32 vs. 0.42, $p = 0.018$). Enabling intrinsically inherent respiratory gating led to no significant differences in hepatic translation between the 2 patient populations.

CONCLUSION

Injection of any type of contrast agent potentially leads to respiratory irregularities with differing intensities and time point of maximum occurrence. Intrinsically enabled respiratory gating through the GRASP methodology compensated for any respiratory irregularities.

CLINICAL RELEVANCE/APPLICATION

Gadoxetate is an essential diagnostic tool for hepatobiliary phase MR imaging, GRASP methodology allows to compensate for any respiratory irregularities.

SSG05-03 Modified CAIPIRINHA-VIBE Without View-Sharing: Excellent Sequence to Detect HCC Without Motion Artifact on Multi-Arterial Gadoxetic Acid-Enhanced Liver MRI

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S503AB

Participants
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PURPOSE

To evaluate the diagnostic performance of the modified CAIPIRINHA-VIBE without view-sharing and compare it with the CAIPIRINHA-DIXON-TWIST-VIBE with view-sharing on multi-arterial gadoxetic acid-enhanced MRI in the assessment of HCC

METHOD AND MATERIALS

We retrospectively identified 65pathologically confirmed hepatic tumors(<=3cm) in 65patients(51men,14women;mean age,60.9years) with cirrhosis or chronic hepatitis who underwent multi-arterial gadoxetic acid-enhanced MRI between June 2016 and March 2018.All patients underwent triple-arterial-phase imaging using the modified CAIPIRINA-VIBE without view-sharing(n=33)or the CAIPIRINHA-DIXON-TWIST-VIBE with view-sharing(n=32).We analyzed images to compare the diagnostic performance of two sequences for HCC, with categorization by LIRAD.We assessed the motion artifacts at triple-arterial phase of two sequences.The diagnostic performance for HCC and the incidence of motion artifacts were compared between two sequences using Fisher's exact test.

RESULTS

Among 65 patients, 33patients with 33pathologic proven liver nodules(28HCCs,3cholangiocarcinomas,1cHCC-CC and 1FNH) underwent triple-arterial-phase image using modified CAIPIRINA-VIBE without view-sharing,and remaining 32 patients with

32pathologic proven nodules(27HCCs, 4cholangiocarcinomas, and 1adenoma) underwent triple-arterial-phase image using CAIPIRINHA-DIXON-TWIST-VIBE with view-sharing.The sensitivity for detecting arterial enhancement in HCC was significantly improved in the group using the modified CAIPIRINA-VIBE without view-sharing(96.4%;95% C.I.,76.39 to 99.9),compared to the group using CAIPIRINHA-DIXON-TWIST-VIBE with view-sharing(74.7%; 95% C.I.,47.7 to 91.8)(p=0.025).Detection of motion artifact in triple-arterial-phase was significantly decreased in the group using modified CAIPIRINA-VIBE without view-sharing(2/33), compared to the group using CAIPIRINHA-DIXON-TWIST-VIBE with view-sharing(9/32)(p=0.023)

CONCLUSION

The modified CAIPIRINA-VIBE without view-sharing can improve the diagnostic performance of multi-arterial-phase of gadoxetic acid-enhanced MRI in the evaluation of HCC without motion artifact, compared to CAIPIRINHA-DIXON-TWIST-VIBE with view-sharing.

CLINICAL RELEVANCE/APPLICATION

Multi-arterial phase using modified CAIPIRINA-VIBE without view-sharing can overcome motion artifacts in multi-arterial phase using CAIPIRINHA-DIXON-TWIST-VIBE with view-sharing, resulting in provide optimal arterial phase imaging.

SSG05-04 Quantification of Hepatic Steatosis and Iron Overload at 3.0 Tesla: Comparison of Qualitative T1 Two-Point DIXON and Quantitative T2* Corrected Multi-Echo DIXON with MR Spectroscopy as the Reference Standard

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S503AB

Awards
Student Travel Stipend Award

Participants
Chenyang Zhan, MD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

To compare the qualitative 3D T1 VIBE two-point Dixon technique (First look Dixon) with Inline Liver Segmentation and quantitative T1 independent T2* corrected volumetric multiecho Dixon proton density fat fraction (PDFF) using HISTO (STEAM spectroscopy sequence) as a reference for evaluation of liver fat and iron content at 3.0 T.

METHOD AND MATERIALS

Retrospective, HIPAA compliant, IRB approved study included 435 patients with known or suspected liver disease. Two-point DIXON, multi-echo DIXON and MR spectroscopy (HISTO) sequences were performed for each patient at 3.0 Tesla.The two-point DIXON sequence qualitatively assigned each patient to one of four categories: 'normal', 'fat', 'iron', 'fat and iron deposition'. A cut off of 5% fat fraction on multi-echo DIXON and HISTO was used to differentiate presence or absence of hepatic steatosis. The results of two-point DIXON and multi-echo DIXON were compared using HISTO as the reference standard.For iron overload, qualitative results from Two-point DIXON were compared with multi-echo DIXON using R2* cutoff values of 70 sec-1 for minimal iron overload and 110 sec-1 for mild iron overload.

RESULTS

PDFF using multi-echo DIXON showed sensitivity of 0.80, specificity of 0.85, with PPV of 0.83, and NPV of 0.83. This technique failed in 18 patients (4.1%) due to fat/water swap. The two-point DIXON technique showed sensitivity of 0.97 and specificity of 0.56, PPV of 0.65, and NPV of 0.95 for presence of hepatic steatosis. Two point DIXON had 0% failure rate.The percentage of patients qualitatively classified as 'iron deposition' by two-point DIXON is 28% among patients with R2* value greater than 70 ms-1, and 75% among patients with R2* value greater than 110 ms-1.

CONCLUSION

Compared with quantitative PDFF from multi-echo DIXON, qualitative fat evaluation from two-point DIXON was more sensitive but less specific for detection of hepatic steatosis. Two-point DIXON detected the presence of iron overload in most patients with mild iron overload, but not minimal iron overload.

CLINICAL RELEVANCE/APPLICATION

Two-point DIXON and R2* multi-echo DIXON are complimentary in evaluation of hepatic steatosis. Multi-echo DIXON has a higher failure rate due to fat-water swap.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Krishna Prasad Shanbhogue, MD - 2012 Honored EducatorKrishna Prasad Shanbhogue, MD - 2013 Honored Educator

SSG05-05 Optimal Simultaneous Multislice Diffusion-Weighted Imaging of Liver: Measurement of Different Breathing Schemes in Comparison to Standard Sequences

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S503AB

Participants
Yigang Pei, MD, Changsha, China (*Presenter*) Nothing to Disclose

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PURPOSE

To obtain the optimal Simultaneous Multislice (SMS) - accelerated diffusion- weighted imaging (DWI) of liver by systematically estimating the reproducibility of apparent diffusion coefficient (ADC), signal-to-noise ratio (SNR) and image quality of different breathing schemes(DBS) in Comparison to Standard DWI Sequences in healthy volunteers.

METHOD AND MATERIALS

In this institutional review board-approved prospective study, DWIs (b=50,300,600 sec/mm2) of the liver were performed in 23 volunteers at 3.0 T MRI using three SMS accelerated DWI sequences with respiratory-triggered (RT-SMS), free breathing (FB-SMS) and breath-hold (BH-SMS), and three Standard DWI (STD) sequences with three DBS techniques (RT-STD, FB-STD,BH-STD) served as reference. Reduction of scan time by SMS-acceleration was measured. Three representative sections-superior, central, and inferior-were selected on right liver lobes respectively, three regions of interest were drawn on each selected section. ADCs and SNRs were measured and image quality were assessed on SMS and STD with three DBS. Qualitative and quantitative parameters were compared using Bland-Altman method, Friedman test and Dunn-Bonferroni post-hoc method with P-values < 0.05 considered statistically significant.

RESULTS

SMS-DWI provided diagnostic image quality with three DBS with a obviously reduction of scan time for each slice scan(1.8 vs. 4.0 sec in RT, 2.3 vs. 4.1sec in FB, 1.1 vs. 1.7 sec in BH). Overall image quality did not significantly differ between STD and SMS sequences acquisition (median RT-STD: 5.0, FB-STD: 4.5, BH-STD :5.0; RT-SMS: 4.75; FB -SMS: 4.5; BH-SMS: 4.75; P>0.0.5). SNR in the right hepatic lobe was comparable between the six tested sequences. RT-SMS have a greater SNR ADC value than RT-STD (82.3 ± 13.2 ×10-6mm2/s vs. 42.2 ± 8.6×10-6 mm2/s; P < 0.001),but FB- SMS and BH-SMS were lower in FB-STD and BH-STD respectively (FB: 56.5 ± 8.7 ×10-6mm2/s vs. 61.3 ± 12.4×10-6 mm2/s; P= 0.035; HB: 71.5 ± 6.7 ×10-6mm2/s vs. 74.5 ± 5.4×10-6 mm2/s; P =0.257).

CONCLUSION

SMS-acceleration provides considerable scan time reduction for hepatic DWI with equivalent image quality compared to the STD technique. In DBS-SMS, RT-SMS as optimal SMS sequence is recommended for liver DW imaging because of its SNR and excellent image quality, good ADC reproducibility and shorter acquisition time.

CLINICAL RELEVANCE/APPLICATION

RT-SMS should be recommended for liver DW imaging.

SSG05-06 Intravoxel Incoherent Motion Diffusion-Weighted Imaging for Preoperative Assessment of Microvascular Invasion in Hepatocellular Carcinoma

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S503AB

Participants
Wei Yi, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To prospectively evaluate the potential role of Intravoxel incoherent motion diffusion-weighted imaging and conventional radiologic features for preoperative prediction of MVI of HCC.

METHOD AND MATERIALS

115 patients with 135 newly diagnosed HCCs between January 2016 and April 2017 were evaluated. For all examinations, studies were carried out by using a 3.0 T MR system (Discovery MR 750, GE Healthcare, Milwaukee, USA). IVIM was performed by using an echo-planner imaging sequence with respiratory gating, twelve b values of 0, 10, 20, 40, 80, 100, 150, 200, 400, 600, 800 and 1000 sec/mm2 (with number of excitations of 1, 6, 4, 2, 2, 2, 1, 1, 2, 4, 6 and 6, respectively) were obtained. All the IVIM images were analyzed by two independent radiologists independently. Freehand region of interest (ROI) was used to outline the tumor on the original IVIM image (b=400 sec/mm2), and try to avoid the necrosis and hemorrhage The ADC, ADCslow, ADCfast and f values were automatically calculated. Univariate and multivariate logistic regression analyses were used to screen the independent risk factors of MVI, receiver operating characteristics (ROC) curves were drawn and to determine the optimal cut-off value. A P value less than 0.05 was considered to indicate a statistical significance.

RESULTS

Features significantly related to MVI of HCC at univariate analysis were reduced ADC (odds ratio, 0.341, 95% CI: 0.211-0.552; P<0.001) and ADCslow (odds ratio, 0.141, 95% CI: 0.067-0.299; P<0.001). At multivariate analysis, only ADCslow was the independent risk factor for MVI of HCC. The mean ADCslow value for MVI of HCC showed an area under ROC curves of 0.815 (95% CI: 0.740-0.877) with the optimal cutoff value of 0.868.

CONCLUSION

The results of the preliminary study have demonstrated that the decreased ADCslow value was independent risk factor for predicting MVI of HCC.

CLINICAL RELEVANCE/APPLICATION

1. IVIM can be used to predict the MVI of HCC.2. The result of ADCslow measurement with an optimal cutoff point of 0.868 was preliminary, and the decreased ADCslow should be considered when developing a treatment strategy for HCC.

SSG05-07 Cross Vendor Validation of Multi-point Dixon MRI for Fat Detection: A Phantom Study

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S503AB

Participants
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PURPOSE

The amount of visceral adipose is increasingly recognized to impact a wide variety of disease processes. We assessed multi-point Dixon pulse sequence in multiple platforms for accuracy and reproducibility.

METHOD AND MATERIALS

7 fat-water phantom sets (0%, 10%, 20%, 40%, 60% and 100% fat) were created and analyzed at on one MRI system (3T Siemens Skyra). 6 phantom sets were distributed to Visceral Adiposity and Physical Fitness in CKD study sites that used 2 Siemens 3T Skyra, 1 Siemens 3T Prisma, 1 Siemens 1.5T Avanto, 1 GE Discovery 3T MR750, and 1 Philips 3T Ingenia. Phantoms were scanned using commercially available 6 point Dixon sequences once for quality assurance at study initiation and subsequently during every subject exam over the 24 months of the study. Summary statistics include cross-sectional accuracy (by weight), short term test-retest reproducibility, and long term test-retest reproducibility for the entire study, for each site, for each manufacturer and for each system type.

RESULTS

391 patients were scanned and phantoms were evaluable in 361 (92%). 99 phantoms were scanned on Siemens 1.5, 115 Siemens 3T, 60 Philips 3T, 87 GE 3T. Average measured fat % (±s.d.) for 100% phantom was 96.2 (±2.8), for 35% phantom was 36.9 (±5.0), for 16% phantom was 18.6 (±5.0), for 10% phantom was 9.9 (±4.3) and for 0% phantom was 2.6 (±3.1). Average % error across all phantom percents for each platform was: 2.7% Siemens 1.5, 2.1% Siemens 3, 3.8% Philips, 1.9% GE.

CONCLUSION

6 point Dixon MRI is highly accurate in quantifying fat percent irrespective of vendor or magnet strength.

CLINICAL RELEVANCE/APPLICATION

6-point Dixon can be used to quantify body fat accurately on multiple vendors.

SSG05-08 Pre-Operative Prediction of Hepatocellular Carcinoma Recurrence After Hepatectomy Using Intravoxel Incoherent Motion (IVIM)

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S503AB

Participants
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PURPOSE

To investigated the diagnostic performance of intravoxel incoherent motion (IVIM)-diffusion-weighted imaging in predicting posthepatectomy recurrence in hepatitis B virus (HBV)-infected adults with hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

With institutional review board approval and informed consent requirement waiver, we retrospectively identified 157 patients who underwent 3.0T IVIM-based diffusion-weighted imaging within one month before hepatectomy for HCC between 2014-2017. HCC with clean margins was confirmed in each hepatectomy specimen. IVIM derived-parameters including apparent diffusion coefficient (ADC), diffusion coefficient (D), pseudodiffusion coefficient (D*), and perfusion fraction (f) were obtained. Regions of interest (ROIs) were drawn manually to encompass as much of the lesion as possible in the maximum tumor cross section and placed at least 5 mm far away from the margin of the lesion and avoided necrosis and hemorrhage. Image analysis was performed independently by two abdominal radiologists who were blinded to pathologic and follow-up. Disagreements were adjudicated in consensus. Pathology was reviewed for each resected HCC by a hepatopathologist. Tumor recurrence was determined by clinical and imaging follow up. The cut-off values of IVIM parameters were determined by receiver operating characteristic (ROC) analysis. IVIM parameters and clinical factors were analyzed the potential predictors for postthepatectomy recurrence using Cox proportional hazards model.

RESULTS

The optimal cut-off values of ADC, D, D*, and f for predicting recurrence of HCC were 0.858 × 10-3 mm2/s, 0.985 × 10-3 mm2/s, 12.5 × 10-3 mm2/s, and 23.4%, respectively. Lower ADC, D, and f values were associated with poor histologic differentiation of HCC (P < 0.001 - 0.001) and the f value was related to microvascular invasion (P = 0.0017). The D value [hazard ratio (HR), 0.190; P = 0.023], age (HR, 0.328; P = 0.034), A-fetoprotein (AFP) (HR, 2.079; P = 0.013) were independently predicted tumor recurrence after hepatectomy resection.

CONCLUSION

In HBV-infected adults with HCC, D value, age and AFP independently predicted tumor recurrence.

CLINICAL RELEVANCE/APPLICATION

Although preoperative IVIM are independent predictors of posthepatectomy recurrence. This finding needs to be further confirmed in the future.

SSG05-09 Compressed Sensing Reconstruction of High Resolution Hepatobiliary Phase Imaging at Gadoxetic Acid-Enhanced Liver MRI: A Feasibility Study

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S503AB

Awards
Student Travel Stipend Award

Participants
Sun Kyung Jeon, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate the clinical feasibility of high resolution (HR) hepatobiliary phase (HBP) imaging using compressed sensing (CS) reconstruction of gadoxetic acid-enhanced liver MRI (Gd-EOB-MRI)

METHOD AND MATERIALS

This retrospective study included 136 patients who underwent Gd-EOB-MRI at one of two 3T scanners (Ingenia or Ingenia CX, Philips) including three breath-hold HBP sequences: i) standard HBP using mDixon-3D-fast field echo (FFE) (S-HBP), ii) HR HBP using mDixon-3D-FFE (HR-HBP), and iii) HR HBP using CS reconstruction (CS-HR-HBP). Acquired resolutions were i) 1.2x1.3x3.0 mm and ii-iii) 1.0x1.0x1.5 mm). HBP images were obtained with either protocol A (Ingenia CX) using acceleration factors (AFs) for S-HBP, HR-HBP and CS-HR-HBP of 2.8, 6.14 and 6.4, and acquisition times of 13.1, 12.4, and 12.9 sec for S-HBP, HR-HBP, and CS-HR-HBP (n=58), or protocol B (Ingenia) using AFs of 2.8, 3.4 and 6.4 and acquisition times of 15.3, 17.2, and 14.2 sec (n=78), respectively. Image quality and diagnostic performance in detecting solid focal liver lesions (FLLs) were compared among the sequences.

RESULTS

Using protocol A with similar acquisition times between CS-HR-HBP, S-HBP, and HR-HBP, CS-HR-HBP showed significantly better overall image quality and lesion conspicuity than the other sequences (Ps <0.05). Using protocol B with a shorter acquisition time in CS-HR-HBP than in S-HBP or HR-HBP, CS-HR-HBP showed comparable results in overall image quality and lesion conspicuity to the other sequences (Ps>0.05), albeit with more severe unzip artifacts than S-HBP (P=0.003). Moreover, the performance of CS-HR-HBP in detecting solid FLLs using protocol A, was better than S-HBP (reader-averaged figures-of-merit (FOM); 0.92 vs. 0.82, P=0.02), while CS-HR-HBP using protocol B was equivalent to S-HBP or HR-HBP (0.86 vs. 0.80 or 0.90; Ps=0.06, 0.23, respectively).

CONCLUSION

CS-HR-HBP was demonstrated to be feasible, providing better image quality and higher performance in detecting solid FLLs at similar acquisition times to S-HBP and HR-HBP. When using shorter acquisition times for CS-HR-HBP, its performance in detecting solid FLLs was comparable to S-HBP and HR-HBP.

CLINICAL RELEVANCE/APPLICATION

Compressed sensing can provide higher resolution and/or faster imaging acquisition, potentially aiding patients who have difficulty sustaining a breath-hold during the entire nonaccelerated imaging.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSG06

Informatics (Artificial Intelligence in Radiology: No Pixels or Fake Pixels)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: N230B

AI IN

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Luciano M. Prevedello, MD, MPH, Dublin, OH (*Moderator*) Nothing to Disclose
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Sub-Events

SSG06-01 Deep Learning for the Automatic Detection of Urgent Radiology Findings from Free-Text Radiology Reports

Tuesday, Nov. 27 10:30AM - 10:40AM Room: N230B

Participants
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PURPOSE

Reliably identifying and communicating urgent radiology findings are crucial to the diagnosis and treatment of diseases. We describe a deep learning algorithm to automatically detect urgent radiology findings from free-text reports and evaluate its performance on a multi-institutional corpus.

METHOD AND MATERIALS

Radiology reports of 156,992 studies from Nov. 2017 to Feb. 2018 were collected from 3 hospitals. These reports were categorized by experts using 4 levels of acuity (1=normal, 2=routine, 3=priority and 4=critical). Reports also received a binary label as requiring follow-up or not. We randomly stratified the reports into a 70% training, a 10% validation, and a 20% test set. For classification we developed a 2-layer long short-term memory (LSTM) network followed by a term weighting layer. We then use the weighted sum of the LSTM states as a vector representation of the report to get the probabilistic estimate of the urgency level. To enable knowledge transfer from a larger corpus, we trained word vectors with the GloVe algorithm on 4.5 million reports and use them to initialize the word vectors used in our network. Additionally, the term weighting layer provided interpretable information about which words were weighted most heavily towards the decision.

RESULTS

We evaluate our algorithm on 3 tasks: (1) binary classification of the reports into urgent (categories 3-4) vs. non-urgent (categories 1-2) findings; (2) binary classification into follow-up vs. non-follow-up recommended; and (3) 4-way classification for acuity categories 1-4. Results for task 1, 2, and 3 are AUC=0.951, AUC=0.961, and micro-averaged F1=0.846, respectively. In comparison, a baseline naive Bayes classifier with hand-tuned lexical features achieves 0.911, 0.915, and 0.773 for the 3 tasks. Task 3 F1 drops to 0.833 when we initialize the word vectors randomly, suggesting that some knowledge was transferred from the larger corpus. Term weighting results showed the network placed a high weight on 'no abnormalities' for normal studies or 'large effusion' for priority studies.

CONCLUSION

Deep learning algorithms can reliably detect urgent radiology findings from free-text radiology reports and provide highly interpretable results.

CLINICAL RELEVANCE/APPLICATION

Automatic detection of urgent radiology findings with natural language processing and deep learning is a useful technique for

improving clinical radiology workflow.

SSG06-02 Automated Determination of Radiology Reports Requiring Urgent Communication Using Intelligent Word Embeddings

Tuesday, Nov. 27 10:40AM - 10:50AM Room: N230B

Awards
Trainee Research Prize - Medical Student

Participants
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CONCLUSION

The model performed extremely well at the task of detecting urgent findings in radiology reports. This model can be further tested in real clinical workflow to further assess its value as a detection tool.

Background

Radiology exams can reveal findings that require the immediate attention of clinicians. Radiologists are responsible for ensuring communication of urgent findings because it may affect patient safety and management. Leveraging Natural Language Processing (NLP) and machine learning (ML) techniques, we developed a model that can predict the likelihood that a radiology report contains findings that require urgent communication.

Evaluation

80,649 radiology reports from a variety of modalities and body parts were extracted from a single institution. Reports were labeled as containing urgent findings if the impression included phrases like 'results communicated to'; these phrases were then removed from the reports to blind the model to ground-truth. Feature selection followed the 'Intelligent Word Embeddings' model: applying standard tokenization, performing negation and phrase identification, using RadLex for synonym detection, and training fastText document embeddings on the processed reports. A variety of different classifiers (convolutional neural network, support vector machine, random forests, and multi-layer perceptions (MLP)) were trained on the document embedding vectors. The accuracies of the classifiers were compared on an internal test set of 8,779 reports and an external test set from a different hospital of 20,208 reports.

Discussion

The linear bag-of-words MLP was the best performing model, achieving an ROC-AUC of 0.94 on validation data, which corresponded to 84% accuracy at 90% sensitivity and an F1 score of 0.87. The model also achieved ROC-AUCs of 0.90 and 0.87 on the internal and external test data, respectively. A web version of the model is also provided for real-time and crowdsourced review: bit.ly/2Ikhce1

SSG06-03 Rule-Based Natural Language Processing Algorithm for Automated Parsing of Clinical Radiology Reports

Tuesday, Nov. 27 10:50AM - 11:00AM Room: N230B

Participants
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PURPOSE

Clinical radiology reports are usually written in free-form text rather in a structured format. In this work, we develop and validate rule based natural language processing (NLP) algorithm to parse these reports into structured data consumable by other information systems.

METHOD AND MATERIALS

Anonymized clinical radiology reports of 290,155 (development dataset) and 1,779 (Q2k dataset) head CT scans were used to develop and validate the algorithms. Target findings were intracranial hemorrhage and its subtypes, intraparenchymal, intraventricular, subdural, extradural and subarachnoid hemorrhages, skull fracture, midline shift and mass effect. Rules based on keywords and regular expressions were constructed to account for the variations in reporting of the these findings in development dataset. Additionally, grammar rules were created to identify the negations in a sentence. To validate the results of this rule based algorithm, we established gold standards of Q2k dataset by manually going through them. We measure sensitivity and specificity of the algorithm for each finding against this gold standard.

RESULTS

Average sensitivity and specificity of the algorithm across the target findings on Q2k dataset are 0.9841 and 0.9956 respectively.

Least performing finding was subdural hemorrhage with sensitivity of 0.9318 (95% CI 0.8134-0.9857) and specificity of 0.9965 (95% CI 0.9925-0.9987) while skull fracture was inferred perfectly with sensitivity of 1 (95% CI 0.9745-1.000) and specificity of 1 (95% CI 0.9977-1.000). A previous similar study on head CT reports, but with machine learning based NLP algorithms, reported average sensitivity and specificity of 0.9025 and 0.9172 across findings.

CONCLUSION

In this work, we showed that rule based NLP algorithms can identify the findings from free text clinical radiology reports with very high accuracies. Their performance is superior to that of machine learning based NLP algorithms which require annotation of reports instead of rule creation.

CLINICAL RELEVANCE/APPLICATION

This algorithm can be used to retrieve studies with desired findings from a PACS for research or educational purposes, or to train AI algorithms.

SSG06-05 Restoration of Motion-corrupted MR Images Using Deep Adversarial Networks

Tuesday, Nov. 27 11:10AM - 11:20AM Room: N230B

Participants
Karim Armanious, MSc, Stuttgart, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

Motion artifacts are a frequent source of image quality deterioration in MRI. Existing motion correction strategies mostly focus on prospective compensation of motion artifacts during acquisition. Currently, strategies for retrospective correction of acquired MR images are very limited. The purpose of this work is to implement and evaluate a framework for retrospective restoration of motion-corrupted MR images using deep adversarial networks.

METHOD AND MATERIALS

Our proposed framework consists of two main components trained simultaneously. The first component is a multi-scale deep architecture consisting of 70 convolutional layers for high-resolution image restoration of MR images.The second component is a convolutional neural network (CNN), which classifies the output of the first multi-scale network as realistic or not. The training of the network is done in the adversarial fashion of generative-adversarial networks, where competition between the two components drives the multi-scale network to improve its performance until a detailed motion-free MR image is acquired. The framework was trained on a dataset of 1500 T1 weighted MR images of the head and pelvis regions from 11 volunteers. Image data were paired such that a motion-free and a motion-corrupted image were acquired. Evaluation of the trained model was carried out on a separate dataset of 600 MR images from 4 patients. The quality of the motion corrected images was attested quantitatively in comparison to MR images without motion correction using the SSIM metric. Additionally, qualitative performance was rated by 2 radiologists using a 4-point score (4: best).

RESULTS

The developed framework achieved state-of-the-art results on MR motion correction for rigid motion artifacts. Motion-corrected images achieved an average score of 2.9 by radiologists in comparison to 1.2 for images without motion correction and to 3.7 for motion-free MR images. In addition, SSIM score of motion corrected images has improved by 27.3 % indicating a remarkable reduction of artifacts.

CONCLUSION

Motion artifacts can be retrospectively corrected using a deep adversarial framework, enabling a high-resolution restoration of MR images.

CLINICAL RELEVANCE/APPLICATION

This project enables the extraction of valuable information from motion-corrupted MR images. This can be used to enhance the accuracy of post-processing tasks, such as segmentation and organ volume estimation.

SSG06-06 Predicting Exam Cancellations Using Machine Learning: Towards Optimized Radiology Scheduling

Tuesday, Nov. 27 11:20AM - 11:30AM Room: N230B

Participants
William Hsu, PhD, Los Angeles, CA (*Presenter*) Research Grant, Siemens AG
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PURPOSE

The capacity of a radiology department is constrained by the number of imaging slots, which is related to the availability of imaging equipment. However, while slots may be filled in advance, last minute cancellations and no-shows may result in underutilization that could have otherwise accommodated additional patients. We evaluated the use of a machine learning approach called gradient boosting trees that were trained on scheduling and medical record data to predict whether an exam would be canceled.

METHOD AND MATERIALS

Using data from 150,000 past scheduled exams during a 2 year time period, we examined whether each exam was completed or

canceled. Metadata about an exam such as its description, modality, anatomical region, duration, site/location, patient demographics (age, gender, associated diagnostic codes), and timestamps (date of scheduling, exam completion) were used as inputs to the model. For each cancellation, we recorded the date and reason. A gradient boosting is a machine learning method that generates a set of decision trees from training data by minimizing the average value of a loss function and incrementally expanding the model. A final prediction is generated based on the collective sum of each tree's prediction. A five-fold cross-validation was used to train and test the model. A random sample of 6,000 exams was set aside from each training set to tune the model hyperparameters.

RESULTS

A total of 44,928 exams (30%) were canceled, many of which are provider-initiated (e.g., erroneous order). Of the canceled exams, 13,962 (31%) were canceled by the patient (in advance or no-show). The average area under the curve across all of the folds was 0.742 +/- 0.004. The most predictive features included patient age, day/time of the scheduled exam, location, and whether the exam was an x-ray or ultrasound.

CONCLUSION

We demonstrate a prediction model with a limited set of clinical and exam variables is still capable of yielding meaningful predictions. We are exploring other factors such as the distance of the patient to the imaging site, weather and traffic, prior history of cancellations, and payor as ways to improve the model's accuracy.

CLINICAL RELEVANCE/APPLICATION

A model to predict exam cancellations may assist departments with identifying and avoiding such occurrences through outreach (e.g., proactive reminders) and mitigation of underlying issues (e.g., difficulty coming to the site, denial by payors).

SSG06-07 Generative Adversarial Neural Networks in the Creation of Synthetic Chest Radiographs: Can We Fool the Experts?

Tuesday, Nov. 27 11:30AM - 11:40AM Room: N230B

Participants
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PURPOSE

Generative Adversarial Neural Networks (GANs), are a form of unsupervised machine learning, utilizing competitive neural networks, which can synthesize realistic images unique from training data. GANs can theoretically allow a near limitless supply of unique and HIPAA compliant cases, which could be used for both computer and human training. The purpose of this study was to determine if chest radiographs synthesized from a GAN could fool radiologists.

METHOD AND MATERIALS

A GAN was trained using a sliced Wasserstein distance criterion, with modifications to suppress variance in the estimate of the sliced Wasserstein distance. Training data is the NIH Chest X-ray8 dataset, using 60,000 images. All frontal radiographic views were used regardless of findings. Synthetic radiographs, 512x512 pixels, were created in PNG format. De novo real/acquired chest radiograph images and synthetic images were randomly assorted into testing sets consisting of pairs of one real and one synthetic image, with the same resolution. These images were then presented to 12 ABR-certified radiologists, with a median experience of 10-15 years. The radiologists were then asked to distinguish between synthetic and real images using a two-alternative forced choice, with random timers between 2-10 seconds. Subjects were presented with as many pairs as they were willing to judge.

RESULTS

GAN training took approximately 70 hours on an NVIDIA P100. The generation of a synthetic image takes on average 2ms on an NVIDIA Titan-X. Overall, expert readers were able to detect the synthetic image in 61% of over 1300 pairs viewed (chance is 50%; this corresponds to a sensitivity of 61% and a specificity of 39%). There is significant variation between subjects, with some subjects reliably able to identify real images quite accurately (3 % of GAN images identified as real) and others reliably detecting GAN images as real (85%).

CONCLUSION

Current GAN methods can generate unique realistic chest radiographs in arbitrary quantities. These radiographs can pass as real images, when presented to radiologists.

CLINICAL RELEVANCE/APPLICATION

Current applications include anonymizing datasets and training images for humans and machines. Improvements could allow generating images guaranteed to contain a particular disease, to show a rare disease state, enhance image quality, create unique views, or to show possible future disease states implied by a current radiograph.

SSG06-08 Realistic CT Images Generation Using Condition Generative Adversarial Network (cGAN) for Accurate Segmentation of Hemorrhagic Stroke

Tuesday, Nov. 27 11:40AM - 11:50AM Room: N230B

Participants
Manohar Karki, Lowell, MA (*Presenter*) Nothing to Disclose

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PURPOSE

Investigate the quality of synthetic brain CT images generated using a cGAN, and their use as augmentation data for accurate detection and dilineation of hemorrhagic stroke.

METHOD AND MATERIALS

Well labeled intracranial hemorrhage on 33391 CT images from 2647 patients consisting of 5 subtypes: intraparenchymal, intraventricular, subarachnoid, epidural and subdural hemorrhages were obtained. Existing GAN implementation on tensorflow framework and images of 256 x 256 were used. Images from 80% of patients were used for training and 20% set aside for testing. Segmented ground truth images were used as the condition to steer the generation process. 2.5%, 10% and 50% of original training data were trained for 10, 50, 100 and 200 epochs each. Because evaluating generated images using a single traditional metric did not reflect the quality of images well, we used a combination of metrics. FCN Scores, Clarity (based on average blurriness) and a classifier that distinguishes between generated images and original images at various thresholds were used. FCN scores were obtained by evaluating the dice similarity coefficients (DSC) of generated images on an existing segmentation algorithm specifically trained only on the original dataset. The best GAN model chosen was then used to generate additional images as training to improve a fully convolutional neural network (FCN) for segmentation.

RESULTS

Using 2.5% of original data, generated images helped to increase sensitivity by 16.7% and DSC by 38%. The increase using 10% of original data was 56.5% and 28.8% for sensitivity and DSC respectively. Whereas using 50% of original data, the increase was 26.7% and 22.6% for sensitivity and DSC respectively.

CONCLUSION

Conditional GANs were effective in generating realistic images that increased detection and delineation performance compared to model trained with just original data. Both dice coefficients and sensitivity increased with the usage of synthetic CT images as augmentation.

CLINICAL RELEVANCE/APPLICATION

Realistic synthetic images generated from accurate labels could help studies and medical tools that rely on access to labeled medical images for training and validation.

SSG06-09 Self PET Attenuation Correction Using Conditional Generative Adversarial Networks

Tuesday, Nov. 27 11:50AM - 12:00PM Room: N230B

Participants
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PURPOSE

Current methods for PET attenuation correction rely on the existence of an attenuation map generated by a second imaging modality which is mostly CT. In certain situations, CT is not available and attenuation correction is performed by estimating an attenuation map using MRI or by importing externally acquired CT images. In this work, we present and evaluate a framework for self attenuation correction of PET data using conditional Generative Adversarial Networks (cGAN) which does not require an accompanying modality.

METHOD AND MATERIALS

The principle idea of the proposed method is to generate an artificial CT image only based on non-corrected PET data. This CT image can then be used for subsequent PET attenuation correction. Our method is based on a cGAN trained on a dataset of corresponding PET/CT brain images from 38 patients. The cGAN consists of three separate convolutional neural networks (CNNs). The first network translates an uncorrected PET image into a synthetic corresponding CT image. The two remaining networks compare the low and high-frequency components respectively between the synthetically generated CT images and the ground-truth CT images. As a result, the generator network is able to match the global structure as well as the texture and style of the desired output. The proposed method was evaluated on a dataset of PET/CT images of the head region from 8 patients. Quantitative comparison between synthetic and ground truth CT images was carried out using the Structural SIMilarity (SSIM) index. In addition, qualitative performance to judge the clinical fidelity of the synthetic CT images was rated by 2 radiologists using a 4-point score (4: best).

RESULTS

The developed method succeeded in translating uncorrected input PET images into highly realistic synthetic CT images. The image quality of synthetic CT images received an average score of 3.1 by radiologists in comparison to 3.7 for real images. Quantitative correlation between our synthetic CT images and corresponding ground truth CT images is indicated by an SSIM score of 0.914.

CONCLUSION

Attenuation correction of PET images without further image modalities is feasible and could be achieved by utilizing cGANs.

CLINICAL RELEVANCE/APPLICATION

The proposed method can be used for fast and reliable attenuation correction of PET data in situations where no CT can be

acquired for this purpose. An extension to whole body imaging is conceivable.

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SSG07

Molecular Imaging (Oncology)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S504CD

MI

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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Ciprian Catana, MD, PhD, Charlestown, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSG07-01 Patient Derived Xenograft Model for Ultrasound Molecular Imaging Applications in Renal Cell Carcinoma

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S504CD

Participants
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PURPOSE

To develop a reliable in vivo model to assess by ultrasound and MRI imaging tumor development and local molecular expressions

METHOD AND MATERIALS

The model used is a patient derived xenograft: an 8 mm tumor core is taken from fresh renal cell carcinoma (RCC) at the time of surgery. The tissue sample is cut into 300 µm homogenous slices with a dedicated device (Krumdieck, Alabama Research & Development). Each slice is grafted into the kidney capsule on immunodeficient mice (RAG2-/-γc-/-) in order to develop a cohort from the same tumor. The grafted tumor is then monitored by ultrasound imaging (Aplio, Toshiba and VEVO2100, Visualsonics) and 7T MRI (Bruker spectrometer). Once the tumor is detected, a first 7T is made to accurately measure the tumor volume and ultrasound molecular imaging series are performed. US molecular imaging is based on antibody -related contrast agents (MicroMarker™, Visualsonics). The antibodies selected for our RCC study are VEGFR1 and FSHR. The targeted signal enhancement is quantified and compared to the signal of the non-targeted microbubbles 10 minutes after the injection. Ultrasound imaging is performed the same week as MRI (T0), then at 1week, 2 weeks and one month on two groups placebo versus sunitinib. Before sacrifice of animals, a second MRI is also performed.

RESULTS

Slices of tumors from 7 patients were removed and implanted on mice. To date, 5 cohorts from 3 different patients have been treated and imaged by ultrasound and MRI. Ultrasound examinations with non-targeted microbubbles validated the lack of specificity of these agents over time for both the placebo and sunitinib groups. On the other hand, the quantification of VEGFR1 and FSHR showed a decrease in the expression of these biomarkers in the sunitinib group, particularly at 1 week and 2 weeks compared to the placebo group. According to the cohorts, the decreases observed are of the order of a factor between 2 to 17.

CONCLUSION

Xenografts derived from patient samples are more realistic models for molecular imaging studies. These first results are encouraging for the follow-up of biomarkers of interest in oncology.

CLINICAL RELEVANCE/APPLICATION

Robust and realistic preclinical models are essential for better-adapted clinical trials and the identification of biomarkers that can guide therapeutic strategies.

SSG07-02 Human Somatostatin Receptor type-2 (hSSTR2) Mutant Muted in Altering T-Cell Signaling and Function Enables Visualization of T-cell Trafficking

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S504CD

Participants
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PURPOSE

Adoptive T-cell therapies have shown great promise in patients, but are limited by clinically translatable methods for following their trafficking in vivo. Reporters (enzymes, transporters, receptors) can alter T-cell cellular milieu and function. We evaluated whether a hSSTR2 mutant reporter is signaling deficient in T-cells and can serve to image these cells in vivo.

CONCLUSION

A hSSTR2 mutant muted in altering OT1 T-cell signaling or function can serve as an in vivo reporter of T-cells trafficking.

CLINICAL RELEVANCE/APPLICATION

Findings suggest that the hSSTR2-based mutant reporter muted in signaling has potential for clinical translation for following adoptive T-cell therapy without affecting T-cell function.

SSG07-03 Out of Sight, Out of Mind: The Detection Rate and Impact on Management Intent of 68Ga-PSMA-HBED-CC PET/CT in Prostate Cancer - Results from a Brazilian Center

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S504CD

Participants
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PURPOSE

The aim of this study was to evaluate the detection rate and the role of PSMA PET/CT on management intent in patients with primary or recurrent prostate cancer.

METHOD AND MATERIALS

A retrospective study of 251 patients who underwent PSMA PET/CT imaging for primary staging and for biochemical recurrence between June and December 2017 was performed. All patients were submitted to the same imaging protocol and were reviewed together by a nuclear medicine physician and a radiologist with at least five years of experience. We conducted a retrospective survey of referring physicians who completed one questionnaire to indicate the initial treatment plan without PSMA PET/CT information and after the scan to denote intended management changes.

RESULTS

Overall 173 PSMA PET-CT studies were performed for biochemical relapse (69%) and 78 (31%) for primary staging. Median total PSA was 9,63 ng/ml (0,099-259,0 ng/ml). The median Gleason-score was 7 (range 4-10). The overall percentage of positive PSMA PET-CT among patients was 70%. In 38 patients (15,1%) no abnormal findings were observed. The average maximum standardized uptake value (SUV) was 16,7 (range 1,8 - 107,3). PSMA PET/CT revealed unsuspected disease in the prostate bed in 12,4% of patients, locoregional lymph nodes in 34,7% (57% were up to 1 cm), and distant metastatic disease in 16,3%. Considering PSA ranges, 3 % of patients had positive scans with PSA up to 0.2, 22% with PSA from 0.2-1.0, 12% with PSA from 1.0-2.0, and 63% positivity with PSA above 2.0 ng/ml. Overall, PSMA PET/CT scanning led to 38.2% change in planned management. The impact was greater in the biochemical failure group (47% change in management intent, most these consisted of conversion from systemic treatment to focal treatment) than in patients undergoing primary staging (19%).

CONCLUSION

The early and accurate detection of prostate cancer disease is important to ensure timely management and appropriate individualized treatment. Currently, conventional imaging has limitations particularly in early disease detection in biochemical failure patients, especially at PSA level < 2.0 ng/mL. PSMA-PET/CT has high diagnostic accuracy for small lymph node, especially at low PSA levels.

CLINICAL RELEVANCE/APPLICATION

68Ga-PSMA-HBED-CC PET/CT is superior to conventional imaging methods, especially at low PSA levels (under 2.0 ng/mL), for early detection of metastases, thereby significantly impacting on appropriate treatment.

SSG07-04 PSMA-Directed Biopsies: Initial Experience from Ongoing Clinical Trial

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S504CD

Participants
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PURPOSE

To evaluate the histological correlates of PSMA PET/CT findings in a mixed cohort of high risk, biochemically recurrent (BCR), and metastatic prostate cancer (PCa) patients.

METHOD AND MATERIALS

Patients enrolled on a clinical trial to evaluate PSMA PET/CT imaging in PCa undergo 18F-DCFPyL PET/CT imaging, along with multiparametric MRI (mpMRI) for patients negative for metastases on conventional imaging (CIM) or 18F-NaF PET/CT for patients with suspicious findings for metastatic disease on CIM. PSMA PET/CT imaging was prospectively interpreted by an experienced nuclear medicine physician. When feasible, patients underwent a core-needle biopsy by image-guidance (CT or US) of regions suspicious for metastases by study imaging. For patients undergoing CT-guided biopsy, biopsy targeting localization was confirmed by anatomical registration with PSMA PET/CT imaging.

RESULTS

Samples were obtained from 18 patients, including 12 patients with negative CIM (5 high-risk [median PSA 18.87], 7 BCR [median PSA 2.08 ng/ml]) and 6 patients with positive CIM (2 high-risk, 4 metastatic [median PSA 12.16 ng/ml]). Twenty-two lesions were sampled from bone (N=11), lymph nodes (N=9), or other soft tissue areas (N=2). PSMA PET/CT findings in these lesions were prospectively interpreted as negative (N=4), indeterminate (N=4), or positive (N=14). PSMA negative or indeterminate lesions were not found to harbor metastatic PCa, with 5/8 samples demonstrating non-cancerous pathologies including fibrous dysplasia, reactive node, and lung carcinoma. Of 14 PSMA-positive samples, 11 were confirmed metastatic PCa, 2 demonstrated an alternative pathology (focal fibrosis in bone and necrosis/inflammation in a node), and one was negative (hematopoietic bone). Patients with solitary findings outside of prostate area were less likely to harbor metastatic PCa (p=0.05). SUVmax was higher in cancer sites (median 30, range 3.7-77, p=0.01); however, SUVmax differed in non-cancerous DCFPyL-avid nodal sites (SUVmax<3) compared to non-cancerous DCFPyL-avid bone sites (SUVmax range 2.5-6.7).

CONCLUSION

Preliminary findings of this ongoing study demonstrates an elevated frequency of non-cancerous benign pathologies with differential DCFPyL uptake based on anatomical locations.

CLINICAL RELEVANCE/APPLICATION

Non-specific PSMA uptake has been noted in several recent studies, further pathological validation and characterization of imaging signatures is warranted.

SSG07-05 Correlation Between Diffusion-weighted MRI and Proliferative Activity ki-67 Expression in Cervical Cancer Cells

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S504CD

Participants
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PURPOSE

To investigate the changes of ADC value and rADC value of diffusion-weighted magnetic resonance imaging (DWI) in patients with cervical cancer with different differentiation degrees and their correlation with proliferative activity ki-67 of cervical cancer cells.

METHOD AND MATERIALS

Forty patients with cervical cancer were diagnosed by pathology. All the patients underwent MR examination and diffusion-weighted imaging before operation, and Ki-67 immunohistochemical staining was performed during the operation.The expression of ki-67 in cervical cancer patients with different differentiation degrees was analyzed by means of ANOVA. Pearson correlation analysis was used to analyze the correlation between Ki-67 and ADC and rADC values.The statistical analysis of data by SPSS 20.0 software has statistical significance ($P < 0.05$).

RESULTS

The ADC value and rADC value of low differentiation group were lower than that of high differentiation group, the difference was statistically significant (P < 0.05).There was no significant difference between the low differentiation group and the middle differentiation group (P > 0.05).With the degree of differentiation, the expression of Ki-67 increased gradually.With the increase of Ki-67 expression degree, the ADC value and rADC value decreased, and the difference was statistically significant (P < 0.05). After the correlation test, it was found that there was a negative correlation between ADCs value and Ki-67 expression degree (P < 0.05).

CONCLUSION

The measurement of DWI value in cervical carcinoma is helpful to evaluate and differentiate the pathological grade of cervical cancer and has the potential as a noninvasive method to evaluate the degree of tumor proliferation.

CLINICAL RELEVANCE/APPLICATION

The grade of cervical cancer was distinguished by the correlation between DWI and ki-67

SSG07-06 PET Proliferation Imaging Biomarkers for Monitoring Treatment Response of Combined Cyclin-Dependent Kinase Inhibitors and Endocrine Therapy in Breast Cancer: Comparison of FLT and ISO-1 Radiotracers

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S504CD

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David A. Mankoff, MD, PhD, Philadelphia, PA (*Abstract Co-Author*) Speaker, Koninklijke Philips NV; Consultant, General Electric Company; Advisory Board, RefleXion Medical Inc; Consultant, Blue Earth Diagnostics Ltd; Research Funded, Siemens AG; Advisory Board, ImaginAb, Inc; Spouse, Owner, Trevarx
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PURPOSE

Cell cycle targeted therapeutics such as CDK4/6 inhibitors (CDK4/6i) in combination with endocrine therapy are the emerging standard of care for treating metastatic ER+ breast cancer (BC). These agents target cell cycle at two independent checkpoints, therefore PET probes reflecting different facets of proliferation, seem promising for identifying patients that might benefit from addition of CDK4/6i. In this study, we compared the ability of 18F-FLT (reflecting S-phase changes) and 18F-ISO1 (reflecting proliferation), for predicting response from combination therapy with CDK4/6i (palbociclib [PD]) and ER antagonist (fulvestrant [F]).

METHOD AND MATERIALS

Six BC cell lines with different ER status and sensitivity to PD were treated with PD and/or F. Cell proliferation assay, flow-cytometric cell cycle analyses, Ki-67, and TMEM-97 western-blot were performed after 24hrs, 72hrs, and 6days. These data were correlated to FLT uptake and ISO-1 analogue ligand-binding. Subsequently, SCID mice bearing MCF7 tumors were used for in-vitro investigation and randomly assigned to PD, F, or PD+F groups. FLT and ISO-1 micro-PET/CT were performed, on days 0, 3, and 14 of treatment. Changes in tumor to muscle uptake ratios (T/M) for each tracer was quantified and correlated to changes in cell-cycle.

RESULTS

PD resulted in a remarkable decrease in FLT accumulation at all time points, correlating with decrease in S-phase. In contrast, change in binding of ISO-1 was delayed and only prolonged combination therapy in ER+ cells (MCF7 & MDA134) resulted in significant reduction ($p<0.01$), correlating with G0 arrest. On day 3 of MCF-7 xenograft treatment, FLT T/M significantly decreased in treated mice ($p<0.005$), without change in ISO1 uptake. On day 14, we noticed significant decrease in ISO-1 T/M in combination therapy group ($p<0.05$). Changes in FLT and ISO1 uptake correlated with S-phase depletion and G0-arrest, respectively, as an indication of contribution of PD and F in treatment response.

CONCLUSION

FLT and ISO-1 PET/CT assess different aspects of proliferation after PD and F treatment. Our data suggest that FLT is more sensitive in evaluating changes in tumor proliferation and provides a prediction of both early and late treatment changes, whereas ISO-1 is more predictive for late response.

CLINICAL RELEVANCE/APPLICATION

Combination of FLT and ISO-1 PET imaging might serve as a clinically translatable approach to guide dual-targeted therapy of ER+ BC.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ David A. Mankoff, MD, PhD - 2013 Honored EducatorDavid A. Mankoff, MD, PhD - 2018 Honored Educator

SSG07-07 MR Imaging of Zinc Depletion in Prostate Cancer

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S504CD

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PURPOSE

Of all soft tissues, the normal prostate has the highest mobile zinc content, but this level decreases dramatically during malignant transformation. We aimed to use iCEST (ion chemical exchange saturation transfer) 19F MRI as a non-invasive means to probe zinc depletion in prostate cancer.

METHOD AND MATERIALS

For in vitro validation studies, normal (RWPE1), ZIP1 zinc transporter-downregulated (RWPE2), and malignant (DU145 and LNCaP) human prostate cells were incubated with 75 µM $ZnSO_4$ and induced to secrete zinc using glucose stimulation. Following the addition of 2.5 mM TF-BAPTA, 19F-derivative of BAPTA which is a fluorescent dye indicator for zinc, the supernatant was assessed with 1H and 19F iCEST MRI at 17.6 T. For in vivo studies, 1E6 cancer cells were injected into the prostate of 6-8 weeks old immunodeficient NSG mice and allowed to grow for 21 days. Immediately after i.p. injection of 80 µL of 20% w/v D-glucose and injection of 0.15 g/kg bw TF-BAPTA into the anterior prostate through a catheter, iCEST MR images were collected at 17.6T using a modified RARE sequence with a FOV=2.6×2.6 cm, 3 mm slice thickness, and a resolution of 0.8x0.8 mm.

RESULTS

In vitro, the strongest iCEST signal was observed for glucose-stimulated RWPE1 cells with a normal zinc transporter level. In normal prostate cells with a downregulated ZIP1 zinc transporter (RWPE2), a weaker iCEST signal was observed. No signal could be observed for DU145 and LNCaP prostate cancer cells. In vivo, the strongest iCEST signal was observed for the normal prostate following i.p. glucose stimulation (Fig. 1). Both the normal prostate without glucose stimulation and the two orthotopic tumor models with glucose stimulation showed much weaker iCEST signal.

CONCLUSION

Using iCEST MRI, differences in glucose-induced zinc secretion between normal and malignant prostate cells can be readily detected, both in vitro and in vivo.

CLINICAL RELEVANCE/APPLICATION

Monitoring the conversion of normal prostate cells into malignant cells using iCEST 19F MRI may be further developed to diagnose prostate cancer in its earliest stages.

SSG07-08 A Novel Treatment for Neuroendocrine Tumors Hepatic Metastases with Combination Everolimus and Trans-Arterial Chemo-Embolization (E-TACE): Role of 68Ga-DOTATATE in Conjunction with CT for Tumor Load Assessment

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S504CD

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PURPOSE

Both TACE and Everolimus are widely used for treatment of metastatic NETs. The standard protocol is to hold Everolimus 2-4 weeks prior to and following TACE. Combining both therapies has shown therapeutic benefit in a preclinical study. RECIST 1.1 is the basic treatment response assessment criteria used, yet is limited. The aim of our study was to investigate the additive value of functional imaging using 68Ga-DOTATATE PET/CT in conjunction to contrast CT in the assessment of viable tumor volume

METHOD AND MATERIALS

We retrospectively reviewed all patients who received concurrent E-TACE between September 2016 and April 2018. Only patients who underwent baseline pre-and post-TACE 68Ga-DOTATATE PET/CT were included in our study. As part of our institutional protocol, 10 mg of Everolimus/1-2 days started $\geq$ 1 month prior to TACE. RECIST 1.1 criteria were followed. Quantitative analysis of PET/CT images were performed and multiple parameters were collected including SUVmax, SUVmean, SUVpeak, binding tumor volume (BTV), and tumor binding index (TBI)

RESULTS

Among the 23 patients who underwent concurrent E-TACE therapy, 5 met our inclusion criteria. Based on RECIST, all 5 cases showed stable disease on contrast CT. Quantitative analysis of PET/CT showed significant difference between the baseline and post-treatment scans in all tested quantitative parameters (p-value < 0.05). The pre/post-treatment mean %difference in SUVmax, SUVpeak, and TBI were -49% + -16.7%, -52.5% + 0.2%, and -71% + 21.6%, respectively. A subset analysis of 2 cases that underwent embolization of one lobe was performed, comparing the quantitative parameters between the TACE treated and non-

treated lobes. There was significant difference between the reduction in TBI after combined E-TACE treatment in the TACE treated versus non-TACE treated lobe in the same patient (-71% + 21.6% versus -25% + 14%, p-value <0.0001)

CONCLUSION

E-TACE combination resulted in reduction of liver metastatic tumor load, which was significantly better than Everolimus alone. Adding functional imaging with 68Ga-DOTATATE PET/CT to the standard follow up with contrast CT has the potential to improve treatment response assessment and overcome the limitation of RECIST

CLINICAL RELEVANCE/APPLICATION

68Ga-DOTATATE PET/CT has potential to improve treatment response assessment and overcome limitation of size based RECIST criteria.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Riham H. El Khouli, MD, PhD - 2012 Honored Educator

SSG07-09 Detecting and Grading Solid Tumor Using ADC as a Marker of Cellularity: Fact or Fiction?

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S504CD

Awards
Student Travel Stipend Award

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PURPOSE

Decreased ADC derived by diffusion MRI has been the most widely accepted clinical imaging biomarker of tumor cellularity in various types of cancer. However, complex microenvironment surrounding tumor foci confounds ADC measurements sometimes failing to reflect tumor cellularity. We have developed a novel diffusion histology imaging (DHI) to characterize tissue structural changes resulting from various pathologies associated with solid tumors. DHI-derived restricted isotropic diffusion ameliorates confounding factors such as vasogenic edema, necrosis, and fibrotic structures, accurately assessing tumor cellularity quantifying signal fraction resulting from cellularity.

METHOD AND MATERIALS

Brain tumor specimens were examined using a 4.7T MR scanner with a homemade surface coil. Breast cancer and prostate cancer patients were examined on a 3T MR scanner with an 8-channel phased-array receive coil. DWI data with 99 (fixed specimens) or 25 (in vivo) diffusion encoding directions was processed using DHI multi-tensor modeling.

RESULTS

Decreased ADC in the adult anaplastic ependymoma (Fig. 1A) misidentified inflammation as tumors. In pediatric primitive neuroectodermal tumor (Fig. 1B), the ADC values of tumor did not consistently decrease as expected missing majority of histology-identified tumors. In contrast, DHI-restricted fraction map accurately delineated the H&E identified increase of tumor cellularity. In invasive ductal carcinoma, DHI more accurately identified increased cellularity revealed by H&E than ADC (Fig. 1C). In prostate cancer (Fig. 1D), ADC overestimated cancer lesion due to the coexisting BPH and inflammation. DHI correctly detected inflammation (highly-restricted isotropic diffusion), tumor (restricted isotropic diffusion), stromal BPH (anisotropic diffusion) and normal prostate tissues (non-restricted isotropic diffusion).

CONCLUSION

Despite its wide use in detecting increased cellularity associated with solid tumor growth, ADC is inconsistent to reflect tumor cellularity as demonstrated in various tumors as shown herein. DHI-restricted fraction accurately reflects tumor cellularity in adult and pediatric brain tumors, breast cancer, and prostate cancer.

CLINICAL RELEVANCE/APPLICATION

Our findings caution the continuing use of decreased ADC as the biomarker of increased tumor cellularity. We propose a better imaging method, such as DHI, more accurately detecting solid tumors will improve patient management.

SSG08

Musculoskeletal (Machine Learning and Artificial Intelligence)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S102CD

AI CT IN MK

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

SSG08-01 SpineNet: Automated Vertebra and Disc Gradings Using Deep Learning

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S102CD

Participants
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PURPOSE

To assess the performance of an fully automated deep learning method in producing radiological gradings of spinal MRI in the context of management of chronic back pain

METHOD AND MATERIALS

A dataset comprising images of 12,018 individual discs from 2009 patients were retrospetively collected from 6 different referrral centers in the UK, Hungary, Slovenia and Italy in a previous EU project (Genodisc). The primary selection for recruitment to Genodisc was "patients who seek secondary care for their back pain or spinal problem" and were sourced from routine clinical management. The MRI machines and protocols varied between the sites but included at least one standard T2 sagittal MRI acquisition which, for consistency, was used for all of the results reported here, though the system is capable of using the T1 and axial images also. The scans were annotated with the following radiological scores by a single experienced spinal radiologist: Pfirrmann grade, disc narrowing, endplate defects, marrow changes, spondylolisthesis and central canal stenosis. To test the radiologist's intra-rater variability, they repeated their grading on a subset of 200 patients randomly interdispersed throughout the entire dataset. For training, the dataset was split into a 80:10:10 train:validation:test sets on a per patient basis (not per disc). This resulted in 1806 patients (10,836 discs) for training and 203 patients (1,224 discs) for testing. A multi-class Convolutional Neural Network (CNN) was trained using Deep Learning to predict all of the gradings. Accuracy was measured by comparing the output of the system to the radiologist annotations using class-balanced accuracy. Multi-way cross-validation was used to test the efficacy and repeatability of the system.

RESULTS

The average class balanced accuracy for the SpineNet system was 86.3% (+/- 0.3). This compares favourably to the radiologists intra-rater repeatability of 82.5%.

CONCLUSION

The SpineNet system can produce accurate and repeatable gradings for a range of spinal MRI radiological gradings used in chronic back-pain clinical management and research. Such gradings may be used to augment the radiologist report, improve consistency and communication with the referring physician.

CLINICAL RELEVANCE/APPLICATION

Quantitative gradings of spinal degeneration may be a useful adjunct to routine qualitative report of spinal MRI and improve communication with the referring phyician.

SSG08-02 Can a Machine Diagnose an Anterior Cruciate Ligament Tear? Fully-Automated Detection System Using Deep Learning

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S102CD

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Richard Kijowski, MD, Madison, WI (*Presenter*) Research support, General Electric Company; Consultant, Boston Imaging Core Lab, LLC

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N/A

PURPOSE

To investigate the use of a deep learning (DL) approach to create a fully-automated prediction model for detecting anterior cruciate ligament (ACL) tears of the knee joint.

METHOD AND MATERIALS

The propsed deep learning approach consisted of two neural networks connected in a cascaded fashion to create a fully-automated processing pipeline. The first network performed rapid segmentation of the intercondylar notch on two to three consecutive image slices, while the second classification network evaluated structural abnormalities within the segmented anatomic region. Sagittal proton density-weighted fast spin-echo (PD-FSE) and fat-suppressed T2-weighted fast spin-echo (T2-FSE) sequences were acquired using the same 3T scanner on the knees of 200 subjects (100 subjects with a torn ACL and 100 subjects with an intact ACL at subsequently performed knee arthroscopy). The DL method was trained to detect ACL tears using both the PD-FSE and T2-FSE images on 100 randomly chosen subjects and evaluated on the remaining 100 subjects. Diagnostic performance of the DL method was assessed with receiver operation characteristic (ROC) and area under curve (AUC) analysis using arthroscopy as the reference standard. The diagnostic performance of a musculoskeletal radiology fellow and an experienced fellowship-trained musculoskeletal radiologist for detecting ACL tears in the same subject poulation was also calculated.

RESULTS

For the fellow and radiologist, the sensitivity (95%CI) for detecting ACL tears was 94% (81%-99%) and 97% (86%-100%) respectively, while the specificity (95%CI) was 98% (92%-100%) and 98% (92%-100%) respectively. In comparison, the sensitivity (95%CI) and specificity (95%CI) for the DL method for detecting ACL tears at the optimal threshold by the Youden index was 89% (74%-97%) and 98% (92%-100%) respectively. The AUC (95%CI) for the DL method was 0.942 (0.876-0.979, $p<0.001$), indicating high overall diagnostic performance.

CONCLUSION

A fully-automated DL approach showed high diagnostic performance for detecting surgically confirmed ACL tears, but its sensitivity was slightly lower than human readers indicating the need for larger training datasets to maximize diagnostic performance.

CLINICAL RELEVANCE/APPLICATION

A fully-automated DL approach trained on a small image dataset shows promise for detecting ACL tears but requires further optimization to achieve diagnostic performance comparable to human readers.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ali Guermazi, MD, PhD - 2012 Honored Educator

SSG08-03 Deep Learning For CT Spine Fracture Detection

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S102CD

Awards
Student Travel Stipend Award

Participants
Karen Cheng, MD, Orange, CA (*Presenter*) Nothing to Disclose
Charles Lin, Irvine, CA (*Abstract Co-Author*) Nothing to Disclose
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Peter Chang, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate a multi-step deep learning tool, based on convolutional neural networks (CNN), for fully-automated localization of vertebral bodies and detection of fracture on CT.

METHOD AND MATERIALS

After IRB approval, an institutional database was queried to identify patients with cervical, thoracic or lumbar CT obtained between January 2016 and 2017. For each patient, sagittal bone reconstructions were used to manually generate bounding cubes for each vertebral body. Additionally, all levels with a vertebral body fracture were identified. Final annotations were confirmed through visual inspection by a board-certified radiologist. A 3D mask R-CNN architecture based on a feature pyramid backbone was used to regress bounding cube locations for each vertebrae (Figure 1A). Subsequently, each vertebrae was cropped, resampled and used as input into a second 3D residual CNN for detection of fracture (Figure 1B). The 34-layer residual CNN architecture was implemented with bottleneck layers and all-convolutional design (no pooling). Performance was assessed on per vertebrae and per patient levels.

RESULTS

A total of 440 patients were included in this study, 88 of which had at least one vertebral body fracture. Overall, 174 of 3,206

individual levels contained a fracture. Accuracy, AUC, sensitivity, specificity, PPV and NPV were 0.961, 0.956, 0.845, 0.967, 0.590, 0.991 (per-vertebrae) and 0.859, 0.836, 0.875, 0.823, 0.558, 0.963 (per-patient). Combined, serial inference for the 3D mask R-CNN followed by the 3D residual CNN required 2.19 seconds per patient on a single GPU workstation.

CONCLUSION

A custom deep learning based tool is accurate for detection of vertebral body fracture. Given the potential subtle appearance of fractures and high resolution of CT spine imaging, a two-part serial architecture was required to integrate complimentary large field-of-view (vertebral body localization) and small field-of-view (fracture detection) information needed for this task.

CLINICAL RELEVANCE/APPLICATION

A high-performing deep learning tool for CT spine fracture detection can be used for rapid triage in the acute trauma setting, optimizing radiology workflow and expediting patient care.

SSG08-04 Automatic Detection of Distal Radius Fractures in X-Ray Images using Deep Learning

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S102CD

Participants
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PURPOSE

The aim of this study was to evaluate the diagnostic performance of a multi-purpose, deep-learning based image analysis software for the detection of wrist fractures.

METHOD AND MATERIALS

In this retrospective study, patients with suspected wrist fractures on X-ray imaging studies ordered by the ER department between 2016 and 2017 were included. After applying exclusion criteria (e.g. presence of osteosynthesis material), the remaining X-ray images were labeled for the presence of radius fractures. In uncertain cases, CT studies were consulted, excluding cases missing CT confirmation. The cases were randomly split into training and test set (85% and 15%, respectively). A multi-purpose image analysis software was trained for the decision whether a distal radius fracture was present on the X-ray image. Training data was augmented (e.g. by horizontal flipping, shifting, rotating, scaling). The test set was subsequently processed by the trained system. Performance was measured as area under the ROC curve (AUC) from the score the software assigned to each image. Sensitivity and specificity were calculated at the optimal threshold as indicated by Youden's index. Finally, the test set was evaluated by an attending radiologist and a radiology resident with 16 and 2 years of experience, respectively.

RESULTS

The included images featured 171 cases with fractures and 562 controls, amounting to 733 X-ray images of 277 different patients. The training and evaluation set consisted of 573 and 160 X-ray images, respectively. The diagnostic performance of the trained software on the test set of 160 X-ray images was excellent with an AUC of 0.91 (95%-CI 0.85-0.95). It therefore performed comparable to a radiology resident (AUC 0.87, $p=0.25$) but worse than the attending radiologist (AUC 0.98, $p<0.01$). Sensitivity and specificity of the software at the optimal threshold were calculated to be 88.5% and 89.9%, respectively. Heatmaps drawn as an image overlay by the software indicated areas suspicious for defects as useful visual feedback. The interreader agreement of the human readers was substantial with a Cohen's kappa of 0.71 (95%-CI 0.60-0.82).

CONCLUSION

The software was able to detect wrist fractures with high sensitivity and specificity, using only a small dataset for training. It performed on a par with the radiology resident reader.

CLINICAL RELEVANCE/APPLICATION

Deep-learing based software is useful for the detection of wrist fractures.

SSG08-05 Multi-Tissue Segmentation for Body Composition Using a Deep Convolutional Neural Network

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S102CD

Awards
Student Travel Stipend Award

Participants
Benjamin Wang, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

To develop and test a deep convolutional neural network (CNN) to automatically segment abdominal CT images for body composition measures. We hypothesized that a deep CNN would achieve high accuracy using a limited training dataset and data augmentation.

METHOD AND MATERIALS

We manually segmented single-slice CT images obtained at the level of L4 (80kV, 70mAs, 10mm slice thickness, 50cm field of view) in 160 subjects for determination of body composition. Manual segmentation was performed on 512x512 pixel images to label 6 classes: background, muscle, bone, bowel/solid organs, visceral and subcutaneous fat. Twenty cases were segregated for a test dataset. The remaining 140 underwent a processing pipeline of histogram equalization followed by data augmentation (N=2,000), which included random deformations, horizontal mirroring, Poisson noise, cropping and magnification. We trained our model from scratch on Keras/Tensorflow using an 80/20 training/validation split and a U-Net architecture (8 batch size, 50 epochs, dropout 0.3, initial learning rate 0.0001, softmax). Testing was performed to obtain the Dice (F1) score as a parameter to compare the similarity between manual vs. CNN-based multi-class segmentation.

RESULTS

The overall mean Dice score was 96% (median 97%, range, 94-98). Mean Dice scores for each class were: background 98% (median 98%, range, 96-99), bone 87% (86%, 83-92), subcutaneous fat 94% (96%, 87-98), muscle 91% (91%, 84-97), bowel/solid organs 89% (90%, 83-94), and visceral fat 81% (88%, 45-93). Visceral fat demonstrated the broadest accuracy range, which may derive from its more variable quantity and morphology, representing an important focus to improve algorithm performance.

CONCLUSION

Our results show overall accurate automated abdominal CT segmentation for body composition using a deep CNN algorithm, trained on a limited dataset with data augmentation. While segmentation accuracy was generally high for most classes (>81%), improvement of algorithm performance will focus on strategies to increase visceral fat segmentation accuracy. This workflow may serve as a basis for future models aimed at automated segmentation of entire abdominal CT studies for body composition.

CLINICAL RELEVANCE/APPLICATION

Deep CNN algorithms for tissue segmentation are promising methods to obtain body composition measurements, and may allow efficient and automatic data extraction in opportunistic and population studies.

SSG08-06 End to End Solution for Complete Thigh Muscle Semantic Segmentation from Musculoskeletal CT using Deep Learning

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S102CD

Participants
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N/A

PURPOSE

The goal is to develop and validate a 2.5D deep learning neural network (DLNN) to automatically classify thigh muscle into 10 classes and evaluate its classification accuracy over 2D DLNN.

METHOD AND MATERIALS

The clinical dataset consists of 48 thigh volume(TV) cropped from 24 anonymized non-contrast CT DICOM of lower extremities. Cropped volumes were aligned with femur axis and resample in 2mm voxel spacing. To reduce the annotation workload, final expert ground truth annotation was created by editing the predicted labels of muscle by a newly developed stacked U-Net DLNN. Stacked U-Net produces relatively higher segmentation accuracy on smaller muscles even when it is trained with small number annotated datasets. Proposed 2.5D DLNN consists of three 2D U-Net(optimizer: Adam, lr=1e-4,decay=1e-3) trained with axial, coronal and sagittal muscle slices respectively. A voting algorithm was used to combine the output of 2D U-Nets to create final segmentation. 2.5D U-Net was trained on PC(Intel Xeon 2.20GHz 128GB, NVIDIA Tesla P100-SXM2-16GB) with 38 TV(Epoch:100, Batch:32) and the remaining 10 TV were used to evaluate segmentation accuracy of 10 classes within Thigh. The result segmentation of both left and right thigh were de-cropped to original CT volume space. Finally, segmentation accuracies were compared between proposed DLNN and 2D U-Net(axial).

RESULTS

Average segmentation DSC score accuracy of all classes with 2.5D U-Net as 91.18% and Housdorff distance(HD) as 17mm. We found DSC score for 2D U-Net was 2.9% lower and HD was more than four times higher than the that of 2.5D U-Net.

CONCLUSION

Successfully implemented end-to-end solution for complete automatic classification with reasonable accuracy of thigh muscle into 10 classes . The same could be easily extend to muscle segmentation of any other body parts (lower limb, arm, shoulder etc.). To date, there is no other study of deep machine learning algorithm used except our study for CT based semantic muscle segmentation.

CLINICAL RELEVANCE/APPLICATION

Muscle segmentation functionality on PACS may improve visibility and can enable automatic quantitative evaluation of muscle atrophy with the disease progression. Change in volume or shapes of muscles will enable therapeutic interventions to be targeted to the affected regions only.

SSG08-07 A Deep-Learning System for Fully-Automated Muscle Assessment on Abdominal CT for Opportunistic Detection of Sarcopenia

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S102CD

Participants
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PURPOSE

Central sarcopenia is a risk factor for mortality in multiple cancers, liver transplantation, cirrhosis, and trauma, and represents a topic of interest in multiple medical and surgical specialties to help guide patient management. We have created a fully-automated deep-learning system to opportunistically analyze truncal musculature for sarcopenia detection on CT scans obtained as part of the patient's routine clinical care

METHOD AND MATERIALS

First, individual lumbar vertebral bodies are segmented to separate bone from soft tissue, and create reference anatomic levels for muscle analysis, via thresholding, morphologic operations, and aggregated intensity profiles. Next, muscle groups at reference vertebral levels are segmented on axial images by a holistically nested neural network through image-to-image training and classification. There are varying reference level and muscle group standards for sarcopenia determination in different medical and surgical specialties. To accommodate this, the system performs analysis for multiple muscle groups and vertebral levels. Segmentation accuracy was assessed via Dice Similarity Coefficient, a measure of overlap between manual and automated segmentations. The system was trained on contrast enhanced portal venous phase CTs of 51 patients and tested on 51 cases (average age 67 (range 59-81), 53 F, 49 M). For demonstration here, the system was designed to calculate sarcopenia via the standard cutoff value for L3 SMI (skeletal muscle index: L3 axial muscle area cm2/patient ht m2) of < 3.62cm2/m2 for women and <4.93 cm2/m2 for men, as proposed by international consensus of cancer cachexia

RESULTS

The Dice coefficients for the psoas, paraspinous, and total abdominal muscle groups in the training and testing sets were 0.953 +/- 0.015 and 0.938 +/- 0.028, respectively at the level of the third lumbar vertebra. The mean normalized L3MI was 5.02 +/- 1.45 cm2/m2 for women and 6.18 +/- 1.83 cm2/m2 for men. Sarcopenia was present in 15.4% (8/52) of women and 13.3% (6/45) of men

CONCLUSION

This fully-automated system can robustly detect, accurately segment, and generate quantitative statistics for multiple abdominal wall muscle groups at multiple lumbar vertebral levels on CT scans

CLINICAL RELEVANCE/APPLICATION

Automated quantification of sarcopenia may guide patient management in pre-treatment risk assessment and surgical planning, and act as a platform to facilitate large scale clinical trials

SSG08-08 Machine-Learning-Based Discovery of Sexual Dimorphism of Hand and Wrist Radiographs

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S102CD

Participants
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PURPOSE

Skeletal sexual dimorphism develops mostly in the pelvis during puberty. Although prior work has shown higher second-to-fourth digit ratio and smaller carpal bones in women compared to men, the distributions of these measures substantially overlap for women and men. We aim to create a machine-learning algorithm to distinguish sex from hand and wrist radiographs and evaluate its performance by comparing it to radiologists'.

METHOD AND MATERIALS

We compiled a dataset of 10,607 (5,148 male and 5,459 female) radiographs of hand and wrist from a cohort of patients, ranging from 5 years to 80 years of age. A total of 7,461 radiographs were used for training, and 1,573 images separate from the training data were randomly selected for validation. Images from the remaining 1,573 cases were reserved for testing. The images were labeled solely with the sex of the subject. We fine-tuned an ImageNet-pretrained VGG16 convolutional neural network (CNN) on our training dataset. The best CNN, selected based on the validation loss, then provided automated prediction of sex, which was compared to the sex in the medical record. To compare the performance with human radiologists, we randomly selected 50 cases for which the CNN correctly predicted sex. Two radiologists independently read the hand and wrist radiographs and predicted sex for these 50 cases. The radiologists were blinded to clinical information of the patients but were allowed to use reference such as the Greulich and Pyle atlas while reading the radiographs.

RESULTS

Of the 1,573 radiographs tested, the algorithm predicted sex correctly with 95.4% accuracy (95.2% in female and 95.7% in male).

The two radiologists showed 58% (45.8% in female and 69.2% in male) and 46% (50% in female and 57.7% in male) accuracy. The class activation maps (CAM) showed that the CNN mostly focused on 2nd and 3rd metacarpal base or 4th and 5th metacarpal head in women, and radioulnar/radiocarpal joint or 2nd, 3rd, and 4th metacarpophalangeal joints in men.

CONCLUSION

We developed an algorithm that accurately distinguishes men and women from hand and wrist radiographs in children as well as in adults.

CLINICAL RELEVANCE/APPLICATION

The current study shows the discovery of previously unrecognized radiologic features using machine learning. It could be used in screening of disorders affecting sexual development.

SSG08-09 Automated Radiograph Based Preoperative Measurements in FAI Patients Utilizing Deep Learning

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S102CD

Participants
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PURPOSE

Utilize deep learning to obtain preoperative measurements from radiographs in patients with femoroacetabular impingement.

METHOD AND MATERIALS

A retrospective study of patients with femoroacetabular impingement was performed. 181 unique patients who underwent CT scan of the hip for preoperative measurement of alpha angle (AA), acetabular version (AV), femoral version (FV) and lateral center edge (LCE) were identified. The training set consisted of 1084 radiographs. This was made up of available preoperative false profile, Dunn, frog leg and AP radiographs (n=419) and augmented with digitally reconstructed radiographs (DRRs) generated from the CT scans at different views (n=665). A novel convolutional neural network (CNN) based on a DenseNet architecture with 54 hidden layers and a regression head was trained on 256x256 input images to predict LCE measurement. For testing AA, AV, and FV measurements, both a regression output and a binary classifier for normal and abnormal ranges were tested. Parameters were tuned based on a 20% validation group generated from the training set. The sequestered testing set consisted of 95 preoperative radiographs at various views and corresponding measurements from accompanying CT scans.

RESULTS

Overall mean absolute error (MAE) and standard deviation of the error for LCE measurement was 3.2° ± 2.3°. Performance of the network was best on false profile views of the hip (3.0° ± 2.2°) but this difference was not statistically significant. AA, AV and FV prediction performance was evaluated, however the performance of the network was not predictive in the current implementation.

CONCLUSION

Deep learning techniques applied to radiographs can be used for quantitative measurement of LCE. With further modification and additional examples, quantitative measurement of AA, AV and FV may be possible.

CLINICAL RELEVANCE/APPLICATION

An accurate, automated system designed to obtain FAI measurements from radiographs can obviate the need for CT and has the potential to decrease healthcare costs, decrease patient exposure to radiation and increase radiologist efficiency.

SSG09

Nuclear Medicine (Gastrointestinal Oncology Nuclear Imaging)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S505AB

CT GI MR NM OI

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

FDA Discussions may include off-label uses.

Participants
Peter L. Choyke, MD, Rockville, MD (*Moderator*) Nothing to Disclose
Jacob G. Dubroff, MD, PhD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSG09-01 Dynamic PET Perfusion Imaging (DPPI) of Esophageal Cancer to Characterize Angiogenicity: A Phase I Study to Explore this Potential Imaging Biomarker Enabled by Ultra-Fast Digital PET

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S505AB

Participants
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PURPOSE

While PET perfusion imaging using dynamic acquisitions has a long history, its use in clinical practice outside of cardiovascular applications remains negligible. This Phase I study assesses the feasibility of dynamic PET perfusion imaging as an alternative methodology to contrast enhanced MRI in esophageal cancer using next-generation digital PET technology with substantially improved TOF timing resolution and reduced dead time.

METHOD AND MATERIALS

FDG PET/CT was performed prior to radiation therapy of advanced esophageal cancer in 12 patients using a next-generation digital photon counting system (Vereos Philips, dPET). Prior phantom and preclinical experiments established the following protocol. Dynamic PET Perfusion Imaging (DPPI) was performed at the time of bolus injection of 5 mCi FDG over a volume of interest for 10 min. PET events were recorded in continuous list mode acquisition and reconstructed using frame rates from 1 sec/fr to 15 sec/fr. A count density adaptive reconstruction approach was previously developed. Data analysis were performed using Intellispace Discovery (Philips) workspace. The reconstructed dynamic PET images were assessed in blinded review by three experienced PET readers. Descriptive statistics were calculated for data analysis.

RESULTS

All dynamic PET acquisitions were successfully acquired and reconstructed according to protocol. Frame rates of 10 sec led to high quality uptake time curves of the well delineated esophageal cancer. Count density adaptive reconstruction was essential to minimize noise. 2mm voxel length (HD) reconstruction was found to be beneficial. The first 2 min duration of the dynamic series were found to be the most relevant and also sufficient for the perfusion assessment. Uptake time curves were found analogous to characteristic findings in DCE-MRI.

CONCLUSION

Dynamic PET Perfusion Imaging (DPPI) of esophageal cancer was achievable using frame rates of 10 sec with acceptable quality for quantitative and visual assessment even at the low FDG dose of 5 mCi. A short table time of 5 min appears to be sufficient combined with the dPET's low dose capabilities making clinical utilization feasible.

CLINICAL RELEVANCE/APPLICATION

Dynamic PET perfusion imaging has the potential to be an alternative methodology to DCE-MRI or CT for assessment of perfusion of esophageal cancer for therapy planning and response assessment.

SSG09-02 Focal Liver Uptake on 18F-FDG PET/CT without CT Correlate: Utility of MRI Evaluation in Patients with Known Malignancy

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S505AB

Participants
Tetsuro Araki, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose
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Sreeharsha Tirumani, MBBS, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

There is insufficient evidence to guide management of focal FDG uptake in the liver without CT correlate. This study aims to assess the utility of MRI for evaluation of focal FDG uptake on PET/CT without CT correlate in patients with known malignancy.

METHOD AND MATERIALS

In this IRB-approved, HIPAA compliant retrospective study, between 2005 and 2012, out of 1851 patients who underwent FDG-PET/CT, we identified 36 patients with known malignancy (19 women, 17 men; mean age, 56.1 years) who had focal hepatic uptake on PET/CT without CT correlate and had follow-up MRI within 100 days for assessment of the uptake. Two radiologists reviewed the PET/CT images in consensus blinded to the area of uptake noting SUVmax of the lesion and background liver. MR images were then reviewed to look for the presence of focal lesion corresponding to the uptake. When a focal lesion was present, the size, signal intensity and enhancement characteristics and follow-up imaging were documented. Statistical analysis was performed to determine correlation between intensity of FDG uptake and presence of focal lesion.

RESULTS

A total of 50 sites of focal hepatic uptake without CT correlate were identified. Median SUVmax was 4.1 (range 2.1-10.1) and median SUVmax ratio of hepatic lesion/normal parenchyma was 1.3 (range 0.98-2.6). MRI confirmed focal lesion in 26/50 sites (52%). Median lesion size was 13 mm (range 3-30 mm). Among 26 hepatic lesions noted on MR imaging, 77% (20/26) were diagnosed as metastatic disease (6 with pathological confirmation, 14 based on follow-up image findings). Other 6 lesions were diagnosed as benign, including 3 with pathological diagnosis of nodular regenerative hyperplasia (n=2) and heterogenous hepatic steatosis (n=1). There was no significant difference in the SUVmax of hepatic lesions (3.85 vs. 4.2, p=0.5) and the SUVmax ratio (1.32 vs. 1.31, p=0.97) between the groups with and without MRI correlate.

CONCLUSION

More than half of focal areas of uptake on PET/CT without CT correlate had a focal lesion on MRI in our study, and more than three-quarters of these MRI lesions were hepatic metastases, regardless of SUVmax values.

CLINICAL RELEVANCE/APPLICATION

In patients with known malignancy, focal FDG uptake in the liver without CT correlate warrants further assessment with MRI regardless of SUVmax as it is likely to be metastasis.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Sreeharsha Tirumani, MBBS, MD - 2016 Honored EducatorNikhil H. Ramaiya, MD - 2017 Honored EducatorAtul B. Shinagare, MD - 2017 Honored Educator

SSG09-03 Focal Colonic Tracer Uptake in 18F-FDG PET/CT Scans: Does the Combined Analysis of Morphological Changes and PET Improve Lesion Characterization?

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S505AB

Participants
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PURPOSE

To evaluate the impact of morphological information derived from contrast enhanced CT on the characterization of incidental, focal colonic uptake in 18F-fluordesoxyglucose positron emission tomography / computed tomography (18F-FDG PET/CT) examinations.

METHOD AND MATERIALS

In this retrospective study, 125 patients (female: n=53, male: n=72, mean age 62.9y) that underwent 18F-FDG PET/CT and colonoscopy (mean time between colonoscopy and PET: 52±58d) were included. By two readers, PET/CT examinations were assessed for incidental, focal colonic tracer uptake in comparison to the background. Focal tracer uptake was correlated with morphological changes of the colonic wall such as focal thickening, polypous shape or focal contrast media uptake. Discrepancies were resolved in a consensus reading. Then, colonoscopy reports were evaluated for precancerous (oligo-tubular adenoma, serrated adenoma, sessile adenoma and tubulo-villous adenoma) and cancerous lesions verified by histopathology, serving as a reference standard. Imaging findings were then compared to the reference standard to calculate sensitivity, specificity as well as positive (PPV) and negative predictive values (NPV) for focal tracer uptake in PET alone as well as focal tracer uptake in PET and

morphological changes in contrast enhanced CT in the detection of precancerous and cancerous lesions.

RESULTS

In 38.4% (48/125) of all patients, focal tracer uptake was observed in 67 lesions. In the corresponding colonoscopy reports, a total of 10 cancerous and 26 precancerous lesions were found. In PET, two cancerous lesions and 10 precancerous lesions were missed, resulting in a sensitivity, specificity, PPV and NPV of 51%, 68%, 29% and 84% for focal tracer uptake in PET alone. By correlation focal tracer uptake with morphological changes in contrast enhanced CT, a sensitivity, specificity, PPV and NPV of 48%; 79%; 37,5%; 86% for precancerous and cancerous lesions could be observed.

CONCLUSION

Focal colonic tracer uptake has a low specificity and sensitivity for precancerous and cancerous lesions. By analyzing additional morphological changes in contrast enhanced CT imaging in 18F-FDG PET/CT examinations, the specificity can be increased without sacrificing sensitivity.

CLINICAL RELEVANCE/APPLICATION

Morphological changes in 18F-FDG-PET/CT examinations help to decide, which patients with focal tracer uptake will profit from additional colonoscopy.

SSG09-04 Clinical Workflow of PET/MR for Primary Staging of Rectal Cancer

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S505AB

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PURPOSE

analyze the clinical workflow of a PET/MR for rectal cancer staging, regarding MR imaging protocol, total scan time, prevalence and distribution of metastasis.

METHOD AND MATERIALS

55 patients with rectal adenocarcinoma were submitted to whole-body PET/MR for primary staging. MR sequences and total scan time were recorded. One reader analyzed the MR (blinded to PET findings) for locoregional staging. Another reader (blinded to the high-resolution MR of the pelvis) analyzed the PET/MR according to T, N and M staging. A third blinded reader analyzed only the liver MRI. Standard of reference was biopsy when feasible or imaging follow-up.

RESULTS

PET/MR workflow consisted of a dedicated pelvic MR, including high-resolution T2w and DWI, followed by whole-body PET/MR from head to mid thigh, ending with a T2w and DWI of the liver. Any dedicated MR sequence was used for the thorax. The mean total acquisition time of PET/MR was 64 minutes, ranging from 53 to 90 minutes. The PET acquisition time was on average 17 minutes, ranging from 12 to 25 minutes and the only-MR time was 52 minutes on average, including the dedicated pelvic and the liver sequences. One patient has not completed the exam due to claustrophoby and one patient was recalled due to low imaging quality (movement artifacts). For primary lesion detection, PET and DWI were positive in 54 out of 55 patients (one patient was negative even at MR). Metastatic disease was observed by PET/MR in 21 (38.2%) patients, mainly in the liver (12/21, 57.1%) non-regional lymph node (10/21, 47.6%), lungs (7/21, 33.3%) and peritoneum (1/21, 4.8%). Liver DWI detected 64 lesions in 12 patients and PET detected 62 lesions in the same 12 patients. Any brain metastasis was found.

CONCLUSION

PET/MR for rectal cancer staging is feasible, with a tolerable scan time and showing a high incidence of synchronic metastasis. DWI of the liver and of the rectum could be omitted in a staging/detection setting. PET coverage could start from skull base instead of vertex. Optimization of MR protocol would decrease scan time and allow the inclusion of other MR sequences.

CLINICAL RELEVANCE/APPLICATION

PET/MR for rectal cancer may be used clinically as a one-stop-shop imaging tool for whole-body staging.

SSG09-05 PET/MR for Staging Rectal Cancer: A Comparison to Conventional Staging with Pelvic MR and Thoracoabdominal CT

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

To compare the detection rate of metastatic lesions on PET/MR versus conventional staging (pelvic MR and thoracoabdominal CT) in rectal cancer patients referred for primary staging.

METHOD AND MATERIALS

Ninety-five patients with biopsy proven rectal adenocarcinoma were submitted to whole-body PET/MR for primary staging in addition to conventional staging with pelvic MR and thoracoabdominal contrast-enhanced CT (ceCT). One reader analyzed the MR (blinded to PET findings) regarding locoregional staging. Another reader (also blinded to the high-resolution part of pelvic MR) analyzed the PET/MR about T-, N- and M-stage. A third blinded reader assessed the M-stage by ceCT. Standard of reference was biopsy when feasible or imaging follow-up. Lesions were cateogrized as positive, negative or indeterminate.

RESULTS

On a lesion-based analysis, PET/MR detected 24.5% more positive metastatic lesions than conventional imaging (305 vs. 254 lesions). The higher detection rate on PET/MR was observed for non-regional lymph nodes (73 vs. 37 lesions). On a patient-based, PET/MR was positive in 38 out of 95 patients (40%), while conventional staging in 24 out of 95 patients (25.3%). PET/MR was indeterminate in 7 patients (7.4%), which 1 was positive on CT (non-regional lymph nodes, later confirmed to be sarcoidosis), while conventional imaging was in 30 patients (31.6%), which 10 were positive on PET/MR, mainly for non-regional lymph nodes and liver.

CONCLUSION

For rectal cancer staging, PET/MR presents not only a higher detection rate of metastatic lesions than conventional imaging (pelvic MR and thoracoabdominal ceCT), but also clarifies the etiology indeterminate lesions.

CLINICAL RELEVANCE/APPLICATION

PET/MR might be preferred for whole-body staging of rectal cancer patients, with a higher detection rate and potential clinical impact.

SSG09-06 Diagnostic Performance of PET/MR in Identifying High-Risk Primary Rectal Cancer Patients

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S505AB

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PURPOSE

to assess the diagnostic performance of PET and MR parameters to identify high-risk rectal cancer patients.

METHOD AND MATERIALS

fifty-three patients with biopsy proven rectal adenocarcinoma were submitted to whole-body PET/MR for primary staging. One reader analyzed the MR (blinded to PET findings) regarding T stage, mesorectal fascia involvement, extramural vascular invasion, and presence of locoregiona nodal disease. Another reader (also blinded to the high-resolution part of pelvic MR) measured the semiquantitative PET parameters using a dedicated software (PETVCAR, GE Healthcare) and assessed the M stage. Standard of reference was biopsy when feasible or imaging follow-up. Mann-Whitney test was performed to compare PET parameters between high and low-risk patients. ROC analysis was also used to define the diagnostic perfomance of PET parameters in identifying the tumor risk.

RESULTS

PET-volumetric parameters, namely TLG and MTV, performed better than SUVmax and mean to distinguish low and high-risk patients. MTV (48.9 vs. 18.4, $p = 0.006$) and TLG (629.4 vs. 190.4, $p = 0.008$), but not SUVmax (23.4 vs. 19.2, $p = 0.306$) or SUVmean (11.7 vs. 9.9, $p = 0.285$) were significantly higher in high-risk patients. Patients with advanced T stage, positive regional node and metastatic disease also presented significantly higher MTV and TLG values. No difference was found in any PET parameters in patients according to the involvement of mesorectal fascia and presence of EMVI. The AUC to distinguish low and high-risk patients was 77.9% ($p = 0.006$) for MTV and 77.0% ($p = 0.008$) for TLG and the best cut-off value (sensitivity of 83.7% and specificity of 70%) of MTV and TLG to detect high-risk patients was 16.1 and 172.8, respectively.

CONCLUSION

In addition to MR adverse risk factors, the volumetric-based PET parameters (MTV and TLG) allow the identification of high-risk patients, which could tailor therapy management.

CLINICAL RELEVANCE/APPLICATION

PET/MR provides morphologic and metabolic parameters to identify high-risk rectal cancer patients that need more detailed staging in a whole-body setting. The volumetric-based PET parameters (MTV and/or TLG) might be included in clinical reports instead of SUVmax.

SSG09-07 PET/MR Characterization of Mucinous versus Nonmucinous Components of Rectal Adenocarcinoma: A Comparison of Tumor Metabolism and Cellularity

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S505AB

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PURPOSE

to analyze the relation of mucinous component of rectal adenocarcinoma to FDG avidity and diffusion restriction.

METHOD AND MATERIALS

ninety-four patients with biopsy proven rectal adenocarcinoma were submitted to whole-body PET/MR for primary staging. One reader analyzed the MR (blinded to PET findings) regarding locoregional staging, including the presence of mucinous component. Another reader (also blinded to the high-resolution part of pelvic MR) analyzed the PET/MR according to T, N and M staging. Two different readers drawn in consensus the volume of interest (VOI) larger than 0.5 cmCubed of the mucinous component (MC) and the non-mucinous component (NMC) of the primary tumor on high-resolution T2w sequence and propagated the VOI to PET, DWI and ADC. SUVmax, SUVmean, TLG, MTV, ADCmax, ADCmean and ADCmin values were recorded and compared using Mann-Whitney test.

RESULTS

Seventeen patients (18.1%) presented MC on MRI. The SUVmax and SUVmean of the NMC were significantly higher than of the MC (16.7 vs. 7.4, p = 0.002 and 13.4 vs. 5.4, p = 0.001). Any of the ADC values was significantly different between MC and NMC groups.. Among the 17 patients with MC, 16 (94.1%) were at least mrT3b, 15 (88.2%) presented positive extramural vascular invasion, 14 (82.4%) had involvement of mesorectal fascia, 13 (76.5%) were N-positive and 8 (47.1%) presented distant metastasis, reinforcing the correlation of MC and tumor risk.

CONCLUSION

The MC identified on PET/MR presents lower glycolytic metabolism than the NMC and is associated with high tumor risk. Tumor cellularity was not different between MC and NMC.

CLINICAL RELEVANCE/APPLICATION

PET/MR enables a conspicuous correlation of mucinous component and tumor metabolism. Imaging readers should be aware of this pattern, recognizing that both primary and metastatic disease of mucinous tumors present low FDG uptake.

SSG09-08 Comparative Accuracy of Qualitative and Quantitative 18F-FDG PET/CT Analysis in Detection of Lymph Node Metastasis from Anal Cancer

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S505AB

Awards
Student Travel Stipend Award

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PURPOSE

To evaluate the diagnostic performance of qualitative and quantitative FDG PET combined with CT in detection of regional and distant lymph node metastases in patients with anal cancer

METHOD AND MATERIALS

In this IRB approved retrospective study between January 2000 and December 2017, a total of 29 patients (F/M;17/12), mean age 59.9±13.7 (15-95) with anal cancer who had staging PET/CT and pathological analysis of suspicious lymph nodes were included for qualitative and quantitative analysis. For qualitative analysis, the positive lymph nodes were defined as uptake close to or higher than the liver background. For quantitative study, lymph nodes were contoured using the 3D region of interest (ROI) to determine

the maximum standard uptake value (SUVmax) and metabolic tumor volume (MTV). Receiver operating characteristic (ROC) curves were analyzed to extract the optimal cut-off values of SUVmax, lesion to background (L/B) ratio, short axis diameter (SAD) and MTV of the lymph nodes. Histopathologic analysis was the reference standard.

RESULTS

A total of 29 lymph nodes (25 inguinal, 2 external iliac, 1 internal iliac and 1 paraaortic nodes) in 29 patients on PET/CT were included for analysis. For qualitative visual analysis, PET/CT interpreted 27 patients as positive for the presence of nodal metastases with sensitivity, specificity and accuracy of 1, 0.25 and 0.79. The optimal cut-off values of SUVmax and L/B ratio were 2.51 and 1.13 with sensitivity and specificity of 0.91, 0.75 and area under the ROC curve (AUC) of 0.863 (95%CI:0.685,0.962) for SUVmax and 0.887 (95%CI:0.714,0.974) for L/B ratio. Using a best discriminative cut-off value 1.5 cm for SAD and 3.53 cm3 for MTV, the sensitivity and specificity were 0.81 and 1 with AUC of 0.952 (95%CI:0.803,0.997) for SAD and 0.935 (95% CI:0.777,0.993) for MTV. If we used the optimal cut-off value of either SUVmax or SAD, the sensitivity will increase to 0.95 (95%CI:0.76,0.99) with a specificity of 0.75 (95%CI:0.35,0.97).

CONCLUSION

Quantitative analysis of lymph node metastases in patients with anal cancer obtained with SUVmax, L/B ratio, nodal size and MTV are more specific and accurate than those performed with qualitative analysis but slightly less sensitive.

CLINICAL RELEVANCE/APPLICATION

The presence of nodal metastasis is crucial for treatment planning. Inguinal nodes with gross nodal involvement will receive a booster dose. Distant metastasis will change the chemotherapy regimen.

SSG09-09 68Ga-DOTATATE PET/CT as a Predictive Marker for 177Lu-DOTATATE Therapy

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S505AB

Participants
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PURPOSE

Lutetium-177 (177Lu)-DOTATATE has shown significant promise in patients with somatostatin receptor positive neuroendocrine tumors (NETs). Here we report our preliminary experience with the use of 68Ga-DOTATATE PET/CT as a predictive marker for outcomes with 177Lu-DOTATATE therapy.

METHOD AND MATERIALS

Fifteen patients with progressive metastatic NETs were enrolled at our institution on the Expanded Access Program for 177Lu-DOTATATE. Pre-treatment 68Ga-DOTATATE PET/CT scans were performed in all patients. A retrospective analysis of these PET/CT scans was performed for tumor burden. Indices measured include maximal SUV uptake (SUVmax) and total SUV uptake (SUVtotal), which is the sum of 68Ga-DOTATATE uptake by all the lesions in one patient's PET scan. Tumor burden is the sum of all tumor volumes. These measurements were correlated with progression-free survival.

RESULTS

Of the 15 enrolled patients, six completed all four 177Lu-DOTATATE infusions, and 9 patients completed 3 or fewer infusions. Median progression-free survival is 80% at 12 months from the date of enrollment. The pre-treatment 68Ga-DOTATATE PET/CT demonstrated well-differentiated NETs and wide-spread metastases in all 15 patients, with liver, lymph nodes and bone being the most common sites. Our data showed a larger tumor burden (1824 ml vs. 748 ml) and higher SUVtotal (636 thousand vs. 186 thousand) in deceased patients vs. patients with stable disease, while SUVmax had the opposite trend (36.5 vs. 51.0).

CONCLUSION

It may be possible to metrics from the pre-therapy 68Ga-DOTATATE PET/CT to predict outcomes of 177Lu-DOTATATE in patients with metastatic NET. While the results are encouraging, larger cohorts are needed to establish 68Ga-DOTATATE PET/CT based predictive factors for progression-free survival.

CLINICAL RELEVANCE/APPLICATION

68Ga-DOTATATE PET/CT could serve as a clinical predictor for response to 177Lu-DOTATATE.

SSG10

Neuroradiology (Brain Tumors: Looking Beyond the Obvious)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: E353A

MR NR

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

FDA Discussions may include off-label uses.

Participants
James R. Fink, MD, Seattle, WA (*Moderator*) Institutional Grant support, Guerbet SA
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Sub-Events

SSG10-01 Improves Diagnostic Value of Pseudoprogression in Early Post-Treatment Glioblastomas: Multiparametric Radiomics Analysis with Diffusion- and Perfusion-Weighted MRI

Tuesday, Nov. 27 10:30AM - 10:40AM Room: E353A

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PURPOSE

Diagnosis of pseudoprogression (PsP) is a challenging issue for glioblastoma patients in their early post-treatment state. We developed a multiparametric radiomics model using diffusion- and perfusion-weighted MRI and externally validated to facilitate the diagnosis.

METHOD AND MATERIALS

Patients with glioblastomas within 3 months followed by Stupp protocols were reviewed and 61 consecutive patients exhibiting enlarging contrast enhancing masses on MRI were enrolled (PsP = 26). 6472 multiparametric radiomic features were extracted from post-contrast T1-weighted, FLAIR images, ADC and CBV maps. Imaging features were selected using the least absolute shrinkage and selection operator logistic regression model and redundant features were removed. The performance of radiomics model was calculated using the area under the receiver operating characteristics curve (AUROC) and compared with histogram parameters of ADC (ADC10) and CBV (CBV90). To improve validity, the multiparametric radiomics model was tested in an external data set with histopathologic confirmation (n = 34).

RESULTS

Twelve significant radiomic features (1 from post-contrast T1-weighted, 2 from FLAIR, 2 from ADC, and 7 from CBV maps) were selected to construct the radiomics model. The multiparametric radiomics model (AUROC 0.90, 95% confidence interval [CI] 0.82-0.98) showed significantly better diagnostic performance of pseudoprogression than any single parameter of ADC10 (AUROC 0.70, CI 0.46-0.76) or CBV90 (AUROC 0.61, CI 0.66-0.88), and outperformed than a conventional radiomics model using post-contrast T1-weighted and FLAIR only (AUROC 0.76, CI 0.63-0.88). The multiparametric radiomics model also showed better diagnostic performance in the external validation (AUROC 0.85, CI 0.71, 0.99) than single parameters (AUROC 0.43-0.50) and a conventional radiomics model (AUROC 0.74, CI 0.67-0.97).

CONCLUSION

The multiparametric radiomics model improved diagnostic performance for diagnosing pseudoprogression in glioblastoma patients in their early post-treatment state and showed robustness in multi-center setting.

CLINICAL RELEVANCE/APPLICATION

Pseudoprogression is a diagnostic challenge in neuroradiology, especially in their early post-treatment state of less than 3 months followed by Stupp protocols for glioblastoma patients. Multiparametric radiomics model has good generalizability with improved diagnostic performance, which augments the role of diffusion and perfusion MRI.

SSG10-02 Immune Checkpoint Inhibitors Against Glioblastoma: Imaging Assessment of Therapy Response

Tuesday, Nov. 27 10:40AM - 10:50AM Room: E353A

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PURPOSE

Immunotherapeutic strategies are increasingly pursued as upfront and salvage therapies in glioblastoma. Early results with vaccine trials have shown a subset of patients achieve radiographic response, develop stable disease, or have enhanced survival despite early worsening of imaging findings. Here, we assess the imaging findings and outcomes in a cohort of glioblastoma patients treated with immune checkpoint inhibitors.

METHOD AND MATERIALS

We analyzed MR imaging from twenty-nine patients with newly-diagnosed or recurrent glioblastoma treated with immune checkpoint inhibitors. Morphologic and physiologic MR imaging characteristics including diffusion and perfusion imaging were evaluated and clinical outcomes were assessed. Relevant histopathology from sampled tissue was also evaluated.

RESULTS

The majority (20, 69%) of patients on immune checkpoint inhibitors developed early radiographic progression of disease within six months of starting therapy. Of those, seventeen (59%) developed definitive progressive disease radiographically or clinically at follow-up. Eight patients underwent re-resection with pathologic confirmation of progression or treatment related changes. Progressive disease was related to increasing volume of FLAIR signal abnormality, decreased normalized apparent diffusion coefficient, and increased cerebral blood flow ($p<0.05$). Patients with recurrent glioblastoma developed marked early progression with significantly shorter progression free survival compared to newly diagnosed glioblastoma ($p=0.02$). While commonly observed imaging patterns of progression included disseminated leptomeningeal and subependymal disease, particularly in cortex and subventricular zone positive tumors, no significant survival difference was found when stratifying by tumor location.

CONCLUSION

In this retrospective study, glioblastoma treated with immune checkpoint inhibitors was often found to demonstrate early radiographic progression of disease with unique patterns of progression. These findings provide an initial insight into the imaging of glioblastoma treated with immune checkpoint inhibitors and highlight the role of imaging in patient selection and therapeutic response assessment.

CLINICAL RELEVANCE/APPLICATION

Immunotherapy is expected to play an ever-expanding role in glioblastoma treatment. Familiarity with radiographic findings following immunotherapy for glioblastoma is paramount for patient care.

SSG10-03 Virtual and Augmented Reality Helps in Pre-Operative Planning of Brain Tumors

Tuesday, Nov. 27 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

To compare virtual reality (VR) and augmented reality (AR) in the pre-operative planning of complex glioma cases.

METHOD AND MATERIALS

After obtaining IRB approval, the clinical MRI exams of 1,250 cases of adult cerebral hemispheric gliomas of all histologic types were examined and characterized. Complex cases were evaluated in 3D with VR and AR using Anatom-e (Houston, TX).

RESULTS

We found that VR which works with a computer screen and a headset in a closed 'purely virtual' environment is a robust technology. It was helpful in pre-operative planning,which included mapping out the gyral anatomy, arteries, veins, as well as tumor infiltration patterns. However, at this time, this technology can only be used by a single user. AR technology is rapidly evolving. AR uses a clear goggle system which allows the user to see his/her 'real' environment and overlays holographic images onto the patients MR imaging. When used, we found AR was superior to VR in anatomy and tumor display. AR is also capable of being shared by multiple viewers, which is of value in communicating with the surgeon and consultation with other colleagues in real time. However, AR is currently not stable enough for consistent use in clinical cases. AR has the potential to be used intraoperatively, by fusing holographic images to the patient's own brain during surgery.

CONCLUSION

Both VR and AR are innovative alternatives to analyse complex glioma cases for pre-operative planning. At this time, VR is superior to AR, as it is better established and a stable platform. However, as technology advances, AR will likely overtake VR for pre-operative planning of brain tumors.

CLINICAL RELEVANCE/APPLICATION

Continued development of technologies such as VR and AR are needed to advance neuroimaging and surgical planning.

SSG10-04 Simultaneous Permeability Measurements Using Dynamic Susceptibility Contrast Imaging Enhances Differential Diagnosis of Primary Central Nervous System Lymphoma from Glioblastoma

Tuesday, Nov. 27 11:00AM - 11:10AM Room: E353A

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PURPOSE

Simultaneous perfusion and permeability measurements become feasible with tissue-residue function based leakage correction in dynamic susceptibility contrast MRI (DSC MRI). We aimed to test whether estimates of adding permeability parameters obtained from single short acquisition of DSC-MRI improves diagnostic performance for distinguishing primary central nervous system lymphoma (PCNSL) from glioblastomas.

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board. Total 145 patients with pathologically proven glioblastomas (n=89) and PCNSL (n=56) were enrolled. Two post-processing methods were used to calculate leakage corrected cerebral blood volume (CBV), using Weisskoff-Boxerman method (normalized CBV, nCBV) and tissue residue function-based method (CBVres). Vascular permeability parameter of extraction fraction (EF) was further calculated with the latter. Diagnostic performance to distinguish PCNSL from glioblastoma was calculated for CBVs and adding EF, using the area-under-the curve from the receiver operating characteristics curve (AUROC) and cross-validated with boot-strapping.

RESULTS

PCNSL demonstrated significantly higher EF (10.49 ± 6.89 %) and lower CBVs (nCBV, 3.13 ± 1.33; CBVres 3.23±2.51 relative units) compared to glioblastoma (EF, 4.30 ± 2.4 %; nCBV, 6.01 ± 4.1; CBVres, 6.45 ± 3.54 relative units, $P < .001$). Combined perfusion and permeability measurements significantly improved diagnostic performance (AUROC, 0.89; 95% confidence interval 0.84-0.94) to any single parameter of nCBV (AUROC 0.78, 0.71- 0.85, $P = 0.02$) and CBVres (AUROC 0.80, 0.73-0.86, $P<0.001$), and performed better than EF (AUROC 0.83, 0.75-0.86).

CONCLUSION

Simultaneous perfusion and permeability measurement on single DSC MRI acquisition improved diagnostic performance in differentiating PCNSL from glioblastoma.

CLINICAL RELEVANCE/APPLICATION

Obtaining permeability parameters for brain tumor evaluation requires double gadolinium contrast injection, long imaging acquisition time and complex post-processing methods. Our results suggests that simultaneous perfusion and permeability parameters derived from a single DSC-MRI acquisition provided useful biomarker and improved diagnosis for differentiating PCNSL from glioblastomas.

SSG10-05 Arterial Spin Labeling for Glioma Grade Discrimination: Correlations with IDH1 Genotype and 1p/19q Status

Tuesday, Nov. 27 11:10AM - 11:20AM Room: E353A

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PURPOSE

To evaluate the diagnostic efficacy of perfusion values derived from arterial spin labeling (ASL) to grade gliomas. In addition, the correlation between perfusion parameters and isocitrate dehydrogenase 1 (IDH1) genotypes and 1p/19q status of gliomas were assessed.

METHOD AND MATERIALS

The institutional review board approved this retrospective study. From October 2015 to January 2018, a total of 53 cases of supratentorial gliomas in adults who received ASL magnetic resonance imaging were included. The cerebral blood flow (CBF) images derived from ASL and the anatomical maps were normalized to the Montreal Neurological Institute coordinate system and then matched. Both qualitative and quantitative analyses of CBF were performed. The mean and maximum CBF were obtained from the whole solid part and the largest perfusion area of the tumor, respectively. The relative values were calculated by dividing the CBF value of the contralateral grey matter area. The pathological results were diagnosed according to the 2016 WHO criteria.

RESULTS

Perfusion in the high-grade group was significantly higher than that in the low-grade group. The maximum CBF, the relative mean

CBF, and the maximum CBF, all showed statistical differences between the low and high-grade groups. Among all the parameters, relative maximum CBF showed the best diagnostic efficacy, with a cutoff value of 1.59, which yielded a sensitivity and specificity of 81% and 75%, respectively. The CBF qualitative analysis showed that the IDH1 mutant group tended to have lower perfusion than the IDH1 wild-type group, with a Phi and Cramer's V coefficient of 0.266. In the sample containing only diffuse astrocytoma, anaplastic astrocytoma, and glioblastoma, the relative mean and maximum CBF were significantly different between the IDH1 mutant and wild-type groups, and correlation analysis found that the Phi and Cramer's V coefficient was 0.395. There was no significant association between 1p/19q codeletion and the perfusion parameters.

CONCLUSION

ASL can offer accurate perfusion values to grade gliomas. There was a mild correlation between IDH1 genotypes and perfusion, and no significant association between 1p/19q status and perfusion of gliomas.

CLINICAL RELEVANCE/APPLICATION

The association between perfusion values from ASL and pathological grades and genotypes of gliomas might enhance the role of MR imaging in the clinical management and prognostic evaluation of gliomas.

SSG10-06 Diagnostic Performance of 2-hydroxyglutarate Magnetic Resonance Spectroscopy for Prediction of Isocitrate Dehydrogenase (IDH) Mutant Glioma: A Systemic Review and Meta-Analysis

Tuesday, Nov. 27 11:20AM - 11:30AM Room: E353A

Participants
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PURPOSE

We aimed to investigate the diagnostic performance of 2-hydroxyglutarate (2HG) magnetic resonance spectroscopy (MRS) for prediction of isocitrate dehydrogenase (IDH) mutant glioma.

METHOD AND MATERIALS

A systematic literature search of Ovid-MEDLINE and EMBASE was performed to identify original articles investigating the diagnostic performance of 2HG MRS for prediction of IDH mutant glioma up to March 20th, 2018. The pooled sensitivity and pooled specificity and their 95% CIs were calculated using a bivariate random-effects model and the coupled forest plot was obtained. Meta-regression was performed to explain the effects of heterogeneity.

RESULTS

Fourteen original articles in a total of 460 patients were included. IDH mutant gliomas consistently showed a significantly higher accumulation of 2HG compared to IDH wild-type gliomas. The pooled sensitivity and specificity for the diagnostic performance of 2HG MRS for prediction of IDH mutant glioma were 95% (95% CI, 85-98%) and 91% (95% CI, 83-96%), respectively. The area under the HSROC curve was 0.96 (95% CI, 0.94-0.98), which suggests high diagnostic performance. The Higgins I2 statistic demonstrated that heterogeneity was present in the sensitivity (I2 = 50.69%) whereas no heterogeneity was noted in the specificity (I2 = 30.37%). In meta-regression, MRS sequence and TE were associated with study heterogeneity. Among the studies using PRESS, studies using long TE (97 ms) showed higher sensitivity (92% [95% CI, 85-99%]) and specificity (97% [95% CI, 92-100%]) compared to studies using short TE (30-35 ms) (sensitivity of 90% [95% CI, 79-100%], specificity of 88% [95% CI, 83-93%]) ($p < 0.01$).

CONCLUSION

2HG MRS demonstrated excellent diagnostic performance for prediction of IDH mutant glioma

CLINICAL RELEVANCE/APPLICATION

Further validation and applying 2HG MRS to daily practice would be critical in glioma management.

SSG10-07 Preoperative Determination of Isocitrate Dehydrogenase Mutation in Gliomas Using Multiparametric MRI

Tuesday, Nov. 27 11:30AM - 11:40AM Room: E353A

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PURPOSE

To predict preoperatively IDH1 mutant status in gliomas using a multiiparametric approach based on tumor volume, presence of 2-hydroxyglutarate (2-HG), dynamic contrast-enhanced (DCE) and intravoxel-incoherant motion(IVIM) derived parameters.

METHOD AND MATERIALS

Patients with a suspicion of a glioma were prospectively enrolled before surgical resection. Each patient underwent a conventional MR examination with the addition of a spectral editing MRS (MEGA-PRESS), DCE-MR and IVIM. Parameters for the MEGA-PRESS sequence were: TR=2000ms, TE=60ms, 64 acquistions, voxel size=8cm3, duration=4.5min. 2-HG of the substracted MEGA-PRESS spectra was analyzed using jMRUI v5.2. ROIs were manually drawn around the whole tumour volumes on conventional MR images and superimposed onto the IVIM and DCE-derived parametric maps to measure volume transfer constant (Ktrans), fractional volume of blood plasma in tissue (Vp), apparent diffusion coefficient (D), pseudodiffusion coefficient (D*), and perfusion fraction(f). Sensitivity and specificity for the prediction of IDH status were calculated using immunohistochemistry as the gold standard.

RESULTS

A total of 45 patients were enrolled: 10 patients with IDH+ gliomas (4 Grade II, 6 Grade III); 35 patients with IDH- gliomas (1 Grade I, 5 Grade III, 29 Grade IV). IDH+ gliomas showed lower enhancing and necrotic volumes but higher non-enhancing volumes. IDH+ gliomas had lower values for Ktrans and Vp. There was no statistically significant difference in the IVIM parameters between the two groups. For differentitation between IDH- and IDH+ gliomas, sensitivity and specificity were 33% and 95% respectively for 2-HG measured from MRS, 89% and 71% respectively from enhancing tumour volume using a cut-off<3640mm3, 89% and 93% for mean Ktrans using a cut-off<0.004min-1, 89% and 64% for mean Vp using a cut-off<0.083%.

CONCLUSION

IDH+ gliomas showed higher non-enhancing tumour volume and lower Ktrans and Vp than IDH- gliomas. The majority of our patients were high grade gliomas, which are less likely to be IDH+. This may have led to the finding that IDH-tumours appeared to have higher vascularity.

CLINICAL RELEVANCE/APPLICATION

IDH status in patients with suspected gliomas can be predicted preoperatively using a multiparametric method combining conventional MRI, MRS and perfusion imaging.

SSG10-08 Glioblastoma versus Cerebral Metastases: Differentiation Using a Radiomic Evaluation on Post-Contrast 3DT1 MR Images

Tuesday, Nov. 27 11:40AM - 11:50AM Room: E353A

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PURPOSE

To evaluate the diagnostic performance of magnetic resonance (MR) texture analysis in differentiating glioblastoma (GBM) from cerebral metastases (MET) on post-contrast 3 dimensional T1 weighted sequences (3DT1).

METHOD AND MATERIALS

140 patients (70 individuals with GBM > 2cm diagnosed between January 2013 and March 2018 and 70 with cerebral MET > 2cm diagnosed between August 2010 and March 2018) were enrolled in this retrospective bicentric study. All patients had post-contrast 3DT1 sequence acquired on 3T MRI (GE Discovery 750w) with the same protocol. Segmentation of all tumoral lesions was performed semi-automatically on Olea Medical software and 42 radiomic features were computed using LIFEx freeware. As a part of radiomics analysis, texture analysis is a method of extracting quantitative features that evaluate specifically the spatial arrangement of gray levels in a volume to obtain more information about tumor heterogeneity. Patients were separated in training and validation sets for statistical analysis. Univariate analysis was first performed to select the most informative radiomic features. A multivariate regression was then realized to construct and validate a model predicting lesion type. Area under ROC curves (AUC) and p-values from Wilcoxon's test were calculated to evaluate the performance of each classifier.

RESULTS

According to univariate analysis realized on the training set (GBM: N = 46, MET: N = 46), 6 textural features were statistically significant (p<0.00001, for 3 features; p<0.001, for 3 features). The mean AUC of the multivariate radiomics classifier combining 3 textural features from gray level zone-length and co-occurrence matrices was 0.854 (95% CI 0.77-0.93). These results are to be confirmed on the validation set which is still in process.

CONCLUSION

Texture analysis on post-contrast 3DT1 MR images is useful to differentiate cerebral MET and GBM. The implementation of this method for automatic characterization of tumoral lesions in clinical software would have a strong impact in the management of patients.

CLINICAL RELEVANCE/APPLICATION

Glioblastoma and cerebral metastases are the most frequent malignant brain tumors. Texture analysis is an objective tool to differentiate these 2 diseases which have different therapeutic strategies.

SSG10-09 Deep Learning-Based Analysis of Quantitative MRI Features to Identify IDH-Mutant Glioblastoma Multiform

Tuesday, Nov. 27 11:50AM - 12:00PM Room: E353A

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PURPOSE

Glioblastoma multiforme (GBM) is the most common primary brain tumor in adults and carries a poor prognosis with a median survival of less than 2 years. Recent studies have shown that GBMs harboring mutations in isocitrate dehydrogenase (IDH) are associated with improved survival, and may benefit from maximal resection including the non-enhancing tumor component. Unfortunately, IDH status is sometimes only available after resection. The purpose of this study is to evaluate quantitative MRI based imaging features that can be used to identify IDH-mutant GBMs on preoperative imaging.

METHOD AND MATERIALS

We analyzed preoperative MR images from 13 patients with pathologically proven IDH-mutant GBMs and 99 patients with IDH-wildtype GBMs. The MRI protocol included T1, T2, FLAIR, and post-contrast T1 images, in addition to 55-direction diffusion tensor imaging. A convolutional neural network-based deep learning algorithm was used to generate automated volumetric segmentation of the three key components of GBM that are seen on MRI: enhancing tumor core, non-enhancing tumor, and necrosis. Tumor compartment volume fractions and DTI parameter values were compared between IDH-mutant and wildtype GBMs.

RESULTS

IDH-mutant GBMs demonstrated lower enhancing tumor fraction compared to wildtype GBMs, as well as lower volume ratios of enhancing to non-enhancing tumor and enhancing tumor to necrosis ($p < 0.05$ with Bonferroni correction). IDH-mutant GBMs also had higher average apparent diffusion coefficient within the necrotic region, consistent with the clinical observation that these tumors often have heterogeneous and/or cystic non-enhancing components; however, this difference was not significant after Bonferroni correction.

CONCLUSION

In this small retrospective study, IDH-mutant GBMs demonstrated statistically significant differences in enhancing tumor fraction compared to IDH-wildtype GBMs. These findings are in line with the theory that IDH-mutant GBMs represent secondary GBMs that develop from lower grade gliomas. Our work suggests that deep-learning based quantitative image analysis may be useful for distinguishing IDH-mutant GBMs on preoperative imaging.

CLINICAL RELEVANCE/APPLICATION

IDH-mutant GBMs are associated with increased survival and may benefit from maximal resection. Analysis of unique imaging features may help radiologists identify this tumor type on preoperative MRI.

SSG11

Neuroradiology (Molecular Neuroimaging: From Diffusion to Beyond)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: E351

MR MI 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

SSG11-01 Subtype Diagnosis in Sporadic Creutzfeldt-Jakob Disease with Diffusion Magnetic Resonance Imaging: A Study of 706 Patients with Definite Pathology

Tuesday, Nov. 27 10:30AM - 10:40AM Room: E351

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PURPOSE

The two aims of this study are i) to measure DWI diagnostic reliability and compare it with that of CSF tests (i.e. RT-QuIC, 14-3-3 and tau); ii) to build a decision algorithm to diagnose sCJD subtypes using the MRI lesion profile obtained by DWI without and with codon 129 polymorphism (obtained with a blood test).

METHOD AND MATERIALS

A total of 1212 patients were recruited in this prospective study as part of a MRI consulting program. At autopsy the diagnosis of sporadic Creutzfeldt-Jakob disease (sCJD) was confirmed in 556 and ruled out in 150 patients. 506 patients were excluded because they are still alive or were lost to follow-up. A neuroradiologist blind to the diagnosis scored the DWI. A semi-quantitative method based on a four-point (0-3) ordinal scale was implemented to grade the hyperintensities of the DWI in 12 specific brain regions.To assess the inter-rater reliability (IRR) of the scoring system, other two neuroradiologists blind to final diagnosis scored DWI of 150 subjects. We measured the DWI diagnostic reliability in 706 patients, then we compared it with those of CSF tests in a subset of 399 patients (339 sCJD and 60 non prion) that had undergone MRI, 14-3-3 and tau tests. To predict the sCJD subtype with the MRI lesion profile, we built an algorithm in the form of a decision tree.

RESULTS

The overall diagnostic reliability of DWI in 706 patients was 0.94 sensitivity and 0.97 specificity. The IRR among the three neuroradiologists was excellent (above 0.80) in 10 over 12 brain regions. Furthermore, in the subset of 399 patients the sensitivity and specificity of DWI (0.94 and 0.97) surpassed those of 14-3-3 (0.84 and 0.34) and tau (0.87 and 0.63). The decision algorithm produced 9 distinct MRI phenotypes that characterized the five sCJD pure subtypes. Key steps in the algorithm are the presence of DWI hyperintensity in the neocortex, striatum, thalamus and cerebellum. The accuracy in predicting the correct subtype was about 0.62 and increased to 0.90 if the codon 129 polymorphism was considered.

CONCLUSION

Diagnostic reliability of MRI for the early diagnosis of sCJD is excellent. The study also provides the neurologists with a diagnostic algorithm for subtype identification at the patient's bedside.

CLINICAL RELEVANCE/APPLICATION

Diffusion MRI is an excellent test for diagnosis of sCJD. Subtype diagnosis with MRI may help to determine prognosis and direct therapies when they will become available.

SSG11-02 Comparative Analysis of Diffusion Kurtosis Imaging, Diffusion Tensor Imaging, and Diffusion

Weighted Imaging in Grading and Assessing Cellular Proliferation of Meningiomas

Tuesday, Nov. 27 10:40AM - 10:50AM Room: E351

Participants
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PURPOSE

To prospectively evaluate and compare diffusion kurtosis imaging (DKI), DTI and DWI metrics in determining the grade and cellular proliferation of meningiomas.

METHOD AND MATERIALS

Consecutive 96 patients with histopathologically confirmed meningiomas were included in this study. Mean kurtosis (MK), radial kurtosis (Kr), axial kurtosis (Ka), fractional anisotropy (FA), mean diffusivity (MD), and ADC were semi-automatically obtained in the solid components of tumors. Each normalized diffusion value was compared between high-grade meningiomas (HGMs) and low-grade meningiomas (LGMs) by using the Mann-Whitney U test. Receiver operating characteristic, multiple logistic regression, and Pearson correlation analysis were used for statistical evaluations.

RESULTS

DKI metrics (MK, Kr, and Ka) were significantly higher in HGMs than in LGMs ($P <= .001$). MD and ADC were significantly lower in HGMs than in LGMs ($P < .003$, and $= .002$). MK had significantly greater area under curve values than MD and FA in differentiating HGMs from LGMs ($P = .038$, and $.002$). MK was the only variable that could be used to independently differentiate HGMs and LGMs ($P < .001$). Significant correlations were found between Ki-67 labeling index and kurtosis metrics ($P < .001$), as well as for MD and ADC ($P = .004$, and $.007$).

CONCLUSION

In conclusion, diffusion techniques, including DKI, DTI and DWI, were useful in grading meningiomas. Moreover, MK demonstrated a better diagnostic efficiency than DTI metrics and was most closely associated with the grade of meningiomas. In addition, diffusion metrics showed great potentials in reflecting the cellular proliferation of meningiomas.

CLINICAL RELEVANCE/APPLICATION

Compared with other diffusion metrics, MK may serve as an optimal parameter for evaluating and predicting the grade of meningiomas. Moreover, diffusion metrics may potentially reflect the cellular proliferation.

SSG11-03 Event-Based Model of Diffusion MRI Shows that sCJD Strains Have Similar Epicenter but Different Lesion Propagation in the Brain

Tuesday, Nov. 27 10:50AM - 11:00AM Room: E351

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PURPOSE

Sporadic Creutzfeldt-Jakob (sCJD) is a very heterogeneous prion disease with five subtypes or strains that have different clinical presentation and survival times. We tested the hypothesis that different subtypes have different path of lesion propagation in the brain. This study aimed at modeling the DWI signal abnormalities spreading in 5 pure strains, in order to determine the epicenter (starting point) and the sequence of propagation of prion lesions in 12 brain regions.

METHOD AND MATERIALS

We considered a novel data-driven model, the event-based model (EBM), recently introduced to study the evolution of Alzheimer's and Huntington's diseases. The EBM describes the disease progression as a sequence of events, defined as the switching from a normal to an abnormal state for a biomarker of a patient. Considering a set of 12 events related to the appearance of DWI hyperintensity in 12 specific brain regions, the EBM finds the most likely sequence of DWI abnormalities given the observed DWI measurements of the subjects. A neuroradiologist blind to the pathological diagnosis visually scored the DWI of 306 patients with definite autopsy diagnosis of sCJD subtype and 123 patients with rule-out diagnosis of prion disease. An ordinal scale (0-3) was implemented to visually score the images and grade the DWI hyperintensities in 12 brain regions. Patients with 5 sCJD pure subtypes were included: MM/MV1 (n=89), MM/MV2C (n=42), MV2K (n=22), VV1 (n=15) and VV2 (n=49). The EBM sequences were based on cross-sectional data and their longitudinal consistency was validated comparing the stages at follow-ups with the baseline.

RESULTS

Results showed that the 5 sCJD strains have different sequence of lesion propagation. The anterior cingulate cortex was affected very early in all strains. Then, three propagation trajectories emerged from the orderings: neocortex is affected before striatum in MM/V1 and MM/V2C; striatum is affected before neocortex in VV2 and MV2K; limbic regions are affected before neocortex and striatum in VV1.

CONCLUSION

The EBM is a good model to determine DWI signal abnormality propagation in the brain. The 5 main sCJD strains share the epicenter but have a different path of lesion propagation in the brain.

CLINICAL RELEVANCE/APPLICATION

EBM provided for the first time data-driven models of spreading of DWI signal hyperintensities in sCJD subtypes. This result may have an impact on patient management and clinical trials.

SSG11-04 Q-Space Trajectory Imaging to Untangle the Source of Microstructural Abnormalities in Schizophrenia Subjects

Tuesday, Nov. 27 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

To untangle the microstructural sources of white matter abnormalities that are commonly identified in schizophrenia patients by using q-space trajectory imaging (QTI) that separates abnormalities into three microstructural domains: orientation coherence (Cc), size variance (CMD) and microscopic anisotropy (Cμ).

METHOD AND MATERIALS

QTI was measured with tensor-valued diffusion encoding (b-tensors), using non-conventional gradient waveforms, on a 3T MAGNETOM Prisma scanner (Siemens Healthcare GmbH). b-tensors were shaped as sticks, planes and spheres (b=0, 50, 250, 500, 1000, and 2000 s/mm2), totaling 95 volumes. Resolution was 2x2x4 mm3, 35 slices, TE=145ms, TR=6500ms, in 12:54 minutes. Participants were 21 inpatient subjects suffering from SZ (4F/17M; mean age 34.9), and 18 controls (4F/14M; mean age 32.6). All participants provided informed consent, and the study was approved by the local institutional review board. The QTI analysis yielded four measures: Cμ , Cc, CMD and macroscopic anisotropy (CM) which is proportional to Diffusion Tensor Imaging (DTI) Fractional Anisotropy (FA). Images were registered to MNI space and FA was used to extract the white matter skeleton, on which the four measures were projected, averaged and group compared using a general linear model with age and gender as covariates.

RESULTS

Significantly lower FA (p=0.038) in SZ subjects was explained by a significant decrease in microscopic anisotropy, Cμ. Differences in orientation coherence, Cc, were not significant (p=0.445), and an increase in size variance, CMD, did not reach significance threshold (p=0.115).

CONCLUSION

We disentangle DTI's FA differences into three domains, showing that the reduction of FA is best explained by a reduction of microscopic anisotropy in white matter rather than increased orientation dispersion, or size variability. Since microscopic anisotropy describes the shapes of microenvironments, regardless of orientation (e.g., dispersion), macroscopic arrangement (e.g., crossing fibers), and size variability (e.g., partial volume) our results suggest that in this population of SZ patients the microstructural shape of white matter is altered, which supports an interpretation of axonal degeneration or demyelination.

CLINICAL RELEVANCE/APPLICATION

Untangling microstructural abnormalities helps identifying underlying pathologies in brain disorders with potentially co-occurring pathologies such as schizophrenia.

SSG11-05 Diffusion Tensor Imaging of Human Optic Nerve Observes Gaze Evoked Changes

Tuesday, Nov. 27 11:10AM - 11:20AM Room: E351

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PURPOSE

Several disorders affect the optic nerve (ON) that are potentially life- and sight threatening. Disorders such as papilledema and ischemic optic neuropathy result in changes to the peripapillary basement membrane caused by ON abnormalities; changes are

known to vary with eye position. DTI allows for non-invasive in vivo assessment of ON structural integrity, providing useful information in the manifestation, progression and recovery of several disorders. This information may detect pathological changes earlier than established methods such as optical coherence tomography (OCT).

METHOD AND MATERIALS

Eight healthy participants were recruited for this IRB approved study on a Siemens Prisma 3T magnet using a single channel loop coil placed over the left eye. A zoom-RESOLVE DTI acquisition was developed to image the ON. The total acquisition time was ~2 min for 20 diffusion directions with b = 800s/mm2. Each subject was imaged with visual fixation at three locations; primary position, ~20° abduction and ~20° adduction. Three repetitions were acquired at each gaze with ~30 sec rest between scans. Structural bSSFP images with 0.8mm3 isotropic resolution were acquired at each visual fixation for planning of each DTI acquisition. DTI data was processed using DSI studio to calculate RD, AD and FA maps. ON regions of interest were automatically calculated for each DTI acquisition using a previously developed method by Spees et al.

RESULTS

Compared to primary, abduction resulted in 15.5%, 10.6%, 12.9% and 0.7% increases in RD, AD, MD and FA respectively. Adduction compared to primary position resulted in 16.6%, 8.8%, 14.3% and 1.7% increases in RD, AD, MD and FA respectively. Compared to abduction, adduction resulted in 1.0%, -1.6%, 1.2% and 1.7% increases in RD, AD, MD and FA respectively.

CONCLUSION

A zoom-RESOLVE DTI method was used to investigate gaze evoked changes in ON DTI parameters. Previous MRI of the ON suggested that the ON sheath is the principal load bearing structure in adduction. This study suggests that some of this strain is also transferred to the ON itself. Gaze evoked changes in diffusion characteristics have the potential to assess diseases that affect the ON.

CLINICAL RELEVANCE/APPLICATION

Gaze evoked changes in diffusion characteristics have the potential to assess diseases that affect the optic nerve before the manifestation of ocular anatomical changes observed in OCT.

SSG11-06 Multi-Center Study Demonstrates Radiomic Texture Features Derived from MR Perfusion Images Predict Pseudoprogression from True Progression in Glioblastoma Patients

Tuesday, Nov. 27 11:20AM - 11:30AM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

To differentiate between pseudoprogression and true progression in patients with glioblastoma using MR perfusion radiomic texture analysis (TA)

METHOD AND MATERIALS

98 patients with pathologically-proven diagnosis of GBM were retrospectively included in this IRB approved HIPAA compliant study. All patients underwent DSC and DCE Perfusion MRI as part of their routine clinical care. Images were analyzed using Nordic ICE 2.3 (NordicNeuroLab) ; rCBV and ktrans maps were obtained. Subsequently, 3D slicer 4.3.1(http://www.slicer.org) was used to segment the entire tumor on the different processed maps to create a volume of interest (VOI) for Radiomic TA. Multiple invariant texture features where then extracted from each VOI. 310 invariant texture features were applied to each map. Radiomic texture features selection was performed using Maximum Relevance Minimum Redundancy (mRMR) feature selection method to narrow down the feature count to the top few hundred features. Two different supervised learning algorithms were evaluated in this analysis for classification and predictive model building, namely Support Vector Machine (SVM) and decision tree algorithm (C5.0). Cross validation was performed using the Leave One Out Cross Validation (LOOCV) approach for the SVM method, and k-fold cross validation (k=10) for the C5.0 method to see if the best model obtained had high accuracy, sensitivity and specificity to descriminate between pseudoprogression and true progression patients

RESULTS

We achieved an accuracy of 90.82% (AUC 89.10%, sensitivity 91.36%, specificity 88.24%, p-value 0.017), when using 60 out of 620 radiomic features obtained from both Ktrans and rCBV pharmacokinetic maps coupled with SVM,Variance and sum entropy were the two most significant radiomic features that discriminated between pseudoprogression and true progression.

CONCLUSION

Radiomic TA derived from perfusion images can be helpful in determining true versus pseudoprogression in GBM. Further, this study illustrates successful application of radiomic TA as an advanced processing step for different MRI perfusion maps (DCE, DSC)

CLINICAL RELEVANCE/APPLICATION

MR perfusion radiomics texture analysis (TA) as a potential noninvasive imaging surrogate to differentiate between True and pseudo progression in glioblastoma

SSG11-07 Reproducibility of Hadamard Encoded Multi-Delay 3D pCASL

Tuesday, Nov. 27 11:30AM - 11:40AM Room: E351

Participants
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PURPOSE

Arterial spin labeling (ASL) can be confounded by varying arterial transit times (ATT) across the brain and with disease. In this study, a Hadamard encoding scheme was used to acquire multiple post-labeling delays (PLD), which were used to estimate ATT and corrected CBF. The goal of this study was to assess the reproducibility of this sequence in a set of normal volunteers to be able to apply it to clinical patients.

METHOD AND MATERIALS

Imaging was performed on 31 healthy male subjects at 4 time points (TPs) over 45 days. An 'enhanced' 3D pCASL (eASL) sequence was acquired with seven delays (1.0-3.3s) using Hadamard encoding. A long (4.0s) labeling block was divided into 7 sub-boluses with control and label sub-boluses corresponding to the Hadamard matrix. Images for each delay were extracted using a linear combination of the eight images. T1-weighted anatomical images were acquired for registration. Uncorrected flow (Flow) was obtained by averaging the delay images. ATT and corrected flow (cFlow) were also computed. Mean gray matter reproducibility was analyzed using the within and between subject coefficient of variation (wCV and bCV) and the repeatability coefficient (RC).

RESULTS

Mean cFlow was significantly higher than Flow (56.3±6.9 vs. 47.5±6.9 mL/100g/min, $p<10^{-6}$). Mean ATT was 1335±62 ms. wCV was significantly lower for cFlow compared to Flow (0.079±0.038 vs. 0.089±0.047, $p=0.005$) and for TD (0.029±0.015) compared to Flow and cFlow ($p<10^{-7}$). bCV followed a similar trend, but was higher compared to wCV (0.142±0.018, 0.121±0.011, 0.046±0.010 for Flow, cFlow, and TD respectively). The RC, normalized to the mean, was 0.300, 0.255, and 0.092 for Flow, cFlow, and ATT respectively.

CONCLUSION

wCV was less than 10% for the majority of subjects, and was lower than bCV indicating eASL is a robust tool for measuring changes in CBF and ATT over time. Corrected CBF was more reproducible compared to uncorrected CBF. ATT was very repeatable with wCV and bCV less than 5 percent.

CLINICAL RELEVANCE/APPLICATION

Corrected CBF and ATT can be measured with eASL in the same scan time as traditional ASL acquisitions. These metrics are stable across time allowing for changes over time to be reliably evaluated.

SSG11-08 Multi-Shell-Multi-tissue Gray Matter-Based Spatial Statistics: A Framework for Voxel-Wise Gray Matter Microstructure Analysis

Tuesday, Nov. 27 11:40AM - 11:50AM Room: E351

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Indices derived from emerging multi-shell diffusion weighted-based modeling techniques (e.g., NODDI) can be used to assess gray matter (GM) microstructure. Accurate tissue segmentation and between-subject registration are critical steps for optimal voxel-wise/vertex-wise analysis of these indices to localize changes related to brain development and disease. Most current methods rely on tissue segmentation of structural images followed by fine registration between diffusion-weighted and structural images, which suffer from poor between-modality registration. In this study, we used multi-shell multi-tissue constrained spherical deconvolution (MSMT-CSD, for accurate single-step tissue segmentation of diffusion images) followed by GM-based spatial statistics (GBSS, for between subject registration) and present example results from voxel-wise heritability analysis on Human Connectome Project (HCP) data.

METHOD AND MATERIALS

After quality control, data from 600 healthy adult participants in HCP (S900 release) with [illegible] multi-shell diffusi

After quality control, data from 689 healthy adult participants in HCP (S900-release) with the complete set of multi-shell diffusion-weighted MRI were used. Orientation dispersion (ODI) and neurite density indices (NDI) were generated using the NODDI toolbox for all brain voxels. Diffusion-weighted images were segmented using MSMT-CSD (MRtrix). GBSS was performed to generate skeletonized maps of GM neuritic indices. Voxel-wise heritability analyses were performed using the Fast and Powerful Heritability Inference (FPHI) toolbox with threshold-free clustering. To further scrutinize GM regions with highly significant heritability, hard-threshold-based clustering was performed at uncorrected-P<0.01.

RESULTS

GM-ODI showed high heritability across the cortex, hippocampi, and amygdalae (FWE-P<0.0001), with both amygdalae surviving secondary more conservative clustering. In contrast, no significant GM-NDI heritability was observed.

CONCLUSION

We demonstrated successful implementation of a new framework for voxel-wise analysis of gray matter microstructure. Across the "healthy GM" spectrum, GM-ODI is significantly affected by genetic factors. Our results suggest that GM-ODI can serve as a candidate in studies of neural endophenotypes underlying the heritable pathology of brain disorders and GM-NDI may be considered as an environmentally-modifiable treatment target for neuropsychiatric traits.

CLINICAL RELEVANCE/APPLICATION

MSMT-GBSS can improve localization of gray matter microstructural variations in health and disease.

SSG11-09 Intrinsic Diffusivity Encoding of Arterial Labeled Spins (IDEALS) for Whole Brain Water Permeability Mapping with MRI

Tuesday, Nov. 27 11:50AM - 12:00PM Room: E351

Awards
Student Travel Stipend Award

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PURPOSE

Blood-brain barrier (BBB) disruption has been linked to multiple neurological diseases and psychiatric disorders. Water molecules are several times smaller than most exogenous contrast agents and transcapillary water exchange is mainly facilitated by active, transcellular transport mechanisms. As such, BBB water permeability, extraction fraction (Ew) and permeability-surface area product (PSw), could provide a more sensitive assessment of BBB dysfunction. Here we propose a novel MRI-based approach, Intrinsic Diffusivity Encoding of Arterial Labeled Spins (IDEALS), to non-invasively map whole-brain BBB water permeability.

METHOD AND MATERIALS

In IDEALS, intra and extravascular labeled water after pCASL preparation are separated by the intrinsic diffusion sensitivity of the segmented 3D-GRASE acquisition that manifests as a point spread function (PSF) in the image domain. The PSFs differ for intra and extravascular labeled spins and are highly dependent on the segmentation scheme. The PSFs were estimated using augmented extended phase graphs and the extravascular signal fraction was estimated by deconvolution. Two post-labeling delay (PLD) values were adopted. A PLD of 2sec was used to estimate cerebral blood flow (CBF), Ew after T1 correction of the extravascular signal fraction, and PSw according to the Renkin-Crone equation. A PLD of 1sec was used to calculate the arterial transit time (ATT). Ten healthy participants were recruited for this IRB approved study. All studies were performed on a Siemens 3T MRI. Total acquisition time was 15min for 4 sets of ASL images; 2 PLDs and 2 segmentation schemes.

RESULTS

Gray matter averages were 1.39sec, 55.7mL/100g/min, 85.8%, and 112.9mL/100g/min for ATT, CBF, Ew, and PSw respectively. White matter averages were 1.47sec, 41.3mL/100g/min, 87.4%, and 84.5mL/100g/min for ATT, CBF, Ew, and PSw respectively. Both Ew and PSw values are in good agreement with PET-based measurements.

CONCLUSION

Encouraging initial results using IDEALS was reported in this study. This novel approach provides whole-brain BBB water permeability maps at comparatively high spatial and temporal resolutions without a MRI contrast agent.

CLINICAL RELEVANCE/APPLICATION

BBB breakdown has been hypothesized as a key mechanism in neurological and psychiatric diseases. The proposed noninvasive method, IDEALS, allows for repeated measurement of BBB integrity without the potential side effects of gadolinium-based contrast agents.

SSG12

Physics (CT: Radiation Dose)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S404CD

CT PH SQ

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

Participants
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Sub-Events

SSG12-01 Radiation Dose from Cone Beam CT in SPECT/CT Examinations

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S404CD

Participants
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CONCLUSION

The CBCT scan may result in higher radiation dose, even exceeding the dose from conventional MDCT scan. Using lower x-ray tube current allowed 3.8-fold dose reduction without clinically significant degradation of image quality. The DLP method provided good estimate of patient effective dose.

Background

Hybrid imaging modalities provide anatomic and functional information improving diagnostic accuracy but also increase patient radiation dose. Combining a cone beam CT (CBCT) with SPECT may result in high radiation exposure due to lack of tube current modulation. The purpose of our investigation was to assess radiation dose for clinical CBCT protocols as part of SPECT/CT examinations and to evaluate dose reduction options.

Discussion

Effective doses calculated from the measurements were 4.21 mSv and 1.11 mSv for 20 mA and 5 mA respectively. The DLP method resulted in very similar values with the differences of 0.05% at 20 mA and 4.76% at 5 mA. With lower tube current image noise was increased by 35%. That was found acceptable for localization and attenuation correction of SPECT data.

SSG12-02 Strategy and Results for Characterization of Dose Outliers in CT Dose Monitoring: Analysis Across 84683 Patient Studies

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S404CD

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PURPOSE

The Joint Commission mandates monitoring of individual patient doses from CT and investigation of outliers. The mechanics of this process was left for the institution to determine. This study presents a novel strategy to identify and characterize dose outliers in a large academic medical center.

METHOD AND MATERIALS

With IRB approval, for the calendar year of 2016, 84,683 CT exams were recorded in an in-house dose monitoring program. For each protocol using AEC, radiation dose and patient diameter was fitted to an exponential relationship. The dose value from the fitting for a patient was considered to be ideal for the given diameter. A patient with higher than 99%ile dose for his/her diameter was flagged as a dose outlier. To streamline the severity of over-dosing and thus prioritizing the investigation of outliers, a dose

deviation index (DDI) was calculated for each outlier as the ratio of received dose and ideal dose minus one. All outliers were investigated by two senior CT technologists by carefully examining the techniques and images. The CT physicist then categorized the found reasons and tagged each outlier with all reasons applicable to that case.

RESULTS

Over 50% of the dose outliers had a DDI between 1-2. A total of 18 different reason categories were identified. Out of the 661 dose outliers, about half were due to multiple accession number grouped together due to dose values extracted from screenshot of the dose reports, a problem resolved when radiation dose structure report can be used in the dose monitoring report. Another common reason for high dose (25%) was correlated with use of high kV, rotation time, or both with extra-large patients. Wrong positioning including patients unable to raise their arms (13%) was the third common issue.

CONCLUSION

A strategy was devised to survey patient CT dose and characterize the dose outliers. The identified categories are representative reasons of high radiation dose in CT imaging, and can be used as reference reasons for the community. The tagged data set can further be used as a training set for machine learning algorithm to automatically characterize the outliers in the future.

CLINICAL RELEVANCE/APPLICATION

A strategy was devised to survey large scale patient CT dose, identifying dose outliers, and characterize the outliers. The identified categories are representative reasons of high radiation dose in CT imaging, and can be used as reference reasons for the community.

SSG12-03 A Data-Centric Strategy for Developing CT Dose and Noise Reference Levels from Clinical Patient Populations

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S404CD

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PURPOSE

To develop a data-centric strategy solution for developing CT dose and noise reference levels across large clinical patient populations and in CT scanners.

METHOD AND MATERIALS

This IRB-exempt study evaluated CT abdominopelvic (AP)-related examinations performed in 2017 by 22 scanners from two vendors with 11 models in 3 site hospitals. An in-house developed informatics system automatically extracted protocol information, patient size (cross-sectional diameter), dose, and in vivo noise magnitude within images. Protocol nomenclature categorization was performed using a decision tree machine learning algorithm. Four reference patient size intervals were identified: 13-20, 20-30, 30-40, and 40-50 cm. Noise Reference Level (NRL), Noise Reference Range (NRR), Dose Reference Level (DoRL), and Dose Reference Range (DoRR) were defined for each size range as the median and interquartile interval of noise and dose, respectively.

RESULTS

60,000 CT AP studies with 64 different convolution kernels for patients ages 0-70 and sizes 13-48 cm were identified. NRLs ranged between 15.8 to 18.4 HU with NRRs for the four size ranges were the following: 13.2-24.7,12.6-22.5,12.5-23.2, and 12.1-22.8 HU. DoRLs ranged within 11.9-16.1 mGy. The four DoRRs were 9.5-21.4,7.9-17.3,9.9-21.3, and 10.8-23.2mGy.

CONCLUSION

This study offers the first even data-crunching solution for developing CT dose and noise reference levels using clinical patient data. New reference levels and ranges simultaneously consider image noise and radiation dose information across patient populations. The new metrics enables prospective optimization of clinical practice to maximize the imaging benefit and patient safety.

CLINICAL RELEVANCE/APPLICATION

A new solution is introduced for simultaneously defining image quality and dose reference levels across different patient body habitus. The methodology enables prospective optimization of clinical practice to maximize the imaging benefit and patient safety.

SSG12-04 Does the Dose Reduction Associated with a Percentage Increase of a CT Statistical Iterative Algorithm Maintain the Detectability of Low-Contrast Details? A Phantom Study

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S404CD

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PURPOSE

To verify if the dose reduction combined with increasing percentages of the ASIR-V algorithm was associated with a maintenance of detectability of low contrast details in the abdominal area.

METHOD AND MATERIALS

An anthropomorphic chest and abdomen phantom containing a liver equivalent insert with details of 10 HU relative contrast was repeatedly scanned with a GE Revolution CT equipment. Given a fixed level of noise index (18 HU combined with a thickness of 1.25 mm), the images were acquired without iterative algorithm and with percentages of ASIR-V of 30%, 50% and 70%. The correspondent dose reductions determined by the tube current modulation system were 48%, 67% and 83%, respectively. The same images were then reconstructed using only FBP, at an ASIR-V percentage of 0%. Five radiologists evaluated randomized image data sets with and without details, scoring the lesion presence on a five-point diagnostic confidence scale and the area under the roc curve (AUC) was calculated as figure of merit. The human observer results were then compared with AUC obtained with a Channelized Hoteling Observer (CHO). CNR values were also measured.

RESULTS

For human observer, AUC values were in the range 0.90-0.93 for images acquired without ASIR-V and with percentages of 30% and 50%, whereas with ASIR-V at 70% the AUC decreased significantly to 0.81. Diagnostic accuracy for FBP reconstructed images were always inferior to ASIR-V images, with an AUC decrease between 6 and 9%. The behaviour of the CHO was coherent with human observer results, with lower AUC differences between FBP and ASIR-V images (from 2 to 6 %). CNR values were stable for the different ASIR-V percentages, confirming the right functionality of the current modulation system, whereas progressively decrease with dose for FBP reconstructed images.

CONCLUSION

The iterative ASIR-V algorithm maintained low contrast detectability and the diagnostic accuracy up to a dose reduction of 67%, consequent to the application of a 50% level with automatic tube current modulation. At further dose reductions with greater iterative percentages, a significant decrease of detectability and diagnostic accuracy was observed.

CLINICAL RELEVANCE/APPLICATION

Prior to define the iterative level combined with dose reduction in a clinical protocol, the maintenance of low contrast detectability must be verified with ROC studies done with human or model observers.

SSG12-05 Effective Dose for Computed Tomography in Large, Clinical Populations

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S404CD

Awards
Student Travel Stipend Award

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PURPOSE

Effective dose can efficiently integrate multiple organ dose values into a singular scalar value of radiation dose. The effective dose can also be calculated using dose length product (DLP) to effective dose conversion coefficients. The purpose of this study was to compare the results from these two methods across a large clinical population.

METHOD AND MATERIALS

This IRB-approved study included 579 chest and 247 abdominopelvic exams from two scanners. The organ doses were estimated based on an established Monte Carlo method. Each patient was matched to an XCAT anthropomorphic phantom of the same anatomical height. Precomputed Monte Carlo data were then applied along with adjustments for tube current modulation and patient size. A bias correction factor was also applied to each organ dose to calibrate the organ doses to validated ground truth dose values. The effective dose of each exam was calculated using both dose-length-product based (EDk) and organ-dose-based (EDOD) methods. The EDk was estimated by extracting the DLP and DLP-to-effective dose conversion coefficients defined by ICRP 102. The EDOD was derived using the patient-informed organ doses from the exam using ICRP 103 weighting factors. The EDk was compared to EDOD and CTDIvol.

RESULTS

For the abdominopelvic protocol, EDk was > EDOD by 80.2±48.7% on average (min: -28%; max: 235%; median: 75%). For the chest protocol, EDk was > EDOD by 64.1±33.1% on average (min: -18%; max: 191%; median: 60%). EDk was highly influenced by mean CTDIvol (abdominopelvic: R=0.9692, chest: R=0.9557). EDk was higher than EDOD, especially for larger patients (abdominopelvic: 9.6%, 66.2%, and 115.6% higher; chest: 30.2%, 77.9%, and 116.2% higher on average for patients with 22, 30, and 35 cm water equivalent diameters, respectively). This can be attributed to the contribution of doses absorbed by remainder tissue in EDk calculations.

CONCLUSION

In this work, we compared the effective dose calculated using DLP-based methods versus those based on organ dose. The result showed that DLP methods may over-estimate effective dose, especially for larger patients

CLINICAL RELEVANCE/APPLICATION

This clinical cohort study showed the substantial differences of effective dose estimated using DLP vs. organ-dose-based methods. This effect is more prominent for larger patients. The study indicates that radiation dose monitoring and reporting could benefit from accurate and robust organ dose estimation.

SSG12-06 Addressing Limitations of the ACR DIR Patient Size Measurement Method

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S404CD

Participants
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PURPOSE

AAPM Reports 204/220 reported the relationship between patient size surrogates and normalized dose coefficients (NDC) needed for size-specific dose estimates (SSDE). When localizer radiographs are used to calculate SSDE then a magnification correction should be applied. In this study, we demonstrate a new patient-model based magnification correction on patient data. We also discuss limitations to thresholding based size measurements for bariatric and pediatric patients.

METHOD AND MATERIALS

We analyzed 573 patient scans obtained from a clinical CT system under IRB approval. There were 229 adult abdomen, 284 adult chest, 48 pediatric abdomen, and 12 pediatric chest exams. We extracted LAT and AP dimensions from CT localizers using the ACR DIR method and a connected component analysis to extract gold standard LAT and AP dimensions from axial CT images. We extracted table height from the DICOM header. We applied the model-based magnification correction to the AP and LAT dimensions from the localizers. We used the equation from AAPM Report 204 to calculate the NDC. 'Gold' standard NDC values were derived using effective diameter measurements from axial CT images. We plot the NDC for our model-based correction and ACR DIR method as a function of the gold standard NDC values.

RESULTS

NDC estimates for the model-based approach have excellent correlation (R2 = 0.92) with the gold standard approach. On average, effective diameter for the ACR DIR and model-based methods are 8.0% and 1.0% greater than the gold standard, respectively. Outlier cases were noted caused by patient truncation, arms down or devices on patients. ACR DIR size extraction method failed for small patients due to the CT couch being included in the size measurement and bariatric patients were underestimated as some of their anatomy was classified as belonging to the CT couch and thresholded away.

CONCLUSION

The model-based magnification method gives an accurate estimate of effective diameter needed for calculating NDC to achieve accurate SSDE. We discuss errors associated with threshold based size methods for very small and very large patients.

CLINICAL RELEVANCE/APPLICATION

We demonstrate how thresholding based size methods, like those used by the ACR DIR fail for very small and very large patients.

SSG12-07 Characterization of Radiation Risk across a Clinical CT Patient Population: Comparison across 12 Risks Metrics

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S404CD

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PURPOSE

Ascertaining radiological procedure radiation burden is essential for justification, optimization, and personalization of the procedure. While the exact radiation risk for an individual exam is unknowable, various risk-related figures have been used as surrogates, e.g., device output metrics such as CTDI, DLP, SSDE, and hypothetical constructs such as Effective Dose (ED) and Risk Index (RI) that take into account specific organ risks, age, and gender factors. Purpose of this study was to compare how twelve different radiation risk metrics characterize the radiation burden across a set of clinical CT examinations differently.

METHOD AND MATERIALS

This IRB-approved study included 265 abdominopelvic exams with contrast. Organ doses were estimated using Monte Carlo methods. The following risk metrics were calculated using previously validated methods: CTDIvol, DLP, SSDE, DLP-based ED (EDk), organ-dose-based ED (EDOD), dose to a defining organ (ODD to stomach), organ-dose-based RI (RI), and RI for a reference 20 y.o. patient (RIr). Additional metrics of ODD,0, ED0, and RI0 were calculated for a reference patient (ICRP 110). Lastly, inspired by the ICRP, an adjusted ED (ED') was computed as the product of RI/RIr and EDOD. A linear regression was applied to each metric dependency to the patient water equivalent diameter (WED). Fit slopes (FS) and relative interquartile ranges (rIQR) at 30 cm reference WED were calculated and normalized to those of RI, which was assumed to be the actual patient risk closest surrogate.

RESULTS

Results showed significant differences between the metrics. EDOD exhibited closest concordance with RI, followed by ODD. Normalized FS ranged between 0.99 (ED') to 2.24 (DLP), and normalized rIQR ranged between 0.30 (DLP) to 4.03 (ED').

CONCLUSION

Different risk metrics lead to different characterization of population risk, particularly risk overestimation for large patients and underestimation for small patients. Furthermore, the risk variability across a population is underestimated for most variables except ED', which exhibits more variability and radiation risk individualization. Care should be exercised in drawing risk predictions from unrepresentative risk metrics applied to a population.

CLINICAL RELEVANCE/APPLICATION

Different risk metrics can lead to different risk predictions. There is a need to standardize risk metrology for proper justification and optimization of radiological procedures.

SSG12-08 Effect of Simulated Micro-Dose (mD) CT on the Performance of Neural Network Convolution (NNC) Deep-Learning (DL) In Radiation Dose Reduction in Chest CT

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S404CD

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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 investigate the effect of simulated mDCT images on the training and performance of our 3D NNC DL for radiation dose reduction in chest CT.

METHOD AND MATERIALS

We developed anatomy-specific (AS) NNC models employing volume-based neural network regression in a convolutional manner to convert mDCT to higher-dose (HD)-like CT. We trained 3 AS NNC models with soft-gating layers with 3 anatomic areas under two training protocols. In our first protocol, we trained our NNC with an anthropomorphic chest phantom (Kyoto Kagaku, Kyoto, Japan) by utilizing real mDCT (120kVp, 10mAs, 0.37mSv) images as input and HDCT (120kVp, 550mAs, 34.9mSv) as "teaching" images. In a second protocol, we trained our NNC with simulated mDCT and HDCT from our diagnostic CT database of 20 patients. Our mDCT simulation consisted of forward-projection of HDCT, addition of photon and electric noise to the sinogram image, filtered back-projection of the noise component, and addition of the noise image to the original HDCT. Through training, our NNC learned to convert lower-dose CT to HD-like CT, where noise and artifacts are substantially reduced; thus, term "virtual" HD (VHD) CT. To compare our NNC models under two different protocols, we collected mD (120 kVp, 5 mAs, 0.2 mSv) and full-dose (120 kVp, 50 mAs, 2.0 mSv) CT of 50 clinical cases including 30 cases with nodules.

RESULTS

Our VHD technology converted mDCT to "virtual" HDCT where noise and artifacts were reduced substantially, while anatomic structures and pathologies were preserved. Our NNCs trained with real mDCT and simulated mDCT improved the contrast-to-noise-ratio (CNR) of mDCT of clinical cases from 4.1±3.9 dB to 21.5±4.9 dB and 22.7±5.0 dB, respectively, which were higher than that of "gold-standard" full-dose CT (CNR: 13.4±5.1 dB). Difference between the 2 models was not statistically significant (t-test; P=0.1).

CONCLUSION

Our 2 NNC models, using real and simulated mDCT images for training, achieved a similar dose reduction performance of 90% and converted mDCT of 50 clinical cases to VHDCT that have higher image quality than "gold-standard" full-dose CT.

CLINICAL RELEVANCE/APPLICATION

Substantial reduction of radiation dose in CT by our new VHD technology would potentially make mDCT screening possible, and it would be beneficial to screening population.

SSG12-09 Radiation Doses from the Dual-Layer Spectral Detector CT at Different Patient Sizes: Comparison with a Conventional CT Scanner

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S404CD

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PURPOSE

To compare the radiation doses from the dual-layer spectral detector CT (SDCT) and a conventional CT scanner at different patient sizes.

METHOD AND MATERIALS

In this retrospective IRB-approved study, consecutive patients scanned on the SDCT scanner (IQon, Philips, Cleveland, USA) with chest CT (PE protocol) and abdominal CT (routine single portal venous phase) protocols from were included. A comparison group of patients scanned using the same matched protocols in a conventional 256- slice scanner (Brilliance iCT, Philips, Cleveland, USA) was selected. The radiation doses (CTDIvol) and the size (WED- Water equivalent diameter) was extracted using Radimetrics software (Bayer, Whippany NJ, USA). The radiation doses of the two scanners for these two protocols were compared by log transformation of the CTDIvol and using linear regression model to measure the differences in log (CTDI) on average when interacting with WED. The percentage difference between iQon and iCT was also calculated. Each variable was estimated using Maximum likelihood method and tested against the hypothesis of being zero (no effect). P value of less than 0.05 was considered as statistically significant. SAS 9.4(SAS Institute Inc., Cary, NC) was used for all analysis.

RESULTS

The study included 482 abdominal CTs (mean patient size 306.4 ± 38.3 mm (182.4 - 442.2 mm)) and 215 chest CTs (296.3 ± 34.1 mm (207.4 - 388.4 mm)) performed in IQon and 741 abdominal CTs (303.1 ± 44 mm (156.8 - 450.1 mm)) and 323 chest CT (299.6 ± 42.3 mm (205.5 - 408.2 mm)) in iCT. For the abdominal CTs, the mean CTDI for IQon was 12.0 ± 6.0(3.1 - 50.8) and for iCT was 11.7 ± 6.7 (2.8 - 44.5). For the chest CTs, the mean CTDI for IQon was 11.7 ± 6.2 (4.0-43.1) and for iCT was 6.3 ± 3.0 (3.9-57.0). The intercept was lower for iQon than that for the conventional CT ($p<.0001$). However, iQon has a higher slope ($p<.0001$). As a result, the percent difference in CTDvol between iQon and the conventional CT increased when the patient size increased.

CONCLUSION

With matched abdominal and chest CT protocols, the SDCT had lower CTDIvol than the conventional CT at small patient sizes, but slightly higher radiation dose than conventional CT at large patient sizes.

CLINICAL RELEVANCE/APPLICATION

Understanding the size-based variability of radiation dose from the SDCT will help in optimizing the dose and utilize the technique appropriately.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Prabhakar Rajiah, MD, FRCR - 2014 Honored Educator

SSG13

Physics (CAD/Machine Learning)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S404AB

AI IN PH

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

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Sub-Events

SSG13-01 Deep Learning-Based Automatic Chest PA Screening System for Various Devices and Hospitals

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S404AB

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PURPOSE

To ensure generalization performance in various hospitals, we developed a deep learning based automatic Chest PA screening System which can detect 5 class findings and performs well on various devices. Its performance was evaluated by using FROC and FOM in various devices.

METHOD AND MATERIALS

Our system can detect 5 class findings which are nodule, consolidation, pleural effusion, interstitial opacity, pneumothorax. We used chest radiographs(PA view) collected from 2013 to 2015 at two hospitals. There were 18,869 labeled CRs comprised of 11,181 normal and 1,943 nodule, 1,293 consolidation, 1,867 pleural effusion, 1,406 interstitial opacity, 1,179 pneumothorax CRs. All abnormal CRs were clinically confirmed by CT scans. Thus, we could collected elaborate segmentation label data. Furthermore, our data were acquired in various devices, the first hospital has x-ray detectors from 3 manufacturers(GE, FUJI, Canon), and the other has devices from 2 manufacturers(Philips, LISTEM). We used only data from the first hospital for training and then used all data of other hospital as test data.

RESULTS

In the test dataset, our screening performance showed AUC of 0.99, with an sensitivity, specificity of 97.6%, 97.9%, respectively. For each class findings, Our system achieved FROC and FP per scan of 81.2% / 0.72, 84.4% / 1.41, 83.1% / 0.35, 85.7% / 1.45, 91.6% / 0.78 for nodule, consolidation, pleural effusion, interstitial opacity, pneumothorax, respectively. In FOM performance, sensitivity is 84.7%, 91.5%, 93.7%, 97.9%, 97.2%.

CONCLUSION

Our screening system demonstrated reliable performance in various devices and multi hospitals. It also showed competitive results in detecting location and classification of 5 class findings.

CLINICAL RELEVANCE/APPLICATION

Our system demonstrates reliable performance on various devices on multiple findings using CAD.

SSG13-02 Curriculum Learning from Patch to Image for Pulmonary Abnormal Pattern Screening in Chest-PA X-Ray: Intra- and Extra-Validation on Multi-Center Datasets

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S404AB

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PURPOSE

To propose and validate a computer aided detection (CAD) for detecting 5 kinds of pulmonary abnormalities in chest-PA X-ray using multicenter data with a curriculum learning strategy to train entire images after training lesion-specified image patches to guide the CAD toward better local minima.

METHOD AND MATERIALS

Chest-PA X-rays collected from two hospitals, which consisted of 10137 healthy subjects and 3244 patients including 944, 550, 280, 1364, and 331 patients with nodule (ND), consolidation (CS), interstitial opacity (IO), pleural effusion (PE) and pneumothorax (PT) from XXX (X1), and 1035 healthy subjects and 4404 patients including 1189, 853, 1009, 998 and 944 patients with ND, CS, IO, PE and PT from YYY (Y1), respectively. 60% and 20% of X1 dataset were used for training and validation. 20% of X1 and Y1 datasets were used for test. Every abnormality lesion was manually drawn by expert thoracic radiologists. Using these regions, image patches were used to specifically train the regional patterns of abnormalities. Entire images were used to fine-tune the network subsequently. Modified resnet-50 architecture for multi-label problem was used to train weak supervisions. To assess the effectiveness of our approach, we compared it with or without this strategy using six-measures including area under the curve (AUC), accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value.

RESULTS

Both models converged well and weights were extracted at the minimum loss on validation set. With curriculum learning, the AUC in X1 test set was 93.2, 88.6, 97.7, 99.5, 96.6% for ND, CS, IO, PE, and PT, respectively. Compared to the model without this strategy, performance improvement was achieved in all metrics, and PPV showed the largest improvement of 11.3% and 4.6% for X1 and Y1.

CONCLUSION

The proposed curriculum learning strategy successfully showed the outperforming results compared with baseline through multicenter validation, which could be used in case of the smaller dataset with complex task.

CLINICAL RELEVANCE/APPLICATION

This curriculum learning strategy could be useful in case of computer-aided detection (CAD) on the smaller dataset with complex task such as CAD on abnormalities of chest-PA X-ray.

SSG13-03 Data Augmentation via Synthetic Mammograms for Improved Training of a Deep Learning Breast Mass Detection Algorithm

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S404AB

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PURPOSE

To evaluate whether training data augmentation using synthetic mammograms may improve the performance of a deep learning system for mass detection.

METHOD AND MATERIALS

Synthetic mammograms were generated from procedurally generated compressed breast phantoms containing masses. The anthropomorphic phantoms were modeled for four different breast density categories, and the masses were modeled with different sizes, shapes and margins. MC-GPU, a Monte Carlo-based x-ray transport simulation code that generates clinically-realistic radiographic projection images, was used to project the 3D phantoms into synthetic mammograms. A total of 530 mammograms with 677 masses were generated. We used Faster R-CNN for our deep learning network with pre-training from ImageNet using ResNet-101 architecture. From the Curated Breast Imaging Subset of Digital Database for Screening Mammography (CBIS-DDSM) data set, we used 573 mammograms (607 masses) for training, and 170 mammograms (177 masses) for testing, all of which contained masses. We compared the detection performance of the Faster R-CNN when the network was trained using only the CBIS-DDSM training images, and when the network was augmented with the 530 synthetic mammograms. FROC analysis was performed to compare performances with and without the synthetic mammograms.

RESULTS

When trained on the CBIS-DDSM data set alone, the Faster R-CNN detected 68.4% (121/177) of the masses on the test set. With the augmented training set, the test set detection prescreening sensitivity was 83.6% (148/177). The difference between the two FROC curves was statistically significant using JAFROC ($p = 0.005$). At 1 false positive per image (FP/image), the test set detection sensitivity was 60.5% (107/177) when trained on CBIS-DDSM alone, and was 68.9% (122/177) when trained with the augmented data set. The difference was statistically significant using McNemar's test ($p = 0.001$).

CONCLUSION

Our study demonstrates that it is possible to generate high quality synthetic mammograms using procedurally generated breast

Our study demonstrates that it is possible to generate high quality synthetic mammograms using procedurally generated breast phantoms and Monte Carlo simulation, that can be used to enlarge the training data set and improve the performance of deep learning systems for mass detection on mammograms.

CLINICAL RELEVANCE/APPLICATION

Training data set can be a limiting factor for deep learning applied to medical imaging tasks. This study shows our synthetic mammograms are useful for data augmentation in computer-aided detection.

SSG13-04 Comparison of Transfer Learning and Deep Feature Extraction Strategies for Breast Cancer Classification in Mammography Using Deep Neural Networks

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S404AB

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PURPOSE

To study the differences between using a pre-trained deep convolutional neural network (DCNN) as feature extractor and a fine-tuned DCNN using transfer learning for classification of malignant and benign masses in mammography.

METHOD AND MATERIALS

3,578 mass lesions from 3,411 mammograms were collected with IRB approval. Three DCNN structures: AlexNet, InceptionV1 (GoogLeNet) and VGG16 that had success in ImageNet classification were used in this study. All the DCNNs were pretrained on ImageNet data for a 1000-class object classification task and then applied to mammographic mass classification. When used as a feature extractor, the features from the first fully connected layers (*FF*) were extracted and a random forest classifier (RF-*FF*) is trained. Under the transfer learning paradigm, two transfer strategies: freezing up to the first convolutional layer (*CF*) and freezing up to the last convolutional layer (*CL*) were studied, which led to four mammography-trained classifiers: mDCNN-*CF* and mDCNN-*CL* with DCNN classifier (consisting of fully connected layers and softmax) and random forest classifier using *FF* features. All the strategies were validated in a 4-fold cross-validation approach while keeping all the views from the same patient together in the same fold. The experiments were repeated ten times with different random stochastic initializations.

RESULTS

ImageNet-trained feature extractor RF-*FF* obtained mean AUCs of 0.77, 0.58 and 0.74 for AlexNet, InceptionV1 and VGG16, respectively. Mammography fine-tuned mDCNN-*CF* and mDCNN-*CL* reached mean AUCs of 0.83 and 0.79, respectively, as the best among the three structures. mDCNN-*CF*-RF-*FF* and mDCNN-*CL*-RF-*FF* also reached similar AUCs of 0.83 and 0.79, respectively. The fine-tuned mDCNNs achieved higher accuracy than without transfer learning.

CONCLUSION

Although DCNN trained with images from a different domain may be used as a deep feature extractor for medical imaging, transfer learning in the target domain has significant advantages where some of the deeper layers can be fine-tuned for the target task. In transfer learning, replacing the DCNN classifier with an external classifier like the random forest classifier does not improve the classifier performance.

CLINICAL RELEVANCE/APPLICATION

With the prolific usage of deep learning in medical imaging, it is important to understand the effectiveness of the features extracted by different DCNN structures with and without transfer learning.

SSG13-05 Detecting Mal-Positioned Endotracheal (ET) Tubes in Portable Chest X-Ray (CXR) Images: Comparing Deep Learning Models with Hand-Engineered Approach on Carina Detection

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S404AB

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PURPOSE

Comparing performances in detecting carina location from deep learning and hand-engineered approaches

METHOD AND MATERIALS

ET tubes are the most commonly used tubes for ICU patents. Mal-positioned ET tubes may lead to collapsed lungs. The ET tube tip placement relative to carina location in a CXR image is used to determine if an ET tube is properly positioned. However, the carina, a ridge of cartilage in the trachea that occurs between the division of the two main bronchi, can be hard to detect on CXR images. Our previously developed hand-engineered approach includes the detection of lungs, spine and aortic arch to identify an initial ROI. Carina location is detected using template matching and feature analysis within the ROI. In this study, we investigate convolutional neural networks (CNN) based models, i.e., the faster R-CNN and U-Net, to detect carina locations. The R-CNN was trained with initial weights from a pre-trained model. U-Net was trained from scratch. Both models were trained on 994 portable CXR images, validated on 136 images, and tested on 212 images. The carina location (x,y) on each image was identified by an experienced radiologist for the 212 testing images and by a trained scientist for the rest of images. The carina detection accuracy was measured by the distance between the human-identified and computer detected locations in terms of <=5mm, 10 mm and beyond.

Each image has only one detection from each approach; detections beyond 10 mm from the truth are regarded as a miss or FP detection.

RESULTS

R-CNN yielded sensitivities of 92% (98%) and 60% (88%) and 58% (87%) for <=5 (10) mm on the training, validation and testing data, respectively . U-Net yielded sensitivities of 94% (94%), 64% (85%) and 67% (89%) for <=5 (10) mm on the training, validation and testing data, respectively. Our hand-engineered approach yielded a sensitivity of 52% (74%) for <=5 (10) mm on the same 212 testing images. The CNN based models yielded a similar performance in detecting carina location measured within 10 mm of truth with more than 10% improvement on average than that of the hand-engineered approach.

CONCLUSION

Use of CNN based models substantially improved carina detection accuracy and performance robustness.

CLINICAL RELEVANCE/APPLICATION

Accurate detection of carina locations in CXR images can help timely detection of mal-positioned ET tubes, thus improving the care and treatment management for critically ill patients in ICU.

SSG13-06 Classification of Glioblastoma Using Machine Learning and Delta-Radiomic Signature Derived from Dynamic Susceptibility Enhanced MRI

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S404AB

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PURPOSE

Glioblastoma (GBM) is the most aggressive cancer with poor prognosis due to its heterogeneity. The purpose of this study is to improve the tissue characterization of these highly heterogeneous tumors using delta-radiomic signature of dynamic susceptibility contrast enhanced (DSC) MR images, which are commonly used to derive blood perfusion parameters to the tumor, with machine learning approaches.

METHOD AND MATERIALS

Multiparametric magnetic resonance (MR) images of 25 patients with histo-pathologically confirmed 13 high and 12 low grade GBM were taken using a standard brain tumor imaging protocol. All DSC images were registered to FLAIR images. The tumor contours from FLAIR images and its contralateral regions of the normal tissue were used to extract delta-radiomic features from each DSC image over the entire volume of DSC time course images before applying feature selection methods. The most informative and non-redundant features (signature) were selected to train a random forest to differentiate high-grade (HG) and low-grade (LG) tumors while feature correlation limits were applied to remove redundancies. Then a leave-one-out cross-validation random forest was applied to the dataset to classify GBMs. To evaluate the performance of our proposed classification method, overall prediction accuracy, confidence, sensitivity and specificity were calculated.

RESULTS

Analysis of the predictions showed that our method consistently predicted the tumor grade of 24 out of 25 patients correctly (0.96). Based on the leave-one-out cross-validation, the mean prediction accuracy was 0.95±0.10 for HG and 0.85±0.25 for LG. The area under the receiver operating characteristic curve (AUC) was 0.94.

CONCLUSION

Our method performed well in classifying high and low grade GBMs based on the DSC MRI data. This study shows that delta-radiomic features of DSC MRI are correlated with GBM grades and may be use to improve imaging characterizing of gliomas. The performance of our method in interrogating DSC MRI data will be explored further using combined spatial and temporal delta-radiomic features.

CLINICAL RELEVANCE/APPLICATION

This study explores the new computational approach of delta-radiomic signature and machine learning to extract additional information from clinically applied DSC MR images to better classify GBMs.

SSG13-07 U-Net-Based Deep-Learning Bladder Segmentation in CT Urography

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S404AB

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PURPOSE

To develop a U-Net based deep learning approach (U-DL) for bladder segmentation in CT urography (CTU) as a critical component for computer-aided diagnosis (CAD) of bladder cancer and treatment planning.

METHOD AND MATERIALS

Bladder segmentation in CTU remains a challenge because the bladder often contains regions filled with intravenous contrast and without contrast. We previously developed a bladder segmentation method using deep-learning convolution neural network (DL-CNN) and level sets within an user-input bounding box. However, some cases with poor image quality or with advanced bladder cancer spreading into the neighboring organs caused inaccurate segmentation. We have newly developed an automated U-DL method to identify the bladder boundary in CTU cases. The entire CTU slice containing bladder is used as input to the U-DL without the need for a bounding box. The output of U-DL is the corresponding bladder likelihood mask of the slice. No level set is used as a post-processing step. We trained the U-DL with a mini-batched stochastic gradient descent algorithm by minimizing a binary cross-entropy cost function using 7629 bladder slices from 81 CTU cases. The segmentation performance was evaluated using 92 independent test cases. 3D hand-segmented contours were obtained as reference standard for all cases. The segmentation accuracy was evaluated relative to the reference standard in terms of the average volume intersection ratio (AVI), average percent volume error (AVE), average absolute volume error (AAVE), average minimum distance (AMD), and the Jaccard index (JI).

RESULTS

For the independent test set, the AVI, AVE, AAVE, AMD, and JI for segmentation with U-DL were 93.0±9.8%, -3.0±13.9%, 8.9%±11.1%, 2.7±2.0 mm, 85.1%±10.9%, respectively. With DL-CNN and level sets, the corresponding values were 81.9%±12.1%, 10.2%±16.2%, 14.0%±13.0%, 3.6±2.0 mm, and 76.2%±11.8%, respectively. The improvement for all measures were statistically significant ($p<0.001$).

CONCLUSION

Compared to the previous method using DL-CNN and level sets, the U-DL is more accurate and does not depend on an user-input bounding box. Further work is underway to improve the U-DL as a fully automated method for segmentation of the bladder.

CLINICAL RELEVANCE/APPLICATION

Bladder segmentation is a crucial step for detection of bladder cancer and wall thickening in CAD and for treatment planning. This study developed a highly accurate method for bladder segmentation.

SSG13-08 Automated Detection of Hemorrhage and Fracture Regions in Head and Neck CT of the Trauma Patient in Emergency Rooms Using 3D Convolutional Neural Networks with Strong and Weak Labels

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S404AB

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PURPOSE

To purpose and validate detection of hemorrhage and fracture using 3D convolutional neural network (CNN) with weak supervision in head and neck CT of brain trauma patient in emergency rooms.

METHOD AND MATERIALS

Brain CT images were acquired from 1785 healthy subjects and 2661 patients including 2451 and 1122 patients with hemorrhage including EDH, ICH and SDH and fracture, respectively. Weakly labeled data could lead to training failure due to high complexity and dimensionality problems. To solve of this problem, we used additional 169 patient's data with information of areas of fracture and hemorrhage were labeled. Using this hard labeled data, 3D patch images were extracted and trained before training weak supervision. After that, the network was fine-tuned using weak supervision with a relatively large amount of data. 3D CNN architecture was designed based on VGGNet-16 and global average pooling was performed before the prediction layer to extract the class activation map. Two independent networks were used to train and detect hemorrhages and fractures individually and evaluated in terms of accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

RESULTS

Our proposed method performance for hemorrhage detection showed 87.7%, 87.7%, and 87.6% and fracture detection showed 80.5%, 69.5%, and 87.8% for accuracy, sensitivity, and specificity. In addition, PPV and NPV of hemorrhage detection and fracture detection were 91.5%, 82.5% and 79.0%, 81.3%, respectively.

CONCLUSION

We proposed fully automated detection system using deep learning networks for brain injury patients in emergency rooms. The system helps to radiologists and physicians in emergency rooms reducing the diagnosis time and human errors. The automated detection system could be applied in various kinds of other abnormal detection with strong and week labels.

CLINICAL RELEVANCE/APPLICATION

This study could be used for CAD on hemorrhage and fracture in head and neck CT of brain trauma patient in emergency rooms.

SSG13-09 Quantitative MRI Radiomics in the Task of Distinguishing Between Malignant and Benign Breast Lesions in a Large Clinical Dataset from China

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S404AB

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PURPOSE

To evaluate the potential of quantitative MRI radiomics in the task of distinguishing between malignant and benign breast lesions in a large clinical dataset from China.

METHOD AND MATERIALS

Our research involved a clinical DCE-MRI database of 600 breast cases retrospectively acquired under a HIPAA-compliant with a waiver of consent IRB protocol. The average ages of the 300 benign and 300 malignant patients were 41.8 and 47.2 years with a standard deviation of 9.5 and 9.6 years, respectively. Characteristics of the breast cancers included clinical and histopathologic findings on axillary lymph nodes and tumors. Once each lesion was indicated to our radiomics workstation, the machine learning algorithm automatically segmented and extracted radiomic features on the primary lesion, including those from six categories: size, shape, morphology, enhancement texture, kinetics, and enhancement-variance kinetics. The selected feature subset was input to a Bayesian artificial neural network (BANN) classifier and underwent leave-one-case-out cross validation. Area under the receiver operating characteristic (ROC) curve (AUC) served as the figure of merit in the task of distinguishing between malignant and benign breast lesions.

RESULTS

In the task of distinguishing between malignant and benign breast lesions, the analyses of each radiomic feature demonstrated AUC values ranging from 0.53 (se = 0.02) to 0.78 (se = 0.02). A subset of features that characterize lesion irregularity, margin sharpness, textural and kinetics were selected. The resulting radiomic lesion signature from the BANN classifier yielded an AUC value of 0.88 (se = 0.01).

CONCLUSION

Quantitative MRI radiomics demonstrated promising classification performance in distinguishing between malignant and benign breast lesions in a large clinical dataset from China.

CLINICAL RELEVANCE/APPLICATION

Our computerized radiomic analysis method has potential to aid clinicians in improving breast cancer diagnosis and patient management.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSG14

Physics (CT: New Techniques)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S405AB

CT PH

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

FDA Discussions may include off-label uses.

Participants
Taly G. Schmidt, PhD, Milwaukee, WI (*Moderator*) Research Grant, General Electric Company
Dianna D. Cody, PhD, Houston, TX (*Moderator*) In-kind support, General Electric Company; Reviewer, ACR CT accreditation program; Researcher, Gammex, Inc

Sub-Events

SSG14-01 Imaging Arterial Vasa Vasorum Proliferation as an Early Marker of Atherosclerosis Using High Resolution Photon-Counting CT

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S405AB

Awards
Trainee Research Prize - Fellow

Participants
Kishore Rajendran, PhD, Rochester, MN (*Presenter*) Nothing to Disclose
Shengzhen Tao, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
Jill L. Anderson, BA , Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To detect vasa vasorum (VV) proliferation in arterial walls as an early marker of atherosclerosis using a whole-body photon counting detector (PCD) CT system.

METHOD AND MATERIALS

A swine carotid model of enhanced vasa vasorum (the micro vessels in artery walls) was developed in an anesthetized animal, by injecting autologous blood into the left carotid wall in multiple locations caudal to the bifurcation to mimic early stage atherosclerosis. The right carotid artery (control) was exposed but was not injected. The animal was allowed to recover, and six weeks later re-anesthetized and scanned using the PCD-CT system. Four locations caudal to the carotid bifurcation were scanned using the ultra-high resolution (UHR) PCD-CT acquisition mode and a 40mL contrast bolus (Omnipaque) followed by a 30mL saline chaser. Axial acquisitions (140kV, 342 mAs) were performed at 20 time points (1s rotation, 3s cycle time) allowing CT number measurements in arterial lumen and wall for peak enhancement and recirculation phases. The PCD-CT energy thresholds were set to be 30 and 70 keV. PCD-CT images were reconstructed using a quantitative sharp kernel(Q65). To reduce image noise, a multi-energy non-local means denoising algorithm was applied to the PCD-CT images. Arterial lumen-wall boundaries in the 30-140 keV images were identified using half-max CT number thresholding, and wall CT number enhancement was calculated using an annular ROI placed in the segmented arterial wall. The animal model of increased VV was validated using microfil-enhanced micro-CT (μCT) of excised carotids from the same animal.

RESULTS

Baseline corrected wall-lumen ratio integrated over the arterial recirculation phase showed a significantly higher value ($p = 0.0036$, unpaired t-test) for the left common carotid with enhanced vasa vasorum measured over a length of 22.5mm. Images from contrast-enhanced μCT showed VV proliferation in the excised left carotid, while the right carotid showed normal VV density.

CONCLUSION

We have demonstrated in vivo quantification of vasa vasorum proliferation in the carotid arteries of an animal model using contrast-enhanced PCD-CT. The findings were compared to ex vivo μCT of the carotids.

CLINICAL RELEVANCE/APPLICATION

Vasa vasorum proliferation precedes atherosclerosis and its detection could enable early diagnosis prior to irreversible consequences occur from vulnerable plauque, stenosis, infarction or stroke.

SSG14-03 High-Pitch Coronary CT Angiography in Revolution CT During Free Breathing versus Breath Holding in Patients with Unlimited Heart Rates

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S405AB

Participants
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PURPOSE

To explore the feasibility of coronary CT angiography (CCTA) using free breathing and evaluate the image quality CCTA in free breathing patients when compared to breath holding patients.

METHOD AND MATERIALS

60 patients with suspected coronary heart disease were randomly divided into two groups for CCTA scans: group A (n=30) were performed during breath-holding ,and the remaining 30 during free-breathing (group B).No heart rate control was performed before examination. The heart rate during planning was 57-113bpm in group A and 48-124bpm in group B .The basic information for the two groups was statistically the same.A coefficient of 25 mgl/kg/s was applied for all patients.CT value in Aortic sinus (AS), right coronary artery (RCA), left anterior descending (LAD), left circumflex (LCX), and pericardial fat and standard deviation (SD) in AS and fat were measured. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) for AS were calculated. We compared the differences in the heart rates during the planning and scanning period between two methods.Image quality of every coronary artery segment according to the American Heart Association 15-segment model with at least 1.0mm diameter was evaluated using 5-point grading scales(1: non diagnostic-5:excellent).Two experienced Radiologists also independently reviewed image quality of each coronary artery segment.

RESULTS

There was no statistical difference between the demographic data of the two groups. The subjective image quality scores for coronary artery image were 4.49±0.41(A) and 4.33±0.36(B).With breath-holding,91.7% of the coronary artery segments were evaluable with image quality scores of 4 and 5 compared to 89.5% with free breathing group($P>0.05$).The CT Value in AS ,SNR,CNR with RCA were significantly($P<0.05$) lower with group B,But CT numbers in LAD, LCX, RCA, as well as CNR between the two groups were not statistically different ($P>0.05$). The mean difference between the heart rates before and during scanning for group A was(1.74±1.86) bpm,and group B was (1.30±1.25) bpm,the two groups were not statistically different ($P>0.05$).

CONCLUSION

Free-breathing CCTA is feasible using 256-MDCT scanner without heart rate control, and aquire high quality image .

CLINICAL RELEVANCE/APPLICATION

Free-breathing CCTA is feasible using 256-MDCT scanner without heart rate control, and aquire high quality image .

SSG14-04 Early Investigation on CT Thermometry as a Tool to Monitor the Ablation Zone During Thermal Ablation Therapy

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S405AB

Participants
April Griffith, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose
Frederic Noo, Salt Lake City, UT (*Abstract Co-Author*) Research Grant, Siemens AG; Consultant, nView medical;
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PURPOSE

Percutaneous thermal ablation, such as microwave or radiofrequency ablation, is a clinical treatment for cancer that utilizes directed heating to induce cell death. Currently, there is no accurate way to evaluate the ablation zone, which can lead to incomplete ablation and thereby precipitate local recurrence of cancer. Since temperature affects mass density and since CT can measure changes in mass density, CT could be used to monitor the ablation zone. In this study, we test the hypothesis that a reliable, clinically significant decrease in attenuation can be seen in water heated from body temperature (36°C) to the temperature at which cell death occurs (above 55°C).

METHOD AND MATERIALS

Four bottles of water stacked in a 2 x 2 arrangement were heated to 75°C and then passively cooled to 30°C. The temperature within each bottle was monitored using independent thermometers (1°C accuracy). CT scans (120 kV, routine abdominal protocol) were taken after every 2°C drop until the desired temperature range was covered. A representative central slice passing through the four bottles was chosen. The mean attenuation coefficient in an 81 x 81 region-of-interest was evaluated within each bottle and plotted against temperature at time of acquisition.

RESULTS

At 73°C (the temperature measured during the initial CT scan), the attenuation of water was -24.6 ± 0.4 Hounsfield Units (HU). As the water cooled to 33°C (the temperature measured during the last scan), the attenuation increased to -5.0 ± 0.6 HU. The measurements were consistent across all 4 bottles. A linear model was fitted to all measurements (R^2 = 0.98). The model demonstrates an 11.52 HU change between 36°C and 60°C (95% confidence interval: [11.21-11.84], based on the Student distribution with 88 degrees of freedom).

CONCLUSION

Our study shows that there is a measurable decrease in CT attenuation between body temperature and 55°C, the temperature at which cell death occurs. This observed 11.5 HU change in attenuation can be clinically differentiated by radiologists at a reasonable radiation dose, indicating that parenchymal changes due to heating could be measured using CT.

CLINICAL RELEVANCE/APPLICATION

In thermal ablation, directed heating is used to treat pathology, especially malignancy. Reliable evaluation of the ablation zone using CT thermometry will allow more accurate cancer treatment.

SSG14-05 Effectiveness of Metal Artefact Reduction Algorithm in a New Generation Spectral CT

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S405AB

Participants
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PURPOSE

The purpose of this study was to quantify the effectiveness of metal artefact reduction (MAR) algorithm in restoring the CT image quality with the new generation spectral CT scanner, and compared the results with those of an older generation CT scanner

METHOD AND MATERIALS

We retrospectively reviewed clinical data of twelve patients with pedicle screw fixation of fractured vertebrae or degenerated intervertebral disc. Institutional review committee approval and written informed consents from patients were obtained. All patients underwent CT scan during the first hospital admission and three weeks thereafter to evaluate the position of the pedicle screws. The initial CT examination was carried out using GE Discovery CT750 HD with 80/140kVp, 0.5s rotation and 0.986 pitch. The follow-up scan was performed at 0.5s rotation and 0.992 pitch using a new generation spectral CT (Revolution CT, GE Healthcare). Virtual monochromatic images (VMIs) were reconstructed at energy levels of 63, 68, 74, 88, and 105 keV. Artefact index (AI=v(Ns2-Nm2) was assessed by region of interest (ROI) measurements in position of the strongest artefact (Ns) and in a muscle structure without artefact (Nm) (noise in HU units). The subjective image quality was assessed by two experienced radiologists independently. The CTDIvol and dose length product (DLP) were recorded. All quantitative analysis was based on the mean value of parameter calculated from five VMIs.

RESULTS

Metal artefact index and radiation dose was significantly reduced in the new generation spectral CT (AI 18.27±7.09, CTDI 11.89±0.89, DLP 212.50±36.96) compared with that in older generation CT (AI 51.98±28.77, CTDI 17.51±1.63,DLP 276.69±42.11, $p<0.05$ for all). There was high agreement between two radiologists (kappa=0.682). Subjective image quality analysis showed significantly higher score at new generation CT scanner (3.82±0.68,3.85±0.66) than older generation CT scanner (2.12±0.76), (2.00±0.74).

CONCLUSION

The MAR algorithm in the new generation spectral CT allows for a significant reduction of metal artefacts and improved subjective image quality in patients with pedicle screw.

CLINICAL RELEVANCE/APPLICATION

Pedicle screw with high atomic number are widely used in orthopedic surgery and can produce severe metal artefact. The present study demonstrated that MAR algorithm in a new generation spectral CT was effective in reducing artefacts arising from pedicle screw.

SSG14-07 Improvement of Image quality in Low-Dose Computed Tomography Using a Deep Learning Based Denoising Algorithm

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S405AB

Participants
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PURPOSE

To assess the image quality of low dose (LD) computed tomography (CT) using a deep learning based denoising algorithm (DLA) compared with filtered back projection (FBP) and advanced modeled iterative reconstruction (ADMIRE).

METHOD AND MATERIALS

Our institutional review board approved this retrospective study. A total of 50 patients underwent routine dose (RD) abdominal CT using FBP. CT images at 50%, 25%, and 13% dose levels of RD were simulated from RD CT images and reconstructed using FBP. We trained the DLA using the simulated LD CT images as input data and the RD CT images as the ground truth. To assess the image quality, we included five patients who underwent abdominal LD CT and additionally performed CT scan for the CTP 528 module of Catphan. CT images were reconstructed using FBP and ADMIRE (LD-FBP and LD-ADMIRE images). LD-FBP images were processed using DLA (LD-DLA images). We compared the mean image noise levels of LD-DLA, LD-ADMIRE and LD-FBA images in the liver, subcutaneous fat, paraspinal muscles and aorta drawing elliptical region-of-interests. Modulation transfer function (MTF) was measured at the images of CTP 528 module to assess the spatial resolution.

RESULTS

Mean image noises in LD-DLA images were significantly lower than LD-FBP images ($p<0.05$ for all) and similar compared with LD-ADMIRE images ($p>0.05$ for all). MTFs (mm^{-1}) of 10% contrast were 0.629, 0.629 and 0.635 in LD-DLA, LD-ADMIRE and LD-FBP images, respectively.

CONCLUSION

The LD-DLA images showed the less noise than LD-FBP images and comparable noise to LD-ADMIRE images while preserving the spatial resolution.

CLINICAL RELEVANCE/APPLICATION

Deep learning based denoising algorithm could improve the image quality of low dose computed tomography and be a new way to reduce radiation dose.

SSG14-08 Potential Application of Photon Counting CT in Cerebrovascular Imaging

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S405AB

Participants
Evan Harvey, Madison, WI (*Presenter*) Nothing to Disclose
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Xu Ji, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
Guang-Hong Chen, PhD, Madison, WI (*Abstract Co-Author*) Research funded, General Electric Company Research funded, Siemens AG
Ke Li, PhD, Madison, WI (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The goal of this work was to study the potential benefit of photon counting CT (PCCT) in imaging the cerebral vasculature. The scientific rationale was that compared with the current cerebral CT angiography (CCTA) technology, PCCT could provide better performance for cerebrovascular imaging tasks due to 1) improved energy weighting scheme applied to the photon signal and 2) significantly relaxed noise-spatial resolution tradeoff offered by the photon counting detector (PCD).

METHOD AND MATERIALS

An in-house experimental PCCT was constructed using a 51 cm CdTe-based PCD with a native pixel size of 100 μm. A customized angiographic CT head phantom containing contrast-enhanced healthy cerebral artery models (diameters ranging from 0.5 to 4.0 mm) was scanned by both the PCCT and a clinical MDCT with a clinical CCTA protocol. Radiation dose, beam collimation (20 mm), kV (100), reconstruction pixel size (0.4 mm) and slice thickness (1.25 mm) were matched between the two systems. MIP images were generated based on the instruction of the clinical CCTA protocol. CNR was measured at both proximal and distal branches of ICA and MCA. In addition, axial- and z-MTFs were measured for the two CT systems.

RESULTS

The CTDIvol and effective dose of the two systems were matched at 35 mGy and 1.23 mSv, respectively. Based on the measured axial MTF of MDCT, the reconstruction kernel of PCCT was adjusted until the axial spatial resolution of the two CT systems was matched; under this condition, the CNR of the proximal arteries (diameter 4.0 mm) was 44.7±12.2 in MDCT and was 87.5±22 ($p=0.0003$) in PCCT. For the distal and smaller artery branches (0.5 mm) the CNR was 11.3±6.3 for CCTA and 17.3±6.1 for PCCT ($p=0.013$). 10% MTF along z was 1.1 lp/mm for MDCT and 2.1 lp/mm for PCCT. The MDCT MIP demonstrated artifactural stenosis in a healthy angular artery due to partial volume effect; in contrast, the PCCT MIP provided more accurate and clearer rendering of all the arteries evaluated.

CONCLUSION

With matched dose and axial spatial resolution, PCCT provides higher vessel CNR, better z resolution, and reduced partial volume artifact, which suggests its promising application in cerebrovascular imaging.

CLINICAL RELEVANCE/APPLICATION

PCCT has the potential to address two major challenges in clinical CCTA: 1) limited CNR and spatial resolution of MDCT in imaging small or partially enhanced vessels; 2) distortions of true artery information due to image artifacts.

SSG15

Radiation Oncology (CNS Malignancies)

Tuesday, Nov. 27 10:30AM - 12:00PM Room: S403B

BQ MR NR OI RO

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

Participants
Hui-Kuo G. Shu, MD, PhD, Atlanta, GA (*Moderator*) Speakers Bureau, Varian Medical Systems, Inc; Stockholder, Medtronic plc; Stockholder, Apple Inc; Stockholder, ICON plc; Stockholder, Raytheon
Brent D. Weinberg, MD, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose
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Sub-Events

SSG15-01 Decoding IDH Genotype in Grade-II and -III Gliomas Using Machine Learning with Protein-based Amide Proton Transfer-Weighted (APTw) and Magnetization Transfer (MT) MRI

Tuesday, Nov. 27 10:30AM - 10:40AM Room: S403B

Participants
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Jinyuan Zhou, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The 2016 WHO includes molecular markers, such as isocitrate dehydrogenase (IDH) mutation status, to classify diffuse gliomas. This reveals an unmet radiographic need-the ability to identify genetic biomarkers preoperatively, with methods such as MRI. This study aimed to evaluate the power of machine learning based on endogenous mobile protein-based APTw and semi-solid macromolecule-based MT MRI features in classifying IDH1/2 mutation status.

METHOD AND MATERIALS

105 patients with grade-II or -III gliomas with pre-operational routine and APTw MR images, and lab test reports of IDH mutation status were retrospectively recruited. 391 radiomics features were extracted from the tumor ROIs on APTw, MT, and structural MR images. The support vector machine (SVM) method was implemented (A). 70, 25 and 10 cases were randomly assigned to the training set, validation set, and test set. 10-fold cross-validation was used for tuning parameter (γ) selection. The dimensionality of all features is reduced using principal component analysis (PCA). Leave-one-out cross-validation was applied to estimate the classification performance of the models. The alpha level of all tests was set at $P < 0.05$.

RESULTS

43 vs. 62 patients were confirmed as IDH-wildtype or IDH-mutant, respectively. Demographic and clinical characteristics showed no significant difference between the training set and validation set. The IDH-wildtype cohort showed significant higher age and higher WHO grade compared with IDH mutant group. Thus, age and WHO grade were added to SVM classifier. An accuracy of 95.2% in the test set was achieved to predict IDH genotype. The 10 features (age, grade, APTw_mean, APTw_10th percentile, APTw_25th percentile, MT_75th percentile, etc.) that contributed most to the model are presented (B).

CONCLUSION

Our SVM model presented here achieved an accuracy of 95.2% in the test set. The findings support the use of textures extracted from APTw and MT MRI to aid the accurate diagnostic classification of IDH genotype.

CLINICAL RELEVANCE/APPLICATION

The textures extracted from APTw and MT MRI could be used in the accurate diagnostic classification of IDH genotype in patients with WHO grade-II and -III gliomas.

SSG15-02 Identifying Recurrent Tumor in Post-treatment Glioblastomas with Volumetric Amide Proton Transfer-Weighted (APTw) Image Metrics as Biomarkers

Tuesday, Nov. 27 10:40AM - 10:50AM Room: S403B

Participants
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Hye-Young Heo, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Yi Zhang, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Jinyuan Zhou, PhD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Post-treatment glioblastomas are biologically complex and often demonstrate highly variable imaging characteristics. Currently

Post-treatment glioblastomas are biologically complex and often demonstrate highly variable imaging characteristics. Currently, patients with suspected recurrent tumor are often referred for repeat surgery to obtain pathologic confirmation due to the lack of reliable imaging modalities. APTw-MRI is a novel molecular imaging technique that generates contrast primarily based on endogenous cellular proteins. Here, we assessed whether volumetric APTw-MRI metrics could identify recurrent tumor in a heterogeneous background in patients with suspected recurrent glioblastoma.

METHOD AND MATERIALS

31 patients with suspected recurrent glioblastoma were enrolled. MRI sequences included T1w, T2w, FLAIR, Gd-T1w, and volumetric APTw sequences. Diagnosis was made by the RANO criteria and pathological results. Volumes of interest (VOIs) were drawn by a neuroradiologist and a research scientist separately. Three ratios of the volumes of Gd-enhancement, abnormal FLAIR intensity, and APTw hyperintensity were recorded: VGd/VFLAIR, VAPT/VFLAIR, and VAPT/VGd. APTw histogram parameters, including mean, mode, and percentiles, calculated from both VOIs on Gd-T1w and FLAIR images (Fig. 1A, B).

CONCLUSION

Volumetric APTw image metrics are valuable predictors of tumor recurrence in patients with suspected recurrent glioblastoma treated with standard chemoradiation.

CLINICAL RELEVANCE/APPLICATION

APTw-MRI is totally noninvasive and now commercially available, and the results can be readily translated into improved diagnostics for patients with suspected recurrent brain tumors.

SSG15-03 Evaluation of Early Acute Radiation-Induced Brain Injury: Hybrid Multifunctional MR Imaging Based Study

Tuesday, Nov. 27 10:50AM - 11:00AM Room: S403B

Participants
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Chengde Liao, MD, Kunming, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Accidental or deliberate radiation injury is a serious threat to humans that requires prompt accurate diagnosis and assessment. At present, there is no effective imaging method to evaluate the extent of acute radiation brain injury at early stage. We use DCE, IVIM-MRI and 1H-MRS to noninvasively evaluate acute radiation-induced brain injury.

METHOD AND MATERIALS

SD rats were divided into five groups and four groups received a single radiation treatment to the whole brain. The different extent of brain injury was created by exposure different radiation dose, 10, 20, 30, 40Gy respectively. DCE, IVIM-MRI and MRS was performed on day 5 post radiation injury.The correlation between parameters and radiation dose grade was analyzed using Spearman's rank correlation coefficients. ROC analysis of each MRI parameter was carried to differentiate the extent of radiation exposure. Immunohistochemistry, western blot and transmission electron microscopy were used to determine radiation-induced histopathological changes of neurons and glial cells.

RESULTS

For DCE, Ktrans, Ve, Vp and AUC increased significantly with the radiation dose increase. For IVIM, S0, f and D* also increased significantly with the radiation dose increase. For Ktrans, Ve and AUC in DCE and S0, f and D* in IVIM, the value in 30Gy group was significantly higher than other groups ($P<0.05$). The ratio of NAA/Cr in the 30Gy group was significantly lower than other groups and the ratio of NAA/Cho was increase from 10Gy to 20Gy group, but decreased significantly in the 30Gy group ($P<0.05$). VEGF and caspase-3 expression in the cortex was increased with the irradiation dose increasing from10 Gy to 30 Gy ($P<0.05$). Astrocyte population elevated with radiation dose increase ($P<0.05$).MBP staining did not show differences among the sham-radiation and every radiation groups ($P>0.05$). ROC analysis demonstrated that DCE and IVIM parameters are more effective for diagnosing the 30Gy group, but lower for the 10Gy and 20Gy groups.

CONCLUSION

Hybrid multifunctional MRI parameters can non-invasively evaluate acute radiation-induced brain injury at early stage, especially high dose radiation exposure.

CLINICAL RELEVANCE/APPLICATION

In the event of acute radiation exposure accidents, radiation damage can be detected non-invasively by MR imaging markers and used to determine the extent of brain injury without the need for invasive histopathological analysis.

SSG15-04 Glioma Survival Prediction with the Combined Analysis of Multi-Modal MRI, Histopathology, and Patient Characteristics by Supervised Machine Learning

Tuesday, Nov. 27 11:00AM - 11:10AM Room: S403B

Participants
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PURPOSE

To establish a survival prediction model for gliomas based on multi-modal MRI, ex vivo histopathology and patient characteristics.

METHOD AND MATERIALS

102 patients with pathologically confirmed WHO I-IV gliomas and complete survival information were retrospectively included. All patients received fluid attenuated inversion recovery, contrast enhanced T1-weighted image, three dimensional pseudo-continuous arterial spin labeling, intravoxel incoherent motion diffusion-weighted images (IVIM-DWI) and dynamic contrast enhanced MRI (DCE-MRI) before surgery. After surgery, histopathology-derived ex vivo features according to WHO 2016, such as tumor grade, histology, isocitrate dehydrogenase mutation status and the methylation of oxygen 6-methylguanine-DNA methyltransferase promoter have been acquired. The histogram and textural features were extracted from tumor volume of interests in each parametric map derived from multi-modal MRI. As for feature selection, pearson correlation and single factor cox regression were utilized to identify relevant features for predicting 2-year overall survival. The multi-factor cox model based on the histopathology and patient characteristics (partial-feature) or their combinations with multi-modal MRI features (full-feature) were established, respectively. Three approaches such as likelihood ratio, Wald and Score (log-rank) test were used to verify the two predictive models.

RESULTS

The predictive model based on the full-feature performed better than that based on partial-feature. The most contributing features to predict overall survival were tumor location, patient age, textural features from DCE-MRI and IVIM-DWI. The likelihood ratio of the full-feature model was 98.23 ($p<0.0001$),while that of the partial-feature one was 62.48 ($p<0.0001$). The hazard ratio of selected image features derived from DCE-MRI and IVIM-DWI were 0.51 ($p = 0.0003$) and -2.37 ($p = 0.0002$) respectively.

CONCLUSION

Survival prediction of glioma patients based on full features containing multi-modal MRI, histopathology and patient characteristics is more accurate than that without multi-modal MRI.

CLINICAL RELEVANCE/APPLICATION

While survival is associated with molecular biomarkers, diagnostic work-up of patients with suspected glioma mainly done by using multi-modal MRI holds great potentials in glioma characterization.

SSG15-05 Clinical Impact of Time Interval Between Gross Total and Subtotal Resection of Glioblastoma and Radiotherapy Using a Large National Database

Tuesday, Nov. 27 11:10AM - 11:20AM Room: S403B

Awards
Student Travel Stipend Award

Participants
Samantha M. Buszek, MD, Houston, TX (*Presenter*) Nothing to Disclose
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PURPOSE

Glioblastoma (GBM) is the most common primary malignant brain tumor in adults and standard of care treatment includes maximal safe surgical resection followed by adjuvant radiotherapy (RT) and chemotherapy. The optimal time interval between surgery and the initiation of adjuvant therapy remains unclear.

METHOD AND MATERIALS

The NCDB was queried for adult patients with diagnostic codes for GBM diagnosed from 2004 to 2015 who were treated with RT following surgical resection. Time interval between surgery and the start of RT were grouped into a. <= 4 weeks, b. 4.1-6 weeks, c. 6.1-8 weeks, and d. >8 weeks. Overall survival (OS) was estimated using Kaplan-Meier and log-rank test methods. Univariate (UVA) and multivariable (MVA) modeling with Cox regression analysis was used to determine predictors of OS.

RESULTS

A total of 46,012 patients, with a median age of 61 years (range 18-90 years) met inclusion criteria. Median time interval from resection to RT was 29 days (range 1-620 days). A total of 11,480 patients underwent a gross total resection (GTR) and 13,608

underwent a subtotal resection or biopsy (STR). Median survival was significantly different between time interval groups: 13.9, 15.2, 14.4, and 14.7 months, groups a-d respectively (p<0.0001). Using all variables significant on UVA, the following variables were associated with better OS on MVA: higher KPS, lower age, female gender, black ethnicity, methylated status, unifocal disease, and treatment initiation of RT >4 weeks. When separated by resection status, these variables remained significant; however patients with GTR initiated on RT >8 weeks had worse survival (HR 1.23, p=0.007) whereas patient's with STR did not.

CONCLUSION

Consistent with prior smaller series, this large retrospective analysis of the NCDB suggests that patients with newly diagnosed GBM who start RT within four weeks of surgical resection have worse outcomes. In terms of prolonged delay from surgery to RT, patients with GTR had worse OS if they initiated RT after 8 weeks whereas patients with STR did not. This finding should be considered in the future designs of clinical trials.

CLINICAL RELEVANCE/APPLICATION

This study aims to use the National Cancer Database (NCDB) to identify predictors for and clinical impact of time from surgical resection to initiation of RT in patients with newly diagnosed GBM.

SSG15-06 Assessment of the Alpha/Beta Ratio of the Optic Pathway

Tuesday, Nov. 27 11:20AM - 11:30AM Room: S403B

Participants
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PURPOSE

Hypofractionation has been recently considered an alternative to improve stereotactic radiosurgery of lesions in close proximity of the optic pathways. To estimate the intrinsic benefit from fractionation versus single dose radiosurgery for peri-optic lesions, the value of the alpha/beta ratio of the optic pathways has to be taken into account. Most studies expect and use an alpha/beta ratio of 2 Gy, or even 3 Gy, for the visual system. So far, to our knowledge, only 3 alpha/beta ratios have been published: In 1992 Goldsmith and Larson published an alpha/beta ratio of 3.06 Gy, which means that there would be no benefit of hypofractionation for most benign lesions. In 1994 Jiang estimated a ratio of 1.6 Gy based on relatively few data from a single center study. In 2010 Vernimmen derived a negative value of -0.6 Gy, and remarked that a negative value is not permitted by the LQ model.

METHOD AND MATERIALS

The alpha/beta ratio of the optic pathways was estimated from a meta analysis of 388 studies published since 2000. We included 27 studies with fraction numbers between 1 and 31, considering the following inclusion criteria: frequency of radiation induced optical neuropathy RION between > 0 %, and < 10 %, follow up of at least 12 months, no tumor progression, no prior radiation, detailed dosimetric analysis for the visual system. Clinical data provided from our center were added, including 54 hypofractionated Gamma Knife Radiosurgery regimens (4 treatments with 5 sessions, 45 treatments with 4 sessions, and 5 treatments with 3 sessions) and 106 single session treatments of different lesions close to the optic pathways.

RESULTS

The FE plot method revealed an alpha/beta ratio of the optic system of 1.11 Gy, confidence interval [0.39 - 3.59]. There is still not enough data in order to distinguish between alpha/beta ratios of the optic chiasm, the nerves and the tracts.

CONCLUSION

A significant intrinsic benefit from hypofractionation can be expected not only for malignant tumors located in the sellar region but for benign lesions as well, because of the very low alpha/beta ratio of the optic system of 1.11 Gy.

CLINICAL RELEVANCE/APPLICATION

The knowledge of the alpha/beta ratio of the optic system helps to optimize fractionation regimens for peri-optical tumors, facilitating dose restraints, BED and single fraction equivalent doses.

SSG15-07 Repeat Whole Brain Radiation Therapy Using a Pulsed Reduced Dose Rate Technique

Tuesday, Nov. 27 11:30AM - 11:40AM Room: S403B

Participants
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PURPOSE

Limited salvage options exist for patients with multiple recurrent brain metastases previously treated with whole brain radiation therapy (WBRT). Pulsed reduced dose rate radiation therapy (PRDR) is a unique irradiation strategy that lowers the effective dose rate, potentially decreasing toxicity to normal tissue by allowing for sublethal damage repair. PRDR is safe and effective in patients with gliomas receiving partial brain re-irradiation. To our knowledge, this technique has not been reported before in patients with brain metastases who have received repeat WBRT with PRDR. We report our early outcomes.

METHOD AND MATERIALS

We conducted a retrospective review of patients with brain metastases who received repeat WBRT with PRDR at the time of clinical and/or radiographic progression. PRDR treatments were delivered with a series of 0.20 Gy pulses given over a 3-minute period. Patients were treated with parallel-opposed whole brain lateral fields with dose prescribed to isocenter.

RESULTS

We identified 26 patients who received WBRT with PRDR since 2012. We excluded 4 patients as 2 patients had no prior WBRT and 2 expired during treatment due to extracranial disease. Primary histology included breast cancer, melanoma, NSCLC, non-seminomatous testicular cancer, SCLC and sarcoma. Initial WBRT dose regimens included 30 Gy in 10 fractions, 37.5 Gy in 15 fractions, and 39.6 Gy in 18 fractions. KPS was 70-100 for all patients at time of first WBRT. Median time to progression after first WBRT was 7.7 months at which time patients underwent repeat WBRT with PRDR. Patients received daily fractions of 2 - 3 Gy to a total dose of 20 Gy - 30 Gy. KPS at repeat irradiation was 70-100. With a mean follow-up of 7.1 months, mean time to intracranial progression after repeat WBRT with PRDR was 4.7 months. Four patients had intracranial disease control after repeat WBRT with PRDR for > 6 months and 1 patient is still alive at the time of this review. No acute grade 3 toxicities were seen as a result of reirradiation based on CTCAE v4.03. Grade 1/2 toxicities included fatigue, anorexia, and alopecia.

CONCLUSION

To our knowledge, this is the first report of repeat WBRT with PRDR. This technique appears to be a safe and feasible option for patients with multiple brain metastases who previously received WBRT.

CLINICAL RELEVANCE/APPLICATION

Future prospective studies using this technique are being considered to determine use as salvage therapy.

SSG15-08 Whole Ventricular Irradiation and Neoadjuvant Chemotherapy for Pure Intracranial Germinoma: A Comparison of Three Dose-Sparing Techniques

Tuesday, Nov. 27 11:40AM - 11:50AM Room: S403B

Awards
Trainee Research Prize - Medical Student

Participants
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PURPOSE

Radiation therapy (RT) plays a major role in the management of pure CNS germinoma, a disease most commonly seen in children 10-19 years of age. Awareness of late effects of RT has led to a shift in the focus of research to maintaining high cure rates with treatments such as chemotherapy with whole ventricular irradiation (WVI). In the present study, we evaluate three brain-sparing treatment techniques for pure intracranial germinomas with dose-volume analysis of normal brain structures.

METHOD AND MATERIALS

Four patients with intracranial germinomas were treated with chemotherapy followed by 22.5 Gy WVI with simultaneous integrated boost (SIB) to the primary site to 30 Gy. Tumor locations include suprasellar, pineal, or both locations. The SIB plans were replanned with the Japanese (24 Gy WVI only) and current Children's Oncology Group (COG) treatment paradigms (18 Gy WVI with primary site boost to 30 Gy). Target volumes were contoured from registered diagnostic MRIs and included the whole ventricular volume (WVV) and boost volume. Organs at risk (OAR) included hippocampi, temporal lobes, whole brain, and brain-WVPTV. V12, V18, and V20 were recorded for each of these structures, and dose-volume metrics were recorded for all 12 plans. PTV dose-volume coverage and OAR sparing were compared.

RESULTS

For the SIB protocol, the mean total brain V12, V18, and V20 were 59%, 34%, and 28%, respectively; the COG protocol values were 48%, 27%, and 20%; and the WVI values were 57%, 33%, and 28%. Analyzed across 4 patients with varying WVV and boost volumes, the WVI plan giving 24 Gy to the WVV without boost did not result in lower OAR dose-volume metrics yet underdosed the primary by 6 Gy compared to the other two treatment methods. The COG paradigm further reduced the dose to normal brain by reducing the WVPTV dose to 18 Gy while maintaining the 30 Gy boost PTV dose.

CONCLUSION

The WVI treatment plan may not reduce neurocognitive deficits yet potentially risks failure to control the primary site. The COG plan may result in even better neurocognitive outcomes than the SIB treatment, but whether there is an increase in ventricular failures remains to be seen.

CLINICAL RELEVANCE/APPLICATION

Minimization of cognitive late effects during treatment planning for CNS Germinoma is not enhanced by omission of a boost dose to

30 Gy to the primary tumor.

SSG15-09 Biomechanical Model-Based Deformable Image Registration for Glioma Patients

Tuesday, Nov. 27 11:50AM - 12:00PM Room: S403B

Participants
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PURPOSE

Assessment of treatment response for gliomas requires alignment of pre- and post-radiotherapy (RT) images. Large deformations in gross tumor volume (GTV) and surrounding brain can occur due to edema and tumor or surgical cavity growth or shrinkage. These large shifts can propose challenges in aligning serial images. The purpose of this study is to evaluate the accuracy of biomechanical model-based deformable image registration (DIR) driven by modeling the GTV volumetric response.

METHOD AND MATERIALS

Serial MR images of 10 glioma patients from post-surgery/pre-RT and post-RT were imported into an RT treatment planning system for analysis. GTV, ventricles, right and left hippocampi, brainstem and optic chiasm were delineated on each image. Automated rigid registration (RR) was performed between the pre- and post-RT MR images, followed by a biomechanical model-based DIR with boundary conditions on the GTV. Normal tissue contours were propagated from the pre-RT MR to the post-RT MR. The accuracy of the DIR method was evaluated using dice similarity coefficient (DSC) for each propagated contour.

RESULTS

The DSC was calculated between each propagated and original contour on the post-RT MR for both RR and DIR. Rigid registration was sufficient for 9 out of 10 patients in this limited cohort, as they did not have significant GTV or brain changes. In one patient with a large tumor (55 cm3), we qualitatively noted normal tissue shifts and tumor response due to treatment. In this patient, the use of DIR improved DSC for the ventricles from 0.56 to 0.74, left hippocampus from 0.36 to 0.48, and right hippocampus from 0.68 to 0.71.

CONCLUSION

In cases demonstrating therapeutic response of the tumor, biomechanical model-based DIR improves alignment compared to RR alone. This method was particularly beneficial for one patient in this limited cohort. Additional patients are needed to further evaluate impact and accuracy. These models will also aid in tracking the delivered dose and incorporating delivered dose into an adaptive protocol for glioma patients.

CLINICAL RELEVANCE/APPLICATION

For patients with therapeutic response to glioma, biomechanical model-based DIR is beneficial in alignment of normal tissues during RT, potentially aiding in tracking delivered dose.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
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MSRO33

BOOST: Gastrointestinal Hepatobiliary-Science Session with Keynote

Tuesday, Nov. 27 1:30PM - 2:30PM Room: S103AB

GI RO OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Tarita O. Thomas, MD, PhD, Chicago, IL (*Moderator*) Nothing to Disclose
Michael F. Bassetti, MD, Madison, WI (*Moderator*) Research Grant, Merck KGaA; Research Grant, AstraZeneca PLC;

Sub-Events

MSRO33-01 Invited Speaker:

Tuesday, Nov. 27 1:30PM - 1:40PM Room: S103AB

Participants
Michael F. Bassetti, MD, Madison, WI (*Presenter*) Research Grant, Merck KGaA; Research Grant, AstraZeneca PLC;

MSRO33-02 Imaging Response Assessment and Outcomes in Hepatocellular Carcinoma after Stereotactic Body Radiotherapy: iRECIST as a Potential Substitute for Traditional Criteria

Tuesday, Nov. 27 1:40PM - 1:50PM Room: S103AB

Participants
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PURPOSE

To compare imaging response assessment criteria in hepatocellular carcinoma (HCC) treated with stereotactic body radiotherapy (SBRT), and to determine which of these criteria better predicts patient survival.

METHOD AND MATERIALS

In this multicenter retrospective IRB-approved, HIPAA-compliant study, we included 56 HCC lesions (mean size 3.1 cm±1.4) treated with SBRT in 45 patients (age 66.73±7.61; 32 M; 13 F) between 2009 -2017. All patients underwent diagnostic CT/MR imaging within 6 weeks pre-SBRT and at least once 1-6 months post-SBRT. Tumor response on pre- and post-SBRT CT/MR over all assessments was determined using RECIST (response Evaluation Criteria in Solid Tumors) version 1.1, iRECIST (immune-RECIST), WHO (World Health Organization), mRECIST (modified RECIST) and EASL (European Association for the Study of Liver) criteria. Each response criteria was used to classify lesions as responders (i.e. local control: stable disease, partial or complete response) or nonresponders (progressive disease). McNemar's test was used to compare proportions of responders by each method vs RECIST 1.1 assuming independence of lesions. The Kaplan-Meier method was used to estimate 1-year overal survival (OS) from SBRT by each method.

RESULTS

Median follow-up was 19 months (3-29 months). Lesion response rates were 80.4% (n=45) by RECIST 1.1, 94.6% (n=53) by iRECIST, 67.9% (n=36) by WHO, 76.8% (n=43) by mRECIST, 71.4% (n=40) by EASL. Compared to RECIST 1.1, lesion response rate was significanly higher with iRECIST (p=0.005) and lower with WHO (p=0.02). Pseudoprogression occurred in 3 lesions (5%) with RECIST 1.1, 0 (0%) with iRECIST, 5 (9%) with WHO, 4 (7%) with mRECIST, and 7 (12.5%) with EASL. The largest difference in 1-year OS was observed for RECIST 1.1 with longer survival in responders (85%, 90% CI:72-93%) vs non-responders (67%, 90% CI: 35-86%). No differences were found for mRECIST, WHO or EASL. Too few events occurred to assess OS for iRECIST.

CONCLUSION

SBRT is an effective local treatment for HCC. RECIST 1.1 identifies patients with better outcomes; yet iRECIST appears to be promising in overcoming pseudoprogression. Further analysis of association between RECIST 1.1, iRECIST and outcomes are needed.

CLINICAL RELEVANCE/APPLICATION

Response assessment of HCC after SBRT by RECIST 1.1 may be superior to other imaging criteria; however, pseudoprogression

occurs with all of these criteria, except with iRECIST.

MSRO33-03 Stereotactic Body Radiotherapy (SBRT) Utilized as a Bridge to Orthotopic Liver Transplant (OLT) in Patients with Hepatocellular Carcinoma (HCC) and Severe Hepatic Cirrhosis

Tuesday, Nov. 27 1:50PM - 2:00PM Room: S103AB

Participants
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PURPOSE

To report outcomes on SBRT as a bridging treatment to OLT for patients with HCC and Child-Pugh (CP) score >=8 hepatic cirrhosis.

METHOD AND MATERIALS

Twelve patients, 17 HCC lesions, within Milan criteria for liver transplant who completed liver SBRT prior to OLT from 2010-2017 were retrospectively analyzed. 4D-CT and SPECT imaging were used to facilitate functional treatment planning.

RESULTS

The median age was 60 years (range 48-69 yrs), with a median CP 9 (range 8-11) and MELD-Na 14 (range 9-24). Main cause of cirrhosis was hepatitis C. Three patients required downsizing to be listed within Milan criteria for transplant. The median SBRT dose was 40 Gy in 5 fractions (range 30-50 Gy in 4-6 fractions). The median tumor max dimension was 2.3 cm (range 1.3-5.2 cm). The median PTV size was 37.5 cc (range 9-164 cc). Two patients had a prior TACE. The median time from SBRT to OLT was 5 mos (range 2-10 mos). All patients in the study received planned SBRT prior to OLT. One patient succumbed to progression of hepatic cirrhosis before OLT. The median follow-up and survival was 40 mos (range 3-70 mos) and 46 mos (range 3-70 mos), respectively. Local control was 100%. One patient progressed distantly at 38 mos, with no patients recurring in the liver. The median decrease in size of the HCC lesion was 60%, with five lesions having complete radiographic response by mRECIST criteria. Out of 5 patients who had elevated pretreatment AFP, 4 normalized by 6 mos. Five patients out of the 11 transplanted (45%) had a pathologic complete response on explanted liver. Acute toxicities (CTCAE v4.03) were two Grade 1 gastrointestinal and six Grade <=2 fatigue. No patients were diagnosed with RILD, however 4 patients had grade <=2 elevation of their liver enzymes. The median time to progression of CP > 2 was 9.7 mos (range 7 days-10 mos) while MELD-Na progression leading to an increased 3-month mortality was not met before OLT.

CONCLUSION

Based on our retrospective study we suggest, that SBRT with functional treatment planning can be used safely as a bridging treatment to OLT in select patients with severe cirrhosis meeting Milan criteria for liver transplant

CLINICAL RELEVANCE/APPLICATION

This paper demonstrates promising efficacy and toxicity results in one of the largest series of select patients with severe (Child Pugh $\geq$ 8) cirrhosis treated with SBRT with functional treatment planning for tumor downsizing prior to OLT.

MSRO33-04 Liver Radiomics Using Sulfur Colloid SPECT/CT for Survival Prediction in Primary Liver Cancer Patients Treated with Radiation Therapy

Tuesday, Nov. 27 2:00PM - 2:10PM Room: S103AB

Participants
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PURPOSE

A critical need in radiotherapy (RT) for primary liver cancer patients is to accurately predict those at risk for toxicity and mortality. We hypothesize that radiomic signatures of the uninvolved liver extracted from pre-treatment functional liver imaging with [99mTc]sulfur colloid (SC) SPECT/CT can improve overall survival (OS) prediction compared with clinical factors alone.

METHOD AND MATERIALS

We retrospectively reviewed 48 primary liver cancer patients with underlying cirrhosis treated with RT for clinical data, including Child-Pugh (CP) score and gross tumor volume (GTV). 30 radiomic features were extracted from pretreatment SC SPECT/CT of the uninvolved liver (histogram, Haralick, neighborhood difference, and zone size features). Cox models were used for univariate and multivariate analysis of OS. Univariate p-values were not adjusted for multiple comparisons. The LASSO was used to construct multivariate models (<=4 variables). Initial model performance was estimated by the apparent c-index (Capp) and models were internally validated with the .632 bootstrap (C.632).

RESULTS

Twelve patients (25%) had CP-B8+ cirrhosis, and median GTV was 10 cc3 [1.2-1573]. 18 died over median follow-up of 13 months. The strongest univariate predictors of OS were GTV (hazard ratio (HR) 2.6, p<0.001) and CP score (HR 1.7, p=0.027), and 9 radiomic features had p<0.05 after adjusting for the strongest predictor (GTV). Multivariate LASSO-Cox performance was Capp=0.75 for GTV, 0.64 for CP score, 0.65 for radiomics, and 0.83 for GTV+CP+radiomics. After internal validation, GTV (C.632 =0.76) and CP models (C.632 =0.64) retained predictive accuracy. However, the radiomics model was not predictive (C.632=0.55, p=0.34) and the GTV+CP+radiomics model was not superior to GTV alone (C.632=0.76, p=0.82).

CONCLUSION

Tumor volume, and to a lesser extent CP score, appear to predict overall survival in primary liver cancer patients. Univariate analysis suggested radiomic features of SC SPECT/CT may provide complementary information beyond GTV and CP score; however, their inclusion did not improve model performance. Prospective validation in a clinical trial is underway.

CLINICAL RELEVANCE/APPLICATION

SC SPECT/CT functional liver radiomics may complement clinical factors to predict survival in primary liver cancer patients for precision radiotherapy that improves outcomes and reduces toxicity.

MSRO33-05 Robotic Stereotactic Radiotherapy for Liver-only Oligometastastic Colorectal Cancer: Single Center Experience

Tuesday, Nov. 27 2:10PM - 2:20PM Room: S103AB

Participants
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PURPOSE

To report on the safety and clinical benefit of robotic stereotactic body radiotherapy for liver-only oligometastatic colorectal cancer.

METHOD AND MATERIALS

Robotic stereotactic radiotherapy (SBRT) with Cyberknife was applied to oligometastatic colorectal cancer patients defined as having 1-4 liver metastases and absent or controlled extrahepatic disease. The intended prescription dose was 37,5 Gy in 3 fractions, prescribed to the 70% isodose line to cover 95% of the PTV, and adapted if risk-related. Liver - implanted fiducials allowed for tumor tracking during delivery. Treatment efficacy was estimated by clinical benefit rate (CBR), progression free survival (PFS) and overall survival (OS). Toxicity was graded according to CTCAE v. 4.03. Regression analysis was performed to establish whether any correlation could be found between treatment efficacy and biologically effective dose (BED), number of metastatic lesions, number of treated lesions, site of primary tumor, presence of extrahepatic disease and number of lines of systemic treatment.

RESULTS

Between 2012 and 2017, 38 patients (66 lesions) were irradiated. The median delivered biological effective maximum dose (maxBED10) was 142 Gy. At a median follow-up of 11.8 months (range 3.2-58.8), the 1 and 2-year OS were 67.3% and 44.1%, respectively.Local relapse or distant progression occurred in 28 (77,8%) patients, with a 1 and 2-year PFS of 19.3% and 12.2%, respectively. The CBR was 71,4%, with no significant association with max BED10. Age at SBRT > 76 ys and presence of extrahepatic disease had a significant impact on PFS, the latter confirmed at univariate and multivariate analyses. In addition, extrahepatic disease and number of metastatic lesions > 3 had a significant impact on OS, both of which significant at univariate analysis. Mean time of local or distant progression was 4,7 months (SD 3.7). No acute grade 3 gastrointestinal (GI) toxicity was observed.

CONCLUSION

Our results underline the importance of patients' selection to identify the oligo-metastatic scenario most likely to benefit from SBRT. Prospective studies are needed to further assess the role of SBRT among loco-regional treatment options for liver metastases from colorectal cancer.

CLINICAL RELEVANCE/APPLICATION

Our retrospective single center experience adds to the limited available evidence on the promising efficacy and tolerability of SBRT for liver metastases from oligometastatic colorectal cancer

MSRO33-06 Preliminary Clinical Study of Biliary Tract Irradiation Stent for Hilar Cholangiocarcinoma with Malignant Obstructive Jaundice

Tuesday, Nov. 27 2:20PM - 2:30PM Room: S103AB

Participants

Ju Gong, Shanghai, China (*Presenter*) Nothing to Disclose

PURPOSE

To evaluate the efficacy and safety of biliary stent loaded with 125I seeds in treatment of hilar cholangiocarcinoma with malignant obstructive jaundice.

METHOD AND MATERIALS

Totally 43 patients with malignant obstructive jaundice caused by cholangiocarcinoma were included. All the paitents were underwent percutaneous transhepatic puncture ,of, the left and right side branch of the bile duct. In the hilar stenosis, the biliary stent with 125I seeds were implanted, and the biliary drainage tube had been kept in 3 to 5 days after procedures. The drainage tube was removed and the puncture road was closed after the patency of stents were confirmed by cholangiography. The changes of liver function before and after procedures were recorded, and the survival time was observed.

RESULTS

Five biliary stents loaded with 125I seeds were implanted in typeI (n=5), 36 in type II (n=18), 8 in typeIII (n=4) and 25 in typeIV (n=16). The Serum total bilirubin and direct bilirubin of paitents before procedures were (145.5 ±65.3) μmol/L and (124.7±35.0) μmol/L respectively, and (65.9±29.4) μmol/L and (35.5±15.1) μmol/L respectively after procedures. Compared with preoperative, the alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, C-reactive protein and gamma glutamic transaminase decreased significantly (all $P<0.05$); and the lactate dehydrogenase increased significantly ($P=1.05$). The median survival time was 13 months (3.0 to 22.5 months). The serious complications such as biliary puncture, pancreatitis, severe biliary tract infection or biliary bleeding were not occurred.

CONCLUSION

Biliary stent loaded with 125I seeds is an effective therapy to alleviate symptoms of jaundice and prolong the survival time of patients with malignant obstructive jaundice caused by hilar cholangiocarcinoma.

CLINICAL RELEVANCE/APPLICATION

To evaluate the efficacy and safety of biliary stent loaded with 125I seeds in treatment of hilar cholangiocarcinoma with malignant obstructive jaundice.

MSRO37

BOOST: Lung, Mediastinum and Pleura

Tuesday, Nov. 27 1:30PM - 2:30PM Room: S103CD

BQ CH CT NM OI RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Meng X. Welliver, MD, Columbus, OH (*Moderator*) Nothing to Disclose
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Sub-Events

MSRO37-01 Dynamic Perfusion Area-Detector CT versus Dynamic Perfusion MR Imaging versus FDG-PET/CT: Capability for Therapeutic Outcome Prediction in Small Cell Lung Cancer Patients with Limited Disease

Tuesday, Nov. 27 1:30PM - 1:40PM Room: S103CD

Participants
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PURPOSE

To directly compare the capability for therapeutic outcome prediction among dynamics contrast-enhanced (CE-) perfusion area-detector CT (ADCT) and CE-perfusion MR imaging (MRI) assessed by same mathematical method and FDG-PET/CT in small cell lung cancer (SCLC) patients assessed as limited disease (LD).

METHOD AND MATERIALS

Forty-three consecutive pathologically diagnosed SCLC patients assessed as LD (25 male, 18 female; mean age 67 year old) underwent FDG-PET/CT, dynamic CE-perfusion ADCT and MRI, chemoradiotherapy, and follow-up examination. In each patient, therapeutic outcomes were assessed as therapeutic effect based on RECIST guideline, disease free interval and overall survival. Then, all patients were divided into two groups as follows: 1) responder (CR+PR: n=33) and 2) non-responder (SD+PD: n=10) groups. In each patient, total perfusion (TP) and tumor perfusions from pulmonary (TPP) and systemic (TPS) circulations calculated by dual-input maximum slope method from dynamic CE-perfusion ADCT and MRI data and SUVmax on PET/CT were assessed at targeted lesions. Then, final values were determined as average values from all targeted lesion, and compared between two groups by Student's t-test. To compare the capability for distinguishing two groups, all indexes as having significant difference were assessed by ROC analysis. 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

There were significant difference of all indexes except TPP determined by each method ($p<0.05$). Area under the curves (Azs) of TPS (ADCT: Az=0.92, MRI: Az=0.92) were significantly larger than that of SUVmax (Az=0.73, $p<0.05$). Disease free survivals of responder were significantly longer than that of non-responder by TP (ADCT: p=0.006, MRI: p=0.02) and TPS (ADCT: p=0.001, MRI: p=0.02). Overall survivals of responder were also significantly longer than that of non-responder by TP (ADCT: $p<0.0001$, MRI: p=0.0003,) and TPS (ADCT: p=0.001, MRI: p=0.001).

CONCLUSION

Dynamic CE-perfusion ADCT and MRI have better potential for predicting therapeutic outcome than FDG-PET/CT in small cell lung cancer patients with limited disease.

CLINICAL RELEVANCE/APPLICATION

Dynamic CE-perfusion ADCT and MRI have better potential to predict therapeutic outcome than FDG-PET/CT in small cell lung cancer patients with limited disease.

MSRO37-02 Modern Treatment Patterns and Overall Survival of Non-Small Cell Lung Cancer Patients Receiving Palliative Radiation Therapy for Brain Metastases at Diagnosis

Tuesday, Nov. 27 1:40PM - 1:50PM Room: S103CD

Awards
Student Travel Stipend Award

Participants
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Christopher D. Abraham, MD, Manchester, MO (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Non-small cell lung cancer (NSCLC) is one of the most common malignancies associated with brain metastases (BM) at diagnosis. Recent randomized trials have shown equivalent survival outcomes and improved neurocognitive outcomes with stereotactic radiosurgery (SRS) compared to whole brain radiation therapy (WBRT). We reviewed the NCDB to identify trends of RT for NSCLC patients with BM.

METHOD AND MATERIALS

11,299 NSCLC patients with BM at diagnosis and treated with palliative brain RT between 2010 and 2014 were identified in the NCDB. Patients receiving "stereotactic radiosurgery, NOS," "LINAC radiosurgery," or "gamma knife radiosurgery," or received external-beam RT with fraction size >=6 Gy were included in the SRS cohort. The WBRT cohort included all patients receiving RT to the brain in >=5 fractions. Patient characteristics were correlated with treatment received using multivariable logistic regression. Kaplan-Meier was used to compare overall survival (OS) between these two groups and Cox Proportional Hazards modeling (CPHM) to identify variables associated with OS.

RESULTS

9,680 (85.7%) patients were included in the WBRT group and 1,619 (14.3%) patients in the SRS group. Median dose in the WBRT was 3000 cGy and 2200 cGy in the SRS group. The frequency of SRS increased from 9.9% in 2010 to 19.6% in 2014. On MVA, variables associated with increased likelihood of receiving SRS included: increasing age (OR 1.01, 95% CI 1.01-1.02; P<0.0001), most recent year (2014) of diagnosis (OR 2.14, 1.78-2.56; P<0.0001), treatment at an academic facility (OR 3.21, 2.51-4.10; P<0.0001), private insurance (OR 2.25, 1.62-3.11), income in zip code >$63,000 (OR 1.33, 1.13-1.56; P=0.001), living >20 miles from treatment facility (OR 1.19, 1.03-1.37; P=0.016), and receipt of chemotherapy (OR: 2.48, 2.12-2.88; P<0.0001). WBRT patients had median OS of 4.1 months (95% CI, 4.0-4.3) vs. 8.9 months (8.2-9.7) for SRS patients (P<0.0001). On CPHM, factors independently associated with improved OS included receipt of SRS, chemotherapy, treatment at an academic center, and private insurance (P<0.02 for all).

CONCLUSION

Our analysis reveals that WBRT remains the most common palliative treatment for BM in NSCLC. SRS use is increasing and has nearly doubled between 2010 and 2014. In this study, SRS was associated with increased OS although there are biases in the selection of patients who receive SRS.

CLINICAL RELEVANCE/APPLICATION

SRS use for NSCLC patients with BM at the time of diagnosis is increasing, and is independently associated with improved OS.

MSRO37-03 Quantification of Radiation Pneumonitis in Lung Cancer Patients Receiving Proton or Photon Radiotherapy Using FDG-PET/CT

Tuesday, Nov. 27 1:50PM - 2:00PM Room: S103CD

Awards
Trainee Research Prize - Fellow

Participants
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PURPOSE

This study assessed the feasibility of FDG-PET/CT to quantify radiation-induced pneumonitis in ipsilateral and contralateral lungs of patients with locally advanced non-small cell lung cancer (NSCLC) who received proton, photon, or combined proton-photon radiotherapy (RT).

METHOD AND MATERIALS

39 consecutive patients (53.8% female, median age 67y) with predominantly stage IIIA (62%) or IIIB (31%) NSCLC underwent FDG-PET/CT before and after proton or photon RT. Regions of interest (ROIs) were drawn manually along the margins of the lung parenchyma on PET/CT images. Lung mean standardized uptake value (SUVmean), global lung glycolysis (GLG), and lung volume were measured. Partial volume correction (PVC) of PET-based parameters was then performed. To quantify tumor metabolic response to RT, metabolically active tumor volume (MTV), tumor SUV, and total lesion glycolysis (TLG) were measured. Total lesion glycolysis was then subtracted from GLG to calculate global lung parenchymal glycolysis (GLPG). Parameters of FDG-PET/CT scans before and after RT were compared using two-tailed paired t-tests.

RESULTS

Among the 9 patients who received photon RT, there was a significant increase in PVC-GLPG of ipsilateral ($p < 0.001$) and in GLG of contralateral ($p = 0.036$) lungs. Also, in the subset of 9 patients who received combination of proton-photon RT, there was a statistically significant increase in PVC-GLPG in only the ipsilateral lung ($p < 0.001$). In contrast, among the 21 patients treated exclusively with proton RT, no significant increase in PVC-SUVmean ($p=0.114$) or in PVC-GLPG ($p=0.453$) were observed in ipsilateral lungs. Also, there were no significant increase in SUVmean ($p=0.841$) or in GLG ($p=0.241$) of contralateral lungs of patients who received exclusively proton RT.

CONCLUSION

We identified significant increases in PVC-SUV and PVC-GLPG in patients who received photon RT (either alone or in combination with proton RT) that were not identified in patients who received only proton RT. These observations suggest less induction of inflammatory response in both ipsilateral and contralateral lungs of patients treated with proton compared to photon or combined proton-photon RT, suggesting a mechanism by which proton therapy reduces radiation-induced pneumonitis.

CLINICAL RELEVANCE/APPLICATION

Proton RT induces less inflammatory response in both the ipsilateral and contralateral lungs of patients compared to photon or combined proton-photon RT.

MSRO37-04 Differentiating EGFR Mutation Status in Non-Small Cell Lung Cancer Using Imaging Features From PET/CT

Tuesday, Nov. 27 2:00PM - 2:10PM Room: S103CD

Participants
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Xiuzhong Yao, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

In this study, we investigated whether epidermal growth factor receptor (EGFR) mutation status in non-small cell lung cancer (NSCLC) can be assessed from quantitative as well as qualitative features extracted from both CT and PET.

METHOD AND MATERIALS

Eighty patients with stage II and III NSCLC and a confirmed EGFR mutation status (30 patients were positive and 50 were negative for EGFR mutation), who underwent PET/CT between January 2017 to December 2017, were included in this study. We extracted 514 quantitative features from PET/CT (257 for PET and 257 for CT) and 12 qualitative features from CT. Principal component analysis (PCA) was applied for feature selection. We selected principal components retaining 95% of the variability from all features. We then rebuilt the original features using the selected principal components and the original features were selected that correlated by at least 99% to the rebuilt features. Finally, 5 qualitative features, 24 quantitative features for CT as well as 10 quantitative features for PET were selected. A predictive model of EGFR mutation in terms of selected features using generalized linear regression with lasso regularization. The regularization parameter was selected through a 10-fold cross validation. All statistical analysis were performed in R software version 3.4.4.

RESULTS

With the total of 39 features selected which were significantly associated with EGFR mutation status, a predictive model for associating image features with EGFR positive/negative was built. We estimated the performance of the model using the area under the receiver operating characteristic curve (AUC). The result revealed an AUC=0.74.

CONCLUSION

By combing the PET-CT images together with first generation gene testing data, we investigate the relationship between image features and EGFR mutation status and built a radiogenomics model which can predict whether the patients have EGFR mutation or not from a certain number of qualitative features as well as quantitative features.

CLINICAL RELEVANCE/APPLICATION

A non-invasive method from image features to predict gene mutation status correlated with NSCLC and further advancing the role of imaging in precision medicine.

MSRO37-05 Stereotactic Body Radiotherapy for Centrally Located Non-Small Cell Lung Cancer: Single Center Experience

Tuesday, Nov. 27 2:10PM - 2:20PM Room: S103CD

Participants

Lorenzo Livi, Florence, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

By definition, centrally located lung tumors are identified as a lesion located within 2 cm or touching the zone of the proximal bronchial tree or tumors immediately adjacent to the mediastinal or pericardial pleura. In these cases, the use of stereotactic body radiotherapy (SBRT) is debated due to the potential risk of severe toxicity. Currently, no high-level evidence is available to support its use.

METHOD AND MATERIALS

Between 2010 an 2015, 40 patients were treated with SBRT for 45 centrally located lesions. SBRT was delivered through either a LINAC-based intensity modulated radiotherapy (IMRT) technique or a robotic technique with Cyberknife. The prescribed total dose varied between 26 and 60 Gy delivered in 1 or 8 fractions, respectively, with median BED10 of 69 Gy (range 37,5-105 Gy). Overall Survival (OS) and Progression Free Survival (PFS) were reported using Kaplan-Meier method. Treatment-related toxicity was evaluated according to CTCAE version 4.0

RESULTS

The median age of the cohort was 62 years (48-86). The majority of treated lesions were secondary hilar or mediastinal lymphadenopathies (31/45, 69%), while unresectable primary tumors represented the remaining 14 cases (14/45, 31%). The most commonly used technique was VMAT for 21 lesions (47%), followed by Cyberknife for 14 (31%) and step and shoot IMRT for 10 targets (22%), respectively. The predominant NSCLC histology was adenocarcinoma (32/45, 71%). The median longest tumor diameter was 31 mm (range 10-60 mm). At a median follow-up of 14.5 months, OS and PFS were 86.5%, 55.6%, 49.4% and 48.6%, 24.1% and 12% at 1, 2 and 3 years, respectively. According to RECIST 1.1 criteria, a clinical benefit was achieved for 23 patients (57.5%) with a complete or partial response or stable disease in 4 (10%), 15 (37.5%) and 4 (10%) patients, respectively. Consistent with previous experiences using the same fractionation regimens, SBRT was well tolerated, with no G3/G4 toxicities: the most severe side effect was G2 esophagitis in 5/40 patients (12.5%).

CONCLUSION

In accordance with standardized risk-dose prescriptions, the use of SBRT for centrally located NSCLC was confirmed to be a safe and effective strategy. Prospective studies are warranted to support its use with high level evidence.

CLINICAL RELEVANCE/APPLICATION

Our single-center experience adds to the limited available evidence on the feasibility and clinical benefit of SBRT for centrally located NSCLC

MSRO37-06 Evaluation of the Tumor Response Using FDG-PET/CT Scans in Non-Small Cell Lung Cancer Patients Treated with Proton or Photon Radiotherapy

Tuesday, Nov. 27 2:20PM - 2:30PM Room: S103CD

Participants
Pegah Jahangiri, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
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PURPOSE

Lung cancer is one the leading causes of death worldwide. Radiation therapy (RT) is a major treatment option for lung cancer, including for unresectable locally advanced non-small cell lung cancer (LA-NSCLC). The aim of this study was to evaluate the response of the primary lung tumor to proton versus photon RT using 18F-fluorodeoxyglucose (FDG)-PET/CT in patients with LA-NSCLC.

METHOD AND MATERIALS

Thirty-nine consecutive patients who underwent FDG-PET/CT imaging pre- and post- proton or photon RT were assessed. Patients were predominantly female (53.8%) with a median age of 67 years and with predominantly stage IIIA (62%). An adaptive contrast-oriented thresholding algorithm was applied to measure metabolically active tumor volumes, uncorrected SUV, partial volume corrected SUV and total lesion glycolysis. Parameters of FDG-PET/CT scans before and after RT were compared using two-tailed paired t-tests.

RESULTS

Among the 9 patients who received photon RT and the 9 patients who received a combination of proton-photon RT, there was a significant decrease in PVC-TLG. Interestingly, among the 21 patients treated exclusively with proton RT, all tumor parameters including MTV, SUVmax, uncorrected SUVmean, PVC-SUVmean, uncorrected TLG, and PVC-TLG after treatment decreased significantly (all $p < 0.001$). The decreases in PVC-TLG and tumor PVC-SUVmean were more obvious than non-PVC ones (ΔPVC-TLG -357.26 cc versus ΔTLG -252.92 cc; ΔPVC-SUVmean -16.2 versus ΔSUVmean -10.19).

CONCLUSION

Adaptive contrast-oriented thresholding algorithm is a promising method to quantify whole tumor glycolysis in LA-NSCLC, and our findings demonstrates that proton RT is as effective as photon RT metabolically in inducing tumor response of LA-NSCLC.

CLINICAL RELEVANCE/APPLICATION

Proton RT, which is much safer, is as effective as photon RT in treatment of LA-NSCLC.

SSJ01

Breast Imaging (Monitoring Response to Treatment)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E450A

BQ BR MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Wendy B. Demartini, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Constance D. Lehman, MD,PhD, Boston, MA (*Moderator*) Research Grant, General Electric Company; Medical Advisory Board, General Electric Company

Sub-Events

SSJ01-01 Complete Response on MR Imaging After Neoadjuvant Chemotherapy in Breast Cancer Patients: Factors of Radiologic-Pathologic Discordance

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E450A

Participants
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PURPOSE

Although MR imaging may show radiologic complete response (rCR) after neoadjuvant chemotherapy (NAC), there may be discordance between the MR imaging and pathology. The purpose of this study was to evaluate the radiologic and clinicopathologic factors of discordance between rCR and pathologic complete response (pCR) after NAC in breast cancer patients, and to determine whether there are differences among molecular subtypes.

METHOD AND MATERIALS

Our institutional review board approved this retrospective study. We evaluated 209 consecutive patients who showed rCR in MR imaging after NAC between January 2013 and December 2015. All patients had mammography, ultrasound and MR imaging before and after completion of NAC prior to definitive surgery. rCR was diagnosed when no enhancement or faint enhancement was shown in the previous lesion site equal to that of the background normal breast tissue. pCR was defined as the complete absence of both invasive cancer and ductal carcinoma in situ in the breast on the surgical histopathological examination. Clinicopathologic and initial radiologic findings were assessed and factors affecting the radiologic-pathologic discordance were analyzed.

RESULTS

One hundred eight patients (51.7%) showed pCR and 101 (48.3%) had residual lesion on surgical histopathology. The false negative findings were significantly more frequent in luminal A and B subtype (67.3%, 68/101), with radiologic findings such as larger tumor size ($p = 0.048$) in mammography, irregular shape ($p = 0.021$), high proportion of persistent component ($p = 0.008$), and low proportion of washout component ($p = 0.001$). On multivariate analysis of radiologic findings in all patients to predict residual lesion, calcification in mammography ($p = 0.037$), multifocal lesion ($p = 0.004$), and nonmass enhancement in MR ($p = 0.023$) were significantly associated with residual lesion.

CONCLUSION

Luminal subtype has a significant high false negative rate who achieved rCR after NAC. Patients with calcification in mammography, multifocal lesion, and nonmass enhancement in initial MR imaging are significantly associated with residual lesion.

CLINICAL RELEVANCE/APPLICATION

Although MR imaging showed rCR after NAC, multifocal breast cancer with calcification and nonmass enhancement, residual lesions should be considered and may impact surgical planning.

SSJ01-02 How Should a Radiologist Diagnose a Complete Imaging Response on Breast MRI after Neoadjuvant Chemotherapy?

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E450A

Participants
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PURPOSE

There is no standard definition regarding what constitutes a complete imaging response (CIR) on breast MRI post-neoadjuvant chemotherapy (NAC). The purpose is to evaluate the accuracy of a CIR defined as no residual enhancement in the tumor bed post-NAC in diagnosing a pathologic complete response (pCR).

METHOD AND MATERIALS

The IRB approved this HIPAA-compliant retrospective study and waived informed consent. Women were identified with biopsy proven invasive breast cancer who underwent: a) NAC, b) pre and post-NAC MRI and c) surgery between 2014-2016. CIR was defined as no residual enhancement on any of the three post-contrast phases on post-NAC MRI. Two breast radiologists (R1 and R2) independently reviewed all pre and post-NAC MRI blinded to pathology. pCR was defined as no residual invasive or in situ carcinoma. Measures of accuracy, including sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) were estimated using no enhancement on MRI to diagnose pCR. Kappa statistic was used to assess agreement between readers.

RESULTS

275 women were included with 280 breast cancers (n=5, 1.8% had bilateral cancers). Of the 280 breast cancers, 256 (91.4%) were invasive ductal carcinoma, 11 (3.9%) were invasive lobular carcinoma and 13 (4.7%) were other invasive carcinoma. 74 (26.4%) had a pCR and 186 (66.4%) had no pCR. The two readers had substantial agreement on enhancement (kappa=0.627, 87.5% concordant readings). Sensitivity was 40.5%(R1)/50.0%(R2), specificity was 87.9% (R1)/86.9%(R2), PPV was 54.5% (R1)/57.8% and NPV was 80.4%(R1)/82.9(R2). These measures of accuracy were not significantly different between different subtypes defined as: ERPR+HER2-(n=99), ERPR+HER2+(n=61), ERPR+HER2equiv (n=1), ERPR-HER2+(n=44) and ERPR-HER2- (n=75).

CONCLUSION

CIR defined as no residual enhancement in the tumor bed on post-NAC breast MRI is not sensitive in diagnosing a pCR. Residual enhancement can be seen with a pCR and a better definition of what constitutes a CIR is needed; our results suggest that it should include some degree of low-level tumor bed enhancement.

CLINICAL RELEVANCE/APPLICATION

Complete imaging response defined as no residual enhancement in the tumor bed is not an accurate assessment of pathologic complete response, which radiologists need to be aware of as management decisions based upon post-NAC MRI interpretation can impact the decision to perform breast conservation versus mastectomy.

SSJ01-03 Predicting Axillary Response to Neoadjuvant Chemotherapy Using Breast MRI and US Based Model in Patients with Clinically Node-Positive Breast Cancer

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E450A

Participants
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Woo Kyung Moon, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The axillary LN pathologic complete response (pCR) is increasingly common after neoadjuvant chemotherapy (NAC) in breast cancer patients, for whom axillary LN dissection may be spared. The aim of our study was to develop a clinical model including MRI and US to better predict axillary pCR after NAC in clinically node-positive breast cancer patients.

METHOD AND MATERIALS

An IRB-approved retrospective review was performed for 172 consecutive clinically node-positive breast cancer patients who were treated with NAC and following surgery at our institution from 2016 to 2017. All the patients underwent breast MRI and US, before and after completion of NAC to evaluate the primary tumor extent and axillary LN status. The multivariate logistic regression analysis determined independent predictors of axillary pCR. With combination of those variables we developed a predictive model to increase axillary pCR rate.

RESULTS

Among 172 patients the overall axillary pCR rate was 59%, with 75% (46/61) and 42% (30/71) in cN1 and cN2 patients, respectively. Pretreatment characteristics of clinical N stage, axillary lymphadenopathy and tumor subtype were correlated with axillary pCR (all, $p<0.05$). Post-NAC imaging features including mean tumor size, the size change rate on MRI and the axillary LN cortical thickness on US were predictors of axillary pCR (all, $p<0.05$). From the multivariate logistic regression analysis, independent variables were clinical N stage, tumor subtype, tumor size change rate on MRI and axillary lymphadenopathy on post-NAC US, with an AUC of 0.884 (all, $p<0.05$). The axillary pCR rate of cN1 and non-luminal A model was 88% (38/43) and addition of absent axillary lymphadenopathy improved pCR rate to 94% (33/35). In cN2 patients, the axillary pCR rate of non-luminal A and no axillary lymphadenopathy model increased from 70% (24/34) to 91% (10/11) with additional condition of more than 80% size decrease on MRI.

CONCLUSION

Clinical N stage, tumor subtype and MRI/US findings were predictors of axillary LN pCR. Our predictive model including clinico-pathologic features and image findings could achieve high axillary pCR rate, which may guide LN dissection planning after NAC in clinically node-positive breast cancer patients.

CLINICAL RELEVANCE/APPLICATION

Our imaging based predictive model can improve risk stratification which may avoid unnecessary axillary LN dissection in clinically node-positive breast cancer patients after NAC.

SSJ01-04 Texture Analysis of Lymph Node MRI Characteristics Improves Prediction of Progression-Free Survival Following Chemotherapy in Breast Cancer

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E450A

Participants
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PURPOSE

Pathological complete response and reduction in lesion volume (LV) after chemotherapy do not guarantee progression-free survival (PFS). About 1/3 of patients with pathological complete response had relapse at 5 years in our cohort. Breast cancer metastasizes through the lymphatic system. Axillary lymph node (LN) is clinically evaluated by palpation and using ultrasound. This study investigated the efficacy the texture analysis of the LN MRI in predicting PFS.

METHOD AND MATERIALS

Data were obtained from I-SPY 1 trial of breast cancer patients undergoing chemotherapy. We extracted 48 textures for pre- (T1), early- (T2), during (T3) and post-chemo (T4) time points for a subset of patients (N=41) in whom LN MRI were usable. Area under the receiver-operating curve (AUC) was calculated, with PFS at 5-year as a reference variable. Multivariable generalized linear modeling was used to estimate model fit and assign a risk score at each time point based on top-ranking features.

RESULTS

For early (T1) in treatment, LV along with LN histogram skewness and grey-level run length matrix long-run emphasis were top predictors of PFS (AUC=0.68). LV became less predictive in later time points. LN features surpassed LV in post-chemo (T4) time point; the top features were neighborhood grey-level matrix coarseness and grey-level zone length matrix zone length non-uniformity. When changes in texture features over time were analyzed, LN features outperformed LV. Top early (T2-T1) predictors were change in compacity, gray-level non-uniformity, and volume of the LN. Top late (T4-T1) predictors were change in zone length non-uniformity and coarseness. The combination of risk scores across all time points resulted in a model with an AUC of 0.89 (sensitivity:91%, specificity:95%, p= 0.004).

CONCLUSION

Texture analysis of lymph node MRI improves prediction of PFS. The multivariable risk prediction model identified key characteristics and could provide strong predictors of relapse.

CLINICAL RELEVANCE/APPLICATION

Texture analysis of axillary lymph node MRI has the potential to accurately predict 5-year progression free survival.

SSJ01-05 Breast 3D Magnetic Resonance Fingerprinting Relaxometry: Utility in Measuring Early Response to Neo-Adjuvant Chemotherapy in Breast Cancer

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E450A

Participants
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PURPOSE

To assess (1) Repeatability of breast 3D MRF-based relaxometry and (2) preliminarily assess utility in measuring early response to neo-adjuvant chemotherapy in breast cancer

METHOD AND MATERIALS

In this IRB approved pilot study,12 healthy pre-menopausal volunteers were scanned with 3D MRF twice within 7-15 days for repeatability analysis.In 5 volunteers,same-day test-retest scans were also performed with repositioning after a 10-minute scan interval.For breast cancer evaluation,13 women with biopsy-proven invasive ductal carcinoma underwent baseline 3D MRF scans before chemotherapy.So far,7 women have undergone repeat 3D MRF 7-10 days after first cycle of chemotherapy.All scans were performed at 3T(Siemens Verio) using 8-channel breast coil.A 3D FISP-based MRF sequence with fat suppression was used.Overall acquisition time was 5.5min.For repeatability analysis,ROIs were drawn on a 3D MRF partition containing the largest area of normal breast tissue by one radiologist(8 years radiology experience) in both breasts.In breast cancer patients,ROIs were drawn on partitions showing tumor and the opposite normal breast.Mean T1 & T2 were estimated for all scans.Treatment response was based on either final pathology staging after surgery or RECIST criteria and T1 & T2 changes were compared in responders & non-responders

RESULTS

Same-visit test-retest within-subject coefficient of variation(wCV) was <5% for T1 and <6.5% for T2.Two-visit wCV was <6% for T1 and <5% for T2,establishing a measurable effect size.In breast cancer,tumor T1 & T2 were longer than normal breast(mean±SD,Tumor T1:1175±203 ms,Normal T1:846±388 ms,Tumor T2:72±13 ms,Normal T2:48±12 ms,p=0.030 for T1,p<0.001 for T2).After one cycle of chemotherapy,responders(n=4) showed greater decrease in T1 & T2(p=0.026 for T1,p=0.033 for T2) while patients with stable/progressive disease(n=3) showed negligible changes in T1 & T2

CONCLUSION

Breast 3D MRF relaxometry was shown to be repeatable.Baseline tumor T1 & T2 were longer than normal breast.Treatment responders showed larger change in T1 & T2 compared to non-responders.These preliminary results suggest that breast 3D MRF may be useful in quantitatively predicting early response to chemotherapy

CLINICAL RELEVANCE/APPLICATION

Breast 3D MRF relaxometry is a repeatable technique for longitudinal studies in patients.Significant decrease in tumor T1 and T2 after one cycle of chemotherapy may predict treatment response

SSJ01-06 Are the Baseline Imaging Characteristics of Breast Cancer Associated With Reponses to Neoadjuvant Chemotherapy?

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E450A

Participants
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PURPOSE

Predictors of response to neoadjuvant chemotherapy (NACT) within subgroups are poor and not commonly used. We aimed to establish if baseline mammographic (MGM) and ultrasound (US) features of breast cancer and breast cancer subtypes are associated with rates of pathological complete response (pCR) after NACT.

METHOD AND MATERIALS

The baseline imaging of 210 consecutive women who underwent NACT were reviewed by an experienced breast radiologist blinded to outcomes. The MGM features assessed were the presence or absence of spiculation and calcification. The US features documented were echogenicity, distal effect, the presence of a circumscribed border and the US lesion size. The relationships between baseline imaging features and pCR after NACT were documented. The findings according to sub-group (HER2+ve, triple negative and ER+ve HER2-ve) were also assessed. The significance of differences were analysed using the chi-square test and ROC curves.

RESULTS

Of the 210 patients, 46(22%) had a pCR while 164 did not. The cohort consisted of women with 82 triple negative (21 pCR's), 75 HER2+ve (21 pCR's) and 53 ER+ve HER2-ve (4 pCR's) cancers. For the complete cohort the features significantly associated with pCR were the absence of MGM spiculation (4 of 58 (7%) vs. 42 of 151(28%), p=0.001), the absence of distal shadowing on US (8 of 73(11%) vs. 38 of 136(28%), p=0.015) and small US size (AUC 0.62, P=0.02). In HER2+ve patients all the above associations were confirmed and in addition the presence of a circumscribed border on US was associated with high pCR rates (7 of 14(50%) vs. 14 of 60(23%), p=0.04). None of the above associations held true for triple negative cancers. The number of pCR's in the ER+HER2-ve group was to small to allow analysis.

CONCLUSION

The baseline imaging features of HER2+ve breast cancer are strongly associated with the chance of achieving a pCR following NACT. This is not so for triple negative cancers.

CLINICAL RELEVANCE/APPLICATION

This data could be helpful when discussing NACT and associated surgery with patients who have HER+ve breast cancer.

SSJ02

Breast Imaging (US Advanced Applications)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E353C

BR MR MI US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Sub-Events

SSJ02-01 Can Baseline Ultrasound and Mammographic Features Help Predict Metastasis Free Survival in Patients Receiving Neoadjuvant Chemotherapy?

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E353C

Participants
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PURPOSE

To determine if baseline mammographic and ultrasound features in patients receiving neoadjuvant chemotherapy (NACT) are associated with metastasis free survival (MFS).

METHOD AND MATERIALS

Informed consent for the study was obtained from consecutive women receiving NACT. All participants were metastasis free at diagnosis. Baseline images were retrospectively reviewed by a breast radiologist blinded to outcomes. Ultrasound (US) features documented included echo pattern, posterior effect, circumscribed margins, skin changes (invasion or thickening), lesion size and shear wave stiffness (mean). Mammogram (MMG) features documented were the presence or absence of spiculation and microcalcification. Tumour immunophenotype was assessed on core biopsy. Statistical significance was assessed using chi-square and ROC analysis.

RESULTS

134 breast patients were included; 52 had triple negative cancer, 48 were HER2+ve and 34 had ER+ve, HER2-ve disease. During the follow-up period (mean 4.3yrs) 41 women (31%) developed metastases. Across the whole cohort, skin involvement on baseline US was the only feature associated with metastasis development. MFS was 56% (23/41) vs 75% (70/93) for those with and without skin involvement respectively, p=0.03. US lesion size was not associated with MFS.In the HER2 positive subgroup mammographic calcification was associated with poorer MFS (12/24 (50%) vs 20/23 (87%), p=0.006). The presence of posterior shadowing on US was also associated with poorer MFS (11/22 (50%) vs 21/26 (81%), p=0.02) in this subgroup.No baseline imaging features were shown to be associated with MFS for triple negative and ER+ve HER-ve cancers.

CONCLUSION

We have demonstrated that baseline imaging characteristics are associated with MFS in patients treated with NACT particularly in the HER2 +ve subgroup. This prognostic information, which is available prior to treatment could aid patient treatment selection and counselling.

CLINICAL RELEVANCE/APPLICATION

Baseline imaging characteristics are associated with MFS in patients treated with NACT. This prognostic information, available prior to treatment, may aid patient treatment selection and counselling.

SSJ02-02 Combination of Different Types of Elastography in Downgrading Ultrasound Breast Imaging-Reporting and Data System Category 4a Breast Lesions

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E353C

Participants
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PURPOSE

When using single type of elastography to downgrade ultrasound (US) Breast Imaging-Reporting and Data System (BI-RADS) category 4a lesions, some cancers would be missed. This study purposed to determine whether combination of different types of elastography could improve the accuracy of elastography aided downgrading BI-RADS category 4a lesions and reduce unnecessary biopsies.

METHOD AND MATERIALS

For this prospective institutional review board-approved study, verbal informed consent was obtained from all patients. From January 2016 to February 2018, 329 consecutive women with 347 US BI-RADS category 4a breast lesions were enrolled in the study. These lesions, prior to biopsy, were subject to conventional US supplemented by elastography assessments, including strain elastography of elasticity imaging (EI), virtual touch tissue imaging (VTI) and Virtual Touch IQ (VTIQ). The diagnostic performances were calculated for BI-RADS category, EI, VTI and VTIQ, and the combination among EI, VTI and VTIQ (combined EI and VTI [EI+VTI], combined EI and VTIQ [EI+VTIQ] and combined VTI and VTIQ [VTI+VTIQ]).

RESULTS

Pathologically, 313 lesions (90.2%) were benign and 34 (9.8%) were malignant. The cut-off values were EI score>3, VTI score>3 and shear wave speed (SWS) on VTIQ>3.29 m/s, respectively. For EI, VTI and VTIQ alone, the specificity were significantly higher than that of BI-RADS (P <0.001), while the sensitivity were significantly lower than that of BI-RADS (76.5%, 70.6%, 67.6% vs. 100%, respectively, P <0.05). Among the combinations of different types of elastography, EI+VTI yielded the highest AUROC of 0.800 and negative predictive value of 99.5%. The sensitivity of EI+VTI was significantly increased as compared with single type elastography (P <0.05). There was no significant difference in the sensitivity between EI+VTI and BI-RADS (97.1% vs 100%, P =1.000) while the specificity was significantly higher than that of BI-RADS (P <0.001). When using EI+VTI to downgrade the lesions, 57.1% of the lesions would be downgraded and 99.5% of these lesions were benign.

CONCLUSION

Combinations of EI and VTI to downgrade BI-RADS category 4a lesions increased the sensitivity and reduced the misdiagnosis of breast cancers.

CLINICAL RELEVANCE/APPLICATION

Combination of different types of elastography provides a high sensitive way to downgrade BI-RADS category 4a lesions, potentially applied in clinical practice without increasing misdiagnosed cancers.

SSJ02-03 Correlation Between Apparent Diffusion Coefficient Values and Ultrasound Elasticity kPa Values in Breast Cancers

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E353C

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PURPOSE

DWI reflects tumor cellularity and integrity of cell membranes. Breast ultrasound elastography is a method of imaging tissue stiffness and the shear-wave elastography (SWE) allows measurement of the propagation speed of shear waves within the tissue to locally quantify its stiffness in kilopascals (kPa) or meters per second (m/sec). This study was performed to evaluate the correlation between breast apparent diffusion coefficient (ADC) values and ultrasound Shear wave elastography kPa values in biopsy proven breast cancers.

METHOD AND MATERIALS

From January 2016 to November 2017, 121 patients who have breast cancer confirmed by US-guided biopsy underwent both pre-operative breast diffusion MRI and breast SWE. Among these patients we included only who underwent examination by same operator to reduce inter-operator variability. Finally, this study included 94 breast cancer patients. The investigated factors included the ADC values, mean kPa values (Emean), maximum kPa values (Emax), pathology, size of tumor, associated calcifications, ER/PR/HER2 status, molecular subtypes, Ki-67 index, mammographic density and BI-RADS US assessment category. The results were analyzed using the statistical software SPSS for Windows (version 24). The correlation analysis was used to study correlation between ADC values, Emean/Emax, size and Ki-67. And independent samples of t-test and ANOVA including post hoc test were performed to evaluate for the above variables.

RESULTS

There was no correlation between ADC values and Emean (p=0.791)/Emax (p=0.634)[Fig1]. However, Emean (p=0.001), Emax (p<0.001), and Ki-67 index value (p=0.010) were significantly correlated with the size of tumor. High Ki-67 index group showed statistically significant lower ADC values (p=0.034) and higher Emean (p=0.064)/Emax value (p=0.065) without statistical insignificance. The Emean (p=0.002)/Emax (p=0.001) were correlation with T stage but ADC (p=0.813) was not. Howevre, the

Eman (p=0.000)/Emax (p=0.000) and ADC (p=0.017) were also correlated with US BIRADS categories.

CONCLUSION

The ADC values and Emean/Emax in breast cancers were nor correlated each other. However, the size of tumor, Ki67 index, BI-RADS assessment category affected the ADC and Emean/Emax values independently.

CLINICAL RELEVANCE/APPLICATION

The size of breast cancer, Ki67 index, BI-RADS assessment category affected the ADC and Emean/Emax values independently.

SSJ02-04 Breast Cancer Staging: Combined Digital Breast Tomosynthesis and Automated Breast Ultrasound versus Magnetic Resonance Imaging

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E353C

Participants
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PURPOSE

To investigate whether combined Digital breast tomosynthesis and Automated breast volume scanner (DBT-ABVS) are comparable to Magnetic resonance imaging (MRI) in staging breast cancer.

METHOD AND MATERIALS

We retrospectively included seventy-three patients with histologically proven breast cancer who underwent preoperative DBT, ABVS and 1.5T MRI in the period July 2015-July 2016. Two radiologists in consensus recorded the number, site and BI-RADS category of breast findings during two independent reading strategies, i.e. DBT-ABVS vs. MRI. Using histology or 1-year follow up as the standard of reference, we calculated the accuracy for cancer of both imaging strategies. Bland-Altman analysis was used to evaluate the agreement between MRI vs. DBT or ABVS in cancer size assessment.

RESULTS

Patients showed a total of 160 lesions (108 malignant and 52 benign). Malignant lesions were monofocal, multifocal, multicentric and biltateral in 53, 15, 4 and 1 cases, respectively. Diagnostic accuracy of DBT-ABVS vs. MRI was comparable for all cancers (90.0% vs. 93.8%, respectively), though DBT-ABVS showed lower sensitivity and positive predictive values for additional disease (76.5% vs. 91.7%, and 78.8% vs 93.4%, respectively). Compared to MRI, ABVS+DBT missed 6 lesions, including two invasive cancers and one extensive intravascular invasion associated to ductal carcinoma in situ. Bland-Altman analysis showed ABVS to agree with MRI at a higher extent than DBT in assessing cancer size.

CONCLUSION

DBT-ABVS is less accurate than MRI in staging additional disease.

CLINICAL RELEVANCE/APPLICATION

Though less performing than MRI, DBT-ABVS showed acceptable diagnostic accuracy in staging breast cancer. This strategy might be used if MRI is unavailable or unfeasible.

SSJ02-05 Quantitative Elastic Heterogeneity as a Potential Noninvasive Marker of Lymphovascular Invasion in Breast Cancer

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E353C

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PURPOSE

To evaluate the association between quantitative elastic heterogeneity (EH) and lymphovascular invasion (LVI) in breast cancers.

METHOD AND MATERIALS

This retrospective study consisted of 97 patients with breast cancers that had undergone shear wave elastography (SWE) with virtual touch tissue imaging quantification (VTIQ) between August 2015 and August 2017. Three region of interests (ROIs) were placed over the highest stiffness and the lowest stiffness areas of each lesion to measure shear wave velocity (SWV) and EH was determined as the difference between the averaged highest SWV and lowest SWV. Classical prognostic factors including lesion size,

histopathological type and grade, subtype [luminal A, luminal B (HER2-), luminal B (HER2+), HER2 enriched and basal-like], and axillary lymph node (LN) status were reviewed and their correlation with EH values were stratified by the presence or absence of LVI. The diagnostic performance of EH in distinguishing LVI or not were analyzed in lesions smaller than 2 cm.

RESULTS

Tumors with LVI showed significantly higher EH values when compared to tumors without LVI (adjusted $P < 0.001$), regardless of the tumor size, histological grade and type, and LN status. Lymphovascular invasion (adjusted $P < 0.001$), large tumor size (adjusted $P = 0.011$) and lymph node involvement (adjusted $P = 0.046$) showed statistically positive association with high EH values. In breast cancers smaller than 2 cm, tumors with LVI (4.31±1.16 m/s) showed significantly higher EH values when compared to tumors without LVI (2.99±1.18 m/s) (adjusted $P < 0.001$). Using EH higher than 3.66 m/s to suggest LVI, the area under the receiver operating characteristic curve was 0.796, and the sensitivity, specificity, positive predictive value and negative predictive value were 78 % (14/18), 75 % (39/52), 52 % (14/27) and 91 % (39/43), respectively.

CONCLUSION

EH could be served as a potential marker to assess LVI status on preoperative imaging, especially for breast cancer less than 2 cm in size.

CLINICAL RELEVANCE/APPLICATION

Quantitative elastic heterogeneity of breast cancer can be used as a non-invasive marker for preoperative evaluation of LVI, thereby guiding clinical regulation and predicting prognosis.

SSJ02-06 Multiparametric Quantitative Ultrasound of the Breast Can Improve the Diagnostic Performance of the Radiologist

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E353C

Participants
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PURPOSE

To evaluate quantitative multiparametric ultrasound (mpUS) of the breast using B-mode US, elastography, Doppler and contrast enhanced US (CEUS) in different combinations of 2, 3 or 4 parameters for the differentiation of benign and malignant lesions and investigate a possible variation according to the degree of experience of the examiner.

METHOD AND MATERIALS

124 patients, each with one biopsy-proven, sonographically evident breast lesion were included in this prospective, IRB-approved study. Each lesion was examined with B-mode US, elastography (Virtual Touch IQ-VTIQ), Doppler US and CEUS. Different quantitative parameters were recorded for each modality: Shear Wave Velocity (SWV) for VTIQ, Pulsatility (PI) and Resistive Index (RI) for Doppler US. For CEUS, 11 different parameters were calculated using a dedicated software. 4 readers (2 experienced breast radiologists and 2 radiology residents) independently evaluated B-mode images of each lesion and assigned a BI-RADS score to it. Using ROC curve analysis, the quantitative parameter with the best diagnostic performance for each modality was chosen and cut-off values were calculated. Using these, all quantitative results were dichotomized. The BI-RADS scores of all readers were then combined with the quantitative parameters. Descriptive statistics were used to evaluate the diagnostic performance of mpUS. Histology served as the reference standard.

RESULTS

59 lesions were benign and 65 malignant. SWV, RI and mean transit time showed the highest diagnostic performance. MpUS with three parameters (B-mode, VTIQ and CEUS) showed the highest diagnostic performance irrespective of the experience level of the readers (averaged AUC 0.812 vs. 0.683 for B-mode US, p-value 0.0001), while the combination of B mode, VTIQ and Doppler US the second best (averaged AUC 0.789, p-value 0.0001). All other combinations (with 2, 3 or 4 parameters) showed a lower AUC. MpUS with B-mode, VTIQ and CEUS was able to significantly reduce the number of false positive biopsy recommendations ($p<0.0001$).

CONCLUSION

Quantitative breast mpUS with three parameters (B-mode US, VTIQ elastography and CEUS) significantly improves the diagnostic performance of B-mode US alone, irrespective of the experience level of the examiner.

CLINICAL RELEVANCE/APPLICATION

MpUS of the breast offers quantitative parameters that may be used as imaging biomarkers for the differentiation of benign from malignant breast lesions.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSJ03

Cardiac (Myocardial Disease)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E353A

CA MR NM

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

SSJ03-01 Utility of Dual Energy CT for Assessment of Myocardial Fibrosis: Comparison of Single-Phase Iodine Map Extracellular Volume Fraction (ECV) With Standard Multiphase ECV Technique

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E353A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

Diffuse myocardial fibrosis is associated with chronic heart diseases, including aortic stenosis, and may be quantified using cardiac CT or MRI calculation of extracellular volume fraction (ECV). This study compared a dual-energy CT approach using an iodine map from a single phase to calculate ECV to the standard multiphase technique to calculate ECV.

METHOD AND MATERIALS

61 patients with aortic stenosis (35 male, 26 female; average age = 81 years) undergoing preoperative CT for transcatheter aortic valve replacement (TAVR) were scanned on a Force (Siemens Inc.) using dual energy mode prior to (non-contrast phase) and 10 minutes following (delayed phase) administration of 120-150 cc of iodinated contrast. Matched 1cm² regions of interest were selected in the interventricular septum and ventricular blood pool in each phase. The ROI densities obtained from blended virtual 120 kV images in each phase were used to compute the ECV (standard technique), while the dual energy data from the delayed phase only was used to calculate ECV using iodine map technique. Bias between ECV computation methods was visualized using Bland-Altman plot. Linear regression with Pearson technique was also performed.

RESULTS

The mean ECV calculated using standard method was 28%, while mean ECV measured using the iodine map method was 30%; for a mean bias of +2% [95% CI, -5% to +9%]. The Pearson correlation coefficient between the two ECV measurements was $R^2 = 0.48$.

CONCLUSION

There was good correlation between ECV measured by standard multiphase technique and ECV measured by dual energy technique using iodine maps created from the delayed phase alone. The dual energy technique trended towards mild overestimation of fibrosis, possibly attributable to beam hardening, however this difference was not significant.

CLINICAL RELEVANCE/APPLICATION

Prior studies using histopathology and cardiac MRI have shown that the greater degree of myocardial fibrosis can predict worse outcomes after surgery. ECV is an accepted way to measure myocardial fibrosis. This study demonstrates a dual energy method that simplifies ECV measurement and reduces radiation dose without significant difference relative to standard measurement of ECV.

Honored Educators

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SSJ03-02 Occurrence of Myocardial Oedema After Sporting Event? Quantification by T1 and T2 Mapping

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E353A

Participants
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PURPOSE

Purpose of this study was to analyse the occurrence of myocardial oedema in triathletes after sporting events using T2 and T1 mapping.

METHOD AND MATERIALS

29 competitive asymptomatic triathletes (45 ±10 years) underwent a CMR study performed on a 1.5T Achieva (Philips) before (baseline) and after a sporting event (follow-up). CMR protocol included SSFP cine, T2w-GraSE and T1, T2 mapping using MOLLI 5(3)3 sequence. Additionally, LGE Imaging was performed in the CMR baseline study. T1 and T2 quantification was performed using the OsiriX Software.

RESULTS

CMR performed before the sporting event revealed a normal global T1 time (with 989 ±28ms) of the left ventricular (LV) myocardium. There was no significant change in the global T1 time after the sporting event (988 ±21ms; p=0.926). Furthermore, T2 time was in the normal range before the sporting event (54 ±3ms) without relevant change after the sporting event (53 ±3ms, p=0.797). In 10 of the 29 Triathletes (34%) a focal myocardial fibrosis with a non-ischemic pattern was detected (LGE+ triathletes). Likewise, in the subgroups (LGE+ und LGE-) no significant changes in T1, T2 times before and after the sporting event were detected.

CONCLUSION

In contrast to the previously published T2 STIR data our results using T1, T2 mapping have not revealed any myocardial oedema after sporting events. Exercise-induced myocardial oedema previously detected using T2 STIR sequences might be falsely interpreted due to signal inhomogeneities.

CLINICAL RELEVANCE/APPLICATION

No myocardial oedema indicating acute myocardial injury was detected using mapping methods after sporting events, suggesting that competitive endurance events are safe.

SSJ03-03 Focal and Interstitial Fibrosis in Highly Trained Endurance Athletes

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E353A

Participants
Blanca Domenech, MD, Barcelona, Spain (*Presenter*) Nothing to Disclose
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PURPOSE

There is evolving evidence that cumulative effects of intensive endurance exercise may induce a broad spectrum of right ventricular (RV) adaptation/remodelling patterns. Thus, our aim was to assess the prevalence of myocardial fibrosis (MF), focal and interstitial, in the myocardium and its relationship with cardiac remodelling/adaptation, among a cohort of highly trained endurance athletes as compared to control subjects.

METHOD AND MATERIALS

93 highly trained endurance athletes (>12 hours training/week at least during the last 5 years; age: 36 ± 6 years; 52.7% male) and 72 age and gender-matched controls underwent a resting cardiac magnetic resonance to assess biatrial and biventricular dimensions and function. The presence of focal MF was assessed by late gadolinium enhancement (LGE). In a subgroup of 28 athletes, T1 mapping sequence was added and extracellular volume (ECV) measurements were performed in remote myocardium to asses interstitial MF.

RESULTS

High endurance training load was associated with larger bi-ventricular and bi-atrial sizes, mildly reduced systolic ventricular function, as compared to controls in both genders ($p < 0,05$). LGE was significantly more prevalent in athletes (n=35, 37.6% vs 2.8%; $p < 0,001$), with a constant pattern in the RV insertion points (Figure 1). Among men population, those athletes with LGE tended to have trained for more hours per week (14.55±3.6 vs 12.21±3.4, $P = 0.07$). In T1 mapping sequences, abnormal ECV values (>28%) were only found in 2 of 28 subjects. Those athletes who had focal fibrosis had higher ECV at remote myocardium than those without LGE (27,3±1,8 vs 25,1±2,2; $P = 0,01$).

CONCLUSION

Highly trained endurance athletes showed ten times higher prevalence of LGE than control subjects; always confined to the hinge point. Although this pattern of LGE may be another feature of the athlete's heart, our results suggest that those with focal fibrosis might have globally higher myocardial ECV values. Its clinical impact is currently uncertain, and it still warrants further investigation.

CLINICAL RELEVANCE/APPLICATION

Myocardial fibrosis, which is a predictive factor for adverse cardiac outcome, has been also described in some endurance athletes and its clinical meaning remains controversial.

SSJ03-04 Evaluation of a Shortened Cardiac MRI Protocol of Left Ventricular Examinations: Diagnostic Performance of T1-Mapping and Myocardial Function Analysis as a Screening Method

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E353A

Participants
Jonathan Nadjiri, MD, Munich, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

In this study we sought to retrospective evaluate whether a very brief CMR protocol comprising only left ventricular(LV) function analysis and T1 mapping sufficiently distinguishes patients with relevant myocardial changes with need for further examination from healthy patients.

METHOD AND MATERIALS

From October 2015 until October 2017 all patients with clinical indication for CMR for any myocardial characterisation (n = 160) were included. The scanner was a Philips Ingina 3T. The full CMR protocol comprised sBTFE Cine-Imaging, T1 and T2 mapping, T2w Dark-Blood as well as Early- and Late-Gadolinium-Enhancement. Patients were categorized into two groups depending on presence of LV dysfunction. ROC-analysis was done for results of T1-, T2- mapping and extracellular volume(ECV) in patients without LV dysfunction. Reference was depicted pathology in the conventional CMR techniques and report.

RESULTS

In the patient's cohort without LV dysfunction (n = 78 [49%]) ROC for T1 mapping was 81% with $p < 0.001$, 65 % for T2 mapping with $p= 0.4$ and 82% for ECV with $p < 0.001$. T1 mapping was superior to T2 mapping by trend; $p = 0.057$. ECV was significantly superior to T1 mapping, $p = 0.026$. For maximum T1 relaxation times of 1300ms sensitivity was 83 % and specificity was 55%; the negative predictive value was 91%. In patients with no LV dysfunction 31 (40%) patients did not exceed a maximum T1 of 1300ms; out of those none had significant myocardial alterations but 3 patients were diagnosed with chronic myocarditis. In general, out of the daily routine study population 111 (70%) patients had a pathological finding and in 49 cases (30%) CMR did not provide additional information. In that group T1 mapping detected 57% of the patients who would not benefit from additional CMR.

CONCLUSION

A shortened CMR protocol comprising T1 mapping and LV-function analysis seems to rule out clinically relevant myocardial alterations. However, 3 cases of chronic myocarditis with normal LV-function were overlooked; yet therapeutic consequences remain uncertain in this entity. These results need to be prospectively confirmed in a lager study to increase confidence in this shortened protocol in clinical use.

CLINICAL RELEVANCE/APPLICATION

The proposed protocol might allow for an improvement of efficiency of CMR examinations in the future.

SSJ03-05 Ferumoxytol-Enhanced MRI for Intramyocardial Blood Volume Mapping: Early Pre-Clinical Results

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E353A

Participants
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PURPOSE

Myocardial perfusion is important for organ vitality. The intramyocardial blood volume (MBV) represents the fractional blood volume of the intravascular space within a unit volume of myocardial tissue. Because ferumoxytol has high r1 relaxivity and a long intravascular half-life, we hypothesize that ferumoxytol-enhanced (FE) MRI may enable mapping of the MBV. We aim to evaluate the vasodilator-induced variation in myocardial T1 signal in normal swine.

METHOD AND MATERIALS

In this ARC-approved study, four healthy Yorkshire swine (33-52 kg) underwent FE-MRI at 3.0T under general anesthesia. We acquired myocardial T1 maps using 5-(3)-3-(3)-3 MOLLI and FLASH-MOLLI pre- and post-ferumoxytol infusion (4mg/kg). We induced coronary vasodilation with 4-minute cycles of adenosine infusion (200-400 mcg/kg/min). Using in-house T1 fitting algorithms, we generated myocardial T1 maps and derived T1 values from regions of interest drawn in the mid interventricular septum of short axis FE T1 maps.

RESULTS

No adverse events occurred and vital signs were stable throughout the adenosine infusion and FE-MRI exam. Myocardial T1 signal differential between pre- and post-ferumoxytol was -48.5%±6.4%. The adenosine-induced native T1 response as reflected by the slope between baseline and peak adenosine was less robust when compared to FE T1 response (3.0±0.6ms/min vs -35.3±16.1ms/min, p=0.03). During the two adenosine-on cycles post-ferumoxytol, the FE T1 values steadily shortened due to adenosine-induced vasodilation and increasing MBV. During adenosine-off cycles, FE T1 values increased towards values at rest. For adenosine 200-300 mcg/kg/min, the FE T1 shortened (decreased) 10.2±5.4% from baseline. For 400 mcg/kg/min dose, the FE T1 shortened >15% (swine #4). Of note, the increase in native T1 from baseline to peak adenosine was 0.7±0.2%.

CONCLUSION

Ferumoxytol, as a potent intravascular contrast agent, sensitizes the T1 signal to changes in the MBV and substantially amplifies the intramyocardial vascular T1 estimate. Additional work in models of varying myocardial perfusion is needed to better characterize the T1 response in normal vs pathologic states.

CLINICAL RELEVANCE/APPLICATION

Vasodilator-induced changes in ferumoxytol-enhanced myocardial T1 reflect dynamic changes in the intravascular myocardial compartment and has implications for a panoply of myocardial disease states.

SSJ03-06 Simultaneous 18F-FDG PET/MR Study for Assessment of Different Stages of Cardiac Impairment in Patients with Anderson-Fabry Disease

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E353A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

We evaluated the relationship between T1 mapping and 18F-FDG PET by cardiac PET/MR imaging in AFD female patients.

METHOD AND MATERIALS

Seventeen AFD female patients with normal left ventricular (LV) function underwent simultaneous cardiac PET/MR (Biograph mMR; Siemens Healthcare, Erlangen, Germany) imaging after administration of 18F-FDG and gadolinium-DPTA for assessment of late gadolinium enhancement (LGE). In all patients and in 7 female controls T1 mapping was performed using pre-contrast T1 Modified Look-Locker Inversion-recovery prototype sequence. Mean T1 values were measured by drawing 6-pixel regions of interest in the septal and lateral segments of LV apical, mid-ventricular and basal short-axis slices. Cardiac FDG uptake was quantified by

measuring the standardized uptake value in 17 myocardial segments in each subject. The coefficient of variation (COV, i.e. the standard deviation divided by the average) of the uptake of the 17 segments was calculated as an index of heterogeneity in the heart and values >0.17 were considered abnormal.

RESULTS

Five patients showed focal LGE indicating intra-myocardial fibrosis and were excluded from the final analysis. Compared with controls, mean T1 values of AFD female patients were significantly lower (1238±51.1 vs. 1334.32±26.6, $p<0.001$). At PET, 7 out of the remaining 12 patients showed abnormal COV values suggesting inflammation pattern and the other 5 demonstrated normal COV values (0.32±0.1 vs. 0.12±0.03, $p<0.005$) with homogeneous FDG uptake. Patients with abnormal COV showed higher mean T1 values of lateral segments of the mid-LV wall (1219.16±23.4 vs. 1154±62.1, $p<0.05$), suggesting a potential relationship between progressive myocyte sphingolipid accumulation and inflammation.

CONCLUSION

This study highlights the role of 18F-FDG PET/MR imaging for early detection of cardiac involvement in AFD patients allowing to identify different stages of disease progression. In particular, pseudo-normalization of T1 mapping values, associated with abnormal COV values, may represent an intermediate "inflammatory" stage before the development of myocardial fibrosis.

CLINICAL RELEVANCE/APPLICATION

Simultaneous cardiac 18F-FDG PET/MR imaging may allow early detection of cardiac involvement in AFD patients identifying different stages of disease progression.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSJ04

Science Session with Keynote: Cardiac (Oncology)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E260

CA MR NM OI

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;
Daniel Ocazionez, MD, Houston, TX (*Moderator*) Nothing to Disclose
Tina D. Tailor, MD, Durham, NC (*Moderator*) Nothing to Disclose

Sub-Events

SSJ04-01 Cardiac Keynote Speaker: Cardiac Complications of Oncology Therapy

Tuesday, Nov. 27 3:00PM - 3:20PM Room: E260

Participants
Gautham P. Reddy, MD, Seattle, WA (*Presenter*) Researcher, Koninklijke Philips NV;

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Gautham P. Reddy, MD - 2014 Honored Educator

SSJ04-03 Myocardial Tissue Characterization in Rat Models of Anthracycline-Induced Cardiotoxicity: Histologic Change and Correlation with T1 Mapping Parameters

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E260

Participants
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PURPOSE

To examine the pathologic changes in rat models of cardiotoxicity and to determine correlation with quantitative magnetic resonance imaging (MRI) parameters.

METHOD AND MATERIALS

All experiments were approved by our institutional animal care and use committee. Cardiotoxicity models were induced by injecting adult male Sprague-Dawley rats with doxorubicin (1mg/kg, twice a week). Cardiac MRI was performed with a 9.4-T scanner (Bruker Biospin Co., Billerica, MA, USA) using cine, pre- and post-T1 mapping sequences. T1 mapping sequences were performed by using a saturation recovery Look-Locker sequence. Left ventricular ejection fraction (LVEF) was evaluated using cine imaging. Native T1 and extracellular volume (ECV) were measured at the mid ventricle. All rats were sacrificed after MRI. Pathologic changes were graded according to their degree and then scored (0:absent, 1:minimal, 2:mild, 3:moderate, 4:severe) and correlated with MRI parameters (native T1 (ms), ECV (%)) and LVEF(%))

RESULTS

A total of 10 control and 14 cardiotoxicity models were included. Rats were classified into two groups, the early (n=9) and late (n=5) group, by 6 weeks after modeling. In cardiotoxicity models, LVEF decreased (control vs. cardiotoxicity subjects: 74%, 63.2%), native T1 and ECV increased (1,186 ms, 15.5% vs. 1,232.44 ms, 18.68%). The main histologic findings were vacuolar changes, inflammation, interstitial edema, expansion of interstitial space, and fibrosis. In subgroup analysis, myocardial fibrosis, expansion of interstitial space scores were significantly different between the two groups (p=0.007, p=0.002). Other histologic

factors (e.g. vacuolar changes, inflammation, interstitial edema), native T1, ECV, and LVEF were not significantly different between the two groups. ECV was correlated with fibrosis (r=0.632, p=0.015), vacuolar change (r=0.705, p=0.005), and the sum of histologic scores (r=0.694, p=0.006). Native T1 was correlated with myocardial inflammation (r=0.638, p=0.012) and expansion of interstitial space (r=0.656, p=0.011)

CONCLUSION

Prominent changes in MRI parameters and pathologic findings were noted in both early and late cardiotoxicity models, even in subjects with preserved LVEF. ECV and native T1 values showed good correlations with histologic scores.

CLINICAL RELEVANCE/APPLICATION

T1 mapping MRI is a useful quantitative method to detect anthracycline-induced cardiotoxicity.

SSJ04-04 Myocardial Tissue Phase Mapping Detects Cardiac Dysfunction in a Mouse Model of Doxorubicin-Induced Cardiotoxicity

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E260

Participants
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James C. Carr, MD, Chicago, IL (*Abstract Co-Author*) Research Grant, Astellas Group; Research support, Siemens AG; Speaker, Siemens AG; Advisory Board, Guerbet SA
Daniele Procissi, MS, PhD, Pasadena, CA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Cardiotoxicity following chemotherapy is common in cancer patients treated with anthracyclines such as doxorubicin (Dox). Conventional imaging approaches to identify anthracycline associated cardiac dysfunction have targeted reductions in ejection fraction (EF) with newer approaches focusing on detecting alterations in myocardial strain. The purpose of this study was to use myocardial tissue phase mapping (TPM) to study early functional changes in a mouse model of Dox-induced cardiotoxicity.

METHOD AND MATERIALS

16 week old female C57Bl/6 mice (n = 9) were imaged at 7T. 25 mg/kg Dox was administered over 3 weeks in the form of 5 mg/kg subcutaneous pellets (Innovative Research of America, Florida, USA). Mice were imaged at baseline, 6 weeks and 10 weeks post-treatment. MRI protocol included multi-slice cine MRI covering the entire LV, and TPM in a single mid-ventricular short-axis slice. The cine images were analyzed using Segment (Medviso, AB) to calculate EF. TPM was performed using 2D cine phase contrast MRI with prospective ECG and respiratory triggering. Imaging parameters included: image/time resolution = 0.117x0.117x1 mm3x20.8 ms, tri-directional VENC=4 cm/s. TPM images were analyzed in MATLAB to measure global peak radial and longitudinal velocities at systole and diastole. Following imaging at 6 weeks, 4 mice were sacrificed for histopathologic assessment utilizing terminal deoxynucleotidyl transferase (TdT) dUTP nick-end labeling (TUNEL) to detect apoptotic cells.

RESULTS

There were no significant differences in EF (72±11% at baseline, 75±12% at 6 weeks and 63±2% at 10 weeks). Global systolic longitudinal velocity was significantly reduced at 6 weeks (p=0.03) but our power was low to detect significant differences at 10 weeks. Histopathologic results demonstrated minimal apoptosis in all mice, suggesting early-stage cardiotoxicity.

CONCLUSION

Using myocardial TPM, we detected cardiac dysfunction prior to reduction in EF and the onset of cardiomyocyte apoptosis in a mouse model of Dox-induced cardiotoxicity. Future studies comparing this technique with other myocardial tissue and functional characterization may demonstrate a role for TPM as an early biomarker of cardiotoxicity.

CLINICAL RELEVANCE/APPLICATION

In the present study, we demonstrated that longitudinal systolic velocity quantified using myocardial tissue phase mapping may represent an early imaging biomarker for doxorubicin-induced cardiotoxicity.

SSJ04-05 68Ga-Galmydar: A PET Imaging Tracer for Noninvasive Detection of Doxorubicin-Induced Cardiotoxicity

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E260

Participants
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Richard Laforest, PhD, Saint Louis, MO (*Presenter*) Nothing to Disclose
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PURPOSE

Doxorubicin (DOX; Adriamycin), an anthracycline analogue is widely used chemotherapeutic drug in cancer. DOX treatments are susceptible to acute and chronic cardiac anomalies, including aberrant arrhythmias, ventricular dysfunction, and heart failure. PET tracers could also provide noninvasive assessment of early and reversible metabolic changes of the myocardium. Herein, we report a preliminary investigation of 68Ga-Galmydar potential to monitor DOX-induced cardiomyopathy in vivo, ex vivo, and in cellulo employing both nuclear- and optical imaging.

METHOD AND MATERIALS

Galmydar was obtained through a ligand exchange reaction. 68Ga-Galmydar was purified on C-18 column using radio-HPLC. MicroPET imaging was performed 5 d post treatment of rats either with a single dose of DOX (15 mg/kg) or vehicle as a control (saline). For correlation of PET imaging data, post-imaging quantitative biodistribution studies were also performed. In cellulo (H9c2) dose and time dependent doxorubicin treatments were also studied using live cell optical imaging.

RESULTS

68Ga-Galmydar, micro-PET static scan (10 min acquisition; 60 min post tail-vein administration) demonstrated 1.91-fold lower uptake in hearts of DOX-treated (Standard Uptake Value; SUV: 0.92, n=3) rats compared with their vehicle treated (SUV: 1.76, n = 3) counterparts. The post imaging pharmacokinetic data demonstrated heart uptake values of 2.02 fold lower for DOX treated rats compared to control counterparts (%ID/g; DOX: 0.44 ± 0.1, n=3; Control: 0.89 ± 0.03, n=3) thus correlating well with micro-PET imaging data. Employing moderate fluorescent traits of Galmydar, live cell optical imaging indicated a gradual decrease in uptake and retention of Galmydar within mitochondria of H9c2 cells following DOX-treatment, while indicating also dose-dependent pharmacological response and time-dependent uptake profiles. Furthermore, the decreased uptake in H9c2 cells also correlated with caspase-3 expression resulting from DOX-induced cardiotoxicity and cell death. Combined data indicate that 68Ga-Galmydar could provide a sensitive and specific readout of DOX-induced cytotoxicity attributed to depolarization of mitochondrial potential in heart cells.

CONCLUSION

68Ga-Galmydar could provide a noninvasive assessment of DOX-related early and likely reversible metabolic changes that remains to be evaluated clinically.

CLINICAL RELEVANCE/APPLICATION

none

SSJ05

Science Session with Keynote: Chest (Thoracic MRI)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S404AB

CH CT MR NM

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Jurgen Biederer, MD, Seeheim-Jugenheim, Germany (*Moderator*) Nothing to Disclose
Patricia J. Mergo, MD, Jacksonville, FL (*Moderator*) Nothing to Disclose

Sub-Events

SSJ05-01 Chest Invited Speaker: Beyond Morphology-Comprehensive Imaging of Pulmonary Disease with MRI

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S404AB

Participants
Juergen Biederer, MD, Heidelberg, Germany (*Presenter*) Nothing to Disclose

SSJ05-02 Combination of MR Free-Breathing 3D T1-Weighted Star VIBE and DWI for the Differentiation of Benign from Malignant Peripheral Pulmonary Lesions: A Comparative Study Using Routine-Dose CT

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S404AB

Participants
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PURPOSE

The differentiation of benign pulmonary lesions from malignant pulmonary lesions is very difficult. High resolution CT is the most commonly used radiology methods for lung. While it is limited to children, child-bearing women and disorders requiring repeated examinations over prolonged periods because of its radiation dose.The result of our previous studies showed that: comparing with routine-dose CT, the MR T1-weighted 3D Star VIBE sequence was slightly lower in differentiating the peripheral pulmonary lesions(PPL) with morphological features. MR can provide not only the morphological information, but also functional information.The apparent diffusion coefficient (ADC) value was used widely in whole body, but this research of combining MR-DWI ADC value with morphological characteristics of PPL was rare. The purpose of this study was to evaluate the no radiation-dose MR (ADC value and T1-weighted 3D Star VIBE sequence) diagnostic efficiency in differentiating the malignant PPL from benign, with the routine-dose CT as a reference standard.

METHOD AND MATERIALS

Fourty-seven patients(30 males and 17 females,mean age 64.1 years old; age range 48-83 years) were enrolled in this study, all the patients had undergone routine-dose CT,MR T1 Star VIBE and DWI with 3.0T MR sanner. These lesions were all diagnosed by transthoracic needle biopsy or surgery. Two radiologists observed the morphological signs of MR and CT images independently. The order of observation was MRI first, and followed by CT. Then the ADC value of lesions were measured. The logistic regression analysis was used to calculate the probability. The ROC curve was used to analyze the capabilities of morphological characteristics and DWI in distinguishing malignant PPL from benign.

RESULTS

There was significant difference of the ADC value between benign and malignant groups(p=0.001). The cut-off ADC value was 1197×10-6 mm2/s. Combined MR T1 Star VIBE with ADC value can distinguish PPL better than only routine-dose CT, ADC value and T1 Star VIBE alone.

CONCLUSION

The ADC value could differentiate the peripheral pulmonary lesions initially, but the distinguishability was better if combing MR T1 Star VIBE morphological characteristics with ADC value.

CLINICAL RELEVANCE/APPLICATION

We can use MR T1-weighted 3D Star VIBE and DWI to replace routine-dose CT to distinguish PSPLs in order to avoid radiation exposure.

SSJ05-03 18F-Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography (PET/CT) and Diffusion-Weighted Magnetic Resonance Imaging (DWI-MRI) Diagnostic Performance in the

Evaluation of Pulmonary Lesions: A Systematic Review and Meta-Analysis

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S404AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To perform a systematic review and meta-analysis of the diagnostic performance of DWI-MRI and 18F-FDG PET/CT in the evaluation of pulmonary lesions.

METHOD AND MATERIALS

Databases of MEDLINE and Embase were searched through December 2017. Studies published in English were included when the diagnostic performances of 18F-FDG PET/CT or DWI in detecting malignant pulmonary lesions were clearly identified in the articles. Two reviewers evaluated the study quality of all selected articles using QUADAS-2 and only those that met a minimum quality score were included. Parameters of lesion quantification were analyzed separately for each imaging modality (e.g., lesion-to-spine ratio (LSR), and apparent diffusion coefficient (ADC) for DWI-MRI). Meta-analysis using a random-effects model were conducted to calculate the pooled sensitivities, specificities, positive and negative likelihood ratios (PLR and NLR), diagnostic odds ratios (DOR) and area under the curve (AUC) for PET/CT and DWI with 95% confidence intervals (95% CI).

RESULTS

The literature search yielded 1280 results, and the inclusion criteria were met by 37 studies (23 FDG PET/CT studies, 8 MRI studies and 6 studies including both methods), with a total of 4224 participants and 4463 lesions (malignant, n = 3090, 69.2%; benign, n=1362, 30.8%). Pooled sensitivity and specificity of SUVmax (n = 25) were 0.86 (95%CI, 0.82-0.90) and 0.73 (95%CI, 0.62-0.82), respectively. For DWI-MRI, LSR studies (n = 4) showed a sensitivity of 0.81 (0.71-0.88) and a specificity of 0.90 (0.79-0.95), whereas studies utilizing ADC (n = 12) had a sensitivity and specificity of 0.83 (0.77-0.88) and 0.86 (0.76-0.92), respectively. DWI-LSR yielded the greatest diagnostic odds ratio (DOR = 38, 95%CI 12-115) compared to DWI-ADC (DOR = 30, 95%CI 14-66) and SUVmax (DOR = 17, 95%CI 10-28).

CONCLUSION

Diagnostic performance of DWI-MRI is comparable to 18F-FDG PET/CT for the evaluation of potentially malignant pulmonary lesions.

CLINICAL RELEVANCE/APPLICATION

This is the first meta-analysis to compare the diagnostic performance of DWI-MRI and 18F-FDG PET/CT in the evaluation of pulmonary lesions. Our study demonstrated that the diagnostic performance of DWI-MRI is comparable or even superior to that of PET/CT, which supports the inclusion of MRI as a low-cost and radiation-free option to the diagnostic work-up of pulmonary lesions.

SSJ05-04 Chemical Exchange Saturation Transfer (CEST) Imaging versus Diffusion-Weighted Imaging (DWI) versus FDG-PET/CT: Capability for Diagnosis of Solitary Pulmonary Nodule

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S404AB

Participants
Yoshiharu Ohno, MD, PhD, Kobe, Japan (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Koninklijke Philips NV; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Fuji Pharma Co, Ltd; Research Grant, Guerbet SA;
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PURPOSE

To directly and prospectively compare the capability for diagnosis of solitary pulmonary nodules (SPNs) among chemical exchange saturation transfer (CEST) imaging, diffusion-weighted imaging (DWI), and FDG-PET/CT.

METHOD AND MATERIALS

113 consecutive patients (69 male and 44 female; mean age 71 year old) with 122 SPNs underwent CEST imaging and DWI at a 3T MR system, FDG-PET/CT, and pathological and/or follow-up examinations. According to final diagnoses, all SPNs were divided into malignant (n=76) and benign (n=46) SPNs. 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, apparent diffusion coefficient (ADC) 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. In addition, ROC analyses were performed to compare diagnostic performance among all indexes as well as combined methods. Finally, sensitivity, specificity and accuracy were compared among all methods by McNemar's test.

RESULTS

MTRasym, ADC and SUVmax had significant difference between malignant and benign SPNs ($p<0.05$). Multivariate regression analyses identified MTRasym (Odds ratio [OR]: 0.54), ADC (OR: 47.6) and SUVmax (OR: 0.47) as significant differentiators ($p<0.05$). ROC analyses showed area under the curve (Az) of MTRasym (Az=0.88) and combined all indexes (Az=0.92) were significantly larger than that of SUVmax (Az=0.77, $p<0.05$). Sensitivity (SE) and accuracy (AC) of MTRasym (SE: 81.6 [62/76] %, AC: 82.8 [101/122] %) and combined methods (SE: 85.5 [65/76] %, AC: 85.2 [104/122] %) were significantly higher than those of ADC (SE: 69.7 [53/76] %, $p<0.05$; AC: 77.9 [95/122] %, $p<0.05$) and SUVmax (SE: 64.5 [49/76] %, $p<0.05$; AC: 71.3 [87/122] %, $p<0.05$).

CONCLUSION

CEST imaging has a better potential and can improve diagnostic performance of SPNs, when compared with DWI and FDG-PET/CT.

CLINICAL RELEVANCE/APPLICATION

CEST imaging has a better potential and can improve diagnostic performance of SPNs, when compared with DWI and FDG-PET/CT.

SSJ05-05 2D-ROI and 3D-VOI Histogram Analysis of Apparent Diffusion Coefficient in Assessing Solitary Pulmonary Lesions

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S404AB

Participants
Shi Y. Deng, Guangzhou, China (*Presenter*) Nothing to Disclose
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PURPOSE

To determine the diagnostic performance of apparent diffusion coefficient (ADC) histogram analysis derived from both largest cross-sectional (2D-ROI) and whole tumor region of interest(3D-VOI) in differentiating benign from malignant solitary pulmonary lesions(SPLs).

METHOD AND MATERIALS

Sixty-nine patients with pathologically confirmed lung lesions (benign: malignant = 23:46) were included in the study. All patients underwent 3.0T diffusion-weighted imaging (DWI) with 2 b values of 0 and 600s/mm2. The histogram metrics including minimum, mean, maximum, 10th, 25th, 50th, 75th and 90th percentiles, skewness, and kurtosis were calculated from the largest cross-section and whole tumor ROI, respectively. Inter-class correlation characteristic(ICC) was used to assess inter-observer reliability. Histogram metrics were analyzed using Mann-Whitney U-test. The diagnostic performance was evaluated using receiver-operating characteristic (ROC) analysis.

RESULTS

Minimum, mean, maximum and 10th,25th,50th,75th,90th percentile ADCs with two groups were significantly lower (all $P<0.05$), except for the maximum and 25th percentile ADCs in whole-volume group ($P=0.128$, $P=0.221$) in malignant lesions compared with benign ones. The 75th and 50th percentile ADCs in two ROI setting group respectively achieved the highest AUC (single-slice: whole-volume=0.891:0.894) with cutoff value of $1.57\times10\text{-}3$ mm²/s and $1.41\times10\text{-}3$ mm²/s in differentiating solitary pulmonary lesions. ICC for the whole-volume ROIs(0.76~0.97) was better the largest-slice ROIs(0.59~0.91) .

CONCLUSION

Both single-slice and whole-volume ADCs are helpful for distinguishing malignant from benign lung lesions. Whole-volume ADC histogram analysis could have greater diagnostic properties and repeatability.

CLINICAL RELEVANCE/APPLICATION

In conclusion, ADC histogram is helpful for distinguishing malignant from benign lung lesions, and the 75th percentile ADC derived from 2D-ROI and 3D-VOI could provide better imformation in characterizing in SPLs, with no statistical difference. Moreover, placing ROIs in the largest lesion would be more suitable for clinic practice considering about saving time.

SSJ05-06 Utilization of 19F MRI for Identification of Iraqi-Afghanistan War Lung Disease

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S404AB

Participants
Joseph G. Mammarappallil, MD,PhD, Durham, NC (*Presenter*) Nothing to Disclose

Scott Shofer, MD, Durham, NC (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Iraq-Afghanistan War Lung Injury (WLI) describes new onset respiratory symptoms occurring in deployed soldiers to the Middle East that can ultimately lead to constrictive bronchiolitis. This study sough to determine if 19F MRI could identify patients with WLI.

METHOD AND MATERIALS

Three soldiers who presented to local VA clinics were evaluated for reactive airways disease, post deployment dyspnea, and decreased respiratory fitness. All subjects had a full pulmonary function evaluation. Inspiratory and expiratory imaging with HRCT was also obtained for each subject. For 19F MRI studies, each subject inhaled a gaseous mixture of 79% PFP mixed with 21% O2 mixture over the course of several minutes in a protocol consisting of three tidal breaths followed by a 6 second breath-hold at total lung capacity during which a 3D imaging of the lung airspaces was obtained. The image data was analyzed to generate regional wash-in and wash-out time constants (seconds) throughout the lung airspaces. Finally, the fraction of slow filling compartments was calculated as the number of volume elements exhibiting a wash-in time constant of > 100 seconds divided by the total number of lung airspace elements in the imaged [FVR1>100].

RESULTS

Two subjects were non-smokers and the third is a current smoker (11 pack-years). All three subjects were exposed to aerosolized contaminants during deployment in Iraq/Afghanistan. Spirometry for all subjects were normal FEV1% predicted (81, 109, 86), FEV1/FVC (72, 75, 73). Expiratory CT imaging was normal for subject 1, while the 2nd and 3rd subjects had mild basilar or lobular areas of air trapping. Imaging with 19F for each subject was as follows: FVR1>100 = 17.5%, 37.8%, and 24.5% for the three subjects respectfully. While the first subject's FVR1>100 was close to values seen in subjects with normal lung function the second and third subjects more resembled patients diagnosed with COPD (25->60%).

CONCLUSION

19F MRI demonstrated delayed regional filling of PFP gas in two subjects with suspected WLI when compared to data from normal subjects.

CLINICAL RELEVANCE/APPLICATION

19F MRI has the potential to detect airway abnormalities at earlier time points than current techniques. This may ultimately lead to better diagnosis of challenging airway abnormalities such as WLI and perhaps a tool for evaluation of interventions.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSJ06

Science Session with Keynote: Emergency Radiology (Practice Management)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S402AB

CT ER

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Zachary S. Delproposto, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose
Jennifer W. Uyeda, MD, Boston, MA (*Moderator*) Consultant, Allena Pharmaceuticals, Inc; Invited Speaker, Siemens AG

Sub-Events

SSJ06-01 Emergency Radiology Keynote Speaker: Dual Energy CT in the ED

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S402AB

Participants
Jennifer W. Uyeda, MD, Boston, MA (*Presenter*) Consultant, Allena Pharmaceuticals, Inc; Invited Speaker, Siemens AG

SSJ06-02 CT Utilization Patterns in an Expanded Level 1 Trauma Center

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S402AB

Awards
Student Travel Stipend Award

Participants
Katie P. Kinzer, MD, San Francisco, CA (*Presenter*) Nothing to Disclose
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PURPOSE

To investigate CT utilization patterns in a major level 1 trauma center before and after the opening of a new facility with expanded ER and critical care capacity.

METHOD AND MATERIALS

A retrospective analysis of all CT scans ordered from the emergency department of a major level 1 trauma center was performed during a 36 month period spanning the opening and transition to a new facility in May of 2016. Eligible for inclusion were CT studies performed within call hours (5pm-8am weekdays, 24 hours on weekends). Data were conducted retrospectively, using ad hoc SQL query against PACS Oracle database, and classified into one of two subcategories based upon the findings 1) Type 1: critically acute findings usually necessitating hospital admission, and 2) Type 2: negative or non-critical. The incidence of Type 1 and Type 2 findings before (January 2015-May 2016) and after (May 2016-Dec 2017) transitioning to the new facility were analyzed.

RESULTS

Comparing 16 months prior and 20 months after opening of an expanded trauma center, there was a 12% increase in overall ED patient volume. There was an associated increase in overall CT utilization of 24.6%. When weighted by number of days, there was a total of 33 CT studies per day ordered before and 41 CT studies ordered per day after opening the new hospital. However, there was no significant increase in Type 1 studies (weighted average total increase of 9.2%). The increase in CT utilization was entirely accounted for by a significant increase type 2 studies which increased by 32.3% ($p<0.05$). The yield for type 1 studies (defined as the ratio of Type 1 to Type 2), decreased from 0.41 to 0.33.

CONCLUSION

Increased CT utilization following the opening of an expanded level 1 trauma center was accounted for entirely by an increase in volume of non-critical (type 2) studies. Potential contributors to this utilization pattern are explored and include overall increase in ED volume and increased proximity of CT scanners within the new emergency department.

CLINICAL RELEVANCE/APPLICATION

Hospital geography can play a role in increasing CT utilization without increasing clinical yield.

SSJ06-03 ED CT Utilization Has Increased but What Has Increased and Who Reads Them?

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S402AB

Participants
Santosh K. Selvarajan, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

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PURPOSE

The growth in CT utilization is considerable and has increased across the world. The continued growth in the ED may be partly related to increased applications with improved technology and partly from inappropriate use. Our purpose was to determine the different subcategories of CT that have increased since code bundling was used only for CT of abdomen and pelvis and secondly assess the change in Non-Radiologists interpretations of CT from 2004 to 2016.

METHOD AND MATERIALS

We used the Medicare Physician/Supplier Procedure Summary Master Files for 2004-2016. The codes for ER CT were selected and the procedure volumes in ED settings were calculated. We doubled the number of bundled codes, since these would have counted as 2 exams in 2010 and before. We performed a secondary analysis of the different CT examinations by categorizing them in to head, body, spine, musculoskeletal and CT vascular. The CTA of the head and neck were assigned to the head CT to help assess the utility of neuroimaging. Then used Medicare provider specialty codes to identify those exams interpreted by Radiologists and other specialties.

RESULTS

The utilization of CT in the EDs grew in all the categories with a more substantial increase in the utilization of CT spines (+423%), CT vascular (+306%), and CT MSK (+164%). The utilization of CT body has increased by 56%. The volume of neuroimaging has significantly increased from 1,875,263 in 2006 to 3,632,617 in 2016 (+94%). A small number of cardiac CTs are performed in the ED, which has increased from 194 in 2006 to 2430 in 2016 (+1153%). Radiologists interpret 99% of the studies in all categories. The percentage of non-Radiologists interpreting CTs in the ED have reduced in all subcategories except a mild increase in the interpretation of CT spines and CT vascular.

CONCLUSION

There is substantial increase in the utilization of all CTs in the ED. The growth is predominantly in CT spine, CT vascular and CT of extremities. The utilization of CT and CTA for neuroimaging has also increased markedly.

CLINICAL RELEVANCE/APPLICATION

These trends may be partially due to defensive medicine in ED and radiologists and ED physicians need to work together to better control utilization.

SSJ06-04 The Effect of Advanced Age on the Utilization of CT in Trauma

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S402AB

Participants
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PURPOSE

In the 1990s the most frequent mechanism of injury (MOI) in trauma was Road Traffic Accidents (RTA) with a mean age of 31; by 2013 falls from <2 meters were the predominant mechanism and the mean age had risen to 53.8. CT plays a major role in the management of trauma. The possibility exists for a delay in investigation and treatment in older trauma patients due to differences in MOI, mode of presentation and awareness.

METHOD AND MATERIALS

Trauma Audit Research Network (TARN) data from a tertiary referral urban university teaching hospital with an annual ED census of over 53,000 patients from 2012 to 2017 was analysed. Fisher's Exact test, multivariate logistic regression and Student's T Test were used for analysis in SPSS 24.

RESULTS

1422 trauma patients were included of whom 928 had CT. 721 were male and 701 were female. Mean age was 63 (range : SD) (3-99:22.2). Mean Injury Severity Score (ISS) was 13 (1-57 : 8.4). Fall <2m was the MOI in 61.5% and RTA in 15.3%. Trauma patients aged >65 were no more likely to require a CT than those <65 ($p=0.575$). Patients >65 were more likely to have a time to CT (TCT) >24 hours ($p<0.001$). This held true controlling for gender, ISS, date and time ($p<0.01$). Patients aged >65 with an ISS >15 were more likely to have a TCT >6 hours ($p=0.016$). Overall mean TCT was 262% longer ($p<0.001$) in those patients aged >65.

CONCLUSION

Trauma patients over 65 years of age wait longer for CT compared to those under 65.

CLINICAL RELEVANCE/APPLICATION

Outcomes for older trauma patients are worse in terms of morbidity, mortality and length of stay. While the cause and effect for the impact on outcomes of the delay to CT is difficult to elucidate; maximising controllable variables has the potential to benefit the patient.With the aging population and the changing face of trauma emergency departments need to plan for a different type of patient. Older patients who suffer traumatic injuries may not be identified as early and strategies should be implemented minimise delay in access to diagnostics and implementation of treatment. Emergency and radiology departments need to be accordingly resourced for this changing practise.

SSJ06-05 Defensive Medicine, Myth or Truth: The Evolution of Geriatric Trauma Imaging

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S402AB

Participants
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Emre Unal, MD, Ankara, Turkey (*Abstract Co-Author*) Nothing to Disclose
Mehmet Mahir Kunt, Ankara, Turkey (*Abstract Co-Author*) Nothing to Disclose
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Bulent Erbil, Ankara, Turkey (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The worldwide population is aging, and in proportion to this development the morbidity and mortality related to geriatric trauma, and its burden on healthcare is increasing. In this study, we aimed to analyze the imaging findings in a series of geriatric trauma patients admitted to our emergency department during the period of 2006-2011 and 2012-2017. We also investigated whether trauma induced pathologies or the need for imaging has changed over the years.

METHOD AND MATERIALS

We randomly selected two sets of 300 patients among 597 and 987 patients admitted to the emergency department during the time periods of 2006-2011(group I) and 2012-2017(group II), respectively. A comprehensive comparison was carried out between the groups regarding age, sex, reason for admission, associated comorbidities, Revised Trauma Score (RTS), Glasgow Coma Scale (GCS), radiological findings and number of radiological examinations, DLP values, duration of hospital stay, and trauma associated morbidity and mortality.

RESULTS

No statistically significant difference was observed between both groups regarding age and gender ($p>0.05$). Falls were the most common cause for admission in both groups, followed by traffic accidents. RTS and GCS values were similar in both groups ($p>0.05$). The number of patients who underwent X-ray and CT examinations in group II was higher compared to group I (89% vs. 82%, 73% vs. 44%, respectively, $p=0.021$). The total number of X-rays and CT scans was also higher in group II (613 vs. 310, 409 vs. 142, respectively, $p=0.01$). In 49% of patients in group I and 55% of patients in group II, CT scans were negative for a trauma related finding. In patients with radiological evidence of trauma, no significant difference was observed between the groups regarding major trauma related change ($p=0.151$). However, trauma related minor CT findings were more common in group II ($p=0.031$).

CONCLUSION

Increased need for radiological examinations over the years seem to occur as a consequence of the tendency to practice defensive medicine. In addition to increased radiation dose, unnecessary radiological examinations result in heavy burden on health care systems and radiologists' workload.

CLINICAL RELEVANCE/APPLICATION

Increased need for imaging in recent years appears to be related to 'defensive medicine' but not to Revised Trauma Score or Glasgow Coma Scale of the patients.

SSJ06-06 CT or MR for Pulmonary Embolism: 10 Years of Experience in Over 10,000 Cases in the Emergency Department

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S402AB

Participants
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Daryn S. Belden, BS, Madison, WI (*Abstract Co-Author*) Nothing to Disclose
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Mark L. Schiebler, MD, Madison, WI (*Abstract Co-Author*) Stockholder, Stemina Biomarker Discovery, Inc; Stockholder, HealthMyne, Inc;
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PURPOSE

We sought to determine if patient characteristics of those referred for pulmonary magnetic resonance imaging (MR) differed from those referred to computed tomographic angiography (CT) for the primary diagnosis of pulmonary embolism (PE) from our

Emergency Medicine Department (ED).

METHOD AND MATERIALS

This is a retrospective HIPPA-compliant, IRB-approved study of CT and MR performed for PE evaluation in the ED from January 1, 2009 - December 31, 2017. All ED patients with an imaging order placed and not canceled during an ED encounter were identified. Patient encounters were included if (1) study type was CT or MR and (2) study description included 'PE protocol' or study information entered by the ED clinician included a PE variant (i.e. pulm* embol*, vte). Patient factors were populated via the electronic medical record (EMR); comorbidity indices were calculated from ICD 9/10 codes. Logistic regression was used to calculate odd ratios (OR) of factors associated with use of MR versus CT.

RESULTS

There were 10,986 CT and 1,448 MR patient EMRs reviewed. MR patients were younger ($p<.001$) and female ($p<.001$). CT patients had higher morbidity indices ($p<.001$). In the patient factor model, female sex, lower age, slightly lower comorbidity index, and history of renal disease increased odds of MR use (female OR 2.7, $p<.001$; age OR 0.93, $p<.001$; Elixhauser OR 0.97, $p<.001$; renal disease OR 3.5, $p<.001$). In a separate vital signs model, slightly lower maximum respiratory rate (RR_max) and slightly higher minimum oxygen saturation (O2_min) increased odds of MR (RR_max OR 0.97, $p<.01$; O2_min OR 1.04, $p<.001$).

CONCLUSION

ED ordering of MR occurred more often in female, younger patients with lower comorbidity and more favorable vital signs. History of renal disease also significantly increased the OR of MR.

CLINICAL RELEVANCE/APPLICATION

ED clinicians have consistently utilized MR for PE evaluation since its introduction, with selection of MR in stable patients to mitigate perceived risks of CT.

SSJ07

Gastrointestinal (Hepatocellular Carcinoma Response Imaging)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S104A

BQ GI MR OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants

An Tang, MD, Montreal, QC (*Moderator*) Research Consultant, Imagia Cybernetics Inc; Speaker, Siemens AG; Speaker, Eli Lilly and Company
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Sub-Events

SSJ07-01 Prediction of TACE Refractoriness in Patients with HCC Using Imaging Features of Gadoxetic Acid-Enhanced MRI

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S104A

Participants
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PURPOSE

To investigate magnetic resonance imaging (MRI) features associated with transarterial chemoembolization (TACE) refractoriness in patients with HCC and to develop a prediction model.

METHOD AND MATERIALS

Among 407 patients with intermediate-stage HCC (BCLC-B) who underwent TACE as a first-line treatment from January 2012 to December 2015, 181 patients having pre-procedural gadoxetic acid-enhanced MRI were included in this study. TACE refractoriness was determined according to the Japan Society of Hepatology guidelines. Univariate and multivariable analyses were performed to investigate the association between clinical factors including MRI features and the refractoriness. A prediction scoring model was constructed by a bootstrap resampling method. The performance of the prediction model was evaluated with respect to discrimination for TACE refractoriness using the area under the receiver operating characteristic curve (AUC).

RESULTS

55 patients (30.4%) showed TACE refractoriness, while the remaining 126 (69.6%) showed good responses after TACE. Independent features associated with TACE refractoriness were alpha fetoprotein level, tumor number, maximum tumor size, atypical arterial enhancement pattern, arterial peritumoral enhancement, and presence of nonhypervascular hypointense nodule (NHHN) on hepatobiliary phase images. The prediction model derived from these variables showed good discrimination (AUC, 0.82, 95% CI, 0.75-0.89) for TACE refractoriness.

CONCLUSION

The prediction model based on the MRI features can be used to estimate the risk of TACE refractoriness in patients with HCC.

CLINICAL RELEVANCE/APPLICATION

The identification of high risk patients of TACE refractoriness can be helpful to the initiation and maintenance of TACE in patients with HCC.

SSJ07-02 Radiofrequency Ablation versus Cryoablation for Perivascular Hepatocellular Carcinoma: Local Tumor Control and Vascular Complications

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S104A

Participants
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PURPOSE

To compare cryoablation with radiofrequency ablation (RFA) in patients wtih perivascular HCC and to evaluate the local tumor control and vascular complications of both therapies.

METHOD AND MATERIALS

The retrospective study was approved by the institutional review board. The requirement for informed consent was waived. Between January 2015 and December 2017, 111 patients (93 men, 18 women; mean age, 62.3 years; age range, 44-48 years) who underwent percutaneous cryoablation (n=61) or FRA (n=50) were enrolled. All patients had a single perivascular HCC (mean size, 1.3 cm) that were in contact with hepatic vessels (periportal or perivenous), $\geq$ 3mm or larger in axial diameter. Cumulative local tumor progrssion (LTP) was evaluated. In addition, several procedure-related vascular complications were evaluated immediately after treatment and during follow-up images: peritumoral vessel thrombosis; transient hepatic ischemia or hepatic infarction; aggressive intrasegmental recurrence (AIR) (the simultaneous deveolpment of $\geq$ 3 nodular or infiltrative tumors).

RESULTS

The median follow-up was 18 months. Both groups did not show significant differences in terms of baseline characteristics except the proportion of periportal tumor location (40.0% in the RFA group vs. 86.9% in the cryoalblation group, p=0.031). The cumulative LTP rates at 1 and 2 years were 5.7% and 22.1%, respectively, in the RFA groups, and 6.5% and 22.7%, respectively, in the cryoablation group, without siginificant difference (p=0.918). However, peritumoral thrombosis (25% vs. 11.5%, p=0.031) and transient hepatic ischemia or hepatic infarction (24% vs. 4.95%, p=0.005) were more common in the RFA group than in the cryoablation group. Although there were not significant differences between two groups, AIR was only occurred in the RFA group (2% vs. 0%, p=0.450).

CONCLUSION

In patients with perivascular HCC, cryoablation is an effective treatment for local tumor control, comparable to RFA, with a low risk of vascular complications.

CLINICAL RELEVANCE/APPLICATION

Although cryoablation has not been included as a standard care for HCC according to the recent Barcelona Clinic Liver Cancer guidelines, based on the our results, cryoablation may be a reasonable alternative for patients with limited liver function to avoid vascular complications.

SSJ07-03 Trends in Ablative and Surgical Treatment of Hepatic Tumors in the Medicare Population, 2003-2016

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S104A

Participants
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PURPOSE

Percutaneous ablation of liver tumors has become increasingly accepted as a less invasive alternative to open ablation and surgical resection in patients with liver tumors. Our purpose was to assess utilization trends in these procedures in recent years.

METHOD AND MATERIALS

Using the nationwide Medicare Part B databases for 2003-2016, we selected the CPT codes for percutaneous ablation (PA), open ablation (OA), and partial lobectomy (PL) of the liver. Codes for both radiofrequency- and cryoablation were included. The databases provide volumes for each code. Medicare's specialty codes were used to identify the specialty of the provider. Trend lines were plotted for total volumes and volumes by radiologists, surgeons, and all other physicians as a group. Because these databases represent a full population, sample statistics are not required.

RESULTS

Medicare total PA volume increased from 1221 in 2003 to 2788 in 2016 (+128%), with the most rapid growth occurring from 2012-2016. Radiologists performed 99% of all PAs in 2016. Of the 2788 performed that year, 2599 were radiofrequency ablations, while 189 were cryoablations. OA volume decreased steadily from 835 in 2003 to 435 in 2016 (-48%). The vast majority of OAs were done by surgeons. PL volume increased from 2090 in 2003 to 2945 in 2016 (+41%). Again, the vast majority were done by surgeons.

CONCLUSION

OA use is declining steadily, while use of both PA and PL has increased. PA growth has been especially strong in recent years. The large majority of PAs use the radiofrequency approach, rather than cryo. Radiologists perform virtually all PAs. The data demonstrate that radiologists have assumed a major role in the treatment of hepatic tumors.

CLINICAL RELEVANCE/APPLICATION

Radiologists are virtually the only physicians performing percutaneous treatment of liver tumors, and have driven the rapid growth

of these procedures in recent years.

SSJ07-04 The Impact of Gadoxetic Acid Enhanced Hepato-Biliary MRI on Treatment Decisions in Hepatocellular Carcinoma: The SORAMIC Trial Diagnostic Cohort

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S104A

Participants
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PURPOSE

SORAMIC is a RCT comprising diagnostic, local ablation and palliative studies in patients with hepatocellular carcinoma (HCC) in BCLC stages A-C. Based on the diagnostic study pts. were assigned to the local ablation or palliative cohort. The diagnostic study (reported here) was designed to determine the accuracy of treatment decisions based on hepato-biliary MRI employing Gadoxetate (hbpMRI) as compared to contrast enhanced CT (CECT).

METHOD AND MATERIALS

This multicenter trial recruited 692 pts. to receive standardized hbpMRI and CECT. Primary study objective was to confirm in a 2-step procedure hbpMRI is non-inferior (first step) or superior (second step) compared with CECT for assignment to a palliative or local ablation treatment strategy. In addition, we included a seperate set of dynamic MRI (dynMRI) sequences (obtained from the Gadoxetate data set) for comparison. Central read of all image sets was performed by 2 readergroups (R1, R2). Image criteria for CECT and dynMRI were wash-in and wash-out according to EASL. Modified HCC criteria for the hbpMRI are outlined in fig. 1. Readers determined a treatment recommendation according to standard criteria (local ablation, palliative treatment, neither recommendation; e.g. <=4 lesions <=5cm: ablation). Standard of reference was a joint truthpanel decision by a hepatologist and a radiologist with access to all available data incl. follow-ups.

RESULTS

The intention-to-treat (ITT) and the per-protocol (PP) population consisted of 530 and 442 pts., respectively. In the ITT population, the accuracy of CECT/ dynMRI was 73.8%/ 75.5% for R1 and 70.9%/ 70.4% for R2, respectively. In the PP population, the accuracy of CECT/dynMRI was 72.9%/ 76.5% (R1) and 72.2%/ 71.5% (R2). Non-inferiority (difference, -5%points; 1-sided; alpha, 2.5%) between modalities was shown for ITT as well as PP (power > 95%). For hbpMRI, the accuracy for R1/R2 was 83.4%/ 80.6% in the ITT and 82.6%/ 81.2% in the PP population. HbpMRI superiority was significant compared to CECT or dynMRI (all, $p<0.001$).

CONCLUSION

hbpMRI was superior to CECT or dynMRI for treatment decision making in HCC. Image artifacts did not affect treatment decisions in Gadoxetate based hbp MRI, dynMRI or CECT.

CLINICAL RELEVANCE/APPLICATION

Hepatobiliary MRI employing gadoxetic acid was superior to CECT or dynamic MRI for treatment decision making in pts. with BCLC stages A-C.

SSJ07-05 Diffusion-Weighted MR Imaging to Assess Immediate Response to Irreversible Electroporation in a Rabbit Liver Tumor Model: Pathologic Correlation

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S104A

Participants
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PURPOSE

Irreversible electroporation (IRE) is a relatively new strategy for the interventional treatment of liver tumors. Accurate follow-up imaging is critical for properly monitoring and evaluating treatment responses. The purpose of our study was to test the hypothesis that DW-MR imaging can be used to assess the immediate treatment response to IRE in animal models with liver VX2 tumors.

METHOD AND MATERIALS

New Zealand white rabbits were implanted with VX2 tumor tissue blocks in the left median and left lateral lobes of liver. Tumors were allowed to grow for 7-10 days to reach a size typically at least 10 mm in longest diameter, as verified with MR imaging. IRE electrodes were inserted, and eight 100-µsec, 2000-V square wave pulses were applied to ablate the tumor tissue in the left median lobe. Tumor in the left lateral lobe served as a control. DWI scans were performed at baseline and immediately after IRE for each animal (b= 0, 400, 800, 1200 s/mm2). Then, rabbits were euthanized and tumors harvested for hematoxylin-eosin (H-E), and caspase-3 staining. The ratio of ADC values (ADClesion/ADCnormal liver) and changes in the ADC measurements were calculated and compared. The percentage of viable tumor was calculated for treated tumors by using both radiologic methods and pathologic techniques. Pearson correlation coefficients were calculated to assess the relationship between ADC and H-E-stained measurements of viable area immediately post-IRE. The differences of apoptosis index (AI) between irreversible electroporation (IRE) zone and reversible electroporation (RE) zone were compared.

RESULTS

The ratio of ADC values, ΔADC, the mean percentage of viable tumor, and AI significantly differed between treated and untreated tumors (P<.05 for all). In treated tumors, the ratio of ADC values and AI significantly differed between IRE zone and RE zone, and there was a strong correlation between results of viable tumor measured on ADC value and pathologic techniques after IRE.

CONCLUSION

DW-MR imaging biomarkers can be used for the early evaluation of therapeutic response to IRE treatment of liver tumors in a rabbit model.

CLINICAL RELEVANCE/APPLICATION

Early changes in ADC values highlighted by DW-MRI correlate with histopathologic changes in liver tumors after IRE procedure. DWI-MRI may be helpful for timely adjustments to patient therapeutic strategies as needed to improve clinical outcomes.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Vahid Yaghmai, MD - 2012 Honored EducatorVahid Yaghmai, MD - 2015 Honored EducatorVahid Yaghmai, MD - 2017 Honored Educator

SSJ07-06 Therapeutic Response Monitoring After Targeted Therapy in an Orthotopic Rat Model of Hepatocellular Carcinoma Using Contrast-Enhanced Ultrasound: Focusing on Inter-Scanner and Inter-Operator Reproducibility

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S104A

Participants
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Joon Koo Han, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess therapeutic responses monitoring after targeted therapy in an orthotopic rat model of hepatocellular carcinoma (HCC) using contrast-enhanced ultrasound (CEUS) with focusing on inter-scanner, and inter-operator reproducibility.

METHOD AND MATERIALS

For reproducibility evaluation, CEUS was performed using two different US scanners by two different operators in sixteen N1-S1 rat models of HCC. Using perfusion analysis software (VueBox ®), 11 parameters were collected, and intra-class correlation (ICC) was used to analyze reproducibility. Then, seventeen N1-S1 rat models of HCC were divided into a treatment group (n = 8, 30 mg/kg/day sorafenib for 5 days) and a control group (n = 9). CEUS was performed at baseline, 1 day and 7 day after the first treatment and changes of perfusion parameters were analyzed.

RESULTS

In treatment group, CEUS perfusion parameters showed significant change, and among them, peak enhancement (PE, 2.50 x103±1.68 x103vs 5.55x102±4.65x102, p = 0.010), and wash-in and wash out AUC (WiWo AUC, 1.07x105±6.48 x104vs 2.65x104±2.25x104, p = 0.009), had significantly decreased 7 day following treatment. On the contrary, in control group, CEUS parameters did not show significant change including PE (1.15 x103±7.53x102vs 9.43x102± 7.81 x102, p = 0.632) and WiWoAUC(5.09 x104±3.25x104vs 5.92 x104±3.20x104, p = 0.646). For reproducibility, the various degrees of inter-scanner reproducibility from poor to good (ICC: <0.01-0.63) and inter-operator reproducibility from poor to excellent (ICC: <0.01-0.93) were observed. However, inter-operator reproducibility was good and excellent in WiWo AUC (ICC: 0.65 and 0.88) and fair and good in PE (ICC: 0.30 and 0.65) in different scanner.

CONCLUSION

CEUS was useful for assessment of treatment response after targeted therapy using PE and WiWo AUC with fair and excellent inter-operator reproducibility.

CLINICAL RELEVANCE/APPLICATION

CEUS perfusion parameters, including PE and WiWo AUC, had significantly decreased after targeted therapy with fair and excellent

inter-operator reproducibility. However, CEUS parameters obtained by different scanner should not be used interchangeably.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSJ08

Gastrointestinal (Pancreas Imaging)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S102CD

GI MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Brian C. Allen, MD, Durham, NC (*Moderator*) Nothing to Disclose
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Sub-Events

SSJ08-01 Accurate Therapeutic Response Assessment of Pancreatic Ductal Adenocarcinoma Using Quantitative DCE-MRI with Novel Perfusion Phantom: A Pilot Study

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S102CD

Participants
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PURPOSE

To validate quantitative dynamic contrast enhanced magnetic resonance imaging (qDCE-MRI) with a novel perfusion phantom for predicting therapeutic response in patients with pancreatic ductal adenocarcinoma (PDAC).

METHOD AND MATERIALS

A pilot study was conducted with eight patients (7 males and 1 female; median age = 66 yrs) having either locally advanced (n=7) or metastatic (n=1) PDAC. All had two DCE-MRI exams before and 8±1 weeks after starting first-line chemotherapy. The perfusion phantom was small enough to be imaged with each patient, serving as an internal reference for accurate quantitative image analysis. Tumor boundary was demarcated by board-certified radiologist blinded to therapy and clinical response. Tumor response was assessed by RECIST criteria. Tumor perfusion was measured with Ktrans using extended Tofts model before and after phantom-based data correction. Results are presented as mean±SD and 95% confidence intervals (CI). Statistical difference was evaluated with one-way ANOVA.

RESULTS

Mean tumor long axis before therapy was 38±17 mm. Tumor-size change of the responding group (n=4) was -12±4% for 8 weeks of therapy, while that of the non-responding group (n=4) was 18±15% (p=0.010). Baseline mean tumor Ktrans before therapy was 0.090±0.032 min-1 without statistical difference between the two groups (p=0.206). Before phantom-based data correction, the Ktrans change of responding tumors was 69±23% (95% CI: 32% to 106%) at 8 weeks, whereas that of non-responding tumors was -1±41% (95% CI: -65% to 64%) (p=0.025). After correction, the data variation in each group was significantly reduced; the Ktrans change of responding tumors was 73±6% (95% CI: 64% to 82%) compared to non-responding tumors of -0±5% (95% CI: -7% to 8%) (p<0.001).

CONCLUSION

To our knowledge, this is the first clinical data to demonstrate significant perfusion increase of PDAC responding favorably to first-line chemotherapy. Use of the small perfusion phantom imaged together with the patient reduced the data variation in quantitative DCE-MRI up to 50%, enhancing precision.

CLINICAL RELEVANCE/APPLICATION

The perfusion phantom is portable, inexpensive, easily utilized, and thus has potential to enhance precision for standard-of-care early PDAC therapy monitoring.

SSJ08-02 Dynamic Contrast Enhanced MRI for Pancreatic Perfusion in Acute Pancreatitis

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S102CD

Participants
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PURPOSE

To assess the characteristics of perfusion for normal pancreas and acute pancreatitis (AP) by using dynamic contrast enhanced MRI (DCE MRI).

METHOD AND MATERIALS

85 patients with AP and 26 normal controls underwent routine and DCE MRI sequences on a 3.0T MRI scanner. The Omitk DCE MRI Tool was used to analyze perfusion parameters, such as Ktrans, Vp and AUC values. The perfusion parameters of pancreas between AP group and control group were compared. In AP patients, the perfusion parameters were also compared between edematous and necrotizing pancreatitis, among different grades of AP by MR severity index (MRSI) and the revised Atlanta classification.

RESULTS

The Ktrans, Vp and AUC values of AP were lower than those of control group (all $P<0.05$). According to MRSI, the Ktrans and AUC values were significant difference between mild and moderate AP, mild and severe AP ($P<0.05$), except for between the moderate and severe AP ($P>0.05$); there was no significant difference for pancreatic Vp value in the different severity grades of AP ($P>0.05$). According to the revised Atlanta classification of AP, the Ktrans value was significant difference between mild and moderately severe AP, mild and severe AP ($P<0.05$), except for between the moderately severe and severe AP ($P>0.05$); there were no significant difference for pancreatic Vp and AUC values in the different severity grades of AP($P>0.05$). And the Ktrans was significant difference between edematous and necrotizing pancreatitis ($P<0.05$), except for the Vp and AUC values ($P>0.05$).

CONCLUSION

The application of DCE MRI to evaluate pancreatic perfusion contributes to AP diagnosis and AP severity grade. Pancreatic perfusion is significantly lower in patients with AP than that in normal pancreas, and with the increase of the severity of acute pancreatitis, pancreatic perfusion tends to decrease.

CLINICAL RELEVANCE/APPLICATION

The application of DCE MRI to evaluate pancreatic perfusion contributes to AP diagnosis and AP severity grade.

SSJ08-03 Multi-Parametric MRI to Assess Focused-Ultrasound Therapy of Pancreatic Ductal Adenocarcinoma

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S102CD

Participants
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PURPOSE

Pulsed focused ultrasound (pFUS) therapy has shown promising results in disrupting dense fibrotic stroma and decreasing high interstitial fluid pressure characteristic of pancreatic ductal adenocarcinoma (PDA). Our goal is to use multi-parametric MRI to non-invasively assess and quantitate tumor response to pFUS in PDA mouse models.

METHOD AND MATERIALS

Three murine models of PDA, including subcutaneous, orthotopic, and a genetic model (KPC) were evaluated with multi-parametric MRI at 14T (Paravision 5.1 software, Bruker Corp, Billerica, MA) to assess tumor response to ultrasound-guided pFUS (VIFU 2000 Alpinion Medical Systems; 475 W peak electric power, 1 millisecond pulse duration, 1 Hz, duty cycle 0.1%) or sham treatments. Maps for T1 and T2 relaxation, apparent diffusion coefficient (ADC), magnetization transfer ratio (MTR), and chemical exchange saturation transfer (CEST) for the amide proton and glycosaminoglycan (gag) spectrum were generated. Images were collected 48hrs pre-pFUS and immediately post-pFUS therapy. Tumors were excised and prepared for sectioning and staining with hematoxylin and eosin, Masson's trichrome, picrosirius red, and immunohistochemistry for CD31 and hyaluronan.

RESULTS

Following pFUS treatment, mean ADC increased significantly for all animal models, with the greatest increase observed in the KPC group. Mean gag CEST and T2 map quantitations decreased significantly post-treatment only for the KPC group. Mean MTR and mean amide CEST values increased 21.6% ($p<0.001$) and 14.5% ($p=0.01$), respectively for the KPC group. No significant differences were observed in sham groups. Significant increase in ADC likely reflects increased diffusivity within the treated tumors. Significant decreases in gag CEST and T2 relaxation may represent disruption of glycosaminoglycans and associated liberation of complexed water molecules. Variable changes in T1 relaxation and significantly increased MTR and amide CEST signals post-treatment most

likely represent hyperacute hemorrhage from microcapillary vessels. Histological quantifications are currently being processed.

CONCLUSION

T2 relaxation, gag CEST, and ADC may provide reliable quantitation for monitoring therapeutic effect of pFUS for PDA.

CLINICAL RELEVANCE/APPLICATION

Multi-parametric MRI may be utilized to non-invasively assess the therapeutic effects and changes in tumor composition to improve medical monitoring of pFUS treatment for patients with PDA.

SSJ08-04 Prediction of Overall Survival after Surgery of Pancreatic Cancer Using Preoperative MR Imaging, Clinical, and Histopathological Findings

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S102CD

Participants
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Hyo-Jin Kang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Joon Koo Han, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To predict overall survival in patients who underwent surgery for pancreatic cancer using preoperative MR imaging, clinical, and histopathological findings.

METHOD AND MATERIALS

In this retrospective study, 150 patients with pancreatic cancer who underwent MR and surgery were included. Preoperative MR findings were assessed by two radiologists. Clinical characteristics and histopathological results such as T, N stage and resection status were investigated as well. Cox proportional hazard model was used to find prognostic factors for overall survival and intraclass correlation coefficient was used to estimate interobserver agreement.

RESULTS

Median and mean survival period was 21.0 months (interquartile range, 10.0-41.3) and 31.1 ± 29.2 months in the patients. Tumor size on MR (hazard ratio (HR) 1.041, 95% CI: 1.011-1.072) and over-abutment of superior mesenteric vein on MR (HR 1.919, 95% CI: 1.177-3.130), N1 stage (HR 2.672, 95% confidence interval (CI): 1.503-4.750), macroscopic residual tumor (HR 10.340, 95% CI: 4.349-24.580), were predictors of poor survival (P<0.05). Interobserver agreement on MR was substantial for tumor size (0.682, 95% CI: 0.582-0.762) and was moderate for superior mesenteric vein involvement (0.469, 95% CI: 0.292-0.607).

CONCLUSION

Both preoperative MR findings and histopathological results are useful for prediction of overall survival after surgery for pancreatic cancer.

CLINICAL RELEVANCE/APPLICATION

Combination of preoperative MR findings and histopathological results can be useful for prediction of overall survival after surgery for pancreatic cancer.

SSJ08-05 Exploratory Study of ADC Histogram Metrics in Assessing Ampullary/Pancreatic Malignancy

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S102CD

Participants
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PURPOSE

To evaluate the utility of whole-lesion 3D-histogram apparent diffusion coefficient (ADC) metrics in the assessment of ampullary/pancreatic malignancy.

METHOD AND MATERIALS

Forty-two ampullary/pancreatic malignancies (36 adenocarcinoma, 6 neuroendocrine) underwent abdominal MRI with DWI followed by endoscopic ultrasound biopsy or surgical resection. A single radiologist used dedicated post-processing software to place 3D-volumes-of-interest encompassing the entire masses to derive whole-lesion histogram ADC metrics. Mann-Whitey tests and ROC analyses were used to assess the diagnostic performance of the histogram metrics for determining lesion histology, and among adenocarcinomas, T-stage, N-stage, and grade.

RESULTS

Whole-lesion ADC histogram metrics demonstrating significant differences between adenocarcinoma and neuroendocrine tumors were mean ADC (1.40 vs. 1.04 x10-3mm2/sec, respectively; p=0.020, AUC = 81%), mean of the bottom 10th percentile (mean0-10) (0.97 vs. 0.50; p<0.001, AUC=88%), and mean of the 10th-25th percentile (mean10-25) (1.16 vs. 0.77, p<0.001, AUC=92%). For the metric with highest AUC for histology (mean10-25), a threshold >0.94 achieved sensitivity of 94% and specificity of 83%. Metrics with significant differences between nodal status No vs. >=N1 were mean ADC (1.69 vs.1.24; p=.004; AUC = 81%), mean0-10 (1.19 vs. 0.71, p=0.012, AUC=82%), and mean10-25 (1.45 vs. 0.96; p=0.002, AUC=82%). For the metric with highest AUC for

nodal status (mean10-25), a threshold >0.94 achieved sensitivity of 94% and specificity of 83%. No metric was significantly associated with T stage (all p>0.195) or tumor grade (all p>0.215). Skewness and kurtosis were not significantly different between any groups (all p>0.087).

CONCLUSION

Volumetric ADC histogram metrics may serve as non-invasive biomarkers in assessing ampullary/pancreatic malignancy. The metric reflecting the bottom quarter of the histogram distribution outperformed the standard mean in determining lesion histology and nodal status, supporting the role of histogram analysis. More advanced methods may be needed for T stage and tumor grade differentiation.

CLINICAL RELEVANCE/APPLICATION

Although these findings require validation in larger studies, histogram diffusion metrics may be helpful in guiding prognosis and treatment selection for ampullary/pancreatic malignancy.

SSJ08-06 Noncontrast Computed Tomography Factors that Predict Outcome after Extracorporeal Shock Wave Lithotripsy in Patients with Pancreatic Duct Stones

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S102CD

Participants
Ri Liu, Shanghai, China (*Presenter*) Nothing to Disclose
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PURPOSE

To assess the usefulness of noncontrast computed tomography (NCCT) factors for predicting the outcome of extracorporeal shock wave lithotripsy (ESWL) in patients with pancreatic duct stone (PDS).

METHOD AND MATERIALS

We retrospectively evaluated 148 patients with multiple PDS in the pancreatic head region who had undergone ESWL therapy. All patients received NCCT examination both before and after ESWL. The following parameters are measured and recorded: patients characteristics including sex and age; NCCT parameters including mean stone length (MSL), mean stone volume before (V0) and after (V1) ESWL, mean value of CT attenuation (MSD), standard deviation of CT attenuation (SDSD), the variation coefficient of CT attenuation (VCSD), skin-to-stone distance (SSD) and pancreatic duct diameter (PDD); ESWL outcome indexes including stone clearance rate (SCR) calculated by , and the number of ESWL sessions (ESWL No.). All patients were respectively divided into A group (patients with SCR>=90%), B group (patients with SCR between 50% and 90%) and the C group (patients with SCR<50%). Analysis of variance (ANOVA) was applied among three groups to evaluate the potential predictors for SCR, and the receiver operating curve (ROC) was made for finding the cutoff value with optimal sensitivity and specificity. The Pearson correlation analysis and histogram were further used for finding factors related to ESWL No. .

RESULTS

ANOVA analysis revealed that MSD was the only significant predictor for SCR ($p < 0.05$), and ROC showed the cutoff value of +1000.45 HU, with sensitivity up to 78.0% and specificity of 48.6%. Stones with MSD lower than +1000.45 HU had higher SCR (69.3%) than that (59.6%) in higher-density ones. The Pearson correlation analysis and histogram indicated significantly positive correlation between ESWL No. and MSL (r= 0.536), MSD (r= 0.250), SDSD (r= 0.247) and PDD (r= 0.227), all with $p<0.01$.

CONCLUSION

MSD is the optimal predictor of ESWL efficacy, and PDS with lower MSD had the better clearance rate with fewer fragment sessions.

CLINICAL RELEVANCE/APPLICATION

MSD(mean stone density) is the optimal predictor of ESWL efficacy, and PDS with lower MSD had the better clearance rate with fewer fragment sessions.

SSJ09

Gastrointestinal (Quantitative Imaging Analysis)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S104B

BQ CT GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Rupan Sanyal, MD, Birmingham, AL (*Moderator*) Nothing to Disclose
Elizabeth M. Hecht, MD, New York, NY (*Moderator*) Nothing to Disclose
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Sub-Events

SSJ09-01 Automated Measurement of Liver Attenuation to Identify Hepatic Steatosis from Low-Dose CT Lung Screening Scans

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S104B

Participants
Artit C. Jirapatnakul, PhD, New York, NY (*Presenter*) Nothing to Disclose
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PURPOSE

To measure liver attenuation automatically from low-dose lung screening CT scans to identify patients with moderate-to-severe hepatic steatosis (HS) and compare the automated method to manual region of interest (ROI) based measurement.

METHOD AND MATERIALS

This IRB-approved, HIPAA compliant study included 251 participants with a baseline low-dose CT scan with a slice thickness of <=1 mm (111 from a lung cancer screening program and 140 from the World Trade Center (WTC) cohort). Radiologists measured the liver attenuation (Hounsfield units; HU) at the level of the portal vein in four sectors defined by the Couinaud system. In each sector, the average liver HU was measured in a 1.0 cm2 circular (ROI), avoiding lesions and large vessels. The automated method samples cubic ROIs in the liver region, which is determined using a computer-based automated segmentation of the right diaphragm as the upper bound of the region, extending to 7.0 cm below the diaphragm. This region is divided into non-overlapping 1.0 cm3 cubes, and the mean intensity is computed for each cube. To account for regions that may be outside the liver or include blood vessels, cubes with mean values outside of the inner quartile range (50%) are excluded. An overall mean attenuation is computed from the remaining cubes for each CT scan. A threshold for HS was defined as the mean - 2*standard deviation from the lung screening cohort for both methods. The manual ROI measurement and automated methods were compared by using limits of agreement of average liver attenuation values and comparing the detection of HS in the WTC cohort using the established thresholds.

RESULTS

The overall mean and SD for the automated liver attenuation measurement was 51.52 HU ± 12.72 and for the manual measurement, 55.31 HU ± 11.21. The limits of agreement were (-14.09, 6.51). The threshold for HS was 40 HU for the manual method and 37 HU for the automated method; using these thresholds, 97.1% (136/140) of WTC participants had the same classification by both methods.

CONCLUSION

Automated measurement of liver attenuation from low-dose chest CT scans is feasible and shows good agreement (97%) with manual ROI based measurements for detecting HS.

CLINICAL RELEVANCE/APPLICATION

Automated identification of hepatic steatosis (HS) from low-dose lung screening CT scans has good agreement with radiologists, enabling physicians to identify patients at risk of liver disease.

SSJ09-02 Increased Adipose Tissue Attenuation on Computed Tomography (CT) Predicts One-Year Mortality in Older Adults

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S104B

Participants
Leon Lenchik, MD, Winston-Salem, NC (*Presenter*) Nothing to Disclose
Kristin M. Lenoir, MPH, Winston-Salem, NC (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine relationships between visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT) index and attenuation on abdominopelvic CT examinations with one-year survival in older adults.

METHOD AND MATERIALS

Relationships between adipose tissue metrics and all-cause mortality were determined retrospectively in a cohort 436 consecutive Medicare patients (52% women, mean age 75 years) who had non-contrast abdominopelvic CT exams for routine clinical indications. On CT images, VAT and SAT were segmented at the level of L3 pedicle using segmentation software (Mimics) and a threshold of -190 to -30 Hounsfield units. VAT and SAT cross-sectional area (CSA) and attenuation were measured. VAT and SAT index was determined by dividing adipose CSA by patient height in meters squared. Cox regression models were fit to determine associations between VAT and SAT metrics and one-year mortality, adjusted for age, sex, race, body mass index, smoking status, and Charlson comorbidity index.

RESULTS

Within one year of follow-up, 90 patients (20.6%) died. In the fully-adjusted models, higher values of VAT and SAT attenuation were associated with higher hazard ratios (HR) for mortality at 1 year. A 1 SD increase in the VAT attenuation was associated with a 103% increase in mortality (HR/SD=2.03; 95%CI=1.45-2.83; p<0.0001). A 1 SD increase in the SAT attenuation was associated with a 75% increase in mortality (HR/SD=1.75; 95%CI=1.40-2.19; p<0.0001). VAT index and SAT index were not associated with increased mortality.

CONCLUSION

In older adults, increased adipose tissue attenuation on abdominopelvic CT examinations was associated with increased one-year mortality, independent of other causes of death.

CLINICAL RELEVANCE/APPLICATION

Quantitative data mining for adipose tissue attenuation on abdominal CTs of older adults may help determine prognosis.

SSJ09-03 Accuracy of CT Texture versus Mean Attenuation for Quantification of Liver Fat Content

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S104B

Participants
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PURPOSE

To develop a CT texture prediction model to accurately and reproducibly measure liver fat content.

METHOD AND MATERIALS

Retrospective secondary analysis of a prospective study that included 50 adult participants (23 men, 27 women; mean age 57 years; BMI 27) who underwent unenhanced single energy CT and MRI proton density fat fraction (MRI-PDFF). In separate independent reading sessions, three readers measured 110 first order CT texture parameters (before and after application of median and Gaussian filters) and liver fat content on MRI-PDFF-maps. Linear regression was used to examine the association between predictors and liver fat content per MRI-PDFF (reference standard). CT texture parameters with higher reproducibility (ICC >0.60) were moved forward into development of a multivariable model. The CT texture multivariable model was built using least absolute shrinkage and selection operator (LASSO) on those significant predictors (p-0.05). The root-mean square error (RMSE) and the coefficient of determination (R) were used to assess the goodness of fit of the models. Using a subset of significant predictors, accuracy (AUROC), sensitivity and specificity for correctly classified patients with >5.56% liver fat content were calculated.

RESULTS

The CT texture model most strongly associated with liver fat content consisted of percent of pixels less than 40 HU on unfiltered images (ICC=0.97-0.98, p=0.001), mean after median filtration (ICC=0.98-0.99, p=0.0001), and percent of pixels less than 40 HU after Gaussian filtration (ICC=0.95-0.97, p=0.0001). The CT texture prediction model had less deviation from and higher correlation with the reference standard than mean attenuation (RMSE = 0.474 vs. 0.513; R = 0.77 vs. 0.72, respectively). The AUROC, sensitivity and specificity for detecting >5.56% liver fat content were 0.96, 86.5%, and 92.3% for the CT texture prediction model vs. 0.93, 83.8% and 92.3% for mean attenuation.

CONCLUSION

A CT texture prediction model is highly reproducible and more accurate than CT mean attenuation for estimating liver fat content.

CLINICAL RELEVANCE/APPLICATION

CT texture can be used to accurately and reproducibly quantify liver fat content in patients at risk for NAFLD.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Perry J. Pickhardt, MD - 2014 Honored EducatorPerry J. Pickhardt, MD - 2018 Honored Educator

SSJ09-04 Quantitative Evaluation of Heterogeneous Hepatic Injury with Gd-EOB-DTPA Enhanced MRI: An Initial Experimental Study

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S104B

Participants
Yanyan Zhang, Shenyang, China (*Presenter*) Nothing to Disclose
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Yang Sun, Shenyang, China (*Abstract Co-Author*) Nothing to Disclose
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Liying Xia, Shenyang, China (*Abstract Co-Author*) Nothing to Disclose
Chaoxu Zhang, Shenyang, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess heterogeneous hepatic injury with Gd-EOB-DTPA enhanced MRI on a novel rat model.

METHOD AND MATERIALS

This study is approved by institutional review board. Seventy male Sprague-Dawley rats were randomly divided into control group (n=10) and colchicine group (n=60). The solution with 0.25% colchicine (0.4ml/kg) was injected via the splenic vein to develop a rat model of heterogeneous hepatic injury. An equal volume of normal saline was injected via the splenic vein in the control group. After the operation, at Day 3, week 1, week 2, week 4, week 8 and week 12 ten rats of the colchicine group were selected randomly for MRI examinations respectively, then they were euthanized. The ten rats of control group underwent MRI examinations at the same time points, and were euthanized at week 12 after MRI examinations. Gd-EOB-DTPA enhanced T1WI, T2WI and diffusion weighted imaging (DWI)were used to evaluate the heterogeneous hepatic injury. The quantitative data of left and right hepatic lobes, which were calculated on MRI, were compared and correlated with the pathological result of hepatic injury, which was assessed on liver sections according to the histological scoring criteria. P value of <0.05 was considered statistically significant.

RESULTS

There was obvious pathological change of rat hepatic parenchyma after colchicine injection through splenic vein, and the hepatic injury of left and right lobes was significantly difference (P <0.05). Meanwhile there were significant difference in ADC of DWI, LMR(liver-to-muscle ratio) of T2WI and ΔLMR(the difference value of LMR between pre- and post-enhanced T1WI)between left and right lobes of colchicine groupat each time point respectively(P <0.05), and it is similarly between colchicine and control group(P <0.05). Besides, there were significant correlation between ADC, LMR, ΔLMR value and hepatic injury score, respectively (r=-0.682, P=0.000; r=-0.245, P=0.018; r =-0.807,P =0.000).

CONCLUSION

Gd-EOB-DTPA enhanced MRI is useful for evaluation of heterogeneous hepatic injuty, which induced by injection of colchicine through splenic vein. It is necessary for the further research on clinic.

CLINICAL RELEVANCE/APPLICATION

Gd-EOB-DTPA enhanced MRI is useful for evaluation of heterogeneous hepatic injuty,which is necessary for the further research on clinic.

SSJ09-05 Expanded Quantitative Ultrasound of the Liver in Healthy Adults

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S104B

Participants
Andrew T. Trout, MD, Cincinnati, OH (*Presenter*) Author, Reed Elsevier; Research Grant, Siemens AG; Research Grant, Canon America Medical Systems Corporation; Board Member, Joint Review Committee on Educational Programs in Nuclear Medicine Technology; Travel support, Koninklijke Philips NV; Consultant, Guerbet SA
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PURPOSE

Imaging techniques including ultrasound are becoming increasingly quantitative. With shear wave elastography (SWE) becoming increasingly utilized clinically, ultrasound system manufacturers are developing additional methods of tissue quantification. Two such techniques are shear wave dispersion (SWD) and attenuation imaging (ATI). SWD quantifies the variation in shear wave speed (SWS) with frequency (i.e. dispersion slope in units of (m/s)/kHz) and should provide information about viscoelasticity. ATI quantifies the ultrasound attenuation coefficient in tissue and may serve as a means to quantify hepatic steatosis. The purpose of this study was to acquire SWE, SWD, and ATI data in healthy adults to demonstrate applicability of the technique and define normal values.

METHOD AND MATERIALS

Under IRB approval, 28 healthy adults without a known personal or family history of liver disease were recruited to undergo a quantitative ultrasound of the liver including SWE, SWD and ATI. Imaging was performed by a group of experienced technologists utilizing an Aplio i800 (Canon Medical Systems, USA). 10 SWE and SWD measurements and 5 ATI measurements were obtained from the right lobe in each patient. Study population data were summarized utilizing descriptive statistics (means, medians, standard deviations and ranges).

RESULTS

Median age for the population was 45.2 years (range: 17.6-64 years) and 18 of 28 participants (64.2%) were female. Median body mass index was 24 kg/m2 (range: 20-29 kg/m2). Mean average (for the 10 measurements) SWS for the population was 1.37±0.11 m/sec (median: 1.34 m/sec, range: 1.17-1.6 m/sec). Mean interquartile range (IQR) was 0.17 for the population and mean IQR/median was 0.15. Mean SWD was 10.68±1.53 (m/s)/kHz (median: 10.15 (m/s)/kHz, range: 8.4-14.8 (m/s)/kHz) and mean attenuation was 0.59±0.09 dB/cm/MHz (median 0.59 dB/cm/MHz, range: 0.42-0.8 dB/cm/MHz).

CONCLUSION

Mean shear wave speed for adults without known liver disease on an Aplio i800 was 1.37±0.11 m/sec. SWD and ATI provide quantitative information that is additive to SWE. Data acquired in healthy adults presented here may serve as a reference against which to compare data from patients with suspected liver disease.

CLINICAL RELEVANCE/APPLICATION

Attenuation imaging and shear wave dispersion provide quantitative measures of tissue characteristics in addition to shear wave elastography. Normative values for adult liver on the Aplio i800 are provided.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jonathan R. Dillman, MD - 2016 Honored Educator

SSJ09-06 Validation of Tumor-Host Interface on Pancreatic Protocol CT Scan as a Prognostic Biomarker in Patients with Pancreatic Ductal Adenocarcinoma

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S104B

Awards
Student Travel Stipend Award

Participants
Ahmed M. Amer, MD, Birmingham, AL (*Presenter*) Nothing to Disclose
Yufeng Li, PhD, Birmingham, AL (*Abstract Co-Author*) Nothing to Disclose
Eugene J. Koay, MD, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To validate a previously published pre-therapy conventional single energy multiphasic CT imaging biomarker that stratifies pancreatic ductal adenocarcinoma (PDAC) patients into different clinical groups and outcomes, using dual energy CT.

METHOD AND MATERIALS

IRB approved HIPAA compliant retrospective analysis of consecutive adult PDAC patients. Single operator recorded regions of interest (ROI) in tumor core, tumor border, pancreas border, normal pancreas using dedicated DECT server. ROIs were simultaneously populated to identical image locations on DECT 70 keV pancreatic parenchymal phase (PPP), single energy portal venous phase (PVP), and conventional unenhanced images. Imaging based classification of High Delta (HD-defined as increased enhancement difference across tumor-host tissue interface >= 40 HU on either 70 keV PPP or PVP) and Low Delta (LD- lower enhancement difference) was evaluated for resectable, borderline resectable (BRPC), locally advanced (LAPC), and metastatic PDAC groups and compared to outcomes using Cox proportional-hazards model.

RESULTS

158 subjects (79M, 79F, mean age 67.8) included: 93 advanced stage -50 locally advanced, 43 metastatic; 65 lower stage -48

resectable, 17 borderline resectable. 44 underwent Whipple. 28 received neoadjuvant therapy. Median overall survival (OS) was significantly shorter for HD tumors in both advanced stage patients (10.8 vs 18 months; HR, 2.03; 95%CI, 1.22 to 3.48; P= .0062) and in lower stage patients (13.5 vs 23.3 months; HR, 1.87; 95%CI, 1.01 to 3.53; P= .042). In lower stage patients, delta was associated with OS after accounting for age, tumor size, surgery, and neoadjuvant therapy (P= .04) In non-metastatic patients, HD was associated with shorter time to distant metastasis development (HR, 2.28; 95%CI, 1.04 to 5.25; P= .03).

CONCLUSION

Our results validate the prognostic value of CT-based classification of PDAC patients using DECT; those with tumors characterized by high delta have significantly shorter survival.

CLINICAL RELEVANCE/APPLICATION

As with conventional MDCT, Delta score is a visually apparent and quantifiable DECT imaging biomarker that can stratify distinct subtypes of tumors in PDAC patients.

SSJ10

Science Session with Keynote: Genitourinary (Benign Gynecologic Disease)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S404CD

GU MR OB US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Victoria Chernyak, MD,MS, Bronx, NY (*Moderator*) Nothing to Disclose
Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSJ10-01 Genitourinary Keynote Speaker: MRI of Ovarian Lesions: 2018 Update

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S404CD

Participants
Elizabeth A. Sadowski, MD, Madison, WI (*Presenter*) Nothing to Disclose

SSJ10-02 Comparison of Routine Pelvic US and MR Imaging in Patients with Pathologically Confirmed Endometriosis

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S404CD

Participants
David J. Bartlett, MD, Rochester, MN (*Presenter*) Nothing to Disclose
Shannon P. Sheedy, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To estimate the benefit of pelvic MR imaging after a negative routine pelvic ultrasound (US) in patients with pathologically or surgically proven endometriosis.

METHOD AND MATERIALS

In this retrospective observational study, patients with surgically or pathologically proven endometriosis had routine pelvic US followed by pelvic MR imaging within six months. Patients were excluded if they had a previous history of confirmed endometriosis, were pregnant, > 18 years of age, or surgery > 1 year after MR. Clinical pelvic US and MR reports were independently reviewed to assess the ability of each modality to detect endometriosis, and to compare the detection rate based on disease location and sequela using the surgical and pathology reports as a reference standard. Examinations were considered negative if findings were normal or if a detected lesion was reported indeterminate or nonspecific.

RESULTS

83 female patients (ages 25-53) with pathologically proven endometriosis were included. The mean duration between the pelvic US and MR was 33 ± 43 days, with 64 ± 69 days between MR examination and surgery. Suspicion of endometriosis occurred in 18/83 (22%) of patients for pelvic US and 51/83 (59%) for MR examinations ($p<0.0001$). Of 65 patients with a negative pelvic US exam, 33/65 (51%) had a positive MR. Of 18 patients with a positive US exam, MR identified additional sites or sequela in the majority (14/18; 78%). Additional information on the MR examinations included extraovarian locations [e.g., fallopian tubes 7/18 (39%), uterus 7/18 (39%), uterosacral ligaments 3/18 (17%), other uterine ligaments 6/18 (33%), posterior cul de sac 5/18 (28%), pelvic side walls 5/18 (28%), abdominal wall 1/18 (6%)] and sequela [tethering of the ovaries 5/18 (28%), 6/18 bowel adhesive disease (33%), obliteration of the posterior cul de sac 2/18 (11%), hydrosalpinx 2/18 (11%), and hydronephrosis 1/18 (6%)].

CONCLUSION

Pelvic MR imaging had a higher detection rate of endometriosis and provides more information about disease location and sequela compared to routine pelvic US. In patients with suspected endometriosis, pelvic MR or endometriosis protocol US is required to identify important sequela identified at surgery.

CLINICAL RELEVANCE/APPLICATION

A substantial proportion of patients undergoing evaluation for endometriosis with a negative routine pelvic ultrasound will benefit from pelvic MR imaging.

SSJ10-04 Efficacy of MRgFUS in Treating Focal Uterine Adenomyosis After 24 Months of Follow-Up

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S404CD

Participants
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PURPOSE

To evaluate the treatment of focal uterine adenomyosis by using MRgFUS as a mini-invasive therapy after 24 months of follow-up

METHOD AND MATERIALS

From June 2014 to June 2016, 17 patients affected by focal uterine adenomyosis (focal form), diagnosed by MRI, were subjected to a single treatment using MRgFUS. The therapeutic plan consisted of a high-energy-grid sonication. MRI was performed without and after administration of contrast medium before treatment and at 3,6,12 and 24 months from the procedure to evaluate the focal thickness of the junctional area, the uterine wall morphology and the possibility of recurrence of this pathology. Clinical symptom outcome was assessed with a symptom severity score questionnaire (UFS-QOL) obtained at baseline and after 24 months from the procedure.

RESULTS

After MRgFUS, 10/17 patients with focal adenomyosis did not show disease recurrence showing a focal thickness of the junctional area of less than 12-13 mm and a good uterine wall morphology. Furthermore, in 7/17 treated-women, we found a disease recovery with focal thickness of the junctional area greater than 12 mm. In all patients, a reduction of about 75% of the symptomatology, assessed by UFS-QOL, was observed after 24 months from MRgFUS.

CONCLUSION

MRgFUS is an important mini-invasive treatment to treat focal adenomyosis allowing to maintain the integrity of the uterus wall in a pathology with limited therapeutic possibility.

CLINICAL RELEVANCE/APPLICATION

Adenomyosis is a gynecologic medical condition characterized by the abnormal presence of endometrial tissue within the myometrium In contrast, when endometrial tissue is present entirely outside the uterus, it represents a similar but distinct medical condition called endometriosis.MRgFUS is an important mini-invasive treatment to treat focal adenomyosis.

SSJ10-05 Urge Urinary Incontinence: Spectrum of Abnormalities on Static and Dynamic MR Imaging

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S404CD

Participants
Rania F. el Sayed, MD,PhD, Cairo, Egypt (*Presenter*) Nothing to Disclose
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PURPOSE

To prospectively analyze static and dynamic magnetic resonance (MR) images to determine whether urge urinary incontinence (UUI) is associated lax uterosacral ligaments (USL)

METHOD AND MATERIALS

Study included 71 women: 41 healthy continent volunteers as a control group and 30 patients with UUI. Static MRI of the 71 women was performed using PD &T2 weighted turbo spin echo sequences; MR defecography was acquired using balanced fast-field echo. A standardized grid system that allowed us to record structural observations of the USL on sequentially numbered axial MR images was used by a radiologist who then applied a 4-point grading scale to assess ligament visibility. Cumulative data from the 41 continent control subjects were compiled so that a "normal" standard appearance for the USL could be defined and then compared with that of the UUI patient. MR images were interpreted by a trained radiologist , trained urologist and revised by an expert radiologist with 20 years experience in MR imaging of the pelvic floor. The expert radiologist was not aware of the clinical data of the patients.Inter observer reliability was evaluated for the collected data by the three observers

RESULTS

In the control group the mean length of right USL= 23.88 ± 9 mms while the left USL is 21.97 ± 9 mms. In the patient group, the mean length of right USL is 35.11 ± 11 mms while the left USL is 34.03 ±11 mms. There is significant statistical difference between the lengths in both groups with longer length in the cases group (P<0.01).The highest inter observer agreement was on the image number on which origin could be visualized .The lowest agreement was on the site of insertion of USL in both control and patient group.

CONCLUSION

We found that the average length of both USLs in the cases group is significantly longer than that of the control group. Moreover, we found a correlation between the increased length of the USLs and UUI.

CLINICAL RELEVANCE/APPLICATION

Pharmacological treatments of UUI are disappointing, since they are only slightly more effective than placebo. Urologist reported that operative repair of the USL know as cervical-rectal-sacral fixation (CERESA) could cure patients withUUI

SSJ10-06 MR of the Female Pelvis on 1.5 Tesla Scanner: Image Quality and Acquisition Time Comparison Between Synthetic MR Imaging and Turbo Spin Eco Sequences

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S404CD

Participants
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PURPOSE

to compare the image quality and acquisition time of synthetic MR imaging, based on multiple-dynamic multiple-echo (MDME) sequence, and turbo spin eco (TSE) sequences on 1.5 Tesla MR study of the female pelvis.

METHOD AND MATERIALS

Fifteen women were prospectively subjected to MRI examination of the pelvis according to the clinical indication. All exams were performed on a 1.5T MR scanner. The acquisition protocol was composed of conventional TSE T2w, TSE T1w, STIR T2w acquired on the axial plane. Then, a multiple-dynamic multiple-echo (MDME) sequence was performed for synthetic reconstruction of T2w, T1w and STIR T2w images on the axial plane. Two radiologists separately evaluated image quality by using Likert scale with 5 values. A quantitative evaluation was performed by measuring the signal intensity (SI) by placing a circular ROI of 5 mm in diameter in endometrium, junctional zone and myometrium. Signal to noise ratio (SNR) for the three layers were estimated. Image acquisition time of synthetic and conventional sequences was recorded. Results of conventional and synthetic imaging were compared using noninferiority statistics.

RESULTS

Overall qualitative and quantitative scores of synthetic MR images were non inferior to conventional imaging ($p>0,05$). The cumulative scan time of conventional sequences was significantly longer than synthetic sequences($p<0,05$).

CONCLUSION

Overall imaging quality and SNR obtained with synthetic imaging were similar to those obtained with conventional sequences. Thanks to the single acquisition, this could lead to a considerable time-saving for the hospital and the patient.

CLINICAL RELEVANCE/APPLICATION

Thanks to a single acquisition there is a great time savings for the patient in terms of comfort and for department in terms of productivity

SSJ11

Genitourinary (Scrotum and Bladder)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S403A

BQ GU MR OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Raghunandan Vikram, MBBS, FRCR, Bellaire, TX (*Moderator*) Nothing to Disclose
Geoffrey E. Wile, MD, Nashville, TN (*Moderator*) Nothing to Disclose

Sub-Events

SSJ11-01 Usefulness of Testicular Volume, Apparent Diffusion Coefficient, and Normalized Apparent Diffusion Coefficient in the Magnetic Resonance Imaging in Evaluation of Infertile Men with Azoospermia

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S403A

Participants
Sung Bin Park, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

To assess retrospectively the usefulness of testicular volume, apparent diffusion coefficient (ADC), and normalized ADC (nADC) as measured using MRI in predicting the histopathological grade of azoospermia and in differentiating obstructive from non-obstructive azoospermia.

METHOD AND MATERIALS

A computerized search generated a list of 30 infertile men with azoospermia who had undergone both scrotal MRI and testis biopsy. MRI-determined testicular volumes, ADCs and nADCs were compared between infertile men with obstructive and those with non-obstructive azoospermia. The nADC was calculated as ADC (testis)/ADC (bladder lumen).

RESULTS

16 were obstructive azoospermia and 14 were non-obstructive azoospermia. The testicular volume in obstructive azoospermia (8.7-27.6 mL) was significantly greater than that in non-obstructive azoospermia (1.8-15.4 mL; $p < 0.001$). The area under the ROC curve for distinguishing non-obstructive from obstructive azoospermia using testicular volume was 0.92 (<= 13.06 mL, sensitivity of 85.71% and specificity of 87.5%). Testicular ADC and nADC in obstructive azoospermia (0.329×10-3 to 1.578×10-3 mm2/s for ADC, 0.113-0.449 for nADC) were significantly lower than in non-obstructive azoospermia (0.801×10-3 to 2.211×10-3 mm2/s; $p = 0.0094$ for ADC, 0.235-0.61; $p = 0.0001$ for nADC). The area under the ROC curves for distinguishing non-obstructive from obstructive azoospermia using testicular ADC and nADC were 0.741 (> 1.031×10-3 mm2/s, sensitivity of 92.86% and specificity of 56.25%) and 0.875 (> 0.425, sensitivity of 78.57% and a specificity of 93.75%).

CONCLUSION

Testicular volume, ADC, and nADC, as measured using MRI, are useful in predicting the histopathological grade of azoospermia and in differentiating obstructive from non-obstructive azoospermia.

CLINICAL RELEVANCE/APPLICATION

MRI can evaluate azoospermia with good performance, the testicular volume, ADC and normalized ADC values measured on MRI are useful in predicting the histopathologic grading of azoospermia and differentiating obstructive from non-obstructive azoospermia. Therefore, DWI seems to be a promising imaging method with great potential for the differential diagnosis of azoospermia.

SSJ11-02 Validation of Vesical Imaging Reporting and Data System (VI-RADS) in Untreated Patients with Bladder Cancer at a Single Reference Center

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S403A

Participants
Stefano Cipollari, Rome, Italy (*Presenter*) Nothing to Disclose
Isabella Ceravolo, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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Valeria Panebianco, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To date, several studies have evaluated the ability of Multiparametric MRI of the bladder (mpMRI) to detect and stage bladder cancer (BCa). Nevertheless, there is still no standardized reporting system. Our aim was to validate the recently developed Vesical Imaging Reporting and Data System (VI-RADS) for BCa.

METHOD AND MATERIALS

This is a retrospective study of 54 consecutive patients who underwent 3T MRI with a body-array coil for diagnostic confirmation and local staging of BCa between September 2017 and April 2018. The mpMRI protocol included T2-Weighted sequences, Diffusion-weighted images with Apparent Diffusion Coefficient Maps reconstruction and Dynamic Contrast-enhancement Imaging. The goal of the mpMRI was to exclude the presence of muscle invasive BCa (MIBCa). MpMRI exams were interpreted by two readers, blinded to cystoscopy and/or other imaging exams. Sensitivity, specificity, and agreement were calculated based on a criterion of VI-RADS score = 4. Inter-examiner agreement was determined by the weighted kappa statistic.

RESULTS

Patients' median age was 67 years. There were 42 males and 12 females. Histological findings were positive for MIBCa in 15 patients. The remaining 39 had superficial BCa. Considering a VI-RADS score of 4 as positive for MIBCa, the accuracy of each reader was 92% and 89%, respectively, and interobserver agreement was excellent (weighted $\kappa = 0.81$; 95% confidence interval: 0.73-0.88; P?=?0.023). Considering PI-RADS 2 as absence of MIBCa, the accuracy of each reader was 95% and 92%, respectively, with excellent agreement (weighted $\kappa = 0.85$; 95% confidence interval: 0.71-0.92; P?=?0.031). Sensitivity and Specificity were 91% and 94% respectively. Positive Predictive Value and Negative Predictive Value were 92% and 95% respectively.

CONCLUSION

The recently developed VI-RADS score at 3T has a high accuracy for exclusion of MIBCa, with excellent inter-reader agreement. These results are promising for improving the management of patients with BCa.

CLINICAL RELEVANCE/APPLICATION

The introduction of a standardized reporting system for multiparametric MRI of the bladder could greatly simplify its introducion in clinical practice.

SSJ11-03 Testicular Microlithiasis and Extragonadal Germ Cell Tumors: Clinical-Radiologic-Pathologic Correlation in 22 Patients

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S403A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The majority of germ cell tumors have testicular origin, while only 2-5% of those tumors have extragonadal location. It has been said before that the presence of testicular microlithiasis has a very strong association with extra gonadal germ cell tumors.Our purpose is to demonstrate the correlation between these two in a series of 22 cases.

METHOD AND MATERIALS

This is a retrospective observational study of prospectively collected data of 22 consecutive patients with extra gonadal germ cell tumors from a tertiary care center between 2008 and 2017. Baseline characteristics (the presence of comorbidities, hypogonadism, primary tumor site, tumor histology, and clinical stage) and testicular ultrasonographic characteristics (testicular volume and the presence of microlithiasis) were recorded for every patient. Imaging characteristics were analyzed between groups according to primary tumor site and tumor histology.

RESULTS

The median age at diagnosis was 24.6 6.5 years and 9.5 % of the patients had a history of cryptorchidia. The most common extragonadal location was mediastinum (63.6%), followed by supraselar region (18.2%) and retroperitoneum (13.6%). Non-seminomatous tumors were more frequent (75%) than seminomas. Sixteen patients had testicular ultrasound and bilateral TML was observed in 43.8% while testicular atrophy (volume <12 cc) was detected in 53.3% of the patients. Furthermore, the presence of bilateral TML was associated with testicular atrophy (85.7% v.s. 14.3%, $p<0.04$). On univariate logistic regression analysis, testicular microlithiasis was associated with testicular atrophy (OR 18, CI 1.3-255.7, $p <0.03$).

CONCLUSION

The most common primary site for EGCT was the mediastinum and the most frequent histologic type were non-semminomatous tumors. The prevalence of TML in patients with EGCT is far more common than the one reported in healthy individuals. Bilateral TML was observed in 43.8% of the patients and it was associated with testicular atrophy.

CLINICAL RELEVANCE/APPLICATION

Testicular microlithiasis has been associated with intratubular germ cell neoplasia in patients with testicular cancer. The clinical relevance of this finding in patients with EGCT remains unknown. To our knowledge, this is the largest case series in literature.

SSJ11-04 Improving Treatment Response Assessment of Bladder Cancer by Integrating Deep Learning, Radiomics and Clinical Information

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S403A

Participants
Lubomir M. Hadjiiski, PhD, Ann Arbor, MI (*Presenter*) Nothing to Disclose
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PURPOSE

To evaluate the accuracy of treatment response assessment of bladder cancer using deep learning, automatically extracted radiomic features from CT scans, and clinically estimated feature.

METHOD AND MATERIALS

A deep-learning neural network (DL) was trained to recognize the patterns of bladder lesions indicative of treatment response. 47 radiomic features (RF) including pre- and post- treatment change in volume, 5 gray level and 9 shape descriptors and 32 texture features were also extracted from automatically segmented lesions. A clinically estimated feature, the bimanual exam under anesthesia (EUA), was also collected from the clinical reports. Linear discriminant analysis and max function were used to generate combined response indices (CRIs): RFs alone (CRI-RF), RFs and DL (CRI-RF-DL), RFs, DL and EUA (CRI-RF-DL-EUA). Pre- and post-chemotherapy CT scans of 98 patients with bladder cancers were collected with IRB approval. For all cases, cystectomy was performed after treatment and the disease outcome was available as reference standard of treatment response. 25% of patients had pT0 disease (complete response) at cystectomy. A radiologist marked 122 temporal pairs of primary site cancers. Stepwise feature selection and leave-one-case-out cross-validation were performed. The area under the test ROC curve (AUC) was calculated to estimate the accuracy for predicting pT0 stage (complete response) at cystectomy by the methods. Two radiologists also estimated the likelihood of pT0 stage of the tumor by reading the pre- and post-treatment paired CT scans.

RESULTS

For the 122 cancers, the AUC for DL in predicting pT0 disease at cystectomy was 0.69±0.05. The AUC for CRI-RF based on 2 Contrast and 2 RLS features was 0.75±0.05, which increased to 0.79±0.04 by adding DL (CRI-RF-DL), and further increased to 0.80±0.04 with EUA (CRI-RF-DL-EUA). The two radiologists' AUCs in predicting pT0 disease were 0.77±0.05 and 0.75±0.05. The differences in any pairs of AUCs did not reach significance ($p>0.05$).

CONCLUSION

CRI-RF, CRI-RF-DL and CRI-RF-DL-EUA performed similarly to the radiologists for estimation of treatment response. The addition of DL and EUA improved the accuracy of treatment response assessment.

CLINICAL RELEVANCE/APPLICATION

The combined response index using deep learning knowledge, the radiomic features and clinically estimated EUA has the potential to provide accurate treatment response assessment.

SSJ11-05 Evaluation of Quantitative T2-Weighted and Apparent Diffusion Coefficient Textural MRI Features to Predict Muscle Invasive Bladder Cancer (Stage >=T2) and Extravesical Extension (Stage >=T3) Prior to Surgery

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S403A

Participants
Christopher Lim, MD, Boston, MA (*Presenter*) Nothing to Disclose
Sreeharsha Tirumani, MBBS, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Richard Thomas, MBBS, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Atul B. Shinagare, MD, Boston, MA (*Abstract Co-Author*) Advisory Board, Arog Pharmaceuticals, Inc; Research Grant, GTx, Inc

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PURPOSE

To evaluate quantitative MRI textural features associated with muscle invasive bladder cancer (MIBC) (stage >=T2) and extravesical extension (stage >=T3) on T2-weighted (T2W) and apparent diffusion coefficient (ADC) images in patients post transurethral resection of bladder tumor (TURBT).

METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant retrospective study identified 36 patients (27 men, 9 women; mean age 70.8, SD 11.1) with bladder cancer diagnosed by TURBT who subsequently underwent mp-MRI, followed by cystectomy, and without intervening

treatment, between 08/2011-08/2016. A radiologist blinded to T stage manually contoured the primary bladder cancer (BC), and extravesicular fat (EF) immediately adjacent to the tumor on T2W and ADC images using a commercially available texture analysis software (TexRAD Ltd, Cambridge, UK). Six textural features (mean, sd, entropy, mpp, skewness and kurtosis) derived from the contoured BC and AF were compared between stage T1 versus >=T2 and between stage =T3 tumors using independent sample Kruskal-Wallis or Mann-Whitney U test and multivariate logistic regression analysis (p-value <0.05).

RESULTS

Total of 72.2% (26/36) bladder cancers were stage >=T2 stage and 52.8% (19/36) were stage >=T3. BC entropy on T2W, and EF entropy on both T2W and ADC, were significantly increased in stage >=T3, compared to stage =T2, compared to stage T1, tumors on T2W and ADC ($p<0.05$) with univariate analysis; however, the difference did not persist on multivariate analysis.

CONCLUSION

Higher entropy of BC and EF may help identify >=T3 tumor on T2W and ADC. Entropy may also be different between T1 and >=T2 tumors but that difference was not significant on multivariate analysis in this pilot study.

CLINICAL RELEVANCE/APPLICATION

Staging bladder cancer with TURBT alone can be inaccurate. Entropy, a quantitative textural feature, of the bladder cancer and extravesicular fat immediately adjacent to the tumor may be predictive of higher stage cancers on multiparametric MRI, allowing for more informed management decisions.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Sreeharsha Tirumani, MBBS, MD - 2016 Honored EducatorAtul B. Shinagare, MD - 2017 Honored Educator

SSJ12

Health Service, Policy and Research (Economics and Cost-Effectiveness)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S403B

HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Hanna M. Zafar, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose
Christoph I. Lee, MD, Mercer Island, WA (*Moderator*) Research Grant, General Electric Company; Investigator, General Electric Company

Sub-Events

SSJ12-01 Can a Pseudo-Reader Study Design Estimate Observer Results Obtained Using Fully-Crossed, Multi-Reader, Multi-Case Studies?

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S403B

Participants
Rickey E. Carter, PhD, Jacksonville, FL (*Presenter*) Nothing to Disclose
David R. Holmes Iii, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose
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Joel G. Fletcher, MD, Rochester, MN (*Abstract Co-Author*) Grant, Siemens AG; Consultant, Medtronic plc; ;
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

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PURPOSE

To examine the ability of a pseudo-reader study design to estimate the observer performance obtained using a traditional prospective, fully-crossed, multi-reader, multi-case (MRMC) study.

METHOD AND MATERIALS

The pseudo-reader study design assumes readers in an MRMC study are exchangeable (same confidence scale usage and detection ability), but uses only a fraction of the total possible reading impressions by randomly allocating what normally would be one reader's reading list to multiple readers (Fig A). To better understand the operating characteristics of the design, we compared results using a pseudo-reader study design with ten radiology trainees and four CT noise reduction methods (NRMs) (2 projection space, 2 image space) to interpretations by 10 different radiology trainees in a traditional MRMC study. Following reader training, JAFROC Figures of Merit (FOM) were calculated for each NRM and reader, and differences of FOMs were estimated using the Hillis improvement to the Dorfman, Berbaum and Metz (DBM) method under the modeling assumption of random readers - random cases using the RJafroc (v1.0.1) and mrmctools (v1.0.2) packages on R version 3.4.2.

RESULTS

The best performing NRM by the pseudo-reader approach retained the first place ranking in this traditional MRMC validation study with the highest FOM (0.71; 95% CI: 0.60 to 0.81), providing qualitative validation to the pseudo-reader approach; however, all FOMs in this traditional MRMC validation study overlapped widely with the pseudo-reader estimate but were numerically lower than that observed using the pseudo-reader with decreases ranging from 2% to 10%. Reading times in the fully crossed study dropped from 3.1 minutes to 1.9 minutes ($p<0.001$). The agreement of the readers' confidence scores, measured by the intraclass correlation, ranged from 0.60 to 0.66 across the NRM, representing moderate agreement.

CONCLUSION

The results of our fully-crossed MRMC validation study design provided qualitative agreement with the pseudo-reader estimate; however, agreement of confidence scores and changes in reading times may suggest that the operating characteristics of the pseudo-reader and fully-crossed MRMC study designs may not be the same.

CLINICAL RELEVANCE/APPLICATION

Multireader multicase studies are needed to determine observer performance; shortening trial design using a pseudoreader may be one optiojn, but requires careful attention to reader training and study design.

SSJ12-02 Which Patients with Small Renal Tumors Would Benefit Most from Preference Elicitation to Guide Management Decisions? A Quality of Life Analysis

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S403B

Participants
Rahul D. Mali, MBBS,MPH, New York, NY (*Presenter*) Nothing to Disclose
Stella Kang, MD,MSc, New York, NY (*Abstract Co-Author*) Royalties, Wolters Kluwer nv

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PURPOSE

To identify patient subgroups for whom the most effective treatment for small renal masses depends upon preferences for watchful waiting, by comparing quality-adjusted life expectancy (QALE) across various treatment strategies.

METHOD AND MATERIALS

We used a state transition microsimulation model to estimate QALE for patients with mild chronic kidney disease (CKD) and small renal masses. The model compared 5 strategies: partial nephrectomy, ablation, biopsy based treatment, watchful waiting using CT, and MRI selection for watchful waiting. We incorporated renal function loss according to treatment and tumor anatomy, CKD and other comorbidities, and oncologic risk. Nephrometry Score (NS), a system for quantifying tumor anatomic complexity, was used to correlate with renal function loss after partial nephrectomy using published regression formulas. Utilities specific to health state were used to weight the quality of life. The utility for watchful waiting can vary widely due to anxiety and preferences for intervention, and we assessed the impact of varying this utility on the optimal treatment. We used sensitivity analysis to test effects of varying parameters on model results.

RESULTS

In 65-year-old men and women with anatomically simple small renal masses (NS 4-6), partial nephrectomy yielded far greater QALE (up to +3.4 months) compared with watchful waiting. For moderate anatomic complexity (NS 7-8), watchful waiting using CT surveillance yielded the highest QALE compared with the next highest QALE from biopsy based management (+1.1 months for NS of 7). In this group, the optimal treatment was dependent upon the utility related to watchful waiting. Specifically, watchful waiting using CT was the preferred treatment for patients with a utility for watchful waiting above 0.88. For high anatomic complexity (NS 9-10), watchful waiting offered greatest benefit compared with all other treatments (+1.2 months vs. ablation); ablation became favored when the utility of watchful waiting was under 0.59.

CONCLUSION

To optimize quality of life in treatment selection for patients with mild CKD, anatomically complex renal tumors warrant formal preference elicitation for watchful waiting vs. other treatment options.

CLINICAL RELEVANCE/APPLICATION

In decision making for small renal tumors, preference elicitation for watchful waiting vs. intervention likely improves longterm quality of life for patients at risk for worsening CKD after surgery.

SSJ12-03 Preference and Cost-Comparison for Iodinated and Barium-Based Oral Contrast Media: Prospective Clinical Trial in Cancer Patients with Multiple Prior CT Exams

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S403B

Participants
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Manuel Patino, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Travis L. Redel, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Fredrick McNulty, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Dushyant V. Sahani, MD, Boston, MA (*Abstract Co-Author*) Research support, General Electric Company Medical Advisory Board, Allena Pharmaceuticals, Inc

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PURPOSE

Oncological patients undergo multiple abdominopelvic CT with positive oral contrast media (CM). Aim of this study was to evaluate patient preference and cost-comparison for iodine- and barium-based CM used in abdominopelvic CT studies.

METHOD AND MATERIALS

In this prospective clinical trial, 157adults (74M, 83F; 63±12 yrs) with prior 120kVp abdominopelvic CT performed using barium-based CM (bCM; Readi-cat 2% w/v, Bracco) were enrolled. Subjects were randomly assigned to receive iodinated CM (iCM; Omnipaque 300mgI/ml, GE Healthcare) in standard concentration (iCMs 7.7mgI/ml) or 25%-reduced concentration (iCMr 5.8mgI/ml). iCM was diluted in water to obtain 900ml solution. Subjects were instructed to consume iCM in a similar protocol to bCM (900ml over 45 minutes). CT scans were performed with 100kVp single-energy-CT or dual-energy CT. A paper survey about patient's experience was conducted to rate and describe the taste of iCM on a 5-point Likert scale (1 dislike very much to 5 like very much), report adverse effects and indicate CM preference for future scans. Cost comparison of the two CM was also performed.

RESULTS

79/157 patients received iCMs and 78/157 received iCMr which was consumed over 37±10 min). Mean volume of iCM consumed was 877ml(450-900ml) and bCM was 870ml(400-900ml). 3 patients found it difficult to consume 900ml of bCM but were able to consume 900ml of iCM. Mean taste score for iCM was 3.7±1, with no significant difference between iCMs and iCMr ($p>0.05$). 77% (121/157) patients preferred iCM over bCM. Nine patients had no preference. Immediately after iCM consumption, 92% (145/157) had no adverse effects with iCM, whereas 5% (n=8/157) complained of minor gastrointestinal symptoms not requiring management (nausea-6, mild abdominal discomfort-2). Within 24 hours of iCM, 2% (4/157) patients developed diarrhea. 12 patients complained of diarrhea with bCM but not with iCM. The cost per patient for bCM was $6.86 compared with $5.30 to $6.6 for iCM, depending on the amount consumed.

CONCLUSION

Cancer patients who undergo multiple CTs as part of standard of care demonstrate a stronger preference for iCM due to its neutral taste and decreased viscosity.

CLINICAL RELEVANCE/APPLICATION

Palatable CM solutions are likely to improve patient acceptance and experience. With increased use of low kVp/keV imaging, iCM has the potential for being used as an oral CM with the advantage of being customizable and as a cost-saving alternate

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Dushyant V. Sahani, MD - 2012 Honored EducatorDushyant V. Sahani, MD - 2015 Honored EducatorDushyant V. Sahani, MD - 2016 Honored EducatorDushyant V. Sahani, MD - 2017 Honored Educator

SSJ12-04 Diagnostic Imaging in the Management of Patients with Possible Cerebral Venous Thrombosis: A Cost-Effectiveness Analysis

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S403B

Participants
Wolfgang G. Kunz, MD, Munich, Germany (*Abstract Co-Author*) Grant, Medtronic plc
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Jose M. Ferro, MD, Lisbon, Portugal (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate the cost-effectiveness of different noninvasive imaging strategies in patients with possible cerebral venous thrombosis (CVT).

METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with the imaging strategies non-contrast CT (NCCT), CT venography (CTV), routine MRI without vascular imaging, and MR venography (MRV, Figure 1). The analysis was performed from a United States healthcare perspective. Model input parameters were based on best available and most recent evidence (Table 1), including outcome data from the International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT). Starting age was 37 years as in ISCVT. The prior probability of CVT was set low at 1.6%, the reported frequency of CVT in consecutive brain imaging exams for isolated headaches at emergency departments. ISCVT outcome data were taken from CVT patients who also presented with isolated headache to reflect this low prior probability. 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 NCCT and CTV were dominant over routine MRI and MRV. CTV led to incremental lifetime QALYs compared to NCCT (23.385 QALYs vs. 23.374 QALYs) at slightly higher lifetime costs ($5,210 vs. $5,057). CTV was the optimal strategy in the base-case analysis. In PSA, CTV was the strategy with the highest percentage of cost-effective iterations if the WTP threshold was set higher than $10,000/QALY (Figure 2). Complying with contemporary WTP thresholds and adjusting for model uncertainty, CTV was thus identified as the most cost-effective strategy. When the prior probability for CVT was set to 50%, diagnostic imaging with CTV was also preferred over MRV, routine MRI, or NCCT.

CONCLUSION

In patients at the peak age of CVT incidence yet low clinical pre-test probability of CVT, diagnostic imaging with contrast-enhanced venous CT angiography is the most cost-effective strategy.

CLINICAL RELEVANCE/APPLICATION

CTV should be the preferred imaging strategy, not only in patients with high prior probability, but also in patients with lower clinical suspicion of CVT.

SSJ12-05 Cost-Effectiveness of Thrombectomy for Ischemic Stroke in Extended Time Windows

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S403B

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

Two endovascular thrombectomy (EVT) trials have recently shown significant benefits over standard care (SC) medical management in large vessel occlusion stroke beyond 6 hours of symptom onset or last known to be well (i.e. for the first time also including the patient population with wake-up stroke). 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 SC (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 two recent late time window randomized clinical trials (DAWN, DEFUSE 3, Figure 2). Probabilistic sensitivity analyses (PSA) were performed using 10,000 Monte Carlo simulations to estimate overall uncertainty of the results. Incremental costs (IC), incremental effectiveness (IE), and incremental cost-effectiveness ratios (ICER) were derived. The willingness-to-pay (WTP) thresholds were set to $50,000, $100,000, or $150,000 per QALY respectively.

RESULTS

The base-case analysis identified EVT as the optimal strategy based on outcome data from DAWN (IC: -$51,561; IE: +1.90 QALYs; ICER: EVT dominant) or DEFUSE 3 (IC: -$6,905; IE: +1.63 QALYs; ICER: EVT dominant). Adjusting for all input parameter uncertainty in PSA, EVT was the preferred strategy with acceptability rates of 100% at WTP thresholds of $50,000, $100,000, and $150,000 per QALY based on DAWN or DEFUSE 3 data (Figure 3). DAWN-based simulations led to 99.9% dominant/cost-saving iterations, DEFUSE 3-based simulations to 66.1% dominant/cost-saving iterations (Figure 4).

CONCLUSION

EVT is not only a cost-effective but also long-term cost-saving therapy of large vessel occlusion stroke in patients presenting beyond 6 hours of symptom onset or last known to be well.

CLINICAL RELEVANCE/APPLICATION

Proven EVT effectiveness in late time windows will markedly increase the need for EVT procedures. Based on its cost-effectiveness, investments are justified to cover this increasing demand.

SSJ12-06 Changing Utilization of Imaging in Multiple Sclerosis Patients during Emergency Department Visits

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S403B

Participants
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PURPOSE

To study the changing nature of imaging utilization in multiple sclerosis patients in US emergency departments (EDs).

METHOD AND MATERIALS

Using 2006-2014 data from the Healthcare Cost and Utilization Project (HCUP) Nationwide Emergency Department Sample (NEDS), the largest all-payer ED database in the US, we identified multiple sclerosis (MS) patients vising EDs, and studied their utilization and independent predictors of imaging tests using logistic regression.

RESULTS

Overall, an estimated total of 275,808 weighted cohort patients with a primary diagnosis of MS visited a US ED between 2006 and 2014 (mean age 44±13; 74% female), increasing from 25,815 in 2006 to 35,680 in 2014. Only 8.8% of patients underwent any imaging tests during their ED visits, and these were most commonly of the brain: CT (3.8%) and brain MRI (1.8%). ED imaging counts in MS patients increased from 1,422 in 2006 to 4,236 in 2014. Patients' primary insurance was Medicare in 34%, Medicaid in 21%, private insurance in 34%, other types in 4% and self-pay in 7%. Independent factors associated with higher utilization of ED imaging tests were age older than 45 year (OR 1.2), an ED visit year after 2009 (OR, 1.3), a primary payer other than Medicare/Medicaid (OR, 1.2), and an ED visit location in Northeast or South (OR 2.3) (All p values < 0.05).

CONCLUSION

Although uncommon overall, the use of imaging tests during ED visits for MS patients has increased over time, and most of these involve brain imaging. A variety of sociodemographic characteristics are associated with a higher likelihood of imaging utilization.

CLINICAL RELEVANCE/APPLICATION

Primary payer, location of ED and patient age are independent factors impacting increased use of imaging tests in MS patients during ED encounters.

SSJ13

Informatics (Patient Safety, Data Sharing and Security)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: N230B

IN SQ

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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Tejas S. Mehta, MD, MPH, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ13-01 Visible Light Imaging: Adding Patient Point-of-Care Photography to Portable Radiography-A First Clinical Implementation Experience

Tuesday, Nov. 27 3:00PM - 3:10PM Room: N230B

Participants
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CONCLUSION

Point-of-care photographs obtained simultaneously with portable radiographs can reduce wrong-patient errors. In addition, they provide clinical context improving confidence in radiograph interpretation.

Background

Wrong-patient errors in Radiology, where one patient's medical images are placed in another patient's Picture Archiving and Communications Systems folder, can cause serious problems for both patients. For example, in the State of Pennsylvania alone, 196 serious adverse events were attributed to wrong-patient errors in Radiology in 2009. To increase the detection rate of wrong-patient errors, we developed an automated system to obtain point-of-care photographs along with portable radiographs. The system is fully automated and does not require any technologist intervention.

Evaluation

Within the first 400 images that were obtained with our automated photography system, we found one potential instance of a wrong-patient error, which the photos helped to identify. The photos also helped in providing clinical context for several abdominal radiographs obtained for evaluation of feeding tube placement. In some instances, no feeding tube was seen in the radiograph, which prompted the radiologist to look at the photo: if, on the photo, no tube was seen in the nose or mouth it provided confidence that no call to the referring service needed to be made. If no feeding tube was seen in the abdomen but was was seen in the nose or mouth on the photo, this would prompt a confident call to the patient's nurse. Soft tissue injuries were also better evaluated by radiography when the concurrently obtained photos were available. The patient's face was captured in the photo along with more than 98% of chest and abdominal radiographs.

Discussion

The addition of point-of-care photographs provides an intrinsic, externally-obtained biometric identifier that can increase the detection of wrong-patient errors. This identifier is superior to identifiers such as arm-bands with bar-codes since the latter is an extrinsic identifier. In addition to providing positive patient identification, the photographs have provided clinical context and have been useful in adding confidence to the diagnosis.

Honored Educators

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SSJ13-02 Sharing De-Identified Medical Images Electronically for Research: Patients Have a Say

Tuesday, Nov. 27 3:10PM - 3:20PM Room: N230B

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PURPOSE

As part of the Medical imaging network enterprise (MiNE) initiative, an electronic repository of medical imaging data and metadata, we have examined health care consumers' opinions regarding sharing their de-identified medical images and related medical information for research purposes. We have considered the criteria that could influence patients' decision, whether or not to share their medical information, like data storage/access, and safeguards to maintain privacy and security.

METHOD AND MATERIALS

Patients from the Greater Toronto Area (GTA) attending Sunnybrook Health Sciences Centre for imaging in MRI, CT or US examination areas were invited to undertake a cross-sectional electronic survey. Patients were recruited while waiting for their examination. The survey was in an electronic format using tablet computers on site. Descriptive and parametric statistical analyses were performed.

RESULTS

Imaging clerks approached 1083 patients within the imaging areas (CT 609, US 314 & MRI 160) during patient check-in, 798 (74%) agreed to undertake the survey. Overall median age was 60 (IQR=18,Q1=52,Q3=70), 52% were females. Participants' level of education was: university degree (42%) and diplomas/certificates (34%), while 7% did not have any high school diploma. When assessing willingness to share their de-identified medical images for research, 453 (76%) were willing (agreed & strongly agreed), while 7% refused. Most patients (85%) felt comfortable with automatic storage of their images and gave unconditional data access to their family physicians (73%) and other physicians (57%). Also, 70% chose hospitals/research institutions to regulate electronic images databases. 89% of the respondents wanted safeguards against unauthorized access to their data and over 70% wanted full control over access.

CONCLUSION

Our study found that people are willing to share their clinically acquired medical images for research after full consent that clearly outlines privacy, confidentiality, security and control over permissions and duration of access. Respondents are more comfortable when medical image data warehouses/repositories are affiliated with universities/research institutions.

CLINICAL RELEVANCE/APPLICATION

Participants support sharing clinically acquired medical imaging data for research. These images could provide a great source of information when shared securely and confidentially among researchers with associated robust policies.

SSJ13-03 Using TLS (Transport Layer Security) and the ACME Protocol (Automatic Certificate Management Environment) for Securing DICOM Communications

Tuesday, Nov. 27 3:20PM - 3:30PM Room: N230B

Participants
Lawrence R. Tarbox, PhD, Little Rock, AR (*Presenter*) Nothing to Disclose
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CONCLUSION

We wish to encourage sites to use the DICOM Secure Transport Connection Profiles, vendors to include the DICOM Secure Transport Connection Profiles in their product offerings, and both sites and vendors to support the ACME protocol to reduce the burden of managing and distributing security certificates.

Background

The Basic TLS (Transport Layer Security) Secure Transport Connection Profile has been part of the DICOM Standard since 1999, and has been updated over the years as technology improves. The lastest enhancements were approved this year. The Profile has also been incorporated into the IHE ATNA (Audit Trail Node Authentication) profile, and has been tested by multiple vendors at multiple IHE Connectathons. One of the barriers to deploying the Basic TLS Secure Transport Connection Profile at institutions is the need to manage security certificates. The ACME protocol (Automatic Certificate Management Environment) has the promise of simplifying the certificate management and distribution needed to properly deploy TLS-secured communications.

Evaluation

To demonstrate how to secure DICOM communications using automated certficate management, we set up an open source DICOM

archive, an ACME server for managing certificates, simulated modalities, and viewing stations. Using wire snooping software, we show how information is clearly visible on the network without encryption, and is hidden when encryption is enabled. We compare the performance of common DICOM operations both with encryption turned on and turned off. Both DIMSE based operations (DICOM binary protocol) and the new DICOM web-based, RESTful operations are demonstrated and measured.

Discussion

The use of the ACME protocol greatly simplifies the task of certificate management and distribution, which in turn makes it easier to deploy the Secure DICOM Connection Profiles. While the addition of TLS to secure DICOM communications does have a small performance hit, with modern compute speeds we feel that the additional security offered by TLS is well worth the performance hit.

SSJ13-04 The Achilles Heel of Draconian Hi-Tech Act Penalties: The Inadequacy of Current Data Encryption and Protection Technology

Tuesday, Nov. 27 3:30PM - 3:40PM Room: N230B

Participants
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PURPOSE

High-profile data breeches are now common. Penalties levied by HHS accompanying these data breeches are often in the millions of dollars. Hi-Tech Act assumes high penalties force players to use only 'breech-proof' systems and workflows. Users require workflows that are intuitive and easy to use. In data security, any skipped step may drastically increase the vulnerability of the entire system being protected. We have examined the healthcare environment to assess viability of the current technologies used in preventing data breeches.

METHOD AND MATERIALS

We examined the available data protection and encryption tools currently available to both civilian consumers and enterprises to assess the capability of storing 100% breech-proof data yet maintain high 'usability' for day-to-day use. We did not assess classified technologies not available for civilian use. We also examined some of the security workflows being enforced by large organizations to gain a realistic view of compliance versus users bypassing these protections in order to 'get their work done.' This was done by data collection of methods used by large and small healthcare organizations.

RESULTS

No single technology is yet available that allows automated, background encryption/decryption on all platforms used, Windows, MacOS, IOs and Android and include portable data transfers using USB Flash technology and other means, is yet available As organizations harden their policies and data access, both onside and remote, users become more creative and use BYOD, or even entire data sets off the enterprise or organizational servers, for access and ease of use.

CONCLUSION

Draconian Hi-Tech Act penalty assumptions appears false. Data currently cannot be 100% protected and adding stiff penalties just pushes organizations to enact harsher data access rules, forcing their own workers to bypass security systems to 'get their work done.'

CLINICAL RELEVANCE/APPLICATION

Organizational and enterprise data security today is being driven by the fear of extreme financial penalties, leading to policies and access rules that actually entice users to bypass the organizational security, weakening the overall security of the protected data.

SSJ13-05 CTrl-Alt-Radiate?

Tuesday, Nov. 27 3:40PM - 3:50PM Room: N230B

Participants
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PURPOSE

Computed Tomography (CT) is an essential and commonly used X-ray generator modality that uses ionizing X-ray radiation to produce images. The CT modality consists of an ecosystem of components, which communicate with each other within the CT's ecosystem. As technology advances, the CT's ecosystem is becoming more connected to the hospital's network and the Internet, exposing it to a variety of security vulnerabilities and threats to potential cyber-attacks. The combination of ionizing radiation, potentially harmful to patients, and security vulnerabilities to cyber-attacks results in possible dangerous scenarios that compromise patients' safety. To illustrate the importance of the topic, we demonstrate how we hacked a CT.

METHOD AND MATERIALS

We present a step-by-step implementation of how we bypass current security protection mechanisms of a CT in order to manipulate its behavior, making it potentially dangerous to patients. This attack demonstrates how additional cyber-attacks on *medical imagining devices* (MIDs) can be similarly implemented. To accurately measure the potential damage to patients' health, we use a phantom device (i.e., a CT radiation measuring device), and analyze the risks that such attack can cause. Furthermore, we demonstrate how to exploit our cyber-attack covertly, so that it is difficult to detect it using current security solutions; thus, such attack may have long-term effects on a large-scale of the population.

RESULTS

A live demonstration of how we hacked a CT device and how we manipulated its behavior to create various dangerous scenarios for patients' health. Moreover, we analyze this attack in depth, to better understand the potential impacts of such attacks.

CONCLUSION

CT and MIDs are vulnerable to cyber-attacks; we demonstrate forcefully that hacking CT and MIDs is no longer theoretical. By analyzing the potential impacts to patients, we can conclude that such impacts are critical and must be dealt with urgently.

CLINICAL RELEVANCE/APPLICATION

This calls for an immediate improvement of CTs and MIDs security and further mitigation of risks to patients.

SSJ13-06 Kaleidoscope: A Series Projection Visualization Tool for Review of DICOM Images for Protected Health Information

Tuesday, Nov. 27 3:50PM - 4:00PM Room: N230B

Participants
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PURPOSE

Collections submitted to The Cancer Imaging Archive (TCIA) can approach one-million DICOM files. It is time consuming to review each image for burned-in-PHI, pixel data that contains names, dates, or other personal identifying information. Kaleidoscope was developed to increase throughput of visual review.

METHOD AND MATERIALS

Kaleidoscope, part of the open source Posda curation suite, displays minimum, maximum, and average projection images of a series. If the geometric information is not consistent across a series (different coordinate system) the series is divided into distinct subsets called equivalency classes to minimize image artifacts. An example of this is a longitudinal scout used to show the spatial positions of axial slices. Each equivalency class is viewed as individual sets of projection images. Kaleidoscope organizes images for review by collection. Upon review, a curator labels the series, or series equivalence class, as Good (definitely no PHI), Bad (has definite PHI), or Indeterminate (curator is unsure whether the image is ok to be included in the archive or not). A curation manager reviews Bad and Indeterminate cases and determines their final acceptance or rejection. Queries may be run to get lists of series based on the label assigned during visual review. If needed, these images may be retrieved by a query and inspected with other visualization tools. Kaleidoscope currently handles modalities CT, MR, PT, and SC.

RESULTS

To review a single image takes on average 0.7 seconds per image using the National Biomedical Imaging Archive (NBIA) quality control (QC) tool where an entire equivalency class can be reviewed using Kaleidoscope in that same amount of time. There are 203,099 series 21,082,265 CT images in the NLST collection. Reviewing NLST with the NBIA QC tool estimated 4100 hours and in practice took multiple curators weeks to complete. Using Kaleidoscope would take 1 curator about 40 hours.

CONCLUSION

Kaleidoscope is two orders of magnitude faster than using the NBIA QC tool.

CLINICAL RELEVANCE/APPLICATION

Kaleidoscope allows rapid inspection of DICOM images to ensure data are free of PHI or other personal identifying information prior to public dissemination to promote Open Science.

SSJ14

Molecular Imaging (Novel Multi-Modal Applications)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S505AB

CT MR MI NM

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

SSJ14-01 Multispectral Optoacoustic Tomography of Systemic Sclerosis: A Feasibility Study Using a Hybrid Approach at the Patient's Bedside

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S505AB

Participants
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PURPOSE

Systemic sclerosis is an autoimmune disease with dysfunctional connective tissue repair inducing skin and internal organ fibrosis as well as vasculopathy, leading to serious complications such as digital ulcers. Microvascular dysfunction is a prognostic marker for morbidity and mortality in systemic sclerosis. However, due to a lack of functional tissue information using established imaging technologies, risk stratification remains challenging.We aimed to evaluate the clinical feasibility of a hybrid multispectral optoacoustic tomography (MSOT)/ultrasound (US) approach in systemic sclerosis.

METHOD AND MATERIALS

We used a combined handheld MSOT/US imaging system (iThera Medical, Munich) for imaging fingers D2 to D5 of systemic sclerosis patients (n=7, n=56 fingers) and healthy volunteers (n=8, n=64 fingers). In subcutaneous tissue, tissue levels of hemoglobin (deoxygenated (HbR), oxygenated (HbO2) and total (HbT)) were calculated after spectral unmixing. Furthermore, MSOT values were analysed to stratify patients with either progressive or stable disease activity. Statistical analysis was performed using unpaired t test.

RESULTS

In systemic sclerosis, MSOT values for HbR, HbO2 and HbT were significantly lower compared with healthy volunteers. On an individual basis, all patients had - as compared to healthy volunteers - a reduced ratio (<1.0) for HbO2 (ratio 0.53, $p<0.0001$) and HbT (ratio 0.49, $p<0.0001$). Additionally, in systemic sclerosis patients with a progressive disease significantly lower MSOT values were detected than in patients with a stable disease activity (HbR: 27.31 vs. 33.03 AU, HbO2: 23.87 vs. 29.22 AU, HbT: 51.18 vs. 62.24 AU; $p<0.001$).

CONCLUSION

This preliminary study demonstrates the feasibility of MSOT imaging to detect and quantify microvascular dysfunction in systemic sclerosis and to distinguish between progressive and stable disease activity. Therefore, MSOT may serve as a valuable non-invasive tool for disease stratification and therapy monitoring.

CLINICAL RELEVANCE/APPLICATION

As an easy-to-use, non-invasive and contrast-free imaging technique hybrid MSOT/US may facilitate both diagnosis and monitoring of treatment response in systemic sclerosis at the patient's bedside.

SSJ14-02 Optimization of Chest Acquisition on Whole Body PET/MRI for HCC Tumor Staging Using Non-Cartesian K Space Reconstructions

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S505AB

Participants
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PURPOSE

To compare diagnostic performance and image quality for chest imaging of stack-of-stars T1 EG acquisition (STARVIBE) with non cartesian reconstructions of k-space, and Caipirinha 3D T1 EG acquisition, during whole-body PET-MR of HCC patients.

METHOD AND MATERIALS

33 consecutive patients referred for HCC staging in PET MRI (Biograph mMR, Siemens erlangen) were retrospectively included. All benefited from Caipirinha Dixon 3D T1 (T1EG Dixon post gadolinium) and Starvibe (post-gadolinium T1EG Dixon with radial filling of the Fourrier plan). A subjective evaluation of the image quality was performed. Detection of pulmonary nodular lesions with both sequences was compared by taking the chest CT scan as the standard of reference (Exact Fisher test). The signal-to-noise ratio of lung parenchyma (SNR) and contrast-to-noise ratio (CNR) of nodules, muscles and pulmonary vessels were compared between the two sequences (Student T-test).

RESULTS

The Starvibe sequence was judged subjectively better in 42% of cases and at least equivalent to Vibe in 88% of cases. It improved SNR (375% vs 89%, p <0.001) and CNR for muscles (53% vs 41%, p <0.001), vessels (84% vs 73%, p <0.001) and pulmonary nodules (34% vs 24%, p = 0.03). The detection of nodules was improved (sensitivity = 55% vs 41%) with a decrease in false positives (VPP = 92% vs 35%), without significant difference.

CONCLUSION

K space non cartesian reconstruction improves MRI's diagnostic performance at the chest stage by elevation of SNR and CNR.

CLINICAL RELEVANCE/APPLICATION

This new type of sequence without apnea could allow an improvement of the MRI diganostic performances especially at the thoracic stage in patients followed in oncology.

SSJ14-03 Whole-Body Functional PET-MR for Multiple Myeloma Staging: Impact of Sequence Design on Bone Marrow Infiltration and Focal Lesion Assessment

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S505AB

Participants
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PURPOSE

To study the impact of functional simultaneous 18FDG-PET-MR on bone marrow infiltration evaluation and focal lesion detection in initial staging of Multiple Myeloma (MM).

METHOD AND MATERIALS

25 consecutive patients referred to our centre for initial staging of a monoclonal gammopathy were included. PET-MR sequence design included whole-body T1-weighted spin-echo and T2-fat supressed DIXON weighted images (CWB-MRI) combined to whole-body Simultaneous Multi-Slice diffusion-weighted imaging (WB-DWI), 3D whole-body isotropic dynamic contrast-enhanced images (WB-DCE) and 3D-T1 weighted images combined with PET (T1-PET) acquisition using 4-5 MBq/kg of 18FDG-glucose. In the first part of the evaluation, the mean apparent diffusion coefficient (mADC), the mean enhancement (mE) and mean maximal standard uptake value (mSUV) of the bone marrow measured at the posterior part of the ischium, the lowest lumbar vertebral, and lowest thoracic vertebral possible outside of focal lesions were measured. The second part of the evaluation comprised the counting of focal lesions on CWB-MRI, CWB-MRI combined with WB-DWI, CWB-MRI combined with WB-DCE, CWB-MRI combined with PET, and PET-MR. Based on these findings, each patient was allocated a specific staging for bone marrow infiltration (BMI) and the number of focal lesions.

RESULTS

Functional imaging significantly impacted assessment of BMI; Compared to CWB-MRI, WB-DWI upstaged 7 and down staged 8 patients, WB-DCE upstaged 17 and down-staged 5 patients, PET upstaged 6 and down-staged 4 patients. Correlation between functional imaging and percentage of plasma cell infiltration were [r=0.7655, p<10^-6], [r=0.549 p<0.005], [r=0.678, p=0.0001] for mADC, mE, and mSUV. Compared to CWB-MRI, PET-MRI detected 30 additional focal lesions among 8 patients and upstaged 6 of them. 4 patients were upstaged from MGUS to stage 1 Multiple Myeloma (MM), 1 patient from stage 1 to stage 2 MM, and 1 patient from stage 1 to stage 3 MM. The detection of additional focal lesions did not modify staging for 2 patients.

CONCLUSION

PET-MRI modifies initial staging of patients with a monoclonal gammopathy. Further studies are necessary to improve medullary infiltration evaluation as well as prospective longitudinal studies to evaluate the prognostic value of these modifications.

CLINICAL RELEVANCE/APPLICATION

Functional PET-MRI significantly impacts initial staging of patients with suspected MM.

SSJ14-04 Multispectral Optoacoustic Tomography of Vascular Malformations

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S505AB

Participants
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PURPOSE

Differential diagnosis and treatment of congenital vascular anomalies is challenging and misdiagnosis is frequent. A novel non-invasive imaging approach combining not only visualization of anatomical features but also quantitative assessment of molecular tissue biomarkers would aid both diagnosis and monitoring of treatment response of vascular anomalies. We aimed to evaluate the feasibility of hybrid ultrasound (US) and multispectral optoacoustic tomography (MSOT) for non-invasive, real-time imaging of vascular malformations.

METHOD AND MATERIALS

In this pilot study 6 patients with arteriovenous (AVM) and 6 patients with venous (VM) malformations were investigated with a clinical hybrid MSOT/US system before and after either endovascular embolization (AVM) or percutaneous sclerotherapy (VM). All patients were diagnosed with AVM or VM according to the classification system of the International Society for the Study of Vascular Anomalies (ISSVA). Region of interest analysis of the lesion and contralateral healthy tissue revealed quantitative values for oxygenated (HbO2) and deoxygenated hemoglobin (HbR). Ratios of HbO2 over HbR were calculated for all vascular malformations and healthy tissue before and after treatment.

RESULTS

HbO2/HbR ratio was significantly higher for AVM versus VM and compared with healthy tissue (1.82±0.08 vs. 1.12±0.04 vs. 0.89±0.03, all p-values<=0.001). Therefore MSOT provided intrinsic biomarker patterns to distinguish arteriovenous from venous malformations. After therapy the HbO2/HbR ratio decreased in correlation to treatment success validated by MRI and angiography.

CONCLUSION

Different types of vascular malformations are clearly distinguished by MSOT-based, non-invasive assessment of hemoglobin levels in vascular malformations. Therapy effects could be instantly visualized and quantified.

CLINICAL RELEVANCE/APPLICATION

As an easy-to-use, non-invasive and contrast-free imaging technique hybrid MSOT/US may facilitate both diagnosis and monitoring of treatment response of vascular malformations at the patient's bedside.

SSJ14-05 Ultra-Fast Whole-body PET/CT Enabled by Digital Photon Counting PET Detector Technology: Findings from a Phase II Clinical Trial

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S505AB

Participants
Michael V. Knopp, MD, PhD, Columbus, OH (*Presenter*) Nothing to Disclose
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PURPOSE

To assess in a Phase II study the clinical feasibility of ultrafast whole body PET imaging using the new generation digital photon counting PET and to compare by intraindividual comparison the diagnostic and quantitative findings to current clinical whole body PET acquisition.

METHOD AND MATERIALS

52 patients scheduled for FDG whole body PET/CT were imaged using three separate acquisitions as part of an intra-individual comparison study to compare a new genertaion digital system, dPET/CT (Vereos) with a current generation conventional sytem, cPET/CT (Gemini). Standard cPET imaging was performed at ~75 min p.i. of 13mCi FDG with investigational dPET imaged at ~55 min p.i. The first dPET acquisition was performed using 90s/bed position, immediately followed by a 9s/bed position acquisition lead to average table times of ~15 and ~2 min and compared with 90s/bed position cPET ~20 min . The 9s/bed dPET were reconstructed using a previously optimized methodology. All other aspects of image acquisition were kept identical. Three blinded reviewers

evaluated the data sets regarding visual characteristics, diagnostic confidence and semi-quantitative readouts.

RESULTS

All ultrafast scans were classified to be assessible. As expected, visual assessment scores were significant higher for 90s/bed dPET whole body (p<.01), while no significant between the ultra-fast wholebidy and the cPET scans were reported. The ultra-fast scan presented with slightly increased background noise levels. The ultra-fast scans also presented with substantially less motion artefacts including bowl movements. A county density regularized reconstruction approach is essential to achieve the acceptable image quality on a consistent basis.

CONCLUSION

Next generation digital photon counting detector technology enabled consisten accepatable image quality even for ultra-fast wholebody imaging with a whole body acquistion time of 2 min. The concept of ultra-fast whole-body acquisition is feasible, however requires count density adaptive, regularized reconstruction, New PET workflow concepts, improved patient comfort, minimized patient motion and whole-body pseudo dynamic imaging of tracer were demonstated as feasible.

CLINICAL RELEVANCE/APPLICATION

Ultra-Fast Wholebody PET/CT with 2 min acquisition time was shown to be feasible using a new generation digital photon counting PET/CT system

SSJ14-06 SiPM-Based versus LYSO-based 68Ga-DOTA-TATE PET/CT: Comparison of Semi-Quantitative Measurements in Normal Tissues and Lesions

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S505AB

Participants
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Andrei Iagaru, MD, Emerald Hills, CA (*Abstract Co-Author*) Research Grant, General Electric Company

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PURPOSE

To compare the performance of a silicone photomultiplier (SiPM)-based PET/CT scanner (DMI) and a LYSO-based PET/CT scanner (D690) used in our clinic and to determine any differences in semi-quantitative measurements.

METHOD AND MATERIALS

We prospectively enrolled patients referred for 68Ga-DOTA-TATE PET/CT. All patients underwent a single 68Ga-DOTA-TATE injection dual imaging protocol: they were randomly scanned first on the D690 or the DMI scanner. SUVmax of detectable lesions and SUVmean of different normal tissues were measured independently by two Nuclear Medicine Physicians, from data acquired using both scanners.

RESULTS

Data from 61 patients (35-80 year-old; 36 women, 25 men) was analyzed. Thirty-one patients out of 61 (51%) underwent DMI as first scan and a total of 95 lesions were detected on both scanners; the average SUVmax measurements for all 95 lesions were higher on DMI than D690 (28.1 and 25.2, respectively, r = 0.944, p<0.001, 95% CI, 1.382 to 4.375). Thirty patients out of 61 (49%) performed D690 PET/CT as first scan and a total of 84 lesions were seen on both scanners; the average SUVmax measurements for all 84 lesions were higher on DMI than D690 (38.3 and 33.8, respectively, r = 0.991, p<0.001, 95% CI, -6.139 to -2.879). Mean lesion:aortic arch ratios were higher on DMI than D690 (47.1 vs 42.7, and 26.6 vs 26.4 when D690 was performed first and when DMI was done first, respectively), but differences were not statistically significant (p<0.006 and p<0.877, respectively). The agreement analysis for different background organs indicated that scanners are similar in normal tissues uptake regardless of scan order.

CONCLUSION

We observed higher SUVmax values for lesions measured from DMI compared to D690 regardless of the order of the scan, while the measurements were similar for normal tissues. While delayed imaging can lead to higher SUVmax values in cancer lesions, in the series of lesions identified when DMI was performed as first scan this was not seen; therefore, the data suggests superior performance of the DMI scanner.

CLINICAL RELEVANCE/APPLICATION

DMI PET/CT new generation scanner have better performance on standard of care PET/CT scanners. This would allow to reduce the injected dose or the scan time without missing images quality.

SSJ15

Musculoskeletal (Advances in Computed Tomography)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E350

CT MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Frank J. Simeone, MD, Boston, MA (*Moderator*) Nothing to Disclose
Stacy E. Smith, MD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSJ15-01 Color-Coded Virtual Non-Calcium Dual-Energy CT for the Detection of Bone Marrow Edema in Patients with Acute Knee Trauma: A Multireader Diagnostic Performance Study

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E350

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

To evaluate the diagnostic performance of a dual-energy computed tomography (CT) virtual non-calcium (VNCa) technique for the detection of bone marrow edema in patients with acute knee trauma.

METHOD AND MATERIALS

Data from 41 patients with acute knee trauma who had presented to a level 1 trauma center emergency department were retrospectively included. Subjects had undergone clinically indicated third-generation dual-source dual-energy CT and 3-T magnetic resonance imaging (MRI) of the knee within 7 days between January 2017 and March 2018. Six blinded radiologists independently evaluated conventional grayscale dual-energy CT series for the presence of fractures; after 8 weeks, readers reevaluated all cases using color-coded dual-energy CT VNCa reconstructions for the presence of bone marrow edema for six femoral and six tibial regions. Quantitative analysis of CT numbers on VNCa reconstructions was performed by a seventh blinded radiologist. Results from MRI evaluated by two separate blinded experienced radiologists (20 and 32 years of experience in musculoskeletal imaging) served as standard of reference. Diagnostic performance was calculated taking into account clustering.

RESULTS

MRI revealed a total of 136 areas with focal posttraumatic bone marrow edema in 492 regions (61/246 femoral, 75/246 tibial). Fractures were present in 12 patients. In the subjective analysis, VNCa showed high overall sensitivity (95.6%), specificity (96.6%), positive predictive value (PPV, 91.5%) and negative predictive value (NPV, 98.3%) for the detection of bone marrow edema. Area under the curve was 0.959 (femur) and 0.962 (tibia). Inter-reader agreement was excellent (κ=0.91). CT numbers obtained from VNCa were significantly different in areas with or without edema (p<0.001). A cut-off value of -35 HU provided a sensitivity of 92.3%, specificity of 93.1%, PPV of 87.3% and NPV of 95.2% for the differentiation of bone marrow edema.

CONCLUSION

Dual-energy CT VNCa reconstructions yield excellent diagnostic performance for the detection of posttraumatic bone marrow edema compared to MRI in patients with acute knee trauma by enabling direct color-coded visualization.

CLINICAL RELEVANCE/APPLICATION

Presence and extent of bone marrow edema may be visualized during dual-energy CT performed for detection of fracture in patients with acute knee trauma by using color-coded VNCa reconstructions, potentially replacing MRI in patients with contraindications.

SSJ15-02 Identification of Bone Marrow Edema of the Ankle and Foot: Diagnostic Accuracy of Dual-Energy CT and Virtual Non-Calcium Techniques

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E350

Participants
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PURPOSE

To evaluate the diagnostic accuracy of dual-energy Computed Tomography (DECT) and virtual non calcium (VNC) techniques to identify bone marrow edema of the ankle and foot

METHOD AND MATERIALS

This prospective institutional review board-approved study included 38 consecutive patients (21 males and 17 females; mean age of 62.3, range 26-79 years) studied between January 2017 and January 2018. All patients underwent DECT (80 kV and tin filter 150 kV) and MRI with Short Tau Inversion Recovery images (STIR) within 7 days. DECT data were postprocessed on a dedicated offline workstation (SyngoVia® VB20; Siemens, Erlangen, Germany) by using a three-material decomposition algorithm for generating noncalcium images of the ankle and foot. Two radiologists, blinded to clinical and MRI data (25 and 11 years of experience, respectively) evaluated the presence of abnormal attenuation of each ankle on dedicated color-coded maps and on grey scale images. STIR images served as standard of reference. Diagnostic accuracy values of the DECT maps and of the CT numbers (quantitative assessment) by using receiver operator curves (ROC) and relative area under the curve (AUC) were calculated. Inter-observer and intra-observer agreement were calculated with k-statistics. Continuous and categorical variables were evaluated by using t test and x2 or Fisher exact test, as appropriate. A value of $p<0.05$ was considered statistically significant

RESULTS

MRI revealed the presence of bone marrow edema in 25/38 cases (65.8%). DECT numbers were significantly different between positive (mean -12.6 ± 29.6 HU) and negative cases (mean -64.2 ± 34.5 HU) with a p value <0.001. The ROC curve analysis revealed an AUC of 0.896 (95% confidence interval: 0.764-0.942). By using -20HU cutoff to identify bone marrow edema, the sensitivity, specificity, PPV and NPV and accuracy of DECT were 88.0, 92.3, 95.6, 80.0 and 89.5%, respectively. The interobserver and intraobsever agreement were near perfect (k=0.88 and k=0.91, respectively)

CONCLUSION

DECT represents a reliable imaging tool for demonstration of bone marrow edema of the ankle and foot

CLINICAL RELEVANCE/APPLICATION

DECT represents a fast and reliable imaging tool for demonstration of bone marrow edema of the ankle and foot and could be proposed as an alternative imaging modality in patients with contraindications for MRI

SSJ15-03 Sub-Milisievert Ultralow-Dose CT of the Cervical Spine: A Feasibility Study in Human Cadavers

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E350

Participants
Julius M. Weinrich, Hamburg, Germany (*Presenter*) Nothing to Disclose
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Azien Laqmani, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare radiation dose and image quality of a standard-dose (SD) and four different reduced-dose (RD) computed tomography (CT) protocols of the cervical spine using filtered back-projection (FBP) and iterative reconstruction (IR) in human cadaver specimen.

METHOD AND MATERIALS

The cervical spine of 29 human cadavers (15 male) was examined using different RDCT protocols (P) with decreasing reference tube currents (P1:70; P2:50; P3:30; P4:10 mAs) at a tube voltage of 140 kV while a clinical SDCT protocol (120 kV, 160 mAs) served as reference. Raw data was reconstructed using FBP and two increasing levels of IR (4&6). Two radiologists assessed image quality for the upper (C1-4) and lower (C5-7) cervical spine. Images were evaluated for overall image quality and visibility of three separate anatomical structures according to a 5-point Likert scale. Additionally, diagnostic acceptability was evaluated. Results were compared using a linear mixed-effects regression model. This study was HIPAA compliant and was approved by our institutional review board, the need for informed consent was waived.

RESULTS

Image quality did not significantly differ between SDCT and RDCT P1-4 using IR 4&6 ($p>0.05$). Subjective image quality of the upper cervical spine was diagnostic for SDCT and all four RDCT protocols using FBP and IR except for only two cadavers in RDCT P4 using

FBP. Image quality of the lower cervical spine was rated as non-diagnostic in RDCT P3 (n=8/29) and RDCT P4 (n=22/29) reconstructed with FBP and in RDCT P4 (n=10/29) reconstructed with IR 4&6. Compared with the SDCT all RDCT protocols resulted in a significant effective dose reduction (SDCT:1.5±0.7 mSv; RDCT P1:1±0.6 mSv; P2:0.7±0.4 mSv; P3:0.4±0.2 mSv; P4:0.2±0.1 mSv; p<0.001).

CONCLUSION

Diagnostic acceptable sub-milisievert CT of the cervical spine is feasible with a reference mAs of 30 at 140 kV with iterative reconstruction.

CLINICAL RELEVANCE/APPLICATION

RDCT of the cervical spine with an effective dose of 0.4 mSv is feasible and should be implemented in clinical routine. Further dose reduction is possible, but IR seems not to compensate for image quality loss at the lower cervical spine.

SSJ15-04 Bone Marrow Imaging Using Dual Energy CT for the Evaluation of Diffuse Infiltrative Lesions of Multiple Myeloma: Correlation with the Severity of Marrow Infiltration Assessed by MRI

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E350

Participants
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PURPOSE

To assess the feasibility of using dual-energy CT(DECT) with virtual noncalcium(VNCa) technique for the evaluation of the severity of diffuse marrow infiltration of multiple myeloma, using MRI as reference standard.

METHOD AND MATERIALS

22 consecutive patients with plasma disorders were recruited prospectively, including active MM(n=12), MM in complete remission(n=2), MGUS(n=4) and systemic amyloidosis(n=4). All patients underwent whole-body DECT scan (80kV/Sn150kV) and MRI evaluation, including T1-weighted sequence, short TI inversion recovery sequence and fat fraction(FF) map quantified by six-echo volume interpolated breath-hold gradient echo Dixon sequence. VNCa CT numbers, regular CT numbers and FF of vertebral bone marrow were measured. The severity of marrow infiltration was graded as "normal", "moderate" and "severe", according to marrow signal intensities on T1-weighted images. The relationship between VNCa and severity of marrow infiltration was evaluated by Spearman correlation. ROC analysis was performed for the diagnosis of diffuse infiltration.

RESULTS

A total number of 173 vertebrae were measured. VNCa CT numbers were significantly positive correlated with the severity of marrow infiltration(r=0.580, P=0.000) and significantly negative correlated with FF of bone marrow (r=-0.546, P=0.000). The AUCs of VNCa(0.958) were significantly higher than that of regular CT numbers(0.472) for the diagnose of marrow infiltration. With the cut-off value of -34HU, the sensitivity and specificity of VNCa was 97.2% and 85.4%, respectively.

CONCLUSION

VNCa based on DECT is feasible for the evaluation of diffuse marrow infiltration of MM. A significant correlation was observed between VNCa and the severity of marrow infiltration assessed by MRI.

CLINICAL RELEVANCE/APPLICATION

VNCa technique based on DECT may severe as an alternative method for the evaluation of the severity of marrow infiltration in MM patients.

SSJ15-05 Diagnostic Accuracy Values of Dual-Energy CT and Virtual Non-Calcium Techniques to Evaluate Bone Marrow Edema in Vertebral Compression Fractures

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E350

Participants
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PURPOSE

To evaluate the ability of dual-energy Computed Tomography (DECT) to identify bone marrow edema in vertebral compression fractures of thoracic and lumbar spine

METHOD AND MATERIALS

This prospective institutional review board-approved study included 76 consecutive patients (29 males and 47 females; mean age of 62.3, range 51-82 years) studied between February 2017 and February 2018. All patients underwent DECT (80 kV and tin filter 150 kV) and MRI with Short Tau Inversion Recovery images (STIR) within 7 days. DECT data were postprocessed on a dedicated workstation (SyngoVia® VB20; Siemens) by using a three-material decomposition algorithm for generating noncalcium images of

vertebral bodies. Two radiologists blinded to clinical data (25 and 11 years of experience, respectively) evaluated the presence of abnormal attenuation of each vertebral body on dedicated color-coded maps. STIR images served as standard of reference. Diagnostic accuracy values of the DECT maps (qualitative assessment) and of the CT numbers (quantitative assessment) by using receiver operator curves (ROC) and relative area under the curve (AUC) were calculated. Inter-observer and intra-observer agreement were calculated with k-statistics. Continuous and categorical variables were evaluated by using t test and x2 or Fisher exact test, as appropriate. A value of $p<0.05$ was considered statistically significant

RESULTS

MRI revealed 61/774 (7.9%) edematous vertebrae and 52/774 (6.7%) collapsed non edematous vertebrae. The sensitivity, specificity, PPV and NPV and accuracy of the DECT maps were 88.6, 92.3, 93.1, 87.3 and 90.3%, respectively. DECT numbers were significantly different between positive (mean -23 HU, range -189, 29 HU) and negative cases (mean -126 HU, range -321, -66 HU) with $p<0.001$. The ROC curve analysis revealed an AUC of 0.886 (95% confidence interval: 0.722-0.913). By using -50HU cutoff to identify vertebral edema, the sensitivity, specificity, PPV and NPV and accuracy of DECT were and 91.8, 90.4, 91.6, 90.4 and 91.1%, respectively. The interobserver and intraobsever agreement were near perfect ($k=0.87$ and $k=0.83$)

CONCLUSION

DECT represents a reliable imaging tool for demonstration of bone marrow edema in vertebral compression fracture

CLINICAL RELEVANCE/APPLICATION

DECT could be proposed as an alternative imaging modality in the suspect of vertebral compression fracture in patients with contraindications for MRI

SSJ15-06 Is CT-Based Cinematic Rendering Superior to Volume Rendering Technique in the Preoperative Evaluation of Complex Lower Extremity Fractures?

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E350

Participants
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PURPOSE

Cinematic rendering (CR) is a recently launched, FDA-approved 3D reconstruction technique which converts conventional CT images into almost photorealistic 3D reconstructions using a unique lightning model. The purpose of this study is to compare CR and volume rendering technique (VRT) in complex lower extremity fractures and to evaluate the value of CR for traumatologists to improve preoperative planning.

METHOD AND MATERIALS

In this retrospective, IRB approved study, 41 consecutive patients (female: n=13; male: n=28; mean age: 52.3±17.9y) with complex lower extremity fractures (calcaneus: n=16, tibial pilon: n=19, acetabulum: n=6) were included. All datasets were acquired using a 128-row dual-source CT. CR and VRT images were reconstructed on a dedicated workstation. Two experienced board-certified traumatologists trained in special lower extremity trauma surgery reviewed VRT and CR images in independent sessions. Image quality, anatomical accuracy and fracture visualization were rated using a 6-point Likert scale (1=non-diagnostic to 6=perfect visualization). Furthermore, the additional value of CR in comparison to conventional VRT images on preoperative planning was assessed. For each score, median values between both readers were calculated. A Wilcoxon-Ranksum test was performed to compare both reconstruction methods. $p<0.05$ indicated statistical significance.

RESULTS

In comparison to VRT, CR had a higher image quality (VRT: 2.5; CR: 6.0; $p<0.001$), a higher anatomical accuracy (VRT: 3.5; CR: 5.5; $p<0.001$) and provided a more detailed visualization of the fracture (VRT: 2.5; CR: 6.0; $p<0.001$). Furthermore, both readers reported an additional value of CR images for preoperative planning in 65.9% (27/41) of all patients in comparison to VRT.

CONCLUSION

CR provides a more detailed visualization of complex lower extremity fractures compared with VRT. Additionally, CR is a useful tool for traumatologists to improve preoperative planning.

CLINICAL RELEVANCE/APPLICATION

Cinematic rendering is superior to volume rendering technique in the preoperative evaluation of complex lower extremity fractures.

SSJ16

Musculoskeletal (Muscle, Tendon and Nerve)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E353B

MR MK US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Darryl B. Sneag, MD, Plainview, NY (*Moderator*) Nothing to Disclose
Michael J. Tuite, MD, Madison, WI (*Moderator*) Nothing to Disclose

Sub-Events

SSJ16-01 Ultrasound versus MRI in Post-Traumatic Brachial Plexopathy

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E353B

Participants
Anne Jonkergouw, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Scott Wolfe, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Steve K. Lee, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Joseph Feinberg, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Darryl B. Sneag, MD, Plainview, NY (*Abstract Co-Author*) Nothing to Disclose
Ogonna K. Nwawka, MD, New York, NY (*Presenter*) Research Grant, General Electric Company

PURPOSE

This study aims to evaluate the use of ultrasound in detecting traumatic lesions of the brachial plexus, comparing them to magnetic resonance (MR) imaging findings.

METHOD AND MATERIALS

Patients with symptoms suggestive of post-traumatic brachial plexopathy were recruited to undergo high resolution magnetic resonance (MR) imaging and ultrasound (US) of the brachial plexus. 30 patients fit criteria for study inclusion. Standard high resolution MR and US imaging was performed. The brachial plexus was imaged from the paravertebral region through the infraclavicular region on both MRI and US. Evaluation of radiographic findings were performed by two fellowship-trained musculoskeletal radiologists expert in brachial plexus imaging, of which one focused on MR imaging and one on US evaluation. MR and US findings were compared for characterization of injury at the root, trunk, division, cord and terminal branch level using kappa coefficient measurements.

RESULTS

On MR imaging, brachial plexus injury was detected in 25 of 30 patients, including 9 with high-grade lesions (neuroma, root avulsion or nerve transection). On US imaging, brachial plexus injury was detected in 28 patients, including 6 patients with high-grade lesions. False-negative US findings, were related to a limited field of view, obscuring of the field by bony structures, and limited mobility of patients. False-positive US findings were related to scarring. MR imaging suffered from hardware susceptibility effects in 3 patients and motion artifacts in 1 patient. Kappa values were >0.75 for the C5-C8 nerve roots, trunks, divisions, cords, and the suprascapular, median and ulnar nerves, indicating excellent agreement. The kappa values were < 0.75 for the T1 nerve root (0.30), axillary (0.74), radial (0.70) and musculocutaneous nerve (0.29). All kappa values were statistically significant ($p < 0.001$).

CONCLUSION

US and MRI demonstrate excellent agreement in the evaluation of brachial plexus trauma. Ultrasound detection is limited in regions obscured by bony structure and in patients with limited mobility. MRI evaluation is limited by hardware susceptibility artifacts and patient motion.

CLINICAL RELEVANCE/APPLICATION

As ultrasound demonstrates excellent agreement with MRI in the detection of traumatic brachial plexus lesions, it can serve as an alternative to MRI for evaluation of traumatic brachial plexopathy, particulary useful in patients who cannot tolerate MR imaging.

SSJ16-02 Shear Wave Elastography Demonstrates Reduced Patellar Tendon Elasticity in Jumping Athletes with Patellar Tendinopathy Compared to Activity-Matched Healthy Jumping Athletes

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E353B

Awards
Student Travel Stipend Award

Participants
Stephan J. Breda, MD, Rotterdam, Netherlands (*Presenter*) Institutional research collaboration, General Electric Company
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Gabriel P. Krestin, MD, PhD, Rotterdam, Netherlands (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Patellar tendinopathy (PT) is characterized by localized patellar tendon pain and decreased performance in athletes. Morphologic changes and neovascularization are sequelae of PT, however sometimes subtle or absent. Evaluating elastic properties of the patellar tendon could improve the sonographic diagnosis of PT. Shear wave elastography (SWE) is a quantitative ultrasound-based imaging method measuring tissue elasticity. To explore the diagnostic performance of SWE to visualize PT, we evaluated patellar tendon elasticity in athletes with PT compared to activity-matched healthy jumping athletes.

METHOD AND MATERIALS

Athletes aged 18-30 years, playing tendon-loading sports at least 3 times per week were included for clinical and radiological evaluation of the patellar tendon. Symptomatic athletes underwent both clinical examination and sonographic evaluation (conventional ultrasound and power Doppler) to confirm the diagnosis of PT. SWE was performed in supine position with extended knees using a GE Logiq E9 ultrasound system. Activity-matched healthy controls without history of knee pain were recruited for ultrasound of both knees. Primary outcome was mean elastic modulus of the proximal patellar tendon measured in kilopascal (kPa). Tendon thickness was a secondary outcome measure. To compare tendon elasticity in healthy versus affected tendons, a Mann-Whitney U test was used. Linear regression analysis was performed to determine the association between tendon thickness and elasticity.

RESULTS

We included 37 athletes (30 affected with PT). Median elastic modulus of the proximal patellar tendon was 76.5 kPa [IQR 59.2-106.9] in PT, compared to 35.4 kPa [IQR 31.9-42.3] in healthy controls ($p<0.001$). Increased tendon thickness was associated with reduced tendon elasticity in jumping athletes with PT after adjustments for age and sex, ß=9.7 (95%CI 5.5-13.8), $p<0.001$.

CONCLUSION

Patellar tendon elasticity is reduced in jumping athletes with patellar tendinopathy compared to activity-matched controls. Furthermore, tendon elasticity is associated with tendon thickness. Further research is ongoing to explore the potential of SWE as an imaging biomarker to monitor treatment response in a randomized clinical trial.

CLINICAL RELEVANCE/APPLICATION

SWE is a promising quantitative imaging tool to visualize patellar tendinopathy and is currently evaluated to monitor treatment effects.

SSJ16-03 Simultaneous Multi-Band Fast Spin Echo MRI: Scan Time and Image Quality Improvement for Peripheral Nerve Imaging

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E353B

Participants
Erin C. Argentieri, BS, New York, NY (*Abstract Co-Author*) Institutional research agreement, General Electric Company
Darryl B. Sneag, MD, Plainview, NY (*Presenter*) Nothing to Disclose

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PURPOSE

To determine whethere a novel, fast spin echo (FSE) MR acquistiion using a multiband (MB) excitation, which has a minimal noise penalty, provides equivalent image quality at reduced scan time compared to a standard of care FSE acquistiion for evaluating peripheral neuropathies.

METHOD AND MATERIALS

This was an IRB-approved study of 8 patients (5F/8M), mean age 41.7± 14.5 years, who presented in clinic for routine MRI evaluation of peripheral neuropathy and who provided written consent. Data was acquired in: 4 knees, 1 elbow, 1 pelvis and 2 lower legs. For the knees and lower legs, evaluation was focused on the saphenous, tibial and commo peroneal nerves, while the ulnar nerve was evaluated for the elbow, and the lumbosacral plexus and sciatic nerves were the focus for the pelvis. All MRIs were performed at 3T (MR750 GE Healthcare, Waukesha WI), using a 16-channel flex-coil for all exams except the pelvis where a 32-channel torso coil was used. Axial proton density (PD) and T2-weighted fat saturation (T2-FS) standard-of-care (SOC)-FSE and MB-FSE scans were acquired with matching scan parameters: FOV:11-30 cm;512x352 (freq x phase); 26-62 slices; PD TR/TE: 4500/24 ms, T2-FS TR/TE 4800/86 ms; NEX:2.

RESULTS

No appreciable differences betweeen MB-FSE and SOC-FSE acquisitions were observed between qualitative evaluations of image quality based on the 5-point scale. All grades of MB-FSE image quality were ± 1 point of the corresponding SOC-FSE images: 38% of grades were + 1, and 50% of grades indicated that MB-FSE and SOC-FSE image sets were of equal image quality. Comparsions of MB-FSE and SOC-FSE image sets with identical imaging parameters revealed that the utilization of a MB-FSE acquisition saved, on average, 1.5 min. of scan stime (min: 30 sec; max: 2.5 min 27 sec).

CONCLUSION

Preliminary results of this pilot study indicate that the MB-FSE acquistion provides similar imaging quality compared to SOC-FSE acquisitions. MB-FSE accelerates FSE imaging without the noise penalty associated with in-plane acceleration techniques. For peripheral nerve imaging, where SNR and resolution are paramount, decreased scan time can be traded off to significantly improve image quality.

CLINICAL RELEVANCE/APPLICATION

Multi-band fast spin echo (FSE) MRI may provide similar image quality to conventional FSE within a shorter scan time, faciliating the acquistion of higher spatial resolution sequences for detecting peripheral neuropathies.

SSJ16-04 MR Neurography for the Evaluation of Peripheral Nerves and Associated Neurogenic Muscle Atrophy in Non-Systemic Vasculitic Neuropathy

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E353B

Participants
Thorsten Lichtenstein, MD, Cologne, Germany (*Presenter*) Nothing to Disclose
Christian Schneider, MD, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose
Alina Sprenger, Cologne, Germany (*Abstract Co-Author*) Nothing to Disclose
Kilian Weiss, PhD, Hamburg, Germany (*Abstract Co-Author*) Employee, Koninklijke Philips NV
David C. Maintz, MD, Koln, Germany (*Abstract Co-Author*) Nothing to Disclose
Tobias D. Henning, MD, Trier, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Non-systemic vasculitic neuropathy (NSVN) is a frequent cause of chronic progressive axonal peripheral neuropathy. Nerve biopsies can demonstrate axonal damage with asymmetric loss of nerve fibers. In contrary, diagnosis and evaluation of the clinical course remain difficult by non-invasive techniques (e.g. electroneurography (ENG) or electromyography (EMG)). Thus, the objective of this prospective clinical study was to evaluate MR neurography at 3T as a potential diagnostic tool for diagnosis and follow-up. NSVN causes damage of nerve fiber integrity, therefore diffusion tensor imaging (DTI) was evaluated to detect changes in NSVN patients. Since NSVN causes neurogenic muscle atrophy, the second aim of this study was to quantify the intramuscular fat fraction using proton density fat fraction (PDFF) mapping.

METHOD AND MATERIALS

In this prospective study, patients with NSVN and healthy controls (HC) were investigated by MR neurography at 3T (n = 9 respectively). In all patients tibial nerves were examined by DTI and fractional anisotropy (FA) was calculated. Secondly, fat fractions of the soleus muscle (SM) and gastrocnemius muscle (GM) were analysed by PDFF mapping. MR neurography data was correlated with clinical follow-up by ENG and EMG.

RESULTS

In tibial nerves of NSVN patients FA values were significantly lower compared to healthy controls (0.33 vs 0.42 respectively, p=0.002). Muscle PDFF showed significantly higher values in NSVN compared to healthy controls, thus detecting fatty muscle atrophy reliably. Mean values measured 5.74% vs 10.78% respectively for SM (p=0.003) and 4.17% vs 23.71% for GM (p<0.001).

CONCLUSION

In this study, MR neurography at 3T proved as a reliable biomarker for the affection of peripheral nerves in NSVN. Fractional anisotropy allows for a reliable distinction between healthy and functionally impaired nerves while PDFF reliably detects fatty neurogenic muscle atrophy as an indirect surrogate marker in those patients. This is possible without the administration of iv contrast agent.

CLINICAL RELEVANCE/APPLICATION

In patients with NSVN, the combination of DTI and PDFF detects nerve damage and neurogenic muscle atrophy and might be helpful to guide treatment.

SSJ16-05 Lumbar Plexus in Patients with Chronic Inflammatory Demyelinating Polyradiculoneuropathy: Evaluation with Simultaneous T2 Mapping and a Neurography Method with SHINKEI

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E353B

Participants
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Osamu Togao, MD, PhD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose
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Kazufumi Kikuchi, MD,PhD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose
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Hiroshi Honda, MD, Fukuoka, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

MR neurography (MRN) is a useful technique with which to evaluate abnormal conditions of the peripheral nerves such as chronic inflammatory demyelinating polyradiculoneuropathy (CIDP). We have developed a simultaneous T2 mapping and MRN method with 'nerve-sheath signal increased with inked rest-tissue rapid acquisition of relaxation enhancement imaging' (SHINKEI). The purpose of this study was to evaluate the usefulness of this technique in lumbar plexus to distinguish patients with CIDP from healthy controls.

METHOD AND MATERIALS

Ten patients with CIDP (7 males and 3 females; age range 11 - 68-year-old; median 47.5 year) from 2015 to 2017 were studied along with five healthy controls (4 males and 1 female; age range 27 - 45-year-old; median 41 year). MRI was conducted on a 3T clinical scanner. Typical imaging parameters were as follows; TR = 2500 ms, TE = 51 ms, FOV = 290 x 290 mm, ETL = 90, matrix =

256 x 245, Acquisition voxel size = 1.13 x 1,18 x 4.0 mm3, Reconstructed voxel size = 0.60 x 0.60 x 2.0 mm3, b = 10 s/mm2, iMSDE duration = 36 and 72 ms, acquisition time = 5 min 45 s. The T2 relaxation time and the size of the dorsal root ganglia and nerves of the lumbar plexus at L3-S1 were measured on coronal plane. Statistical analyses were performed with the Mann-Whitney U-test and a receiver operating characteristics (ROC) analysis.

RESULTS

The T2 relaxation times of the dorsal root ganglia and the nerves of the lumbar plexus were longer in the CIDP patients (133.34 ± 41.36 msec and 130.40 ± 47.78 msec) compared to the healthy controls (114.69 ± 24.90 msec and 83.72 ± 17.51 msec, p=0.0265 and p<0.0001, respectively). The sizes of the nerves were larger in the CIDP patients (6.19 ± 2.28 mm) compared to the controls (4.54 ± 0.86 mm, p<0.0001). However, there was no significant difference between the sizes of the ganglia in the CIDP patients and the controls. The ROC analysis revealed that the T2 relaxation time of the nerves was best at distinguishing the CIDP patients from the controls (Az = 0.848).

CONCLUSION

Patients with CIDP could be distinguished from healthy controls using simultaneous T2 mapping and MRN method with SHINKEI in lumbar plexus.

CLINICAL RELEVANCE/APPLICATION

With our new method we could obtain high resolution neurography with simultaneous T2 mapping. CIDP could be distinguished from controls using our technique.

SSJ16-06 Quantitative Ultrasound Measures in the Patellar Tendon are Associated with VISA-P Scores of Collegiate Basketball Players Over One Season of Play

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E353B

Participants
Ogonna K. Nwawka, MD, New York, NY (*Presenter*) Research Grant, General Electric Company
Bin Lin, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Brett Toresdahl, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Answorth Allen, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

This study of collegiate basketball players evaluated change over time (COT) in ultrasound shear wave (SW) elastography metrics across the basketball season, and correlated to morphologic changes on conventional ultrasound imaging, and VISA-P scores.

METHOD AND MATERIALS

In eleven male collegiate basketball players (mean age 19, age range 18-21), patella tendon (PT) ultrasound and SW elastography of both knees were performed at pre-season and post-season time points, and players reported their VISA-P scores throughout the season. Patella tendinopathy grade and SW metrics were correlated to VISA-P scores using Spearman correlation coefficients. Paired t-test was used to assess differences in mean SW metrics at pre-and post-season timepoints, accounting for leg dominance.

RESULTS

6 of 11 players (54.5%) had baseline patella tendinopathy on ultrasound progressing in 4 players. The mean change in VISA-P score was 15.18 (+/-8.55). No significant correlation was seen between ultrasound grades of tendinopathy and VISA-P. Pre-season SW velocities did not significantly correlate with baseline VISA-P scores. Post-season SW values and SW COT demonstrated strong correlation with change in VISA-P score in dominant and non-dominant knees. Although not statistically significant, there was a trend towards higher SW velocity for tendinopathy in both dominant and non-dominant knees at both study visits.

CONCLUSION

SW metrics of the PT correlated to change in VISA-P scores in the dominant and non-dominant knees, whereas conventional ultrasound grades of patella tendinopathy did not. There was a trend towards higher SW velocities in patella tendinopathy which may indicate detection of change in intrinsic tissue stiffness.

CLINICAL RELEVANCE/APPLICATION

These results showed significant correlation between SW values and patella tendinopathy symptom scores, demonstrating the benefit of this quantitative imaging technique over conventional ultrasound imaging in the characterization of clinically symptomatic patella tendinopathy.

SSJ17

Science Session with Keynote: Nuclear Medicine (Chest/Breast Oncology Nuclear Imaging)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S504CD

BR CH CT MR NM OI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Peter S. Conti, MD, PhD, Los Angeles, CA (*Moderator*) Nothing to Disclose
Andrew C. Homb, MD, Rochester, MN (*Moderator*) Nothing to Disclose

Sub-Events

SSJ17-01 Nuclear Medicine Keynote Speaker: Radiomics in Lung Cancer

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S504CD

Participants
Lawrence H. Schwartz, MD, New York, NY (*Presenter*) Committee member, Celgene Corporation Committee member, Novartis AG Committee member, ICON plc Committee member, BioClinica, Inc

SSJ17-02 An Updated and Validated PET/CT Volumetric Prognostic Index for Non-Small Cell Lung Cancer

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S504CD

Participants
Joshua H. Finkle, MD, Chicago, IL (*Presenter*) Nothing to Disclose
Bill C. Penney, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Yonglin Pu, MD, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Whole-body metabolic tumor volume (MTVWB) and TNM staging are independent prognostic factors for overall survival (OS) in non-small cell lung cancer (NSCLC). We aimed to update and validate the PET/CT volumetric prognostic index (PVP index) using the new 8th edition TNM staging system to evaluate its prognostic power versus TNM staging and MTVWB alone.

METHOD AND MATERIALS

This study was a retrospective analysis of 949 non-small cell lung cancer (NSCLC) patients diagnosed between 2004 and 2014. Clinical TNM stage, MTVWB, age and gender, tumor histology type at the initial staging PET/CT exam, as well as treatment history and long-term survival data were obtained. Patients were randomly assigned to modeling or validation group. Univariate and multivariate Cox regression analyses were performed to compare PVP index, TNM stage, and MTVWB in the validation group.

RESULTS

The updated PVP index included the 3 variables TNM stage, and MTVWB and age. Univariate Cox models showed significant association of PVP index with overall survival (OS) in patients with NSCLC (with Hazard ratio HR= 2.88 in the validation group, $p<0.001$). The C-statistic of the PVP index (C-statistic = 0.71 in the validation group) was significantly greater than that of 8th edition TNM staging (C-statistic = 0.68, $p=0.029$), MTVWB (C-statistic = 0.68, $p=0.001$), and patient age (C-statistic = 0.53, $p<0.001$). Multivariate Cox regression analyses demonstrated significant association of PVP index with OS (with HR= 2.80, $p<0.001$) after adjusting patient's gender and tumor histology.

CONCLUSION

The updated PVP index provides a quantitative risk assessment for NSCLC patients using 8th edition TNM staging, MTVWB, and age. The index provides a simple and practical way for the care team to incorporate the independent prognostic value of both the TNM stage and MTVWB. This approach can further improve the accuracy of overall survival prognosis.

CLINICAL RELEVANCE/APPLICATION

The PVP index combines the prognostic power of the TNM stage, whole-body metabolic tumor volume and age, offering prognostic accuracy superior to whole-body metabolic tumor volume or TNM stage alone.

SSJ17-03 Prospective Comparison of 18F-FDG PET/MRI and 18F-FDG PET/CT for Thoracic Staging of Non-Small Cell Lung Cancer

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S504CD

Participants
Lino Sawicki, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Julian Kirchner, Dusseldorf, Germany (*Presenter*) Nothing to Disclose
Benedikt M. Schaarschmidt, MD, Essen, Germany (*Abstract Co-Author*) Stockholder, Bayer AG; Stockholder, General Electric Company; Stockholder, Siemens AG; Stockholder, Teva Pharmaceutical Industries Ltd
Ken Herrmann, Essen, Germany (*Abstract Co-Author*) Co-founder, SurgicEye GmbH; Stockholder, SurgicEye GmbH; Consultant, Sofie

Biosciences; Consultant, Ipsen SA; Consultant, Siemens AG; Research Grant, Advanced Accelerator Applications SA; Research Grant, Ipsen SA
Gerald Antoch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose
Philipp Heusch, MD, Duesseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To compare the diagnostic performance of 18F-FDG PET/MRI and 18F-FDG PET/CT for primary and locoregional lymph node staging in non-small cell lung cancer (NSCLC).

METHOD AND MATERIALS

In this prospective study a total of 84 patients (51 men, 33 women, mean age 62.5 ± 9.1 years) with histopathologically confirmed NSCLC underwent 18F-FDG PET/CT followed by 18F-FDG PET/MRI in a single injection protocol. Two readers independently assessed T and N staging in separate sessions according to the seventh edition of the American Joint Committee on Cancer staging manual for 18FFDG PET/CT and 18F-FDG PET/MRI, respectively. Histopathology as reference standard was available for N staging in all 84 patients and for T staging in 39 patients. Differences in staging accuracy were assessed by McNemars chi2 test. The maximum standardized uptake value (SUVmax) and longitudinal diameters of primary tumors were correlated using Pearson's coefficients.

RESULTS

T stage was categorized concordantly in 18F-FDG PET/MRI and 18F-FDG PET/CT in 38 of 39 (97.4%) patients. Herein, 18F-FDG PET/CT and 18F-FDG PET/MRI correctly determined the T-stage in 92.3% and 89.7% of patients, respectively. N-stage was categorized concordantly in 83 of 84 patients (98.8%). 18F-FDG PET/CT correctly determined the N stage in 78 of 84 patients (92.9%), while 18F-FDG PET/MRI correctly determined the N stage in 77 of 84 patients (91.7%). Differences between 18F-FDG PET/CT and 18F-FDG PET/MRI in T and N staging accuracy were not statistically significant ($p > 0.5$, each). Tumor size and SUVmax measurements derived from both imaging modalities exhibited excellent correlation ($r=0.963$ and $r=0.901$, respectively).

CONCLUSION

18F-FDG PET/MRI and 18F-FDG PET/CT showed an equivalently high diagnostic performance for T and N staging in patients suffering from NSCLC.

CLINICAL RELEVANCE/APPLICATION

PET/MRI as a dose-saving alternative to PET/CT proved coequal to the current gold standard for thoracic staging of NSCLC. Thus, clinicians might use PET/MRI instead of PET/CT for this purpose. However, considering the longer examination times and higher expenses of PET/MRI, a general recommendation in favor of PET/MRI cannot be drawn from this study.

SSJ17-04 The Relationship Between PET/CT Imaging Features and Pathological Types and Gene Mutations of Primary Lung Cancer: A Study of 213 Untreated Lung Cancer Patients with Bone Metastases

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S504CD

Participants
Xiaomeng Li, MD, Beijing, China (*Presenter*) Nothing to Disclose
Ning Wu, MD, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the relationship between 18F-FDG PET/CT image characteristics and pathological types and gene mutations of primary lung cancer in untreated lung cancer patients with bone metastases.

METHOD AND MATERIALS

A total of 213 untreated lung cancer patients with bone metastases were enrolled in this study. All patients underwent 18F-FDG PET/CT examination, pathological and gene mutation examination of primary lung cancer. Spearman's correlation test was performed to evaluate the association between primary tumors and bone metastases. Single factor analysis of variance was used to compare groups.

RESULTS

(1)A total of 213 cases were evaluated. The mean SUVmax of primary lung cancer was 7.9±4.7; that of bone metastases was 8.2±4.3. The SUVmax of primary lesions had a significantly positive correlation with the SUVmax of bone metastases ($r = 0.622$; $p = 0.000$). Osteolytic metastasis was the most common type. (2)The SUVmax of primary lung lesions with different pathological types were statistically different (all $P = 0.000$): squamous cell carcinoma > small cell carcinoma > adenocarcinoma. Their SUVmax were 11.7±3.7, 9.3±3.1, and 6.7±4.6, respectively. (3)In non-small cell lung cancer (NSCLC), the gene mutation rates of epidermal growth factor receptor (EGFR), K-ras and anaplastic lymphoma kinase (ALK) were 35.7%, 10.1% and 3.8%, respectively. There was no statistical difference in SUV*max* of primary lung cancer between gene mutation type and wild type ($P>0.05$).

CONCLUSION

The SUVmax of primary lung lesions with different pathological types were statistically different. Squamous cell carcinoma was the highest, and adenocarcinoma was the lowest. The SUVmax of primary lung cancer had a significantly positive correlation with the SUVmax of bone metastases. In NSCLC, the mutation rate of EGFR is the highest. There was no statistical difference in SUVmax of primary lung cancer between gene mutation type and wild type.

CLINICAL RELEVANCE/APPLICATION

The SUVmax of primary lung cancer is suggestive of its pathological type. But the SUVmax of primary lung cancer is not helpful to predict the gene mutations in NSCLC.

SSJ17-05 Local and Whole-Body Staging in Patients with Primary Breast Cancer: A Comparison of One-Step to Two-Step-Staging-Algorithms Utilizing PET/MRI

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S504CD

Participants
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Ann-Kathrin Bittner, Essen, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare the diagnostic value of a one-step to a two-step staging algorithm for local and whole-body staging utilizing 18F-FDG PET/MRI in breast cancer patients.

METHOD AND MATERIALS

A total of 38 patients (37 females and one male, mean age 57 ± 10 years; range 31-78 years) with newly diagnosed, histopathologically proven breast cancer were prospectively enrolled in this trial. All PET/MRI examinations were assessed for local tumor burden and metastatic spread in two separate reading sessions: (1) One-step algorithm comprising supine whole-body 18F-FDG PET/MRI, (2) Two-step algorithm comprising a dedicated prone 18F-FDG breast PET/MRI and supine whole-body 18F-FDG PET/MRI.

RESULTS

On a patient based analysis the two-step algorithm correctly identified 37 out of 38 patients with breast carcinoma (97%), while 5 patients were missed by the one-step 18F-FDG PET/MRI algorithm (33/38; 87% correct identification; p=0.37). On a lesion-based analysis 56 breast cancer lesions were detected in the two-step algorithm and 44 breast cancer lesions could be correctly identified in the one-step 18F-FDG PET/MRI (79%), resulting in statistically significant differences between the two algorithms (p=0.0015). For axillary lymph node evaluation sensitivity, specificity and accuracy was 93%, 95 % and 94%, respectively. Furthermore, distant metastases could be detected in 7 patients with both modalities.

CONCLUSION

The results demonstrate the necessity and superiority of a two-step 18F-FDG PET/MRI algorithm, comprising dedicated prone breast imaging and supine whole-body imaging, when compared to the one-step algorithm for local and whole-body staging in breast cancer patients.

CLINICAL RELEVANCE/APPLICATION

Two-step 18F-FDG PET/MRI comprising dedicated breast and whole-body imaging enables high-quality local and whole-body staging in patients with breast cancer.

SSJ17-06 Multimodal Radiomic Imaging: Comparison of PET and MRI-pCM Heterogeneity in Breast Cancer

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S504CD

Participants
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Christian Leissing, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose
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Patrick Veit-Haibach, MD, Zurich, Switzerland (*Abstract Co-Author*) Research Grant, Bayer AG Resaarch Grant, F. Hoffmann-La Roche Ltd Research Grant, General Electric Company

PURPOSE

This study investigated the value of pre-treatment F-18-Fluorodeoxyglucose (FDG)-positron-emission-tomography (PET) radiomics in comparison to T1-weighted-post-contrast-magnetic-resonance-imaging (MRI-pCM) radiomics in patients with breast cancer.

METHOD AND MATERIALS

Following IRB approval and informed consent, a total of 30 patients with histologically proven breast cancer were prospectively recruited. Patients were injected 225+/-55 MBq FDG intravenously. PET and MRI-pCM were acquired on the same machine. 154 radiomic features of first, second, and higher order were extracted from the primary tumor. Dimensionality of features was reduced with a Principal Component Analysis. The relationship of selected features to staging and histological parameters was determined. Association of features between the different modalities was compared (Spearman "ρ").

RESULTS

Selected radiomic features of PET showed moderate correlation to T-stage ($-0.52 < \rho < 0.54$) and weak correlation to N-Stage ($-0.35 < \rho < 0.38$). Selected radiomic features of MRI-pCM showed moderate correlation to T-stage ($-0.64 < \rho < 0.57$) and to N-stage ($-0.52 < \rho < 0.54$). Correlation of radiomic features of both modalities to hormone receptor status is shown in Table 1. Comparison between PET and MRI-pCM showed moderate to strong correlation for the comparison of all radiomic features (-0.66 <

ρ < 0.68) (Figure 1), whereas the correlation for the comparison of a respective radiomic parameter was only weak to moderate (0.22 < ρ < 0.56) (1st diagonal in Figure 1).

CONCLUSION

Radiomics in a multimodality approach might be a complementary tool for non-invasive pre-therapeutic characterization of breast cancer.

CLINICAL RELEVANCE/APPLICATION

Combining radiomic features from different imaging modalities may help in non-invasive specification of breast cancer.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSJ18

Neuroradiology (Artificial Intelligence in Neuroimaging)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E451B

AI MR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Max Wintermark, MD, Lausanne, Switzerland (*Moderator*) Advisory Board, General Electric Company; Consultant, More Health; Consultant, Magnetic Insight; Consultant, Icometrix; Consultant, Nines;
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Sub-Events

SSJ18-01 Automated Detection of Abnormality in Multi-Parametric Brain MRI Using an Artificial Intelligence 3D Pipeline

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E451B

Participants
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PURPOSE

With rapid growth and increasing use of brain MRI, there has been a significant interest in automated image processing and classification of brain MRI scans to supplant human interpretation and improve workflow. In this study we aim to assess the diagnostic accuracy of an AI 3D pipeline in classifying multi-parametric brain MRI to normal vs. abnormal.

METHOD AND MATERIALS

A total of 1,516 consecutive clinical brain MRI studies including sagittal T1W and axial FLAIR, ADC and B1000 sequences were selected from our institution HIPAA compliant imaging registry. Brain MR studies were obtained using standardized protocol across 1.5T MR scanners from two manufacturers (GE and Siemens). Each sequence was reformatted to common resolution to accommodate for differences between vendors. A board certified neuroradiologist assigned each case to normal vs. abnormal based on the review of clinical report of each case. Consequently, 88% of the MRI scans were marked as abnormal. A 3D AI pipeline was developed: first, a deep reinforcement learning based landmark detection was used to estimate positioning and brain coverage. Brain was extracted using an adversarial dense image-to-image based technique then sequence-independent dense convolutional networks were trained in a supervised way, with data augmentation (random rotation, translation and added noise at each iteration), and merged to flag abnormal cases. Training was performed on 1,566 cases (200,448 images - 85% abnormal) with class weights to address class imbalance, testing included 175 cases (22,400 images - 84% abnormal).

RESULTS

Receiver operating characteristic (ROC) analysis showed that an area-under-the-curve (AUC) of 0.90 with accuracy of 86%, sensitivity of 85%, and specificity of 89% for our detection pipeline.

CONCLUSION

Our proposed intelligent pipeline accurately identifies abnormal brain MRIs from the individual patients. If its potential is realized, it can be used as a clinical tool to flag abnormal MRIs, allowing for improved triage and timely interpretation of abnormal scans in a busy and large clinical practice.

CLINICAL RELEVANCE/APPLICATION

Our proposed automated and intelligent 3D pipeline can flag abnormal brain MRI scans, catering available human expertise in interpreting abnormal cases in a timely manner.

SSJ18-02 Multi-Metric Characterization of Resting-State Functional Connectivity for Machine Learning Classification in Major Brain Networks

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E451B

Participants
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PURPOSE

Population differences have been identified based on resting-state functional connectivity (FC) derived from blood-oxygen-level-dependent (BOLD) response using machine learning classification. While Pearson's correlation is the conventional metric used to quantify FC, it may not capture the true dynamic and non-linear relationship between BOLD responses from distinct brain regions. This motivates the need for a more complete notion of FC for better classification performance.

METHOD AND MATERIALS

Ten-minute eyes closed functional MRI were acquired on 3T GE MR750 scanner from 50 right-handed healthy participants consisting of 25 older (age=57.5±7.1 years; 13 females; education=16.68 years) and 25 younger (age=23.9±5.9 years; 13 females; education=16.76 years) participants. Data were preprocessed using standard steps on SPM12 to extract the BOLD time courses in 6 major brain networks. Network-wise FC was computed based on 8 distinct metrics: cross-correlation, coherence, mutual information, dynamic time warping (DTW) distance, Euclidean distance, cityblock distance, wavelet coherence and the conventional Pearson's correlation. Individual and combined discriminatory power of the metrics was assessed using a linear support vector machine classifier to differentiate between the older and younger groups for each network. Neighborhood component analysis and leave-one-out cross-validation were used for feature selection and evaluation of classification performance respectively.

RESULTS

Groups were significantly different in age (p-value<0.001) but not in gender distribution or education. Comparative results showed that Pearson's correlation may not always be the optimal choice for FC. The combined metric performed comparable/better than individual metrics for each network. This could imply that a more meaningful definition of FC encompassing linear, non-linear, dynamic, time-, frequency- and wavelet-domain information could be created for classification by drawing contributions from multiple metrics.

CONCLUSION

Combining the inter-dependencies in BOLD signals in time, frequency and wavelet domains could provide a more comprehensive notion of FC for population-based classification using machine learning.

CLINICAL RELEVANCE/APPLICATION

Multi-metric characterization offers a more complete definition of FC and could be useful in delineating group differences between patient and healthy population using machine learning classification.

SSJ18-03 Use of a Deep Convolutional Neural Network for Automated Detection of Intracranial Hemorrhage

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E451B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The purpose of this study is to investigate the possibility of automated detection of all varieties of intracranial hemorrhage (ICH), including epidural (EDH), subdural (SDH), subarachnoid (SAH), intraparenchymal (IPH), and intraventricular (IVH) on unenhanced head CT examinations (HCT) using a deep residual convolutional neural network (DRCNN) in all possible clinical scenarios, including initial HCT for diagnosis of ICH, follow-up HCT for known ICH, and post-operative HCT after surgical intervention.

METHOD AND MATERIALS

IRB approved retrospective HIPAA compliant study with requirement for informed consent waived. Included cases were identified through a keyword search of our RIS for HCT with ICH and normal HCT (NHCT) between 7/1/2014-7/1/2016. A total of 95 ICH cases and 46 NHCT cases were included in this study. The hemorrhages in the ICH cases were segmented by hand using an inhouse MATLAB annotation tool. The DRCNN was trained using 60 annotated ICH cases and validated with 5 ICH cases. The trained DRCNN was then tested on 30 ICH cases (with many of the cases including different types of hemorrhage for a total of 56 hemorrhages) and 46 NHCT cases using two different DRCNN thresholds for hemorrhage detection and minimal post-processing of the DRCNN output. The percentage of hemorrhages detected, and the false positive rate (FPR) were evaluated at each of the DRCNN thresholds. For the lower DRCNN threshold, a minimum number of DRCNN identified pixels containing hemorrhage was employed to consider the case positive for hemorrhage to limit the FPR.

RESULTS

The DRCNN with a high threshold (HT) for ICH detection correctly detected 70% (39/56) ICH including, 0% (0/1) EDH, 60% (6/10) SDH, 50% (6/12) SAH, 81% (17/21) IPH, and 83% (10/12) IVH. The DRCNN with a low threshold (LT) for ICH detection correctly

detected 89% (50/56) ICH including, 100% (1/1) EDH, 80% (8/10) SDH, 83% (10/12) SAH, 90% (19/21) IPH, and 100% (12/12) IVH. The DRCNN with a HT for ICH detection had a FPR of 2% (1/46 NHCTs evaluated). The DRCNN with a LT for ICH detection had a FPR of 28% (13/46 NHCTs evaluated).

CONCLUSION

DRCNNs can be trained to successfully detect all types of ICH on HCT examinations in all possible clinical scenarios.

CLINICAL RELEVANCE/APPLICATION

Automated detection of intracranial hemorrhages could potentially be used clinically to help triage completed unread examinations and assist with detection of subtle hemorrhages.

SSJ18-04 Substantially Shortened Brain and Lumbar Spine MR Scan Times with a Machine Learning-Based Iterative Image Reconstruction Algorithm

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E451B

Participants
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PURPOSE

To evaluate the scan time shortening potential of a novel 3D image enhancement algorithm for brain and lumbar spine MRI exams.

METHOD AND MATERIALS

Fifty-six subjects (mean age 48+/-16 years) were scanned on four 1.5T scanners (Philips-Ingenia: 18 brain, 6 spine; Siemens-Aera: 9 brain, 2 spine; General Electric Signa-HDxt: 10 brain, Optima MR450w 11 spine), at three different sites using the site's routine clinical protocols as well as an average of ~30% shorter scan time-reduced variants. The time-reduced variant protocols were set by altering routine acquisition parameters, trading scan time reductions, mainly, for decreased signal to noise ratio. The faster, SNR challenged scans were processed with a novel 3D image enhancement algorithm (iQMR by Medic Vision Ltd.) and compared with the corresponding sites' routine scans (153 brain scans and 43 lumbar spine scans). Independent, blinded, side-by-side comparisons of diagnostic quality, visual image quality, presence of artifacts and brain gray-white matter differentiation were performed by six neuroradiologists for brain data and three neuroradiologists for spine data, using a 5-point Likert-scale (3= equal, >3 processed image is superior).

RESULTS

The processed-reduced scan time images (614 brain reads, 129 lumbar spine reads) were rated higher or equal to the conventional routine scans with respect to diagnostic quality (brain: median=3, mode=3, mean=2.94+/-0.39; spine: median=3, mode=3, mean=3.05+/-0.39), visual image quality (brain: median=3, mode=3, mean=2.83+/-0.69; spine: median=3, mode=3, mean=3.14+/-0.77), the presence of artifacts (brain: median=3, mode=3, mean=2.91+/-0.54; spine: median=3, mode=3, mean=3.11+/-0.66) and for brains, gray-white matter differentiation (median=3, mode=3, mean=2.91+/-0.46).

CONCLUSION

iQMR processed, reduced scan time images were similar in overall image quality to standard protocols with a reduction of MRI exam scan time of about 30%.

CLINICAL RELEVANCE/APPLICATION

iQMR can produce clinically acceptable MR images at significantly shorter scan times, facilitating patient comfort and clinical practice workflow. Faster scans could potentially decrease motion artifacts and reduce the need for repeat scans.

SSJ18-05 Radiomics-Based Prediction of Malignant Potential in Patients with Parotid Gland Cancer

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E451B

Participants
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PURPOSE

Prediction of malignant potential (low+intermediate and high grades) in patients with parotid gland cancer (PGC) is crucial in determination of treatment approaches. Although the fine needle aspiration cytology (FNAC) is performed for prediction of malignant

potential for PGC, various researchers have reported the prediction accuracy of malignant potential in PGC by the FNAC, which depends on the operator experience, was from 69 to 92%. Therefore, we developed the radiomics-based prediction of malignant potential in patients with parotid gland cancer.

METHOD AND MATERIALS

A total of 972 radiomic features (statistic, texture, wavelet-based features) were extracted from tumor regions in preoperative T1- and T2-weighted images of 42 PGC patients. Radiomic signatures for prediction of malignant potential in PGC patients were generated by using least absolute shrinkage and selection operator (LASSO), which is one of sparse coding approaches that performs both feature selection and regularization to avoid the curse of dimensionality. Malignant potential for PGC was predicted by using Gaussian support vector machine (G-SVM), which is a machine learning classifier. The accuracy and the mean area under the receiver operating characteristic curve (AUC) of G-SVM model by a leave-one-out cross validation test were evaluated.

RESULTS

The 5 features, which included T1_LLH_Skewness, T1_HLH_Min, T2_gray-level non-uniformity (GLN), T2_LLH_Long Run Emphasis (LRE), and T2_LLH_Small Zone High Gray-Level Emphasis (SZHGE), were selected by LASSO as the radiomic signatures for the malignant potential for PGC. The prediction accuracy of the malignant potential for PGC by using the G-SVM based on the selected 5 features was 90.5%, and the AUC was 0.96 with a sensitivity of 0.90 and a specificity of 0.90.

CONCLUSION

The proposed approach demonstrated high accuracy in classification of the malignant potential for PGC. Our results suggested that the proposed approach based on radiomics using preoperative MR images could be feasible to predict the malignant potential for PGC.

CLINICAL RELEVANCE/APPLICATION

The proposed approach contributes to the higher accuracy and lower intra- and inter-observer variabilities for prediction of malignant potential in parotid gland cancer.

SSJ18-06 Brain Tumor Segmentation on Fluid-Attenuated Inversion Recovery MRI Using Transfer Learning on U-Net

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E451B

Participants
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Nikdokht Farid, MD, San Diego, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Lesion assessment of glioma hyperintense volumes on fluid-attenuated inversion recovery (FLAIR) MRI is important for surgery, treatment planning, and genomic analysis. Manual delineation of the hyperintense region is time-consuming and subject to inter- and intra-operator variability. The purpose of this study is to assess the feasibility of FLAIR hyperintense region segmentation using a fully automated convolutional neural network (CNN) technique.

METHOD AND MATERIALS

We retrospectively collected 151 patients (363 time points) with low and high-grade gliomas. Each of the patients had a 3D T2-weighted FLAIR sequence with TE/TR = 126/6000 ms, TI = 863, and FOV = 24 cm. Prior to analysis, raw data were corrected for bias field and distortion, image registration, and skull stripping. FLAIR hyperintense volumes were segmented semi-automatically (Amira software package, Visage Imaging) on the co-registered images by two trained image analysts and approved by a board-certified neuro-radiologist with expertise in neuro-oncology. We developed a 2D U-net algorithm for segmentation and serially trained the model with images containing large lesions, small lesions, and no lesions. Three hundred of the cases were used for training and sixty-three were used for validation. We evaluated our model using Dice coefficients between the manually segmented and CNN-derived FLAIR volumes on the validation set.

RESULTS

Our proposed model segmented the hyperintense regions with the average Dice coefficient of 0.85. In 79% of patients, the dice coefficient was more than 0.8. Prediction of FLAIR volume from our cascaded U-net model closely matched with expert annotation (ρ=0.91).

CONCLUSION

In this study, we demonstrate the utility of a fully-automated CNN technique for segmenting the hyperintense region on FLAIR. We increased the performance of our model with transfer learning from images with large hyperintense regions to the images with no lesion. Implementation of this CNN into the clinical workflow may help improve the ROI drawing performance and reduce the discrepancies among image analysts.

CLINICAL RELEVANCE/APPLICATION

We present a fully automated technique for tumor segmentation of the FLAIR MRI of the patients with gliomas. Our model will increase accuracy of clinical interpretations by standardizing and quantifying the determination of the FLAIR hyperintense volume as a crucial part of Response Assessment in Neuro-Oncology (RANO).

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSJ19

Neuroradiology (Movement Disorders: Moving Fast and Moving Slow)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E351

BQ MR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Kei Yamada, MD, Kyoto, Japan (*Moderator*) Nothing to Disclose
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Sub-Events

SSJ19-01 Prediction of Presynaptic Dopaminergic Function in Subjects with Parkinsonism: Quantitative Comparison Between Nigrosome-1 Susceptibility Map-Weighted Imaging and High-Spatial-Resolution Neuromelanin-Sensitive Imaging

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E351

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PURPOSE

Dopamine transporter imaging such as 18F-FP-CIT PET (CIT PET) is needed to assess presynaptic dopaminergic function, but its accessibility and cost are limited. We sought to compare nigrosome-1 susceptibility map-weighted imaging (SMWI) with 0.8-mm isovoxel NMI for predicting presynaptic dopaminergic function.

METHOD AND MATERIALS

We enrolled 79 subjects who underwent both MRI and CIT PET for parkinsonism. Oblique axial 0.5×0.5×1.0-mm3 SMWI and 0.8-mm isovoxel 3D T1-weighted NMI were obtained at 3T. SMWI was resliced in 0.5-mm increments. Below the red nucleus, 4 consecutive SMWI images (2-mm slab) and were only assessed. Three NMI images (2.4-mm slab) that encompassed the slab of the 4 SMWI images were also included for analysis. For SMWI, the pixels less than the mean background (decussation of the superior cerebellar peduncle) signal intensity (SImean) - 3SD (SMWI3SD) and those less than SImean - 7SD (SMWI7SD) were separately selected in a semi-automated manner. For NMI, the pixels greater than SImean + 3SD (NMI3SD) and those greater than SImean (NMImean) were selected in a similar way. The volume ratios of SMWI7SD to SMWI3SD and NMI3SD to NMImean were calculated. Each side of the basal ganglia was separately assessed on CIT PET and was served as the reference standard for per substantia nigra (SN) analysis. For per participant analysis, more affected side was chosen on each MRI.

RESULTS

Patients were diagnosed as Parkinson's disease (n=54; advanced stage [n=16]) and drug-induced parkinsonism (n=25) based on clinical and imaging findings (106 abnormal basal ganglia on CIT PET). For per SN analysis, NMI showed sensitivity of 86.8% and specificity of 88.5% (AUC=0.896[95% CI, 0.838-0.939]; criterion<=0.424); SMWI demonstrated sensitivity of 89.6% and specificity of 75.0% (AUC=0.846[95% CI, 0.780-0.898]; criterion>0.368), showing no significant difference (*P*=0.2593). For per participant analysis, NMI showed sensitivity of 96.3% and specificity of 92.0% (AUC=0.939[95% CI, 0.861-0.980]; criterion<=0.385); SMWI demonstrated sensitivity of 92.6% and specificity of 72.0% (AUC=0.881[95% CI, 0.789-0.43]; criterion>0.4), showing no significant difference (*P*=0.3404).

CONCLUSION

For predicting presynaptic dopaminergic function, SMWI and high-spatial-resolution NMI were comparable.

CLINICAL RELEVANCE/APPLICATION

Both SMWI and NMI can serve as a screening imaging tool for patients who need further evaluation by dopamine transporter imaging.

SSJ19-02 MR Fingerprinting: A Possible Source for Imaging Biomarkers in Parkinson's Disease

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E351

Participants
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PURPOSE

Parkinson's Disease (PD) is a neurodegenerative disease with increasing incidence but currently limited availability of an MRI-based diagnosis or monitoring by imaging biomarkers. MR fingerprinting (MRF) is a recently developed quantitative MR acquisition and post-processing technique, which may have the potential to both significantly shorten MR protocols and detect PD-specific alterations of T1 and T2 signal relaxation times.

METHOD AND MATERIALS

25 PD patients (18m/7f, mean age±SD 69.6±6.9 yrs) and 25 healthy controls (HC; 13m/12f, mean age±SD 67.5±4.3 yrs) participated after informed consent. A new FISP-based MRF sequence (TR 15ms, TE 3.5ms, two spiral interleaves / layer; starting with an adiabatic inversion pulse; scan time: 3.2 min.) was added to the 3T standard MRI protocol (scan time: 28 min). The MRF dictionary used the extended phase graphs algorithm to generate B1-corrected MRF-qT1 and qT2 maps. The registration and segmentation of substructures was performed with FSL. Independent T-tests were applied to compare regional T1 and T2 values between PD and HC. Each participant was evaluated by a neurologist including the minimal mental state test (MMST).

RESULTS

PD patients and HC did not differ significantly with regard to age, sex and MMST score (p=0.2, 0.08, 0.28 respectively).MRF-qT1 mapping, but not MRF-qT2, identified significant differences between PD patients and HC: Gray matter: (PD: 1408.6±42.7ms vs. HC: 1435.9±39.3ms, p=0.02); white matter: (PD: 1053.9±45.1ms vs. HC: 1010.8 ± 65.8ms, p = 0.01); left amygdala: (MP: 1517.9 ± 81.3 ms vs. HC: 1579.7±95.7ms, p=0.02); right amygdala: (PD: 1523.1±111.6ms vs. HC: 1601.7±87.8ms, p=0.01).

CONCLUSION

MR fingerprinting-based T1 mapping seems to be a promising tool to identify PD patients. The regions identified as abnormal, including white matter and the amygdalae, indicate that PD affects the brain globally rather than being limited to the basal ganglia.

CLINICAL RELEVANCE/APPLICATION

We are in need for reliable MR tools to diagnose and monitor PD by MRI. This study indicates that MR fingerprinting is a method worth following as a solution to achieve this goal. Future studies need to go deeper into machine learning applications of MRF for PD.

SSJ19-03 Clinical Application of Quantifying Consecutive Dopamine Neuronal Changes in the Substantia Nigra Pars Compacta During the Development of Early Parkinson's Disease Using Neuromelanin and Diffusion Tensor Imaging

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E351

Participants
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PURPOSE

Early Parkinson's disease (PD) develops from rapid eye movement sleep behavior disorder (RBD) which has been previously reported as a precursor of PD. Our aim was to assess the utility of consecutive dopamine neuronal changes in the substantia nigra pars compacta (SNpc) with MRI in evaluating the early stages of PD development.

METHOD AND MATERIALS

Eighteen patients (PD group) with early PD (Hoehn and Yahr scale: 1-2), 13 patients with RBD (RBD group) and 20 age-matched healthy controls (HC group) underwent neuromelanin imaging and diffusion tensor imaging (DTI) on a 3T magnetic resonance imager. The neuromelanin SNR (signal-to-noise rario) and the DTI value [mean diffusivity (MD) and fractional anisotropy (FA) values] of the SNpc were calculated using an automatic volumetric region of interest selection method. The significance of the intergroup differences using analysis of variance with Tukey's post hoc test was tested for each neuromelanin area with an SNR higher than that of the background and DTI value. The correlation between the neuromelanin area and the DTI value of all the groups was assessed. Logit (p) was used to estimate the probability of each RBD and early PD in relation to the neuromelanin area

and the DTI value, and the diagnostic performance of each value for RBD and early PD was assessed using receiver operating characteristic (ROC) analysis.

RESULTS

The neuromelanin area was significantly less and the MD value was significantly higher in both RBD and PD group than in HC group ($P < 0.05$), whereas, no significant intergroup difference was shown in the FA value. A moderate correlation between the neuromelanin area and the MD value was found ($|r|$: 0.47). The respective areas under the ROC curve for neuromelanin area/MD value were 0.76/0.79 for RBD and 0.80/0.80 for the early PD. The respective areas under the ROC curve for logit (p) in relation to neuromelanin area and MD value were 0.81 for RBD and 0.85 for the early PD. (See optional figure)

CONCLUSION

Quantifying consecutive dopamine neuronal changes in the SNpc using both neuromelanin and MD values may be a useful technique in the evaluation of the early stages of PD.

CLINICAL RELEVANCE/APPLICATION

Comprehensive MRI assessment for PD-related consecutive dopamine neuronal changes in the SNpc can provide a high diagnostic accuracy of the early stages of PD.

SSJ19-04 Differentiation of Atrophy Patterns and Diagnosis of Parkinsonian Syndromes Based on Combination of Manual and Automated Brain Measurements

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E351

Participants
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PURPOSE

To retrospectively assess the value of magnetic resonance (MR) imaging automated volumetric measurements of midbrain, pons, cerebellum, third ventricle, putamen and manual magnetic resonance (MR) imaging indexes to study the different atrophy patterns of Parkinsonian syndromes and differentiate progressive supranuclear palsy (PSP) from Parkinson's disease (PD) and multiple system atrophy (MSA).

METHOD AND MATERIALS

Brain volumetric ratios adjusted for intracranial volume (ICV) of pons, midbrain, cerebellum, third ventricle and putamen were automatically measured by segmentation tool Accubrain on 3D T1-weighted MR images in 56 consecutive patients with PSP (39 male, 17 female; mean age, 70.9 years), 69 with PD (36 male, 33 female; mean age, 63.9 years), 15 with MSA (9 male, 6 female; mean age, 58.2 years), and 50 healthy controls (30 male, 20 female; mean age, 66.1 years). MR parkinsonism index and midbrain-pons short axis ratio (M/P) were also manually calculated. Differences in MR imaging volumetric measurements among groups were evaluated with Kruskal-Wallis H test and differences between two groups were evaluated with Mann-Whitney U test. Receiver operating characteristic curve analysis was used to define cutoff values in PSP.

RESULTS

Pons volumetric ratio in MSA was smaller than that in PD (P=0.0007) and control (P=0.0006). Midbrain volumetric ratio in PSP was smaller than that in PD (P 0.52 and 34 patients (60.71%) whose MRPI 13.55. In our study, midbrain-pons short axis ratio (M/P) of 0.57 (specificity 86.57%, sensitivity 76.54%) and MRPI of 10.81 (specificity 82.84%, sensitivity 78.57%) were the more proper cutoff values for PSP.

CONCLUSION

Combination of manual and automated cerebral measurements can present different brain atrophy features in Parkinsonian syndromes and help distinguish PSP from other Parkinsonian degenerative disorders.

CLINICAL RELEVANCE/APPLICATION

Different brain atrophy features of Parkinsonian Syndromes may help clinically differentiate these degenerative disorders and the more accurate cutoff values for diagnosis of PSP was newly set in our study

SSJ19-05 Quantifying Consecutive Changes in Dopaminergic Nigrostriatal System During the Early Stages of Parkinson's Disease Development Using Diffusion Tensor Imaging

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E351

Participants
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Noriyuki Tomiyama, MD,PhD, Suita, Japan (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation

PURPOSE

The development of Parkinson's disease (PD) is characterized pathologically by dopaminergic neurodegeneration in the substantia nigra pars compacta (SNpc) and resulting in dopamine neuronal dysfunction in the striatum. Recently, rapid eye movement sleep behavior disorder (RBD) has been reported as a precursor of PD. Our aim was to access the clinical application of measuring water diffusivity in consecutive changes in dopaminergic nigrostriatal system during the early stages of PD development.

METHOD AND MATERIALS

Eighteen patients (PD group) with early PD (Hoehn and Yahr scale: 1-2), 13 patients with RBD (RBD group) and 20 age-matched healthy controls (HC group) underwent diffusion tensor imaging (DTI) and three-dimensional T1W imaging on a 3T magnetic resonance imager. All MR imaging data were transferred to a computer. For highly reproducible image analysis, an automatic volumetric region of interest selection method was developed with the voxel-based morphometric technique. By using this method, the DTI value [mean diffusivity (MD) and fractional anisotropy (FA) values] of each SNpc and putamen was calculated. The significance of the intergroup differences using analysis of variance with Tukey's post hoc test was tested for the DTI value of each SNpc and putamen.

RESULTS

In the SNpc, the MD value in both RBD and PD group was significantly higher than in HC group ($P < 0.05$), while no significant intergroup difference was shown in the FA value. In the putamen, the MD value in PD group was significantly higher than in both HC and RBD group and the FA value was significantly higher in RBD group than in HC group and significantly less in PD group than in RBD group ($P < 0.05$). (See optional figure)

CONCLUSION

The measurement of water diffusivity in dopamine neuron in the SNpc can significantly differentiate patients with both RBD and early PD from healthy subjects. Meanwhile, the measurement of water diffusivity in the putaminal dopamine neuron may be useful in not only differentiating patients with both RBD and early PD from healthy subjects but also, in evaluating the evolution of RBD to early PD.

CLINICAL RELEVANCE/APPLICATION

Quantifying consecutive changes in dopaminergic nigrostriatal system with DTI technique can be useful in monitoring the early stages of Parkinson's disease development.

SSJ19-06 Individual Classification of Parkinson Disease with Diffusion Magnetic Resonance Imaging

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E351

Participants
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PURPOSE

To investigate the feasibility and performance of the PD classification using diffusion MRI of different machine learning methods.

METHOD AND MATERIALS

A total of 285 PD patients and 135 healthy controls were included and underwent diffusion tensor imaging scans. DTI images were processed with the FSL toolbox to get the parameters such as fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD). Values of each brain areas in stereotaxic white matter atlas were extracted by the ICBM template as the raw features for subsequent machine learning based classifiers. All of the PD patients and healthy controls were separated to training data sets and testing data sets. Feature optimization was performed by the LASSO and principal component analysis. And both the filter- and wrapper-based feature selection models were used to get the final features used in the last classifier. The k-nearest neighbor algorithm (KNN), naïve Bayes algorithm and support vector machine (SVM) models were trained on the training data sets and the performance of these models were evaluated by the testing data sets.

RESULTS

Compared to healthy control subjects, PD patients showed significantly alteration of white matters in wide spread brain regions. The machine learning analyses showed that the SVM model performs best than KNN and naïve Bayes algorithm with an overall accuracy of 86.7%, sensitivity of 83.3% and specificity of 89.0% when discriminated PD patients from healthy controls.

CONCLUSION

The combination of DTI and machine learning methods is a promising method to discriminate PD patients from healthy controls. These findings may be useful for future incorporation of DTI and machine learning methods for disease classification, or as a useful tool for clinical diagnosis by diffusion MRI.

CLINICAL RELEVANCE/APPLICATION

DTI-based machine learning methods can help to better PD diagnosis.

SSJ20

Neuroradiology (Spine Imaging: Backbone of Neuroradiology)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E352

NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSJ20-01 Comparative Trends in Utilization of Cervical Spine Imaging: A Reflection of Shifting Trends in Outpatient Imaging to the ED?

Tuesday, Nov. 27 3:00PM - 3:10PM Room: E352

Participants
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PURPOSE

To study utilization trends in CT, MRI, and plain radiography (XR) of the cervical spine (CSP) among outpatients in the Medicare population.

METHOD AND MATERIALS

The nationwide Medicare Part B Physician/Supplier Procedure Summary databases for 2004 to 2016 were queried. Medicare's location codes were used to identify CSP imaging examinations done in EDs, outpatient offices, and hospital outpatient departments (HOPDs). These are the 3 locations where virtually all outpatients will undergo imaging. CPT-4 codes were selected for CT, MRI, and plain XR of the CSP. For each code, the database provides procedure volume; utilization rates per 100,000 beneficiaries were then calculated. Utilization trends were studied between 2006 and 2016. As this database represents a complete population, sample statistics are not required.

RESULTS

In EDs, the CSP CT rate per 100,000 enrollees increased from 217 in 2004 to 2031 in 2016 (+836%). The ED CSP XR rate decreased from 783 in 2004 to 261 in 2016 (-67%). ED CSP MRI utilization rate also increased, rising from 13 in 2004 to 47 in 2016 (+262%). In HOPDs the rate changes from 2004 to 2016 were as follows: CT 154 to 335 (+117%); MRI 555 to 791 (+43%); XR 1109 to 1142 (+3%). In private offices the rate changes were as follows: CT 64 to 96 (+50%); MRI 616 to 700 (+14%); XR 1497 to 1495 (no change). In all 3 outpatient locations together, the CSP rate changes were: CT 435 in 2004 to 2462 in 2016 (+466%); MRI 1184 in 2004 to 1538 in 2016(+30%); XR 3389 in 2004 to 2898 in 2016 (-14%). In 2004, CT and MRI comprised 21% and 1.3% of CSP imaging in the ED, which increased to 71% and 1.6% respectively in 2016.

CONCLUSION

The utilization rate of outpatient CSP CT imaging is increasing rapidly, especially in EDs. The utilization rate of CSP MRI has more than doubled but is well below that of CT. CSP XR utilization is declining. By 2016, the CT rate was almost as high as the XR rate.

CLINICAL RELEVANCE/APPLICATION

Among Medicare population outpatients who undergo imaging of the CSP, the utilization rate of cross sectional imaging is increasing rapidly, especially in EDs, while the utilization rate of XR is declining. The proportion of the increase in ED utilization may represent a shift of outpatient imaging to the ED.

SSJ20-02 Evaluation of Dual-Energy Metal Artifact Reduction Methods for Patients with Instrumented Spines

Tuesday, Nov. 27 3:10PM - 3:20PM Room: E352

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PURPOSE

Spine hardware causes artifacts in CT imaging due to beam hardening, photon starvation, scatter, noise, and non-linear partial volume effect. This study aims to evaluate three dual-energy CT (DECT) metal artifact reduction methods in patients with instrumented spines.

METHOD AND MATERIALS

20 patients with instrumented spines who underwent DECT were retrospectively identified. All scans were performed on a dual-source 128-slice scanner (SOMATOM Flash, Siemens Healthcare) using 100/140Sn kV pair with CARE Dose4D. In addition to the original DE linearly mixed images, images were reconstructed using iterative metal artifact reconstruction algorithm (DE iMAR), virtual monochromatic imaging (DE Mono+) at 130 keV, and a combination of the two methods (DE iMAR Mono+). Slice thickness and reconstruction kernel were kept the same. The four image series were anonymized and randomized for a reader study. Four experienced neuroradiologists rated them in terms of artifact scores for four relevant anatomical regions and an overall image quality score for both bone and soft tissue display window settings. In addition, a quantitative analysis was performed to assess the performance of the three metal artifact reduction methods by counting artifact-contaminated pixels that were recovered by the metal artifact reduction methods.

RESULTS

There were statistically significant differences in the artifact scores and overall image quality scores among the four image sets (both $p < 0.001$). DE iMAR Mono+ showed the best artifact scores and quality scores (all $p < 0.001$). Intraclass correlation coefficient among the readers was 0.779 and 0.892 for the overall quality score using the bone display window and soft tissue window, respectively (both $p < 0.001$). In addition, DE iMAR Mono+ reduced the artifacts by the greatest amount in the quantitative analysis.

CONCLUSION

DE iMAR Mono+ method demonstrated the best performance for spine metal artifact reduction using DECT data. These results may be specific to this CT vendor and spine implant types.

CLINICAL RELEVANCE/APPLICATION

A dual-energy CT metal artifact method was identified to best reduce metal artifacts for patients with spinal hardware, which would benefit spine and other CT exams affected by spine metal artifacts.

SSJ20-03 Osteoporosis Identification and Treatment Among Previously Undiagnosed Patients with Vertebral Fractures

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E352

Participants
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PURPOSE

Unexplained fractures are an accepted indication for osteoporosis screening. Our aim was to determine how often patients without prior histories of osteoporosis undergo bone densitometry (DEXA scans), receive their initial diagnoses, or start osteoporosis medication after imaging studies demonstrated vertebral fracture.

METHOD AND MATERIALS

We used data from a pragmatic cluster randomized trial, consisting of adult patients from four integrated health care systems who received lumbar spine plain films, CT or MRI ordered by primary care providers from 10/2013 through 9/2016. We identified men $\geq$ 50 and women $\geq$ 52 years old with at least one vertebral fracture on their index imaging exams. We excluded patients with histories within the previous 12 months of severe trauma, diagnosis codes for osteoporosis/osteoporotic fractures or cancer, and/or bone densitometry procedure codes. Prior prescriptions for osteoporosis medications will be added as an exclusion factor, as well as an

outcome, before presentation. We report the proportion of patients with subsequent osteoporosis diagnoses, defined as having at least one of the following within 12 months: CPT code for DEXA; ICD diagnosis code for osteoporosis; or prescription for an osteoporosis medication. (Patients with any of these on day 0 were considered to be newly diagnosed, and therefore were classified as outcomes, rather than excluded.)

RESULTS

Of the 23,199 patients who had fractures on index imaging (10% of the entire cohort), 56% (n=12,935) met inclusion criteria. After 12 months, 16% (n=2130) had bone densitometry scans and 23% (n=2999) received osteoporosis diagnoses; 29% (n=3772) had at least 1 of these outcomes, and 10% (n=1357) had both.

CONCLUSION

Only 29% of primary care patients who underwent lumbar spine imaging and had vertebral fractures received *de novo* osteoporosis diagnoses and/or bone densitometry scans within the next year. A large proportion of patients who have potentially identifiable osteoporosis remain undiagnosed.

CLINICAL RELEVANCE/APPLICATION

A large proportion of patients who present with vertebral fractures and are at risk for osteoporosis remain undiagnosed.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jeffrey G. Jarvik, MD - 2017 Honored EducatorJeffrey G. Jarvik, MD - 2018 Honored Educator

SSJ20-04 MR-Based Radiomic Analysis of Radiofrequency Lesion Predicts Outcomes After Percutaneous Cordotomy: A Feasibility Study

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E352

Participants
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PURPOSE

The aim of the present study is to evaluate the utility of MR-based radiomic analysis to quantify microstructural changes created by the cordotomy lesion and predict outcome in patients undergoing percutaneous cordotomy for medically refractory cancer pain.

METHOD AND MATERIALS

This is a retrospective interpretation of prospectively acquired data in 10 patients (5 males, age range 43-76 years) who underwent percutaneous CT-guided high cervical cordotomy for medically refractory cancer pain between 2015-2016. All patients underwent MR imaging of the cordotomy lesion on postoperative day 1. Aftersegmentation of T2-weighted images, 310 radiomic features were extracted. Pain outcomes were recorded on postoperative day 1 and day 7 using the visual analog scale. R software was used to build statistical models based on MRI radiomic features for prediction of pain outcomes.

RESULTS

Six of 10 patients (60%) showed decreased pain on postoperative day 1, and all patients had decreased pain on postoperative day 7. Twenty relevant radiomic features were identified using the mRMR method. Radiomics predicted postoperative day 1 pain scores with an accuracy of 90% (p-value= 0.046), 100% sensitivity, 75% specificity, 85.7% positive predictive value and 100% negative predictive value. The radiomics model also predicted if the postoperative day 1 pain score was sustained on postoperative day 7 with an accuracy of 100% (p-value= 0.02825), 100% sensitivity, 100% specificity, and 100% positive and negative predictive value.

CONCLUSION

MR-based radiomic analysis of the cordotomy lesion was predictive of pain outcomes at 1 week after percutaneous cordotomy for intractable cancer pain.

CLINICAL RELEVANCE/APPLICATION

MR-based radiomic analysis can non-invasively characterize microstructural changes created by the cordotomy lesion.

SSJ20-05 How Can Inter-Observer Reliability of Cervical Central Spinal Stenosis Evaluation and Cord Compression Be Improved?

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E352

Participants
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William T. Yuh, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the potential value of quantitative analysis of the bony canal size and CSF space to improve the quality and consistency of the standard qualitative visual assessments of cervical spinal stenosis (CSS).

METHOD AND MATERIALS

IRB-approved retrospective review of 39 levels of CSS from 20 patients were qualitatively assessed independently by 3 radiologists to rate the degree (mild, moderate, or severe) of CSS. The degree of CSS was then separately assessed quantitatively using calipers and categorized by the reduction of the bony canal level relative to the assumed normal diameter (10 mm): 7-10 mm (<30%), 4-6 mm (31-60%) and <4 mm (>61%), respectively. Similarly, quantitative analysis of the CSF space was assessed at the levels of CSS with different parameters of the thecal sac, including AP diameter, Left-right (LR) diameter and CSF area. Inter-reader agreement among the 3 readers was evaluated using Light's kappa and the intraclass correlation coefficient (ICC). The non-parametric bootstrap was used to calculate confidence intervals (CIs) and compare kappa/ICC values.

RESULTS

Inter-reader agreement of the qualitative assessment of the degree of CSS was fair with unweighted kappa 0.39 (95% CI: 0.23-0.57). Inter-reader agreement for the quantitative analysis of bony canal narrowing was significantly higher than that for qualitative degree of CSS (p=0.005), with unweighted kappa 0.69 (95% CI: 0.46, 0.86). For the quantitative analysis of the CSF space, there was also good inter-reader agreement on CSF AP diameter (ICC 0.80, 95% CI: 0.65-0.86) and CSF axial areas (ICC 0.75, 95% CI: 0.50-0.90), though agreement was lower for CSF LR diameter (ICC 0.50, 95% CI: 0.25-0.64).

CONCLUSION

Consistency of qualitative visual analysis of CSS can be improved with quantitative measurements of the bony canal diameter, although this 'one size fits all' approach to CSS evaluation does not account for individual size variation of the spinal canal and cord. Quantification of the CSF space has great potential since it can be performed consistently by different readers, accounts for thecal sac deformity and size variations of the bony canal and cord, and provides direct visualization of cord compression.

CLINICAL RELEVANCE/APPLICATION

Qualitative evaluation of cervical spine stenosis suffers from inconsistent interpretation and individual anatomic variation which can be improved by quantitative analysis of bony canal and CSF space.

SSJ20-06 Over-Reliance on Fluoroscopy Guided Lumbar Punctures Can Negatively Impact Neuroradiology Training in Radiology Residency: An Analysis and Potential Solution through Establishing Departmental Guidelines for Referring Clinicians

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E352

Awards
Student Travel Stipend Award

Participants
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Leo J. Wolansky, MD, Farmington, CT (*Abstract Co-Author*) Institutional Grant, Guerbet SA
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PURPOSE

Requests for fluoroscopy guided lumbar punctures have increased over the past decades. They are primarily performed by radiology trainees in many academic institutions. We evaluated the impact of the number of fluoroscopy guided lumbar punctures performed on the number of cross-sectional neuroimaging studies residents dictated during their neuroradiology rotation. We also evaluated the effect that introducing department guidelines for lumbar punctures had on the number of lumbar puncture referrals we received in our neuroradiology division.

METHOD AND MATERIALS

We retrospectively reviewed the fluoroscopy guided lumbar punctures and myelograms performed and neuroimaging studies dictated by radiology residents on our neuroradiology service from July 2008 - December 2017. We used Poisson regression analysis to directly examine the relationship between the number of fluoroscopy guided lumbar punctures performed and neuroimaging studies (CT and MRI) dictated per day by residents. We developed and instituted guidelines for ordering fluoroscopy guided lumbar punctures and evaluated its effect on the number of these procedures performed before and after institution of the guidelines.

RESULTS

Radiology residents (n=84) performed a total of 3436 fluoroscopy guided lumbar punctures and myelograms and interpreted 33,402 cross-sectional studies. For each fluoroscopy guided lumbar puncture or myelogram performed, there was an estimated factor reduction in the total number of neuroimaging studies dictated of 0.77 for both first year residents and all residents (p<0.001). After institution of the guidelines, there was a statistically significant decrease in the number of fluoroscopy guided lumbar punctures performed (p<0.001).

CONCLUSION

We demonstrated that performing fluoroscopy guided lumbar punctures has an inverse relationship with the number of neuroimaging studies radiology residents dictate on the neuroradiology rotation. We instituted department guidelines which significantly decreased the number of fluoroscopy guided lumbar punctures performed.

CLINICAL RELEVANCE/APPLICATION

Performing fluorscopy guided lumbar punctures significantly decreases the number of cross-sectional neuroimaging studies read by radiology residents, which could potentially delay the development of their diagnostic neuroradiology skills.

SSJ21

Physics (Diagnostic X-Ray)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: N229

CH 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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Wei Zhao, PhD, Stony Brook, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSJ21-01 METIS: Next-Generation Performance Informatics Platform for Value-Based Clinical Imaging Practice

Tuesday, Nov. 27 3:00PM - 3:10PM Room: N229

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PURPOSE

To develop a new performance informatics platform, called 'METrology for Imaging Systems (METIS)', that enables both radiation safety and image quality monitoring for prospective and retrospective assessments of dose and quality

METHOD AND MATERIALS

METIS has been developed with multi-year input and pilot trials at a large academic medical center. This data-centric platform integrates a multi-infrastructure workflow for collecting patient data and clinical images from the PACS, imaging workstations (CT, Mammography, Radiography, and Fluoroscopy), and electric health record system (Epic). Dose and image quality metrics are implemented from previously validate algorithms in a modality context-specific fashion. Device-, protocol-, and size-specific reference levels are established with supervised machine learning technologies. High-dimensional data analysis is performed to provide multi-dimensional visualizations to aid users in evaluating clinical performance and highlighting inconsistencies. All metrics and image data are managed in a MySQL-MongoDB hybrid database.

RESULTS

METIS was deployed in clinical operation since 2016. Dose data from 460,000 CT, 350,000 Mammography, 300,000 Radiography, and 10,000 Fluoroscopy exams are recorded. Over 500 dose reference lines are created for CT outlier identification. Over 60,000 chest radiographs are automatically evaluated to simulate radiologists' perceptual evaluation process. 1000 adult and 1000 pediatric CT scans are sampled from contrast and non-contrast enhanced CT chest/abdomen/pelvis exams to build the dose-quality metrics by using measured image noise, spatial resolution, contrast, and dose. A web-based dashboard with high-dimensional data visualization is developed to provide a holistic performance view, consolidating large-scale diverse clinical and operational data into a single graphics.

CONCLUSION

METIS offers the first strategy for combined dose and image quality monitoring. Adding quality-dose metrics and advanced prospective and retrospective data analysis, it provides opportunities for assessing and addressing the aggregate aspects of clinical imaging practice to ensure rigorous patient safety and consistent imaging quality.

CLINICAL RELEVANCE/APPLICATION

METIS fulfills an unmet need for a prospective and retrospective dose monitoring, along with image quality and device performance assessment, to ensure rigorous patient safety and consistent image quality.

SSJ21-02 Signal and Noise Performance of the Apodized-Aperture Pixel (AAP) X-Ray Detector Design to Increase Detective Quantum Efficiency (DQE)

Tuesday, Nov. 27 3:10PM - 3:20PM Room: N229

Participants
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PURPOSE

Recent studies from screening programs have shown significantly higher detection rates attributed to higher detector performance. X-ray detector performance, in terms of signal-to-noise ratio (SNR) for a given amount of radiation, is quantified by the detective quantum efficiency (DQE). Current clinical detectors have low DQE (<30%) at high-frequencies which are important for visualization of small image features. We have developed a novel x-ray detector design, called Apodized-Aperture Pixel (AAP), that could achieve high DQE at high-frequencies. The purpose of this research is to determine AAP performance in the presence of correlated or uncorrelated noise due to x-ray interactions or converter blur.

METHOD AND MATERIALS

Conventional x-ray detectors have the same element and pixel size. AAP design separates physical elements from image pixels by using micro-elements (0.01-0.025mm) to produce current clinical pixel sizes (0.07-0.2mm). Conventional and AAP designs were modeled with cascaded system analysis including x-ray interactions, converter blur, collection efficiency and readout noise. DQE was measured to evaluate proof-of-concept experiments with radiography and mammography detectors. Simulations of sinusoidal patterns and demonstration x-ray images were acquired for visual comparison.

RESULTS

Excellent agreement was found between theoretical and experimental results. AAP design provides 1.5x greater MTF at high frequencies than conventional design. For cases when detector DQE is dominated by converter blur (ie. pixel size is smaller than converter blur), x-ray reabsorption or element size, high-frequency DQE of the AAP design was 1.5x greater, 1.8x greater and 2.5x greater respectively compared to conventional design.

CONCLUSION

Compared to conventional design at high-frequencies, the AAP design has greater MTF from use of a micro-elements and greater DQE due to reduced noise aliasing. MTF and DQE improvement is greatest when x-ray reabsorption and converter blur effects are minimal. Simulations and x-ray images with the AAP design (Fig. 1) show increased contrast and reduced aliasing artifacts. The AAP design can achieve a flat-DQE that approaches an 'ideal detector' which was not previously possible.

CLINICAL RELEVANCE/APPLICATION

The Apodized-Aperture Pixel (AAP) x-ray detector design can increase high frequency MTF by 1.5x and DQE by 2.5x with the implication that this may help increase cancer detection rates.

SSJ21-03 Validation and Performance Evaluation of a Remote and Automated QC Program for Digital Radiography

Tuesday, Nov. 27 3:20PM - 3:30PM Room: N229

Participants
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PURPOSE

This study evaluates the performance viability of the Remote QC program as well as comparing the performance of ATIA with other established image quality assessment tools.

CONCLUSION

The easy-to-use ATIA provides results that are in agreement with those obtained by established methods. The results show the great applicability of the Remote QC program in monitoring trends. The results also show that however, caution needs to be used as not to damage the QC phantom and avoid using different image filtering, the consistent results will be still reproducible upon using the same phantom and acquisition protocol.

CLINICAL RELEVANCE/APPLICATION

Insufficient qualified medical physics support in some parts of the world may lead to an ineffective quality control program for digital radiography systems. To mitigate this situation a remote QC program package (ATIA) including a simple, yet data-rich phantom and software tool was developed in order to quantitative image assessment which remotely informs the medical physicists of issues in trend analysis.

SSJ21-04 Assessment of Scatter Emitting From the Exit Window of Interventional X-Ray Tubes

Tuesday, Nov. 27 3:30PM - 3:40PM Room: N229

Awards
Student Travel Stipend Award

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PURPOSE

Radiation safety practices have been based on the tenet that the primary source of occupational radiation dose to interventional radiologists is from the patient. The purpose of this work was to quantify the contribution of scatter emitting from the exit window of the x-ray tube to occupational radiation dose.

METHOD AND MATERIALS

Air kerma (KA) to the average location of the upper body of an interventional physician (height = 150cm) was measured with and without a 25 cm thick anthropomorphic phantom positioned in the x-ray beam. The experimental technique allowed isolation of radiation dose emitting from the phantom versus directly from the X-ray tube. KA measurements were normalized by dose area product. Experimental geometry was consistent with that of PA imaging during thoracic and abdominal interventional procedures. No accessory radio-protective shields were used. Scatter from x-ray tubes by three manufacturers was assessed and systems were configured to produce similar quality beams (81 kVp, filtration: 0.2 mm Cu or 0.1 mm Cu + 1 mm Al). Further, scatter from a selected X-ray tube was reassessed following the addition of 0.5 mm Pb to the inside surface of the collimator assembly housing.

RESULTS

The magnitude of scatter originating from within the phantom was equivalent for all systems. Considering all x-ray tubes and variable distance from the central ray, scatter emitting from the beam exit window of the tubes accounted for 20% to 55% of the total scatter. There was a minimum of 20% tube scatter at all distances with respect to the central axis of the X-ray beam, with some tubes exhibiting increased tube contribution as the measurement point was moved toward the central axis. The X-ray tube scatter originated from interaction of the x-ray beam with x-ray collimator assembly components, including the DAP meter. The addition of 0.5 mm Pb to the collimator assembly housing provided an approximately 50% reduction of tube scatter to the location of an interventional physician.

CONCLUSION

X-ray scatter originating from within the x-ray collimator assembly was found to contribute substantially to the radiation dose measured at a typical location of the upper body of an interventional physician.

CLINICAL RELEVANCE/APPLICATION

The primary source of occupational radiation dose was thought to be from the patient. However, our study shows that X-ray tube scatter is in fact a significant contributor to occupational dose.

SSJ21-05 Comparison of Stationary Digital Chest Tomosynthesis to Portable Chest Radiographs: A Patient Study

Tuesday, Nov. 27 3:40PM - 3:50PM Room: N229

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PURPOSE

ICU patients are often too unstable to move for CT imaging. In these cases, portable chest radiographs (CXR) are used to assess pathology. Tomosynthesis can provide additional diagnostic information, but is not readily available at the bedside. The primary goal of our study was to compare the stationary digital chest tomosynthesis (s-DCT) system to portable CXR in the evaluation of patients with various lung pathologies.

METHOD AND MATERIALS

Patients undergoing clinically indicated chest CT were recruited to have a portable CXR and s-DCT scan, with our carbon nanotube (CNT) x-ray source array. Three thoracic radiologists evaluated the images. Readers scored the imaging on a scale of 1-5 based on 10 criteria; visualization of lung fields, vasculature, trachea, proximal bronchi, retrocardiac lung, diaphragm, costophrenic angles,

ribs, spine, and hardware. Readers were asked to rate their confidence in interpreting the scans on a scale of 1-7. Furthermore, readers evaluated whether s-DCT gave them more information than CXR. A t-test for independent means was used to analyze the data.

RESULTS

A total of twenty-two patients were successfully imaged. The average age was 64.7 +/- 8.5 years. All readers gave s-DCT statistically higher scores when evaluating vasculature, proximal bronchi, and the spine (p: <0.00026). Readers 1 and 2 rated the ribs higher on s-DCT (p: <0.00001). Reader 2 gave statistically higher scores to s-DCT for the trachea, retrocardiac lung, and costophrenic angles (p: <0.0033). Reader 3 gave CXR higher scores for visualization of the diaphragm (p: 0.018). Confidence scores were not statistically different between techniques for readers 1 and 3. Reader 2 gave higher confidence scores to s-DCT (p: <0.00001). Readers 1 and 3 stated that s-DCT gave them information that CXR did not 36% and 41% of the time. While reader 2 indicated that s-DCT gave additional information 95% of the time.

CONCLUSION

Portable stationary-DCT in the ICU setting should be possible with our CNT s-DCT system. Tomosynthesis imaging improves visualization of thoracic structures compared to portable CXR. Reader confidence in s-DCT can be comparable or higher to CXR, and in a significant number of cases s-DCT gives information that is not provided by CXR.

CLINICAL RELEVANCE/APPLICATION

Stationary digital chest tomosynthesis is a potentially superior alternative to portable chest x-ray for patients in the ICU setting that cannot undergo CT examination.

SSJ21-06 Virtual Dual-Energy (VDE) Imaging: Separation of Bones from Soft Tissue in Chest Radiographs (CXRs) by Means of Deep Residual Learning (DRL)

Tuesday, Nov. 27 3:50PM - 4:00PM Room: N229

Participants
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PURPOSE

Lung nodules that overlap ribs and/or clavicles in CXRs can be difficult to be detected by radiologists, as well as by computer-aided detection (CAD) systems. Our purpose was to develop a new VDE imaging technique to separate ribs and clavicles from lung nodules and soft-tissue in CXRs by means of our newly developed DRL.

METHOD AND MATERIALS

We developed a novel DRL model employing our neural network convolution (NNC) framework in a residual convolutional manner to convert a standard CXR to an image that looks like a dual-energy (DE) bone image; thus, term VDE imaging. Our model consisted of 2 convolutional layers and 9 residual blocks, resulting in a deep 20-layer network. Each residual block contained two convolutional layers with batch normalization, and a shortcut connection, passing information from finer to coarser image features. Our DRL model was trained in an image-based fashion to learn the relationship between input CXRs and the corresponding "teaching" DE bone images. We used a large database of 118 CXRs with nodules with corresponding "gold-standard" DE images acquired with a DE imaging system (FCR 9501 ES, Fuji Medical Systems, CT). We trained and evaluated our model with a nested 2-fold cross validation protocol. Once trained, our technology no longer required DE images, and it provided VDE bone images where soft tissue was substantially attenuated, while bony structures were preserved. This image was then subtracted from the corresponding CXR to provide a VDE soft-tissue image from which bones were removed. We performed quantitative evaluation of our results by using the structural similarity (SSIM) image-quality index.

RESULTS

Our VDE technology was able to separate ribs and clavicles from lung nodules and soft-tissue structures very accurately in 118 CXRs and provided bone and soft-tissue images. Comparing to a state-of-the-art bone-suppression technique, our new VDE soft-tissue images had higher (t-test; P<.01) similarity (SSIM from 0.90 to 0.93) to the "gold-standard" DE soft-tissue images.

CONCLUSION

Our new DRL model converted CXRs to VDE soft-tissue images, where bones were separated from soft-tissue accurately, which offered the improved conspicuity of lung nodules and vessels.

CLINICAL RELEVANCE/APPLICATION

VDE technology requiring only a "single" CXR without requiring specialized equipment or additional radiation dose would be beneficial to radiologists as well as CAD in detection of lung nodules in CXRs.

SSJ22

Physics (Image Reconstruction)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: N227B

AI CT MR NM 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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Sub-Events

SSJ22-01 Modified Model Based Iterative Reconstruction Method to Improve CT Number Accuracy in Low-Dose CT

Tuesday, Nov. 27 3:00PM - 3:10PM Room: N227B

Participants
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PURPOSE

Recent theoretical and experimental studies about CT number accuracy in low dose CT have shown that filtered backprojection (FBP) and conventional model based iterative reconstruction (MBIR) methods are biased by an amount that is dose and contrast dependent. This work validates that the data weighting scheme in the MBIR framework is the culprit for both these biases and that a more optimal weighting scheme has been found to eliminate bias across all dose and contrast levels.

METHOD AND MATERIALS

Raw CT data was acquired for two phantoms on a benchtop CT system using a photon counting detector (XC-HYDRA FX50, XCounter AB, Sweden). The Catphan phantom (Catphan 600, Phantom Laboratory, Salem, New York) was scanned at several dose levels in the range 69-367 mAs, with 50 repeated scans for each dose level. A customized head phantom was also scanned in the range 40-400 mAs, with 30 repeated scans for each dose level. Reference images for each phantom were obtained by averaging the pre-log projections for the highest dose level across all repetitions, and then performing FBP reconstruction. These references served as the experimental ground truth. For each dose level and reconstruction method (FBP, MBIR, proposed MBIR), bias images were calculated by subtracting the reference image from the mean of the reconstructions of each repeated scan. Bias was measured in 4 small inserts of varying contrast in the Catphan phantom. Bias images of the Catphan and head phantoms were also assessed across the image field of view (FOV).

RESULTS

There are three main results: 1) The theoretical relationship bias=±a/mAs*(1+ßΔHU) was validated experimentally for both FBP (positive polarity) and conventional MBIR (negative polarity). 2) The proposed MBIR method, which uses a modified weighting scheme, eliminates bias for each contrast and dose level in the Catphan phantom. 3) The proposed MBIR method demonstrates promising preliminary results for reducing bias across the FOV in a more complex anthropomorphic head phantom.

CONCLUSION

The proposed MBIR method maintains CT number accuracy of varying contrast across dose levels by using a theoretically based modified data weighting scheme.

CLINICAL RELEVANCE/APPLICATION

Certain tasks, e.g. detection of acute cerebral venous sinus thrombosis (CVST), rely on CT number estimation. It is critical the CT reconstruction method maintains accurate HU values.

SSJ22-02 Joint Reconstruction of Low-Count PET and Undersampled MR in PET/MR Using Deep Learning

Tuesday, Nov. 27 3:10PM - 3:20PM Room: N227B

Participants

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PURPOSE

Acquiring low-count PET and undersampled MR can shorten PET/MR scan time, which, however, may also lead to noisy PET images and MR images with artifacts. The goal of this report is to evaluate whether deep learning method can reconstruct high-quality PET/MR images from its low-quality counterpart, potentially enabling shorter scan time in PET/MR. We also compared the proposed model with single modality models to investigate whether the resulting image quality can benefit from sharing features of the two modalities in the network.

METHOD AND MATERIALS

We developed a fully convolutional encoder-decoder network to predict high quality PET and MR images from low-count PET and undersampled MR. Concatenate skip connections and strategy of residual learning is adopted to restore high resolution details. Brain PET/MR data are acquired with a simultaneous PET/MR system (uPMR790, United Imaging Healthcare) from 50 patients who received 0.12 mCi/kg FDG. To generate low-count PET, the PET list-mode data was randomly undersampled for 10% events. Both standard-count and low-count PET images were reconstructed with OSEM (4 iterations, 20 subsets). Undersampled T1 weight MR is generated using radial sampling in k-space with sampling rate equal to 10%. Standard-count PET and fully sampled MR were taken as ground-truth in network training.

RESULTS

Models were trained on 40 patients and evaluated on the other 10 patients. The proposed joint model gains 4.5/7.9dB in peak signal-to-noise ratio (PSNR) and 0.036/0.42 in structural similarity index (SSIM) compared with low-count PET/undersampled MR. When compared with the single modality model of PET/MR, results shows that our joint model has an improvement of 0.97/0.15dB in PSNR and 0.006/0.0012 in SSIM.

CONCLUSION

Using a deep learning algorithm, we can estimate high-quality PET and MR images from low-count PET and undersampled MR images. Results also showed that joint reconstruction of PET and MR by sharing features in network can improve image quality of two modalities compared with single modality model.

CLINICAL RELEVANCE/APPLICATION

This method was demonstrated promising in greatly reducing the scan time in PET/MR imaging by up to 90%.

SSJ22-03 Implementation of a CT Reference Library Containing Manufacturer-Neutral Projection Data, Images, and Clinical Metadata

Tuesday, Nov. 27 3:20PM - 3:30PM Room: N227B

Participants
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PURPOSE

A manufacturer-neutral CT projection data (PD) format (DICOM-CT-PD) has been previously developed and used to allow access to CT PD and the scanner information required for image reconstruction. Access to such data was not previously possible, limiting the ability of reconstruction scientists to work with patient data. In this work, we aim to construct a reference DICOM-CT-PD library containing patient PD with corresponding images and clinically relevant metadata, and to publish this library for public access.

METHOD AND MATERIALS

CT images and PD were acquired from three different manufacturers for three clinical scanners at routine dose levels for head, chest and abdomen exams. The PD were converted to the DICOM-CT-PD format and a lower dose exam was simulated for each PD set using a validated noise-insertion method. Radiologists reviewed each case and marked lesion locations and diagnosis. Reference truth was obtained from the patient medical record, either from histology or subsequent imaging. Metadata such as lesion location, diagnosis, and source of truth were acquired for each case and formatted into a reference report. Each case was anonymized to remove protected health information for transfer to an NCI-hosted public data archive, The Cancer Imaging Archive (TCIA).

RESULTS

450 total cases from Siemens (n=150), GE (n=150), and Philips (n=150) scanners were obtained, including both negative and positive patient cases. PD are available for two dose levels, routine full dose and simulated low dose (25% of routine dose for head and abdomen cases and 10% of routine dose for chest cases). Routine dose image series are available for all of the cases, and reduced dose images are additionally available for exams acquired on a Siemens scanner. Clinical metadata are organized in an easy to use spreadsheet. The assembled projection, image and clinical data provide a rich data library with which CT image reconstruction scientists can validate their algorithms.

CONCLUSION

A large patient library containing manufacturer-neutral PD, the corresponding full dose images, and clinical reference information has been developed and is being made available through the TCIA.

CLINICAL RELEVANCE/APPLICATION

The successful implementation of this library will provide open source CT PD with correlated images and clinical information to investigators for reconstruction research and development.

SSJ22-04 Motion Compensation in Liver SPECT using Simultaneous X-Ray and Nuclear Imaging

Tuesday, Nov. 27 3:30PM - 3:40PM Room: N227B

Participants
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PURPOSE

Quantitative accuracy of liver SPECT/CT is crucial for e.g. dosimetry in radioembolization, but due to respiratory motion limited in precision. Motion can be compensated for in the reconstruction, but in clinical practice this requires an external device for the tracking of the motion signal and a prior motion vector field estimate to link the motion signal to organ movements, complicating the acquisition. A device under development, which simultaneously measures x-ray and nuclear projections, could be used to retrieve both measures intrinsically. Such a data-driven approach eliminates the need for external devices and provides a real-time vector field. The purpose of this work is to evaluate the performance of the proposed motion compensation technique using simulations.

METHOD AND MATERIALS

Nuclear and x-ray projections of a realistic digital phantom with respiratory motion were generated using Monte Carlo simulations for several breathing patterns. X-ray projections were sampled at 1 to 5 Hz; nuclear projections were acquired continuously. Total x-ray imaging dose was varied from 1 to 1000 µGy. The motion signal was extracted from x-ray projections by calculation of the center of mass and then used to bin the projections into gates. The x-ray gates were individually reconstructed and registered onto each other, resulting in the vector field to be included in the nuclear reconstruction.

RESULTS

The respiratory motion signal was accurately extracted from the x-ray projections, provided the x-ray sampling rate was greater than 2 Hz and the motion was stable in amplitude. The total minimally required dose for x-ray sampling was 10 µGy for a 5 minute scan. The inclusion of motion correction into the SPECT reconstruction improved contrast-to-noise ratio, in comparison with no motion correction, from 11.9 ± 0.5 to 19.1 ± 0.7.

CONCLUSION

The proposed motion compensation technique has the potential to improve quantitative SPECT reconstructions. Additionally, the need for external devices and a prior vector field estimate are eliminated. Only a limited amount of dose is required to obtain significantly improved results, paving the way for clinical use.

CLINICAL RELEVANCE/APPLICATION

Liver radioembolization requires quantitative SPECT to study the activity distribution. In order to improve accuracy and personalize dosimetry, motion should be accounted for in reconstructions.

SSJ22-05 Motion Compensated Reconstruction of the Aortic Valve for Non-Gated Helical CT Scans

Tuesday, Nov. 27 3:40PM - 3:50PM Room: N227B

Participants
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PURPOSE

Precise CT imaging is prerequisite for reliable planning of transcatheter aortic valve implantation (TAVI). Especially in non-gated CT scans, cardiac motion leads to severe artifacts in the reconstructed CT images. Blurring of the valve and the neighboring vascular anatomy potentially result in incorrect device sizing. A second pass motion correction method for non-gated helical CT scans with a pitch <1 is introduced here.

METHOD AND MATERIALS

The new post-processing method was applied to five non-gated clinical datasets acquired with a 256-slice CT scanner (Brilliance iCT, Philips Healthcare). Redundancy in the helical projection data was used to generate three image volumes at identical spatial positions, but different time points. During each reconstruction a subset of detector rows was selected which may be either overlapping or fully separated depending on the pitch size. The 3D edge-filtering scheme included Gaussian smoothing for noise reduction, gradient calculation for edge enhancement, non-maximum-suppression and hysteresis thresholding for reduction of incoherent edges. The sparse filter results were taken as input for an elastic registration to estimate the displacement of each

voxel between the given time points. Reconstructed datasets were evaluated with a TAVI planning software (IntelliSpace Portal, Philips Healthcare) by two blinded readers.

RESULTS

The method achieved significant motion artifact reduction in CT aortic valve reconstructions. A removal of doubled structures at the aortic boundaries could be observed, as well as reduced blurring compared to the uncompensated reconstructions.

CONCLUSION

Motion compensated reconstruction is feasible for non-gated helical CT scans using edge filtering and image based registration for motion estimation. Reconstructed CT image datasets may improve planning and device selection for TAVI procedures.

CLINICAL RELEVANCE/APPLICATION

Motion compensated reconstruction yields reduced artifact levels at the aortic valve in non-gated helical CT scans with a pitch <1.

SSJ22-06 Multi-Channel GAN: A Machine Learning Approach to Parallel MRI Reconstruction

Tuesday, Nov. 27 3:50PM - 4:00PM Room: N227B

Participants
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PURPOSE

Magnetic resonance imaging (MRI) has a low imaging speed. MRI acceleration relies on undersampling that may introduce aliasing artifacts in image reconstruction. Here we propose a machine learning approach that can automatically learn parallel MRI mechanisms underlying multi-channel k-space data and reconstruct high-quality MR images from undersampled data.

METHOD AND MATERIALS

Parallel MRI is a standard approach to imaging acceleration on clinical MRI scanners. This approach can effectively suppress aliasing artifacts associated with undersampling, but requires an additional calibration procedure that limits the overall imaging speed. Here a deep learning based neural network model, multi-channel generative adversarial network (multi-channel GAN), is developed to process multi-channel raw MRI data. This model can learn parallel MRI reconstruction mechanisms underlying a large amount of multi-channel k-space data. The trained model can be used to reconstruct images from undersampled data without calibration, thereby providing a higher imaging speed than conventional parallel MRI. In our approach, the basic unit of multi-channel GAN has two sub-networks: a generator network which learns the relationship between undersampled and fully-sampled data and a discriminator network which justifies if the generated data are real. The whole model consists of the same number of basic unit networks as that of radiofrequency channels on the MRI scanner for parallel MRI reconstruction. The training process uses a stochastic gradient descent and back-propagation algorithm. The trained multi-channel generator network is used to perform image reconstruction.

RESULTS

We evaluate the proposed method with a total of 170 sets of 2D multi-channel brain MRI images. Figure 1 shows an example of reconstruction results with an undersampling factor of 5. It is found that the machine learning method outperforms other state-of-the-art parallel MRI reconstruction methods.

CONCLUSION

We demonstrate a machine learning approach to parallel MRI reconstruction.This approach can generate high-quality images from undersampled data without calibration, providing a higher imaging speed than conventional parallel MRI.

CLINICAL RELEVANCE/APPLICATION

The machine learning approach to parallel MRI reconstruction can enhance diagnostic MRI quality, shorten clinical MRI procedures and improve clinical MRI throughput.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSJ23

Physics (CT: Cone-Beam CT in Imaging and Radiation Therapy)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: N226

CT PH RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Joseph W. Stayman, PhD, Baltimore, MD (*Moderator*) Research Grant, Canon Medical Systems Corporation; Research Grant, Carestream Health, Inc; Research Grant, Elekta AB; Research collaboration, Fischer Medical; Research Grant, Medtronic plc; Research collaboration, Koninklijke Philips NV; Research Grant, Siemens AG
Cem Altunbas, PhD, Aurora, CO (*Moderator*) Nothing to Disclose

Sub-Events

SSJ23-01 Quantitative Extremity Cone-Beam CT Using Model-Based Polyenergetic Reconstruction

Tuesday, Nov. 27 3:00PM - 3:10PM Room: N226

Participants
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PURPOSE

Quantitative evaluation of bone mineral density (BMD) using cone-beam CT (CBCT) is challenged by a high level of artifacts typically associated with CBCT. We apply a polyenergetic model-based iterative reconstruction (MBIR) with a material mixing model to obtain accurate and reproducible density estimates in extremity CBCT.

METHOD AND MATERIALS

An ideal solution model was used in polyenergetic MBIR (MBIR-poly, Elbakri PMB 2003) to account for mixing of Ca and marrow in bone. The model was calibrated using BMD inserts of known concentration (Gammex 467, 472). Scans were acquired at 90 kVp on a test-bench emulating the geometry of extremity CBCT. Monte Carlo scatter estimates obtained from water-corrected FBP were subtracted from projection data. Artifact reduction and quantitative accuracy were evaluated in water phantoms with muscle, adipose and BMD inserts (from 20 mg/cc to 500 mg/cc Ca). MBIR-poly reconstructs the density map of the object and thus the reconstructed voxel values were compared with measured physical densities of the inserts. To assess robustness to imaging conditions (essential in longitudinal studies), we compared density estimates in cortical and trabecular regions-of-interest (ROI) of a cadaveric ankle imaged in the following configurations: ankle alone (C1), ankle+water+2 BMD inserts (C2), ankle+water+2 BMD inserts+2 cm shift (C3).

RESULTS

With MBIR, the error in density was <0.009 g/cc across all BMD inserts. The magnitude of streak artifacts (departure from uniformity in a water region) was reduced by 96% compared to FBP with water-correction only. The spread (standard deviation) of mean cortical and trabecular density across configurations C1-C3 was reduced by 78% and 51%, respectively. The estimates of physical BMD insert density remained accurate when imaged in the presence of the ankle (configurations C2 and C3), with errors<0.015 g/cc.

CONCLUSION

MBIR-poly with an ideal solution mixture model yielded correction of beam hardening artifacts and provided quantitatively accurate estimates of object density in extremity CBCT. The density estimates were reproducible across a variety of imaging conditions.

CLINICAL RELEVANCE/APPLICATION

A polyenergetic model-based reconstruction algorithm yields accurate and reproducible estimates of tissue density in extremity CBCT, enabling quantitative studies of bone mineralization.

SSJ23-02 Two-Dimensional Anti-scatter Grids for CBCT: Transmission Properties of High Grid Ratio 2D Grid

Prototypes

Tuesday, Nov. 27 3:10PM - 3:20PM Room: N226

Participants
Cem Altunbas, PhD, Aurora, CO (*Presenter*) Nothing to Disclose
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PURPOSE

CT number accuracy and low contrast resolution can be poor in CBCT images due to high levels of scattered radiation. To reduce scatter, we have been investigating the utility of 2D antiscatter grids for flat panel detector based CBCT. In this study, we developed two prototypes, and characterized their scatter and primary transmission performance in a CBCT system for image guided radiation therapy.

METHOD AND MATERIALS

Two prototypes with grid ratio of 12 (R12) and 16 (R16) were developed and fabricated by using direct metal laser sintering process. Both grids have 2 mm grid pitch, and 0.1 mm septal thickness, and their grid cells were focused towards the x-ray source, in offset detector CBCT geometry. Prototypes were integrated with the flat panel detector in a clinical CBCT system. Primary and scatter transmission properties were measured using PMMA phantoms and beam-stops, at tube voltages of 80, 125, and 140 kVp. To benchmark the performance of prototypes, a fluoroscopic 1D antiscatter grid with a grid ratio of 21 (R21) was also evaluated under identical imaging conditions.

RESULTS

At 140 kVp, scatter-to-primary ratio (SPR) at 40 cm phantom thickness was 10.1 without a grid. SPR was reduced to 0.36 and 0.29 with our R12 and R16 prototypes, whereas SPR was 1.47 with the 1D grid. Scatter transmission fraction (Ts) with R12 and R16 prototypes were 3.1% and 2.4%, and Ts for 1D grid was 10.8%. When tube voltage increased for 80 to 140 kVp, Ts values increased by 13% for both 2D grids, whereas Ts increased by 31% for the 1D grid. Similar trends were observed for all grids when phantom thickness was varied between 10 and 40 cm. Average primary transmission fraction of R12, R16 prototypes, and 1D grid were 83%, 71%, and 70%, respectively.

CONCLUSION

Scatter transmission of our 2D grids were up to factor of 4.5 lower than a conventional antiscatter grid, while providing higher primary transmission. Thus, lower scatter transmission provided by 2D grids may lead to higher CT number accuracy and improved contrast resolution in CBCT. Lower scatter transmission may also play an important in the context of dual-energy CBCT, where highly accurate projection images are required.

CLINICAL RELEVANCE/APPLICATION

Scattered radiation is one of the leading causes of image quality degradation in CBCT imaging, limiting the utility of CBCT in a range of clinical applications. Our research on 2D antiscatter grid development aims to address this problem.

SSJ23-03 Deep Scatter Estimation (DSE) for Truncated Cone-Beam CT (CBCT)

Tuesday, Nov. 27 3:20PM - 3:30PM Room: N226

Participants
Joscha Maier, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
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Stefan Sawall, PhD, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To correct for x-ray scatter in truncated CBCT in real time.

METHOD AND MATERIALS

Cone-beam CT (CBCT) acquisitions suffer from scatter artifacts. To correct for these artifacts, we recently developed the deep scatter estimation (DSE) that trains a deep convolutional neural network to reproduce Monte Carlo (MC) scatter estimates. Once trained, DSE combines both real-time capability and high accuracy. Applied to non-truncated data, DSE turned out to be equivalent to MC while outperforming known scatter estimation approaches. In the present work, however, we deal with truncated data as they occur in interventional C-arm CBCT or dental CBCT. In this case MC simulations are not possible because the object, which is needed as input to the MC simulation, cannot be fully reconstructed. To overcome this drawback, we developed the truncated DSE which uses a U-net architecture to reproduce the outcome of MC simulations from non-truncated objects given only the truncated projection data as input. Here, DSE is trained on 10800 simulated truncated projection images (pelvis, abdomen, and thorax). The training is performed on a GeForce GTX 1080 for 100 epochs using an Adam optimizer and the mean absolute error between the output and the MC scatter distribution as loss function. The performance of DSE was evaluated for simulated and measured testing data of a truncated CBCT system and compared against a kernel based scatter estimation (KSE).

RESULTS

Considering simulated data, the accuracy of KSE and DSE scatter estimates was quantified by calculating the mean absolute error (MAE) with respect to the simulated ground truth scatter distribution. Here, we observe a MAE of 19.2 % (KSE) and 1.8 % (DSE).

To quantify the performance for measured data, a slit scan measurement was performed as reference. Compared to the slit scan, CT reconstructions that were corrected using DSE show an almost similar CT value distribution while there are discrepancies of up to 150 HU using KSE.

CONCLUSION

DSE is able to derive highly accurate scatter estimates very close to MC simulations. Compared to conventional scatter estimation approaches DSE shows a superior performance while requiring similar processing time (20 ms / projection).

CLINICAL RELEVANCE/APPLICATION

Scatter correction is crucial to maintain the diagnostic value of CBCT examinations. DSE can overcome the drawback of existing approaches that are optimized for performance at the cost of accuracy.

SSJ23-04 Daily Edge Deformation Prediction Using a Conventional Neural-Network Regression for Low Dose Prior Contour Based Total Variation CBCT Reconstruction (PCTV-CNN)

Tuesday, Nov. 27 3:30PM - 3:40PM Room: N226

Participants
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PURPOSE

Previously we developed a PCTV reconstruction method to enhance the edge sharpness of low-dose CBCT. PCTV deforms the edge map from planning CT to on-board volumes to obtain the on-board edge information for enhancement in TV reconstruction. However, the deformable registration used for deforming the edge is time consuming and prone to errors due to the low quality of CBCT. This study aims to develop a novel method for predicting daily on-board edge deformation using deep conventional neural networks (CNN) to bypass deformable registration to improve the PCTV reconstruction efficiency.

METHOD AND MATERIALS

The new method uses patch-based CNN deformation prediction and PCTV reconstruction. Deformation vector field (DVF) registered from CT to full-sampling CBCTs and retrospectively under-sampled low-dose CBCT are obtained on the first day to train the model, which is then updated with following days' data. The model predicts DVF for low-dose CBCT acquired on the following day to generate on-board contours for PCTV reconstruction. Specifically, 3D patches are extracted from the same location in the planning-CT and low-dose CBCT as the inputs. Only DVF and voxels at the edge regions of planning-CT are selected for the prediction model. The CNN model is developed in MATLAB using 4 convolutional layers interleaved with pooling layers to directly learn the mapping from the input image patch pair. The method is evaluated using lung SBRT patient data. The first n-1 day's CBCTs are used for CNN training to predict nth day edge information (n=2, 3, 4, 5). 45 half-fan projections covering 360° from nth day CBCT is used for reconstruction. Results from Edge-preserving (EPTV), PCTV and PCTV-CNN are compared.

RESULTS

The cross-correlations between predicted and reference edge maps are 0.9734, 0.9706, 0.9624 and 0.9477, for day 2-5 respectively. PCTV-CNN enhanced bone edges in CBCT compared to EPTV and achieved comparable image quality as PCTV while avoiding time-consuming deformable registration process.

CONCLUSION

Preliminary results demonstrated the feasibility to use CNN to predict daily deformation of on-board edge information for PCTV based low-dose CBCT reconstruction.

CLINICAL RELEVANCE/APPLICATION

PCTV-CNN has a great potential for enhancing the edge sharpness with high efficiency for low dose 3D CBCT or 4D CBCT to improve the precision of on-board target localization and adaptive radiotherapy.

SSJ23-05 A Robust Fully Automatic Method for Intrinsic Respiratory and Cardiac Gating for Cone-Beam CT Scans of the Thorax Region

Tuesday, Nov. 27 3:40PM - 3:50PM Room: N226

Participants
Andreas Hahn, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
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Marc Kachelriess, PhD, Heidelberg, Germany (*Presenter*) Nothing to Disclose

PURPOSE

To automatically extract a respiratory and a cardiac signal from cone-beam CT (CBCT) rawdata.

METHOD AND MATERIALS

Due to the relatively slow acquisition speed of CBCT systems, patient respiration and cardiac motion lead to motion blurring. This can be compensated using motion-compensated image reconstruction in 4D and in 5D [Brehm et al., MedPhys 42(4)] which requires accurate motion information. Without an external signal, motion surrogates have to be retrieved intrinsically from the rawdata. While there are several methods for respiratory gating, only few are dedicated to cardiac gating but are not very robust. We propose a robust method that is able to retrieve a respiratory and a cardiac signal fully automatically. The respiratory signal is retrieved by analyzing the mean signal over the whole detector as a function of the projection angle. The cardiac signal starts from

50×50×50 uniformely distributed grid points in the field of measurement to which x-y-circles of radius r are attached. We iterate over radii between 3 cm and 5 cm in steps of 2 mm and compute the intersection of the x-ray that runs through the tangent of each circle with the detector. The intersection points are centers of rectangular ROIs of about 8 cm by 4 cm whose mean value serves as a surrogate for the cardiac motion phase. The most regular signal after band pass filtering is selected as the cardiac surrogate. The method was tested on 10 patient thorax scans acquired with a Varian True Beam system and compared to the AS method [Van Herk et al., ICCR 07] (M1) and the method of reference [Hahn et al., SPIE Medical Imaging 2016] (M2).

RESULTS

The proposed method, M1 and M2 determined the correct number of respiratory peaks. While the proposed method showed good results for the cardiac gating with a maximum error of 1 heart beat, M2 showed good results for 6 patients (max. error 1), it did not perform well for 4 patients (max. error 23). M1 cannot detect cardiac motion.

CONCLUSION

The proposed method is able to acquire a respiratory and cardiac surrogate in a fully automatic way for CBCT scans of the thorax region and outperformed M2 in terms of robustness.

CLINICAL RELEVANCE/APPLICATION

Clinically, intrinsic gating will be useful in cases where no gating signals are available, such as it is the case in many interventional imaging scenarios. With intrinsic gating those cases can benefit from motion-compensated reconstruction and thus from better image quality.

SSJ23-06 Multi-Structure Segmentation of Hard Tissues, Maxillary Sinus, Mandible, Mandibular Canals in Cone Beam CT of Head and Neck with 3D U-Net

Tuesday, Nov. 27 3:50PM - 4:00PM Room: N226

Participants
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PURPOSE

we proposed automatic segmentation method on four facial structures including hard tissues, maxillary sinus, mandible, and mandibular canals using 3D U-Net with convolutional neural net (CNN) in CBCT.

METHOD AND MATERIALS

We obtained 100 data sets of i-Cat CBCT scans (Imaging Science International, Hatfield, PA, USA).The training and validation dataset of hard tissues, maxillary sinus and mandible consists of 7 and 4 cases, 20 and 4 cases, and 20 and 4 cases, respectively. The training, and validation dataset of mandibular canals consist of 40 and 15 cases, respectively. Each test dataset was used in the same 7 patients. Depending on the structures, the segmentation result as gold standard was made differently. The hard tissues and mandibular canals were manually drawn by an expert and confirmed by an expert dentist. The initial mandible and maxillary sinus mask was created by in-house software with conventional image processing techniques including 3D sculpting and thresholding. These masks were filled per slice, and manually corrected by experts. Before training,we pre-processed images to change brightness (window level = 450) and contrast (window width = 5000). Also, the number of each dataset was augmented by flip and rotation. We used the 3D U-Net, one of the most widely used CNN architectures for image segmentation.

RESULTS

For the evaluation metrics, the Dice similarity coefficient (DSC), Jaccard similarity coefficient (JSC), mean surface distance (MSD) and Hausdorff surface distance (HSD) were 82.60±0.04%, 70.47±0.06%, in hard tissues, 86.60±0.01%, and 92.80±0.01%, and 82.00±0.07%, 0.35±0.29mm, 0.49±0.09mm in maxillary sinus, 90.00±0.04 %, 0.89±0.66 %, 11.29±10.21mm, 3.21±2.56mm and 18.42±19.72mm, in mandible, respectively. In the mandibular canals, mean error distances were 0.89±0.40mm.

CONCLUSION

In this study, we proposed an automatic 3D segmentation method, demonstrated very fast segmentation results with reasonable accuracies of multi-facial structures in CBCT including hard tissues, maxillary sinus, mandibular, and mandibular canals.

CLINICAL RELEVANCE/APPLICATION

This study could be used to the planning of dental implant and orthognathic surgeries.

SSJ24

Science Session with Keynote: Radiation Oncology (Gastrointestinal Malignancies)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: E261

GI RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Tarita O. Thomas, MD, PhD, Chicago, IL (*Moderator*) Nothing to Disclose

Sub-Events

SSJ24-01 Invited Speaker:

Tuesday, Nov. 27 3:00PM - 3:20PM Room: E261

Participants
Tarita O. Thomas, MD, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

SSJ24-03 Dose Escalation with Simultaneous Integrated Boost (SIB) Using 3DCRT and VMAT in Neoadjuvant Radiotherapy of Rectal Cancer: Evaluation of Normal Organ Doses

Tuesday, Nov. 27 3:20PM - 3:30PM Room: E261

Participants
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PURPOSE

To evaluate normal organ doses in rectal cancer patients treated with neoadjuvant radiotherapy using dose escalated SIB with three-dimensional conformal radiotherapy (3DCRT) and volumetric modulated arc therapy (VMAT).

METHOD AND MATERIALS

Treatment planning CT images of 88 rectal cancer patients (F: 31, M: 57) were included. Median patient age was 60 (30-85). Patients with inguinal lymph nodes in the treatment field were excluded. Two treatment plans were done for each patient using SIB with VMAT and 3DCRT techniques. Normal organ and target volume doses in two plans were dosimetrically compared. CTV-tumor volume was covering GTV plus 2 cm proximally and distally, and mesorectum radially. Pelvic lymph node dose was 50.4 Gy with 1.8 Gy/fx and PTV-tumor dose was 56 Gy with 2 Gy/fx in 28 fractions, for both plans. Maximum target volume doses (Dmax), homogeneity index (HI) and conformity number (CN) for target volumes (PTV-Tumor and PTV-Total), maximum bladder dose (Dmax), bladder volumes receiving 40 Gy (V40), 50 Gy (V50), 56 Gy (V56), maximum bowel dose (Dmax), doses to 90 ml (D90), 130 ml (D130) and 230 ml (D230) bowel, mean femoral head (FH) doses (Dmean) and FH volumes receiving 40 Gy (V40), and 50 Gy (V50) were compared between two plans.

RESULTS

Median bladder and bowel volumes were 393 (43-1128) and 1629 (280-4792) cm3, respectively. For both PTV volumes, HI ($p<0.02$) and CN ($p<0.01$) were significantly better in VMAT plans and Dmax was ($p<0.65$) not significantly different between two plans. Bladder and bowel Dmax were not significantly different between VMAT and 3DCRT plans. Bladder V40, V50, V56 volumes and bowel D90, D130 and D230 doses were significantly lower in VMAT plans compared with 3DCRT plans ($p<0.01$). FH Dmean and V40, V50 were significantly lower in VMAT plans compared with 3DCRT plans ($p<0.05$).

CONCLUSION

Except bladder and bowel Dmax, VMAT decreases all normal organ doses compared with 3DCRT in rectal cancer patients treated with neoadjuvant radiation therapy using dose escalated SIB. Clinical studies are needed to evaluate these results' clinical impact on treatment side effects.

CLINICAL RELEVANCE/APPLICATION

VMAT decreases normal organ doses compared with 3DCRT in rectal cancer patients treated with neoadjuvant radiotherapy using dose escalated simultaneous integrated boost, but maximum bladder and bowel doses do not change. Clinical studies needed to evaluate impact of these results on treatment side effects.

SSJ24-04 Fat-Free Muscle Mass Predicts Overall Survival of Patients Undergoing Radioembolization of Colorectal Cancer Liver Metastases

Tuesday, Nov. 27 3:30PM - 3:40PM Room: E261

Participants
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Julian A. Luetkens, MD, Bonn, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Sarcopenia is associated with poor prognosis in various types of cancer. We therefore aimed to investigate the clinical potential of fat-free muscle mass as a marker for outcome prediction in patients with liver-predominant metastatic colorectal cancer undergoing radioembolization (RE) with 90Yttrium-microspheres.

METHOD AND MATERIALS

Patients with liver-predominant metastatic colorectal cancer who underwent RE between June 2008 and August 2014 at our department were included in this retrospective study. Medical records were reviewed and several clinical parameters were determined. Using standard liver magnetic resonance imaging (MRI) scans, the total erector spinae muscle area and the intramuscular fat tissue area were measured and subtracted to calculate the fat-free muscle area (FFMA). Sarcopenia was defined as FFMA less than 3653 mmSquared and 2866 mmSquared for men and women, respectively. The main outcome was overall survival (OS). Univariate and multivariate Cox-regression analyses were performed comparing various variables with potential impact on OS (e.g. age at RE, bodyweight, ascites prior to RE, cholestasis, clinical scores, tumor burden).

RESULTS

Seventy-seven patients (49 male, mean age 59.9±10.8 years) were investigated. Mean time between MRI and RE was 19±38 days. Mean FFMA was 2878±613 mmSquared in female patients and 3706±779 mmSquared in male patients. Median OS after RE was 200 (range: 25-1650) days. In patients without sarcopenia OS was significantly longer compared to patients with sarcopenia (mean 348±48 vs. 226±36 days, p=0.006). On multivariate Cox-regression analysis, OS was best predicted by FFMA (p<0.001, HR 2.692, 95% CI 1.559-4.648), Model for End-Stage Liver Disease (MELD) (p<0.001, HR 1.165, 95% CI 1.089-1.245), and pattern of tumor manifestation (solitary, oligofocal, multifocal, diffuse) (p<0.001, HR 2.006, 95% CI 1.418-2.840).

CONCLUSION

Fat-free muscle mass might be a new prognostic biomarker for survival prognosis in patients receiving RE for treatment of colorectal liver metastases.

CLINICAL RELEVANCE/APPLICATION

This study offers an easy-to-apply MRI-based measurement of fat-free muscle mass as a marker of sarcopenia which can predict OS in patients receiving RE for treatment of colorectal liver metastases.

SSJ24-05 Stereotactic Body Radiotherapy (SBRT) in Pancreatic Cancer Patients Aged 70 and Older

Tuesday, Nov. 27 3:40PM - 3:50PM Room: E261

Awards
Student Travel Stipend Award

Participants
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Jasmine Martin, MD, Boca Raton, FL (*Abstract Co-Author*) Nothing to Disclose
Michael DeDonno, PhD, Boca Raton, FL (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Over 50% of pancreatic cancer is diagnosed in people over the age of 70, many of whom have limited treatment options due to preexisting comorbidities. This study reports on the outcomes and tolerability of stereotactic body radiation therapy (SBRT) in patients aged 70 and older with pancreatic cancer.

METHOD AND MATERIALS

Twenty-six and 2 patients aged >=70 with pancreatic and ampullary cancer respectively, treated with SBRT +/- chemotherapy and surgery at one institution from 2009 to 2017 were retrospectively reviewed. Patients without up-to-date records or at least 6-months of follow-up were excluded. Patients were analyzed for treatment toxicity, local recurrence, and distant metastases. Kaplan-Meier was used to estimate overall survival, defined as date of diagnosis to date of death or last follow-up.

RESULTS

Median age was 84 years (range 70-94), and median follow-up was 6.9 months. Twenty-five (89%) patients had locally advanced disease and 3 (11%) had metastatic disease. Most common doses delivered were 30, 32.5, 35 and 37.5 Gy (20-45 Gy), most commonly in 5 fractions. Twenty-four (86%) patients were treated at time of initial diagnosis and 4 (14%) were treated for recurrence. Six patients had pre-radiation surgery, either with a Whipple procedure (14%) or an endoscopic resection (7%). Two patients had previously been treated with external beam radiation therapy (EBRT) before SBRT. Nineteen patients (68%) were

treated with some form of chemotherapy. Twenty-one (75%) patients had an acute toxicity grade of 1-2, and 3 patients had an acute toxicity grade of 3, 2 with GI symptoms and 1 with sepsis and fatigue (CTCAE V5.0). Most common acute toxicities were GI symptoms (57%) and fatigue (36%), while most common late morbidities were GI symptoms (68%), fatigue (68%), and nutritional disorders (50%). There were no acute or late grade 4+ toxicities. Fourteen (50%) patients recurred locally, 14 (50%) patients developed distant metastases, and 10 (36%) had both. Median overall survival was 15.0 months.

CONCLUSION

SBRT for pancreatic cancer seems to be a safe and effective method for treatment of elderly patients who decline surgery, have unresectable disease, or comorbidities precluding surgery.

CLINICAL RELEVANCE/APPLICATION

The literature on treatment of elderly patients with pancreatic cancer is sparse. SBRT appears to be safe and effective for those who cannot undergo surgery.

SSJ24-06 Evaluation in Predicting Tumor Sensitivity on Radiotherapy for Esophageal Cancer Using Magnetic Resonance Diffusion Kurtosis Imaging

Tuesday, Nov. 27 3:50PM - 4:00PM Room: E261

Participants
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PURPOSE

To evaluate magnetic resonance diffusion kurtosis imaging (MR-DKI) values for predicting the tumor sensitivity on radiotherapy for esophageal cancer.

METHOD AND MATERIALS

There were 40 Eca-109 nude mice models with esophageal cancer xenogrfts before and during radiotherapy (test group=24; control group=16) used in this study. The test group was given 6MV-X line 15Gy single dose during radiation therapy. The control group did not undergo any radiation or other treatments. Sixteen time points included at 1 day before and 1 day after radiotherapy and then very two days during radiotherapy until 29th day. In the time points, mice models in both test and control groups were performed on MRI scan with T1WI, T2WI, and multiple b-value DWI values. Tumor volume, MR-DWI ADC value, MD value and MK value in test group were compared with the control group.

RESULTS

The tumor volume was double at the 5th day in the control group and at the 17th day in the test group after the radiotherapy. At the 7th day after radiotherapy and then, the volume of the transplanted tumor was significantly smaller in the test group (1.729±0.906 mm3) than that in the control group (2.671±0.915 mm3) ($P<0.05$). ADC values in test group rapidly increased at the 3rd day (reached highest point at the 7th day) and then gradually decreased and returned to pre-therapy levels from the 17th day. In the control group, the ADC values gradually decreased from the first day and kept at a low level from the 9th day. The MK values in the test group decreased after radiotherapy (reached lowest point on the 9th day), and then gradually increased to the pre-therapy level from the 17th day. In the control group, the MK values gradually increased (high level since the 17th day). The changes of the MD values were similar to those in ADC values in both groups.

CONCLUSION

MR-DKI values could change prior to tumor morphological features in esophageal cancer during radiotherapy in an animal experimental study, and may have the potential in predicting tumor sensitivity for clinical tumor patients during their radiation or chemotherapy.

CLINICAL RELEVANCE/APPLICATION

(dealing with MR-DKI) 'MR-DKI values could change prior to tumor morphological features in esophageal cancer during radiotherapy in an animal experimental study, and is recommended in predicting tumor sensitivity for clinical tumor patients during their radiation or chemotherapy.'

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSJ25

Vascular Interventional (Dialysis and Venous Intervention (Including IO))

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S503AB

VA IR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Gordon McLennan, MD, Chagrin Falls, OH (*Moderator*) Grant, Siemens AG; Grant, Surefire Medical, Inc; Speakers Bureau, Medtronic plc; Speakers Bureau, General Electric Company; Speakers Bureau, Stryker Corporation; Advisory Board, Siemens AG; Advisory Board, Surefire Medical, Inc; Advisory Board, Stealth Medical; Advisory Board, Rene Medical, Inc; Advisory Board, F. Hoffmann-La Roche Ltd; Advisory Board, Bristol-Myers Squibb Company; Advisory Board, B. Braun Melsungen AG; Advisory Board, General Electric Company;

Sub-Events

SSJ25-01 Rapid Geometric Estimation of Dialysis Fistula Blood Flow Using 2D Angiography

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S503AB

Awards
Student Travel Stipend Award

Participants
Sanjit Datta, MS, Cleveland, OH (*Presenter*) Nothing to Disclose
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Jessica Nelson, MSc, Cleveland, OH (*Abstract Co-Author*) Employee, Siemens AG
Nischal Koirala, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The ability to quantify the blood flow rate in a particular vessel using two-dimensional digital subtraction angiography (DSA) remains an elusive goal. Proceduralists could use such a technique to plan and define quantitative endpoints for interventions involving embolization and recanalization among others. Dialysis fistula interventions are an ideal testbed since alternative validated techniques, such as thermodilution, are commonly used. This study aims to assess the precision of simple, rapid geometric flow estimation techniques applied to in vitro acquisitions mimicking dialysis fistulagrams.

METHOD AND MATERIALS

The true flow rate through a phantom with 9.5mm internal diameter was measured by collecting the outflow. Triplicate DSA acquisitions were performed using a fixed contrast injection protocol. Flow rates were calculated by dividing the cylindrical volume of the tube (based on linear measurements from each acquisition) by transit time determined using three methods: (1) visual estimation of contrast arrival time on DSA ("DSA"), (2) automated measurement of time of arrival using parametric color-coded angiography ("TOA"), (3) automated measurement of time-to-half-peak using parametric color-coded angiography ("TTHP"). Results were analyzed using Bland-Altman plots and ANOVA.

RESULTS

True flow rates through the phantom ranged from 620-1210 ml/min. The normalized variance was 0.023 for DSA, 0.031 for TOA, and 0.013 for TTHP ($p<0.05$), with a significant pairwise difference only between TOA and TTHP. Bland-Altman analysis showed the normalized 95% confidence interval for a given measurement was 0.75 to 1.34 for DSA, 0.67 to 1.36 for TOA, and 0.70 to 1.16 for TTHP. The normalized bias of each measurement technique was +0.047 for DSA, +0.016 for TOA, and -0.070 for TTHP.

CONCLUSION

Any proceduralist using any angiographic system without advanced post-processing software can quickly perform a geometric calculation to obtain an estimate of blood flow rate using the DSA method. In this preliminary in vitro study, the margin of error for such a calculation was ±15%. Using a parametric color-coded angiography tool that calculates time-to-half-peak can reduce this margin of error to ±11%.

CLINICAL RELEVANCE/APPLICATION

This preclinical study demonstrates a rapid, accessible estimation technique. In vivo characterization is necessary in both healthy

and diseased vessels at a wider range of flow rates and frame rates.

SSJ25-02 Transjugular Access for Interventions in Upper Extremity AV Fistulas

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S503AB

Participants
Maria A. Kotarska, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

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PURPOSE

Describe our experience using a transjugular venous approach for endovascular interventions in patients with dysfunctional hemodialysis AV fistulas.

METHOD AND MATERIALS

This is an IRB approved, retrospective study. The imaging files of all patients who underwent a hemodialysis access intervention between January 2015 and May 30, 2017 were reviewed. Patients who underwent the procedure using a transjugular approach were selected for analysis. A total of 600 upper extremity hemodialysis intervention procedures were performed and 30 were performed using a transjugular approach (5 %). Technical procedural details were recorded.

RESULTS

The technical success rate was 97 % (29/30). An additional puncture into the AV fistula was necessary in 13% (4/30) cases to enable retrograde access to the circuit. Indications for the use of the transjugular approach included: Declotting: (13/30) juxta-anastomotic stenosis (13/30), non-maturing AV fistula (2/30) and bleeding pseudoaneurysm (2/30). Most procedures were initially performed using an ipsilateral jugular venous approach, however, most of our recent procedures have been performed using a contralateral approach as it appears to be technically easier. A temporary dialysis catheter can be inserted after the procedure in case of a technical failure or in case the fistula is not ready for use immediately after intervention. No major complications were encountered. There was no post-procedural jugular vein thrombosis.

CONCLUSION

The transjugular approach is safe and effective for interventions in dysfunctional or clotted upper extremity AV fistulas. In selected case, this approach may be better than using the direct access technique.

CLINICAL RELEVANCE/APPLICATION

AVFs have lowest morbidity and mortality among choices for hemodialysis and well-functioning vascular access is the crucial to performing efficient AV fistula intervention.

SSJ25-03 Prospective, Randomized Single-Center Trial to Compare the Efficacy of Ultrasound-Guided Supraclavicular Brachial Plexus Block to Reduce Pain During Angioplasty of Dysfunctional Arteriovenous Fistulas

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S503AB

Participants
Subin Heo, Suwon, Korea, Republic Of (*Presenter*) Nothing to Disclose
Je Hwan Won, MD, Suwon, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Jinoo Kim, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the efficacy and safety of ultrasound-guided supraclavicular brachial plexus block (BPB) for reducing pain during angioplasty of dysfunctional arteriovenous fistulas (AVFs).

METHOD AND MATERIALS

Eighty patients (mean age, 64.6 years) were enrolled in this study. Forty were randomized to receive regional BPB (0.75% ropivacaine and 2% lidocaine) prior to undergoing angioplasty and forty to receive local anesthesia (2% lidocaine). Pain was assessed on a 10-point visual analog scale after the procedure. Both patient and operator satisfactions were examined.

RESULTS

There were no significant differences in the baseline demographics between the two groups. The mean block execution time was 5.1 minutes and the mean time to achieve complete block was 10.7 minutes. The mean time to fully recover from the BPB was 476 minutes. BPB group showed profoundly lower average pain scale compared to the control group (0.93 vs 6.40, $p<0.001$). Patient satisfaction ($p<0.001$), and operator satisfaction ($p<0.001$) were significantly higher in the BPB group. There were no significant differences in procedure time ($p=0.084$), fluoroscopy time ($p=0.059$), and cumulative dose area product ($p=0.869$). There were no major complications and two patients experienced minor complications of self-limited nausea. In 6 months follow up periods there were no delayed complications.

CONCLUSION

Compared with conventional local anesthesia, ultrasound-guided BPB provides excellent benefit of reducing pain with acceptable safety profile during angioplasty of dysfunctional AVFs.

CLINICAL RELEVANCE/APPLICATION

US-guided BPB is a superior method of pain control compared to local anesthesia during angioplasty of dysfunctional AVFs.

SSJ25-04 Single-Center Experience of IVC Filter Placement and Retrieval Practice Patterns

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S503AB

Participants
Peter Lo, St Louis, MO (*Abstract Co-Author*) Nothing to Disclose
Marah Van Diest, BS, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose
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Louis M. Morel, MD, Omaha, NE (*Abstract Co-Author*) Nothing to Disclose
Jerome L. Kao, MD, Knoxville, TN (*Abstract Co-Author*) Nothing to Disclose
Sameer D. Gadani, MD, St. Louis, MO (*Abstract Co-Author*) Nothing to Disclose
Kirubahara Vaheesan, MD, Chennai, India (*Presenter*) Research Grant, Siemens AG; Proctor, Terumo Corporation; Consultant, Terumo Corporation; Proctor, Sirtex Medical Ltd; Speaker Bureau, Sirtex Medical Ltd

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PURPOSE

To compare practice patterns in the placement and retrieval of inferior vena cava filters (IVCF) at a single academic center over four years (2013-2017).

METHOD AND MATERIALS

Retrospective analysis of 238 patients (136 M,102 F; mean age, 58.6±16.8 y) who underwent IVCF placement and retrieval at a single academic center from 2013-2017. Variables assessed were placement indication, filter type, fluoroscopy time, dwell time, and placement and retrieval differences over time and between services (interventional radiology [IR] or vascular surgery [VS]).

RESULTS

We identified 233 IVCF placements and 44 retrievals from 2013-2017. IVCF placement for classic indications increased compared to extended or prophylactic indications (85% in 2013 vs 96% in 2017). There was an increase in the percent of filters retrieved (17% in 2013 vs 30% in 2015) and the percent of filters placed and retrieved by the same service (13% in 2013 vs 28% in 2015). Filter dwell time decreased over the years ($p<0.0001$). The percent of IVCF placed by IR increased with time (76% in 2013 vs 92% in 2016) and decreased for VS (24% in 2013 vs 8% in 2016). IR preferred placing Bard Denali IVCF (53%) while VS preferred placing Optease IVCF (33%). IR used venograms for IVCF placement more often than VS (84% vs 16%, $p<0.0001$), while VS used intravascular ultrasound more often than IR (82% vs 18%, $p<0.0001$). Mean fluoroscopy time (min) was 3.8 [95%CI (2.6,4.9)] for IR IVCF placement and 1.4 [95%CI (1.0,1.8)] for VS IVCF placement ($p=0.001$). IVCF retrievals paralleled placement trends, with IR rates increasing (8% in 2013 vs 22% in 2016) and VS rates decreasing (27% in 2013 vs 0% in 2016) over time. The percentages of placed filters retrieved were similar between IR and VS. IVCF placed by IR had shorter dwell times compared to those placed by VS (median 503 vs 975 days, $p<0.05$).

CONCLUSION

Within four years at a single academic center, changes in IVCF placement and retrieval patterns over time and between services were observed. Increasing contribution of a single service may not only improve patient follow-up and oversight, but may also provide a more consistent patient experience, including the use of similar pre-procedure modalities and filter types.

CLINICAL RELEVANCE/APPLICATION

Single service placement and retrieval of IVC filters may lead to better patient follow-up and improve patient experience.

SSJ25-05 Transvenous Pulmonary Chemoembolization (TPCE) for Palliative and Neoadjuvant Treatment of Lung Metastases

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S503AB

Participants
Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Presenter*) Nothing to Disclose
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Duaa B. Thabet, Assiut, Egypt (*Abstract Co-Author*) Nothing to Disclose
Mostafa A. El-Sharkaway, Assiut, Egypt (*Abstract Co-Author*) Nothing to Disclose
Hossam M. Kamel, Assiut, Egypt (*Abstract Co-Author*) Nothing to Disclose
Moritz H. Albrecht, MD, Frankfurt am Main, Germany (*Abstract Co-Author*) Speaker, Siemens AG
Nagy N. Naguib, MD, MSc, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
Afaf A. Hassan, Assiut, Egypt (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate tumor response, local tumor control and patient survival after the treatment of pulmonary metastases using transvenous pulmonary chemoembolization (TPCE) in palliative and neoadjuvant intent.

METHOD AND MATERIALS

143 patients (mean: 56.7±13.4 years) underwent repetitive TPCE (mean: 5.8±2.9 sessions) between August 2004 and April 2017 for the treatment of unresectable lung metastases not responding to systemic chemotherapy. Patients had predominant lung metastases with bilateral lung involvement in 80.4% of the cases. Regional delivery of the chemotherapeutic agents was performed through selective catheterization of the tumor-supplying pulmonary arteries with subsequent injection of iodized oil and/or microspheres. Patients who underwent subsequent ablation (n=51) either for all lesions (complete) or for dominant lesions

(incomplete) were in the neoadjuvant group, and those who underwent TPCE alone were in the palliative group (n=92). The response was assessed according to the revised RECIST criteria.

RESULTS

Partial response was achieved in 11.9% (n=17), stable disease in 66.4% (n=95) and progressive disease in 21.7% (n=31). The mean survival time and time to progression were 24.5±1.7 and 7.5±0.5 months, respectively. The mean survival time was shorter for the palliative group (19.7±2 months) compared to the neoadjuvant group (30.1±2.6 months). The use of TPCE alone or with incomplete ablation had a significantly decreased 4.6-fold (p=0.002) and 3.1-fold (p=0.027) hazard of death in comparison with TPCE with subsequent complete ablation.

CONCLUSION

TPCE has the potential to improve local tumor control and to prolong survival with a neoadjuvant potential when combined with thermal ablation.

CLINICAL RELEVANCE/APPLICATION

Combined TPCE and thermal ablation therapy can improve local tumor control and survival versus TPCE alone.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSJ26

Vascular Interventional (Spine and Bone Intervention)

Tuesday, Nov. 27 3:00PM - 4:00PM Room: S502AB

IR MR MK VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Alexios Kelekis, MD, PhD, Athens, Greece (*Moderator*) Medical Advisory Board, BTG International Ltd; Medical Advisory Board, Merit Medical Systems, Inc; Research Grant, Mindray Medical

Sub-Events

SSJ26-01 CT Guided Pulsed Radiofrequency in Patients with Acute Low Back Pain and Sciatica: 1 Year Follow-Up versus Image-Guided Injection Only as Control Group

Tuesday, Nov. 27 3:00PM - 3:10PM Room: S502AB

Participants
Alessandro Napoli, MD, Rome, Italy (*Presenter*) Nothing to Disclose
Roberto Scipione, MD , Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Fabrizio Andrani, MD , Roma, Italy (*Abstract Co-Author*) Nothing to Disclose
Susan Dababou, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Cristina Marrocchio, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Michele Anzidei, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To determine the clinical impact of CT-guided Pulsed Radiofrequency in the management of pa-tients with acute or sub-acute neuro-radicular pain from lumbar disc herniation, refractory to pro-longed conservative treatment.

METHOD AND MATERIALS

We conducted a single center, prospective, randomized trial (1:1) in patients with acute or sub-acute neuro-radicular low back pain (EMG confirmed), refractory to usual care (conservative). Pulsed radiofrequency (pRF) treatment was performed using a 22-20 G needle-electrode with probe tip directed to the symptomatic dorsal root ganglion under CT guidance; E-pulsed radiofre-quency (Cosman G4) was administered for 10 min at 45V with constant local temperature of 42°C. Masking group received 1 to 3 sessions of CT-guided steroid injection on the same anatomi-cal target. Primary outcome was clinical efficacy measured with Visual Analogue Scale (VAS), Oswestry Disability Index (ODI) and Roland-Morris (RM) score for quality of life assessment; all questionnaires were obtained at baseline and at 1-week, 1-3-6 and 12-month follow-up. Analyses were performed on a per-protocol basis.

RESULTS

Of 260 patients enrolled, 128 patients received Pulsed Radiofrequency, 120 were treated with in-jection only strategy treatment. Median VAS scores decreased linearly in both groups; patients that received radiofrequency obtained greater significant overall improvement in pain and disabil-ity scores during the first year ($P<0.001$). Relief of leg pain was faster for patients assigned to pRF ($P<0.001$). Patients assigned to pRF also reported a faster rate of perceived recovery (hazard ratio, 1.97; 95% confidence interval, 1.72 to 2.22; $P<0.001$). The probability of perceived recovery after 1 year of follow-up was 95% in the pRF group and 61% in the injection only group. There were 6 patients considered partial responders that required a second PRF session. Eight pa-tients required further surgical management.

CONCLUSION

The 1-year outcomes demonstrated CT-guided Pulsed Radiofrequency superior to injection only strategy. pRF is an effective and repeatable percutaneous treatment option for patients with acute or sub-acute neuro-radicular low back pain.

CLINICAL RELEVANCE/APPLICATION

The results of this study are superior to those reported from literature for usual care strategies and injections and may avoid surgery for a substantial number of patients with sciatic disc com-pression.

SSJ26-02 Treatment of Osteoid Osteomas with Magnetic Resonance Guided Focused Ultrasound: Evaluation of the Prognostic Value of Post-Treatment Perfusion Differences for Pain Reduction and Bone Remodeling

Tuesday, Nov. 27 3:10PM - 3:20PM Room: S502AB

Participants
Hans Peter Erasmus, Rome, Italy (*Presenter*) Nothing to Disclose
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Cristina Marrocchio, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
Susan Dababou, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose
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Carlo Catalano, MD, Rome, Italy (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Magnetic Resonance guided focused ultrasound (MRgFUS) has proven a safe, feasible and effective treatment modality for osteoid osteoma (OO). To date, however, there are no proven factors to evaluate the patient's prognosis during /immediately after treatment. To address this question, this study evaluated the role of perfusion scans and the gained data to assess the likelihood of pain reduction and bone remodeling after treatment.

METHOD AND MATERIALS

A total of 42 consecutive patients with symptomatic osteoid osteomas were treated with MRgFUS from 2011 to 2018. MR (inc. perfusion scan) and CT scans of the lesion were acquired before and immediately after the treatment; follow-up MR and CT scans were acquired at 3, 6, 12, 24 and 36 months and 12 months, respectively. Visual Analog Scale (VAS) score was used to assess pain and was evaluated over the same time periods and, additionally, at 1 week post-treatment. 3 patients were lost during follow-up. Statistical analysis of the correlation with the perfusion data (namely, KTrans) was performed using Spearman's rho.

RESULTS

In the overall study, the mean age was 25 ± 13.5 years, and 77% of patients were male. 4 patients were retreated with MRgFUS. Mean pre-treatment VAS score was 8.4 ± 1.0 months and 0.6±1.4, 0.1±0.3, 0.1±0.3 0.1±0.2 and 0.1±0.2 at 3, 6, 12, 24 and 36 months, respectively. The median VAS dropped to 0 at 1 week from 8 before treatment and stayed there during the entire follow-up. Mean KTrans was 0.69±0.7 pre-treatment and 0.15±0.13, 0.20±.25, 0.12±0.1, 0.07±0.05, 0.13±0.08 and 0.1±0.08 immediately after treatment and at 3, 6, 12, 24 and 36 month follow-up. Spearman's rho showed a positive correlation for a >50% KTrans reduction and significant pain reduction, as well as for >90% KTrans reduction and both pain reduction and bone remodeling. Age appeared to be an additional factor with an inverse correlation to bone remodeling. No adverse events were recorded.

CONCLUSION

The current study demonstrated that KTrans could be a good prognostic tool to evaluate the patient's likelihood of pain remission and bone remodeling.

CLINICAL RELEVANCE/APPLICATION

In the future, evaluation of KTrans could allow for more reliable treatment efficacy and patient satisfaction after treatment of OO with MRgFUS.

SSJ26-03 O2-O3 Chemiodiscolysis: Any Issues for Spine Biomechanics? 5 Years MRI Imaging Follow Up

Tuesday, Nov. 27 3:20PM - 3:30PM Room: S502AB

Participants
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Luigi Zugaro, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Aldo Victor Giordano, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Alessandra Splendiani, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose
Carlo Masciocchi, MD, L'Aquila, Italy (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

O2-O3 dyscolysis is a well-validated technique for the treatment of symptomatic lumbar disc herniation. Although it is a highly effective procedure, up to now there are only a few evidences about long-term changes on disc treated and on biomechanical changes of the lumbar spine "in toto" after O2-O3 dyscolysis treatment. Indeed, dehydration of a lumbar disc with subsequent volume loss could lead to the same alteration of a degenerative pathology. The purpose of our study was to compare long-term follow-up MR images of patients treated by O2-O3 dyscolysis and long-term follow-up MR images of patients affected by lumbar disc herniation treated without intradiscal administration of O2-O3

METHOD AND MATERIALS

We recalled 80 patients for an MRI follow-up treated in our department with O2-O3 mixture 5 years earlier; 40 patients treated

We recalled 80 patients for an MRI-follow-up treated in our department with O2-O3 mixture 5 years earlier: 40 patients treated with dyscolysis and the remaining 40 treated by intraforaminal injection of steroids only as the control group. We compared T2 sagittal and axial images of MR exams performed before the procedure and after 5 years during our follow-up imaging. In all patients in each affected level, we evaluated: disc height, disc area, disc protrusion beyond the vertebral posterior wall, the degree of disc degeneration (according to Pfirmann classification), degenerative changes in adjacent vertebral discs, endplate Modic changes, facet joint changes (Weishaupt classification)

RESULTS

Our analysis showed a significant decrease in disc height and protrusion (respectively mean of 15% and 37,42%) in patients treated with intradiscal O2-O3, despite a decrease of circumferences of 4,72%, differently from control group findings. There was no significant difference in the degree of disc degeneration between the two groups (even more pronounced in patients not treated by dyscolysis), as in both groups we found the same endplate changes (Modic) in about 20% of cases. Analysis of facet joint degeneration shows significant alteration according to Weishaupt classification in both groups, and no significant differences in comparison

CONCLUSION

Compared with control group, patient treated by O2-O3 dyscolysis didn't show significant difference in lumbar disc degeneration, despite a stable shrinkage of the disc herniation

CLINICAL RELEVANCE/APPLICATION

Our findings reveal that O2-O3 dyscolysis don't determine significant differences in biomechanical changes compared with the natural course

SSJ26-04 A Matched Case-Control Study of MR-Guided Focused Ultrasound (MRgFUS) versus CT-Guided Radiofrequency Ablation (RFA) for the Clinical Evaluation of Patients with Osteoid Osteoma

Tuesday, Nov. 27 3:30PM - 3:40PM Room: S502AB

Awards
Student Travel Stipend Award

Participants
Roberto Scipione, MD , Rome, Italy (*Presenter*) Nothing to Disclose
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Fabrizio Andrani, MD , Roma, Italy (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To examine and compare the clinical outcome of MR-guided focused ultrasound (MRgFUS) and CT-guided Radiofrequency Ablation (RFA) in patients with painful non-spinal osteoid osteoma (OO).

METHOD AND MATERIALS

Patients with clinical and radiological findings suggestive for OO were included in this multicenter study; eligible patients had pain scores >=4 (assessed with Visual Analogue Scale, VAS) and could safely undergo both MRgFUS and RFA. Vertebral locations were excluded as considered inaccessible by MRgFUS. Selected participants were assigned to receive either MRgFUS or RFA according to a matched case-control protocol; the two groups were homogeneous in terms of age, gender distribution, pain onset and pain level. Patients underwent periodical three-month follow-ups over a period of 1 year. Safety (rate of complications), clinical effectiveness (Visual Analogue Scale [VAS] pain score reduction) and durability (stability of results over time) of MRgFUS were assessed and compared between the two arms.

RESULTS

112 patients (M: 61; F: 51) were enrolled and assigned to MRgFUS or RFA. In the RFA arms, 2 complications were recorded (1 skin burn, 1 infection at the skin entry site); no treatment-related complications were observed in the MRgFUS arm. No statistically significant difference was recorded between the two arms in terms of efficacy: a complete clinical response (VAS 0) was obtained in 50 patients treated with MRgFUS (89.3%) and in 52 patients treated with RFA (92.9%) at 3-month follow-up ($p>0.05$). Clinical results were stable over the whole period of follow-up, and no pain recurrence was recorded in both groups.

CONCLUSION

MRgFUS has shown similar clinical results compared to RFA in the management of OO, with the advantage of complete safety. MRgFUS is limited to non-spinal locations.

CLINICAL RELEVANCE/APPLICATION

MRgFUS non-invasiveness provides relevant advantages in the treatment of this impairing disease affecting mostly young population: no ionizing radiation, no incisions or needles, and no complications.

SSJ26-05 The Role of Multi-Modal Analgesic Cocktail for Pain Control in Patients Undergoing Microwave Ablation

Tuesday, Nov. 27 3:40PM - 3:50PM Room: S502AB

Awards
Student Travel Stipend Award

Participants
Melvin Omodon, MD, Boston, MA (*Presenter*) Nothing to Disclose
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PURPOSE

There has been significant advancement in techniques and outcomes in various aspects of interventional radiology with much emphasis on radiological procedural advances and innovations. However research in pain management of these patients has taken a back seat. Procedures such as microwave ablation may result in significant post procedural pain and increased opioid use. There have been significant advances in the treatment of pain and enhancing recovery which may be applicable to interventional radiology patients. The goal of this study is to compare post procedural pain in patients who received regular monitored anesthesia care during microwave ablation to those who received a multimodal analgesic cocktail (consisting of Gabapentin, Toradol and Dexamethasome) prior to microwave ablation. A secondary goal is to familiarize the audience with the Enhanced Recovery After Surgery protocols offered by anesthesia.

METHOD AND MATERIALS

A retrospective analysis was performed on 34 patients who underwent microwave ablation for liver and renal cancer with anesthesia services. The patients were in either of 3 groups: (1) standard monitored anesthesia care, (2) multimodal analgesic cocktail only (with Toradol, Gabapentin and Dexamethasome) and (3) combination of regional block and multimodal analgesics. Post procedure pain scores and opioid consumption (dilaudid and oxycodone) were recorded.

RESULTS

Multimodal pre-procedural cocktail consisting of Gabapentin, Toradol and Dexamethasome is associated with decreased pain and opioid consumption in the immediate post-procedure recovery.

CONCLUSION

Patients undergoing liver and renal microwave ablation receiving the multimodal analgesic cocktail generally have less pain scores using the visual analogue scale. They also required less immediate post procedural anesthesia.

CLINICAL RELEVANCE/APPLICATION

This multimodal cocktail consisting of Gabapentin, Toradol and Dexamethasome is associated with decreased pain and opioid consumption post microwave ablation

SSJ26-06 Histologic Diagnosis of Incidentally Discovered Parotid Lesions: Should Biopsy Be Pursued?

Tuesday, Nov. 27 3:50PM - 4:00PM Room: S502AB

Participants
Sarah N. Eberson, MD, Houston, TX (*Presenter*) Nothing to Disclose
Hassan Al-Balas, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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David Sada, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Purpose: With increased utilization of imaging in evaluation of head and neck conditions, there has been an increase in the detection of incidental parotid lesions. This study compares the pathology of incidentally discovered parotid lesions to a cohort of symptomatic parotid lesions.

METHOD AND MATERIALS

Materials and Methods: A single institution retrospective review of all patients who underwent percutaneous biopsy of parotid lesions between January 2010 and December 2017 was performed. 143 patients were identified and divided into two groups: patients with symptomatic parotid lesions and patients with incidentally detected parotid lesions. Patient demographics, lesions characteristics and final histologic diagnosis were recorded and compared between the two groups. Histologic diagnosis in resected lesions was considered the final diagnosis in patients who underwent parotidectomy.

RESULTS

Results: Of the 143 study patients, 64 (44.8%) had symptomatic parotid lesions and 79 (53.2%) had incidentally discovered parotid lesions. Histologic diagnosis in the symptomatic group included 27 Warthin tumors (42%), 7 pleomorphic adenomas (11%), 3 intra-parotid lymph nodes (5%) and 27 (42%) with miscellaneous pathology (mucoepidermoid carcinoma, sialadenitis, lymphoepithelial lesion, oncocytoma and equivocal pathology). Histologic diagnosis in the incidental group included 34 Warthin tumors (43%), 14 pleomorphic adenomas (18%), 5 intra-parotid lymph nodes (6%) and 26 (33%) with miscellaneous pathology. There was no significant difference in final histologic diagnosis between the two groups ($p = 0.34$).

CONCLUSION

Conclusion: Incidentally detected asymptomatic parotid lesions have a similar histologic profile to symptomatic lesions and tissue diagnosis is warranted.

CLINICAL RELEVANCE/APPLICATION

Clinical Relevance: The distribution of histologic diagnoses of incidentally discovered parotid lesions is similar to that of symptomatic lesions and tissue diagnosis should be pursued.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSK01

Breast Imaging (Digital Breast Tomosynthesis: Screening and Diagnostic Indications)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: E451A

BR

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

FDA Discussions may include off-label uses.

Participants
Sarah M. Friedewald, MD, Chicago, IL (*Moderator*) Consultant, Hologic, Inc; Research Grant, Hologic, Inc;
Susan Weinstein, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose

Sub-Events

SSK01-01 Blinded Observer Study: "Virtual" Full-Dose (VFD) Digital Breast Tomosynthesis (DBT) Images Derived from Reduced-Dose Acquisitions versus Clinical Full-Dose DBT Images

Participants
Junchi Liu, MS, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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Kenji Suzuki, PhD, Chicago, IL (*Presenter*) Royalties, General Electric Company; Royalties, Hologic, Inc; Royalties, MEDIAN Technologies; Royalties, Riverain Technologies, LLC; Royalties, Canon Medical Systems Corporation; Royalties, Mitsubishi Corporation; Royalties, AlgoMedica, Inc

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PURPOSE

We developed a deep-learning-based "virtual" higher-dose (VHD) technology for radiation dose reduction in DBT. The purpose of our study was to compare the image quality of our VFD images generated from half-dose acquisitions to that of real clinical full-dose images in DBT.

METHOD AND MATERIALS

Our deep-learning-based VHD technology employed our original patched-based neural network convolutional deep learning to convert lower-dose (LD) to higher-dose (HD) tomosynthesis images. To evaluate our VHD technology, we collected half-dose (50% of the standard dose: 32±14 mAs at 33±5 kVp) and full-dose (100% of the standard dose: 68±23 mAs at 33±5 kvp) images of 51 clinical screening cases with a DBT system (Selenia Dimensions, Hologic, Inc, Bedford, MA) at University of Iowa Hospitals & Clinics. We applied our VHD technology to the 51 cases to convert half-dose images to VFD images. We invited 35 breast radiologists to participate in our observer rating study to rate and distinguish blinded VFD and real full-dose DBT images of 10 of the 51 cases. A VFD image and its corresponding real full-dose image were shown on two clinical LCD monitors (EIZO RadiForce GX540) in a blinded manner. Radiologists were asked to rate the image quality on a 0-to-100 scale and to provide their choices as to which one was better in image quality.

RESULTS

Among the 35 breast radiologists, 21 (60%) radiologists either preferred our VFD DBT images over the real full-dose images or could not distinguish between the two in our observer rating study. The mean scores of the image quality of our VFD images and the real full-dose images were 83.2±3.2 and 84.0±3.0, respectively. The difference in image quality between VFD and real-full dose images was not statistically significant (p=0.37).

CONCLUSION

Our blinded observer study with 35 breast radiologists demonstrated that our deep-learning-based VFD images generated from half-dose acquisitions were equivalent to real full-dose DBT images. Thus, our VHD technology achieved 50% dose reduction without sacrificing the image quality.

CLINICAL RELEVANCE/APPLICATION

Substantial radiation dose reduction with the observer-study-proven VHD technology would benefit patients by reducing the lifetime risk of radiation-induced cancer from DBT screening.

SSK01-02 Comparison of DM/Tomosynthesis and Synthesized DM/Tomosynthesis False Negative Cancers in a Population-Based Breast Cancer-Screening Program

Wednesday, Nov. 28 10:40AM - 10:50AM Room: E451A

Awards
Student Travel Stipend Award

Participants
Samantha P. Zuckerman, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
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PURPOSE

Synthesized 2D imaging (s2D) is replacing 2D digital mammography (DM) in digital breast tomosynthesis (DBT) screening to reduce radiation dose. However, there have been reports of decreased rates of detection of in situ carcinomas with s2D/DBT screening. The purpose of this study is to compare screening outcomes as well as false negative rates and lesion types in DM/DBT versus s2D/DBT screening.

METHOD AND MATERIALS

Recall rate percentage (RR), cancer detection (CDR) and false negative (FN) rates per 1000 screened, false negative cancer subtype (invasive versus in situ) and the method of detection of the false negative cancer (symptomatic versus by another imaging modality) were compared for 37,184 women screened with DM/DBT from 10/3/2011-1/6/2015 and 37,996 women screened with s2D/DBT from 1/7/2015-1/6/2018. Differences were compared using chi-squared tests at the standard a=0.05 significance level with Yates correction. All statistical tests were two-sided.

RESULTS

RR decreased with s2D/DBT versus DM/DBT screening - 6.9% versus 8.9% ($p<0.001$). CDR for DM/DBT and s2D/DBT screening were not statistically different (6.0/1000 vs. 5.5/1000, p=0.37). However, FN rate doubled for s2D/DBT (0.84/1000, n=32) versus DM/DBT screening (0.40/1000, n=15), p=0.02. While not statistically significant, there was a trend of more asymptomatic FN cancers detected by other modalities (i.e., MR, US, CT) in the s2D cohort than in the DM/DBT cohort (13/32 (41%) versus 5/15 (33%), p=0.11) and a trend of higher proportion of DCIS in the s2D cohort than in the DM cohort (9/32 (28%) versus 3/15 (20%), p=0.16).

CONCLUSION

s2D/DBT maintains CDR with the benefit of decreased recall rates. However, the FN rate increased with s2D/DBT compared to DM/DBT with both in situ and invasive FN cancers increased in the s2D cohort. While not statistically significant, a greater proportion of s2D FN cancers were detected by other modalities in asymptomatic patients. The increase in false negative rates is multifactorial and may be intrinsically related to the new technology and/or a learning curve in implementing the s2D technology.

CLINICAL RELEVANCE/APPLICATION

The replacement of DM with s2D in a large DBT breast cancer screening program maintained cancer detection rates and decreased recall rates, but increased false negative rates.

SSK01-03 Integration of Digital Breast Tomosynthesis into Breast Cancer Screening Practices in the United States: A Comparative Modeling Analysis

Wednesday, Nov. 28 10:50AM - 11:00AM Room: E451A

Participants
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Martin J. Yaffe, PhD, Toronto, ON (*Abstract Co-Author*) Research collaboration, General Electric Company; Shareholder, Volpara Health Technologies Limited; Co-founder, Mammographic Physics Inc; Research Consultant, BHR Pharma LLC
Clyde Schechter, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose
Amy Trentham-Dietz, Madison, WI (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To project long-term outcomes and cost-effectiveness of transitioning from breast cancer screening using digital mammography (DM) to digital mammography with digital breast tomosynthesis (DBT) in the United States.

METHOD AND MATERIALS

Two established breast cancer models were used to simulate two scenarios: complete transition from DM to DBT for all women ages 40+ between 2011-2020 versus continued use of DM alone. Screening utilization was based on observed dissemination patterns from national surveillance datasets. We assumed current screening and treatment patterns continued, and women were followed for their remaining lifetimes. DM and DBT performance was based on screening data from the NCI's Population Based Research Optimizing Screening through Personalized Regimen (PROSPR) consortium from 2011-2014. Costs and quality of life weights were based on US national averages and published literature. Outcomes included life-years (LY), quality-adjusted life-years (QALYs), breast cancer deaths, false positive exams (FP), costs (2017 US$) and incremental cost-effectiveness ratios (ICER). Analyses were performed from the payer perspective. Results were summarized within and across models.

RESULTS

Transition to DBT had the greatest impact on FP screening mammograms, which reduced FP exams by 278-288/1,000 women. The small difference in test sensitivity observed in the PROSPR data translated to minimal differences in breast cancer deaths and LY gains, with a reduction in deaths from 0 to 0.03/1,000 women and LY gains from -1 to 0.05 years/1,000 women. Total costs increased by $5.64-$5.66 million, with ICERs of $193,634-$217,532/QALY with DBT relative to DM. In sensitivity analyses, ICERs were sensitive to both the test performance and costs of screening DBT. For example, ICERs decreased to $141,043/QALY with 2% absolute improvement in DBT sensitivity; ICERs decreased to $163,092/QALY and $59,872 with $20 and $40 reductions in cost of DBT exams, respectively.

CONCLUSION

The transition from DM to DBT for routine breast cancer screening in the U.S. reduces FP results, but substantially increases costs assuming current estimates of performance and reimbursement rates.

CLINICAL RELEVANCE/APPLICATION

Digital breast tomosynthesis for routine breast cancer screening in the U.S. reduces false positive exams, but substantially increases costs based on current estimates of performance and reimbursement rates.

SSK01-04 Interval Cancers at Digital Breast Tomosynthesis (DBT) and Full-Field Digital Mammography (FFDM) in a Hybrid Imaging Environment

Wednesday, Nov. 28 11:00AM - 11:10AM Room: E451A

Participants
Gunjan M. Senapati, MD, Boston, MA (*Presenter*) Nothing to Disclose
Aijia Wang, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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Catherine S. Giess, MD, Wellesley, MA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To review imaging features and histopathology of interval cancers (IC) on screening full-field digital mammography (FFDM) and screening digital breast tomosynthesis (DBT) in a hybrid imaging environment.

METHOD AND MATERIALS

This HIPAA-compliant IRB approved retrospective review of consecutive screening exams (9,828 DBT and 41,713 FFDM exams) from October 2012-September 2014 identified interval cancers by cross reference to the institutional cancer registry. Interval cancer was defined as cancer detected within 365 days of a negative screening exam. During the study period a hybrid imaging environment for screening existed, using both FFDM and DBT. Three breast radiologists reviewed prior mammograms of all IC in consensus. Cancers were classified as missed (actionable), minimal signs (non-actionable), or true negative. Mammographic lesion features and breast density were described. Electronic medical record review of patient demographics and histopathology was performed. Percentages were compared using Fisher's exact test.

RESULTS

There were 34 interval cancers (20 FFDM, 14 DBT). IC were considered missed, actionable in 2/20 (10%) FFDM and 2/14 (14%) DBT; minimal signs, non-actionable in 3/20 (15%) FFDM and 0/14 (0%) DBT, and true negative in 15/20 (75%) FFDM and 12/14 (86%) DBT (p-value = 0.4061). Of the 5 cancers visible (2 missed, 3 minimal signs) on prior FFDM, 3 were asymmetries, 1 calcifications, and 1 architectural distortion. Both cancers visible (both missed) on prior DBT were spiculated masses. Most IC on both FFDM and DBT were moderate-to-high grade invasive carcinoma (n=29): 17/20 (85%) FFDM and 12/14 (86%) DBT (p-value = 0.9999). 1 case of pure intermediate grade DCIS, presenting as nipple discharge, was missed on FFDM; the remaining four, 2 FFDM and 2 DBT, were grade 1 invasive carcinoma. Most IC were in Category 3 and 4 dense breasts (n=26): 15/20 (75%) FFDM and 11/14 (79%) DBT (p-value = 0.9999).

CONCLUSION

In this hybrid FFDM/DBT screening environment, most IC are mammographically occult at prior imaging, occur in dense breast tissue, and are moderate to high grade invasive cancers.

CLINICAL RELEVANCE/APPLICATION

Because FFDM and DBT techniques both rely on lesion morphology for detection, IC on each technique have similarities, occurring in dense tissue and with moderate to high grade invasive histopathology.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying

educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Catherine S. Giess, MD - 2015 Honored EducatorCatherine S. Giess, MD - 2017 Honored Educator

SSK01-05 Evidence Supporting Digital Breast Tomosynthesis as Primary Mammographic Screening Tool: Sustained Improved Outcomes over 7 Consecutive Years

Wednesday, Nov. 28 11:10AM - 11:20AM Room: E451A

Participants
Liane E. Philpotts, MD, New Haven, CT (*Presenter*) Consultant, Hologic, Inc
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PURPOSE

Digital breast tomosynthesis (DBT) has shown promise in multiple individual, multi-institutional and population based practices to improve screening metrics, particularly reduce recall rates and improve cancer detection. The sustainability of the early results has not yet been well demonstrated. Long term results are needed to demonstrate if the technology is the preferred screening tool compared with 2D full field digital mammography (FFDM). The purpose of this study was to assess screening metrics with DBT over a 7 year period.

METHOD AND MATERIALS

DBT screening (Dimensions, Hologic, Inc, Bedford, MA) was offered to all women free of charge at a dedicated academic breast center starting in August 2011 and 3 out-patient satellite offices that obtained DBT units in the following years. Over a 7 year period, 124,669 screening DBT exams were performed. Screening metrics were obtained from the breast imaging electronic database (PenRad, MN) and assessed by one-year intervals starting in August 2011. Recall rate (RR), Cancer detection rate (CRD), positive predictive value of screening recall (PPV1) and of biopsy (PPV3) were assessed. Comparison with historic 2D rates (8/1/08 though 7/31/11) were performed.

RESULTS

The RR was significantly reduced over 2D and showed a decreasing trend for each consecutive year: 7.9%, 8.8%, 7.8%, 7.5%, 6.9%, 6.7%, 6.2% (2D = 11.4) ($p<0.0001$). The CDR (per 1000) showed a stable trend that was statistically significantly improved over 2D: 5.8, 5.2, 5.4, 5.6, 6.6, 5.6, 5.1 (2D = 3.8)($p<.0001$). The PPV1 showed a sustained significant improvement over 2D: 7.2, 5.8, 7.0, 7.5, 9.5, 8.4, 8.2 (2D=3.3) ($p<.0001$). The PPV3 also showed a striking significant increase over 2D and an upward trend over consecutive DBT years: 35%, 31%, 36%, 37%, 47%, 42%, 44% (2D=29%) ($p<0.05$).

CONCLUSION

Screening metrics with DBT over 7 years were sustainably significantly improved over 2D rates and further demonstrate favorable trends of improvement over time. This may reflect learning curve and/or increasing availability of prior comparison tomosynthesis exams.

CLINICAL RELEVANCE/APPLICATION

The sustained use of DBT demonstrates that there are fewer false positive screening recalls and biopsies which is essential for shifting the harms and benefits of screening.

SSK01-06 Impact of Using Digital Breast Tomosynthesis in Diagnostic Mammography

Wednesday, Nov. 28 11:20AM - 11:30AM Room: E451A

Participants
Emily Ambinder, MD, MSc, Baltimore, MD (*Presenter*) Nothing to Disclose
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PURPOSE

The use of digital breast tomosynthesis (DBT) in the screening setting has been shown to decrease recall rate and improve cancer detection. This study evaluates the impact of using DBT in the diagnostic setting at a large academic institution.

METHOD AND MATERIALS

All diagnostic mammograms performed from 7/1/2013 to 8/24/2017 were reviewed. Diagnostic mammograms performed to further evaluate calcifications were excluded, as spot magnification views, rather than DBT views, are typically used for diagnostic evaluation in these cases. Studies were divided into two groups: those performed with at least one DBT view and those performed with only full field digital mammography (FFDM). We compared the frequency of a negative/benign assessment (BI-RADS 1 or 2), a probably benign assessment (BI-RADS 3), and a suspicious or highly suspicious assessment (BI-RADS 4 or 5) between the two groups. We also compared positive predictive value 2 and cancer detection rate between the two groups. The Chi-squared test was used for statistical analysis.

RESULTS

12,324 studies were included in the DBT group and 11,775 studies were included in the FFDM group. There was a significantly higher percentage of BI-RADS 1 or 2 assessments (77.8% vs. 74.9%, p<0.001) and a significantly lower percentage of BI-RADS 3 assessments (10.6% vs. 12.9%, p<0.001) in the DBT group compared to the FFDM group. There was no significant change in the percentage of BI-RADS 4 or 5 assessments (biopsy recommendations) between the two groups (12.1% vs. 11.6%, p=0.20). Both PPV2 and CDR were significantly higher for studies performed with DBT compared to FFDM (PPV2: 36.1 vs. 26.6, p<0.001; CDR: 41.8 vs. 32.3, p<0.001).

CONCLUSION

In our study, using DBT in the diagnostic setting led to more studies being assessed as normal with less frequent need for short-term follow-up, implying decreased associated cost of follow-up and decreased stress and anxiety for patients. While the number of biopsy recommendations was similar between the groups, PPV2 and CDR increased when DBT views were included, suggesting improved accuracy of biopsy recommendations.

CLINICAL RELEVANCE/APPLICATION

Routine use of digital breast tomosynthesis for diagnostic mammography may result in more confident assessments, and could lead to resource savings and improved patient-centered care.

SSK01-07 Architectural Distortion (AD) on Digital Breast Tomosynthesis (DBT): Outcomes, Histopathology, and Predictive Features of Malignancy

Wednesday, Nov. 28 11:30AM - 11:40AM Room: E451A

Participants
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PURPOSE

1) To determine histopathologic outcomes for architectural distortion (AD) detected on tomoshynthesis (3D) mammography, (2) to investigate imaging features predictive of malignancy.

METHOD AND MATERIALS

A HIPAA-compliant IRB approved retrospective review of a mammography screening database between 12/2012-5/2015 identified 297 consecutive screening mammograms classified as BI-RADS 0 for AD. All breast imaging available for cases classified as BI-RADS 4 and 5 at diagnostic work-up were reviewed in consensus by 3 breast radiologists. Imaging features and biopsy accuracy were assessed. Medical records were reviewed for patient demographics, histopathology and follow-up imaging. Chi-square tests were performed with <0.05 significance.

RESULTS

Of 297 BI-RADS category 0 screening detected AD on DBT, 45 (15.2%) were subsequently categorized as BI-RADS category 4-5. Cases were excluded if the finding was a mass rather than AD alone (n=3) or if no pathology results were available (n=2). Within the study population of 40 cases, 20/40 (50%) were malignant (18/20 [90%] invasive, 2/20 [10%] ductal carcinoma in situ), 3/40 (7.5%) atypical ductal hyperplasia, and 17/40 (42.5%) benign. 31/40 (77.5%) cases of AD were visible on 3D only and 9/40 (22.5%) were seen on 2D and 3D. Malignancy was found in 15/31 (48.4%) 3D only AD and 5/9 (56%) AD visible on 2D and 3D (p=1.00). While presence of a sonographic correlate did not increase likelihood of malignancy (US correlate in 33 cases [17 benign, 16 malignant] and no US correlate in 7 cases [3 benign, 4 malignant] [p=1.00]), the specific finding of a mass was more likely malignant than non-mass findings (17 masses [4 benign, 13 malignant] and 16 non-mass [13 benign, 3 malignant] [p=0.0016]. Diagnostic MRI was performed in 7/40 (17.5%) cases, of which 3/7 (1 malignant, 2 benign) had a correlate for AD and 4/7 (0 malignant) did not.

CONCLUSION

The majority of AD cases in this series were seen on 3D only, although risk of malignancy for 3D only visible compared to 2D plus 3D visible was similar. AD is more likely to represent invasive disease than in situ and is more likely malignant if a sonographic mass is present. Given the high malignancy rate, negative US or breast MRI should not obviate the need for biopsy of mammographic detected AD.

CLINICAL RELEVANCE/APPLICATION

Given the high malignancy rate associated with AD detected on 3D mammography, lack of US or MRI correlate should not obviate biopsy.

Honored Educators

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SSK01-08 Evaluating the Clinical Performance of Stationary 3D Mammography

Wednesday, Nov. 28 11:40AM - 11:50AM Room: E451A

Awards
Student Travel Stipend Award

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PURPOSE

The purpose of this study was to assess the clinical performance of *stationary* 3D mammography, which is a new approach to digital breast tomosynthesis that uses a fixed array of carbon nanotube-based x-ray sources to acquire the projection views.

METHOD AND MATERIALS

Women with a suspicious abnormality (BIRADS 4 lesion) identified by screening digital mammography were recruited for the study, which involved imaging by *stationary* 3D mammography prior to biopsy. Pre-clinical testing has demonstrated that *stationary* 3D mammography offers a higher spatial resolution than commercially-available 3D mammography devices, since it solves the problem of source blur. In this study, the *stationary* 3D mammography device collected 15 projections over an angular span of 28°. Four radiologists were asked to evaluate the likelihood of malignancy and rate breast density (BIRADS 1-4) when interpreting the standard mammogram and *stationary* 3D mammography images. Using pathology as ground truth, reader performance was quantified as the area under the receiver operating characteristic curve (AUC), while multivariate analysis with a fitted linear mixed-effect model was used to relate breast density to reader performance.

RESULTS

43 women [average age: 56.7 (35 to 83) years] provided a lesion-enhanced image set, in which malignancy was found to be present in 28% of participants by pathology. On average, readers were more accurate identifying malignancy when interpreting the *stationary* 3D mammography images compared to the standard mammograms, as demonstrated by the significantly higher ($p<0.0001$) mean AUC for *stationary* 3D mammography. This higher accuracy was present and statistically-significant across the full range of breast densities.

CONCLUSION

In this first-in-human study, readers were more likely to identify malignancy correctly when interpreting *stationary* 3D mammography images compared to the standard digital mammogram. Given these encouraging findings, as well as the results of pre-clinical testing, future trials are being designed to compare the performance of *stationary* 3D mammography to commercially-available 3D mammography devices in the clinic.

CLINICAL RELEVANCE/APPLICATION

Stationary 3D mammography may prove to be a valuable clinical tool, as readers were more accurate identifying malignancy when interpreting its images compared to the standard digital mammogram.

SSK01-09 Molecular Characterization of Breast Cancers: Could It Change Potential Overdiagnosis Analysis?

Wednesday, Nov. 28 11:50AM - 12:00PM Room: E451A

Participants
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PURPOSE

To compare the amount of potentially overdiagnosed breast cancers in two screening populations using tomosynthesis (DBT) and digital mammography (FFDM) considering only tumor stage or also molecular features.

METHOD AND MATERIALS

Cancers detected within a prospective screening trials using DBT were compared with those obtained from an historical FFDM screening cohort. The amount of potentially overdiagnosed breast cancers in the two cohorts was calculated according to two different assumptions: (1) stages 0 and 1 cancers (DCIS, IDCs, ILCs); (2) considering low-grade DCIS and IDCs/ILCs that are simultaneously grade 1, stage IA or IB, luminal A subtype. Rates (Fisher exact test) were used to compare the two hypotheses of potential overdiagnosis. A p-value lower than 0.05 was considered statistically significant. The same analysis was performed on the complementary subgroups for the two hypotheses: (1) stage > 1 tumors; (2) any other combination of features with the exception of that defined with the second assumption.

RESULTS

Cancers detected in the two screening populations was 322 from the DBT trial and 153 from the FFDM cohort. Considering only tumor stage, cancers potentially overdiagnosed were 268 with DBT and 116 with FFDM, equivalent to 83.2% and 75.8%, respectively. Comparing rates, DBT found 7.9/1000 stage 0/1 cancers vs. 4.0/1000 found by FFDM (P<0.0001), with an incidence rate ratio (IRR) equal to 1.99 (95%CI = [1.60-2.50]. Rates of cancers with stage >1 were 1.6/1000 with DBT vs. 1.3/1000 with FFDM, not significantly different (P=0.2817); the IRR was 1.26 (95%CI = [0.81-1.97]). Including in the definition of potentially overdiagnosed cancers also molecular features, the numbers become 61/322 (18.9%) with DBT and 13/153 (8.5%) with FFDM; rates of overdiagnosed cancers with the second assumption were 1.8/1000 with DBT and 0.4/1000 with FFDM (P<0.0001) corresponding to an IRR of 4.04 (95%CI = [2.20-8.02]). Rates of any other cancers (not overdiagnosed) were 7.7/1000 with DBT vs. 4.8/1000 with FFDM (P<0.0001), with an IRR of 1.61 [95%CI = [1.30-1.99]].

CONCLUSION

DBT increased the amount of potentially overdiagnosed cancers with both definitions. However, the second assumption (inclusion of stage, grade, and molecular features) showed that cancers detected by DBT were mostly not overdiagnosed.

CLINICAL RELEVANCE/APPLICATION

Overdiagnosis by DBT is overestimated using only cancer stage as metric for overdiagnosis.

SSK02

Breast Imaging (Artificial Intelligence)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: E451B

AI BR

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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Maryellen L. Giger, PhD, Chicago, IL (*Moderator*) Stockholder, Hologic, Inc; Shareholder, Quantitative Insights, Inc; Shareholder, QView Medical, Inc; Co-founder, Quantitative Insights, Inc; Royalties, Hologic, Inc; Royalties, General Electric Company; Royalties, MEDIAN Technologies; Royalties, Riverain Technologies, LLC; Royalties, Mitsubishi Corporation; Royalties, Canon Medical Systems Corporation

Sub-Events

SSK02-01 Using Deep Convolutional Neural Networks to Predict Readers' Estimates of Mammographic Density from Raw and Processed Mammographic Images

Participants
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Susan M. Astley, PhD, Manchester, United Kingdom (*Presenter*) Nothing to Disclose

PURPOSE

Mean percentage density assessed visually by two independent readers using Visual Analogue Scales (VAS) has a strong association with breast cancer risk, but is resource-intensive and impractical for stratified screening. We describe a fully-automated method for predicting this mammographic percent density measure from raw (for processing) or processed (for presentation) mammograms, and compare association of predicted VAS score with risk.

METHOD AND MATERIALS

Convolutional Neural Networks (CNNs) were trained using 67520 whole-image mammograms from 16968 women, each labelled with the average VAS score of two independent readers. The networks learned a mapping between mammographic appearance and mammographic density so that they can predict density for unseen images. To evaluate its use for risk assessment, we tested on case-control datasets of contralateral mammograms of screen detected cancers (SDC) and prior screening mammograms of women with cancers detected subsequently. Each cancer was matched to three controls on age, menopausal status, parity, HRT and BMI. The test datasets contained 366 cancers (SDC) and 338 (priors). Odds ratios between the top and bottom quintile were derived, and matched concordance indices were estimated. All images were acquired on GE Senographe systems, and none of the images from the case-control test sets were used in the training process.

RESULTS

For density estimates derived from raw images, odds ratios of cancer in the highest vs lowest quintile were 3.07 (95%CI: 1.97 - 4.77) for SDC and 3.52 (2.22 - 5.58) for priors, with matched concordance indices of 0.59 (0.55 - 0.64) and 0.61 (0.58 - 0.65) respectively. For processed images we obtained odds ratios of 3.22 (2.06 - 5.03) for SDC and 3.65 (2.27 - 5.88) for priors. Matched concordance indices were 0.58 (0.53 - 0.62) for SDC and 0.61 (0.57 - 0.65) for priors.

CONCLUSION

Our fully automated method demonstrated encouraging results on both raw and processed mammographic images, indicating that either image type could be used for screening stratification.

CLINICAL RELEVANCE/APPLICATION

Mammographic density is one of the most important risk factors for breast cancer. Our fully automated method could provide a pragmatic solution for population-based stratified screening.

SSK02-02 Breast Density Classification with Deep Convolutional Neural (DCN) Networks Utilizing 200,000 Screening Mammograms

Wednesday, Nov. 28 10:40AM - 10:50AM Room: E451B

Participants

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PURPOSE

To develop a DCN network to reliably assess mammographic breast density

METHOD AND MATERIALS

In this retrospective study, we trained a multi-column DCN network on 200,000 digital screening mammograms performed at our institution from 2010-2016 to assess breast density. We extracted the textual reports associated with each exam to obtain the breast density as determined by the original interpreting radiologist. The algorithm was trained on 80% of the data sets, validated on a separate 10%, and tested on the remaining 10%. Once this convolutional neural network classifier was trained, we performed a reader study comparing our model to 3 radiologists. All readers independently evaluated the breast density in 100 mammograms in a randomized order. Breast density was assessed using the conventional BI-RADS categories: Class 0 - fatty, Class 1 - scattered fibroglandular densities, Class 2 - heterogeneously dense, and Class 3 - extremely dense. Performance of the model and the readers were assessed using the area under the ROC curve (AUC). Kappa score was used to assess for intra-observer and inter-observer variability.

RESULTS

Both the radiologists and our DCN model achieved a fair agreement (k = 0.34 - 0.51) with the labels in the reader study. The agreement between the predictions of our model and the labels in the data were higher (k = 0.65 - 0.72) compared to the inter-observer agreement between the radiologists. There was higher agreement for the fatty and extremely dense breast tissue. Comparing our CNN model to an average of the radiologists, the CNN achieved AUC of 0.934 (class 0: 0.971, class 1: 0.859, class 2: 0.905 and class 3: 1.000) while the radiologists achieved an AUC of 0.892 (class 0: 0.960, class 1: 0.812, class 2: 0.807 and class 3: 0.990) (Figure 1).

CONCLUSION

The level of agreement between the trained classifier and the classes in the data was found to be similar to that between the radiologists and the classes in the data, as well as among the radiologists.

CLINICAL RELEVANCE/APPLICATION

The classifier provides quantitative, reproducible prediction of breast density, while there is often poor intra-reader and inter-reader correlation in the qualitative assessment of breast density.

SSK02-03 Improving Radiologists' Breast Cancer Detection with Mammography Using a Deep Learning-Based Computer System for Decision Support

Wednesday, Nov. 28 10:50AM - 11:00AM Room: E451B

Participants
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PURPOSE

To compare the breast cancer detection performance of radiologists reading mammography exams unaided versus reading using an interactive deep learning-based computer system for decision support (DS).

METHOD AND MATERIALS

A retrospective, fully-crossed (two sessions >4 weeks apart), multi-reader multi-case (MRMC) study was performed. 240 cases (100 cancers, 40 false positive recalls, 100 normals) were scored by 14 MQSA-qualified radiologists, once with and once without using DS. For each case, a forced BI-RADS® score and a level of suspicion (1-100) were provided. When reading with the DS system (Transpara, Screenpoint Medical, Nijmegen, The Netherlands), radiologists could activate the DS for a specific breast region by clicking on it and the system then displayed a cancer likelihood score (1-100). Additionally, traditional computer-aided detection was available to prompt calcification and soft tissue lesion markers. Area under the receiver operating characteristic curve (AUC), specificity and sensitivity, and reading time were compared using MRMC Analysis of Variance.

RESULTS

On average, with the DS system, the AUC increased significantly from 0.866 to 0.886 (P=0.0019) compared to unaided reading. Sensitivity increased from 83% to 86% (P=0.046), while specificity only slightly improved from 77% to 79% (P=0.061). Considering lesion type, AUC increased for soft tissue lesions (0.886 to 0.902, P=0.033), and calcifications (0.878 to 0.898, not significant, P=0.1021). Reading time per case was similar in both situations (unaided = 146 s, with DS = 149 s, P=0.147). As a stand-alone, the computer system had an equal detection performance (AUC=0.887) than the average of radiologists (P=0.333).

CONCLUSION

Radiologists significantly improved their cancer detection in mammography when using a deep learning-based computer system for decision support without taking more time.

CLINICAL RELEVANCE/APPLICATION

The use of decision support might prevent overlook and interpretation errors that are relatively common in the reading of mammography. The increase in performance when concurrently using DS does not lengthen radiologists reading time per case, as opposed to traditional computer-aided detection systems. The use of single-reading in combination with the computer system might achieve a performance similar to double human reading considering that the stand-alone performance of the system is similar to the average of radiologists.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Elizabeth A. Krupinski, PhD - 2017 Honored Educator

SSK02-04 Data-Driven Imaging Biomarker for Breast Cancer Screening in Mammography-Reader Study

Wednesday, Nov. 28 11:00AM - 11:10AM Room: E451B

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PURPOSE

Previously, we demonstrated data-driven imaging biomarker in mammography (DIB-MMG; an imaging biomarker that is derived from large-scale mammography data by using deep learning technology) for detection of malignant lesions. Now, we assess the feasibility of DIB-MMG as a diagnosis-support-tool for radiologists.

METHOD AND MATERIALS

Total 96,191 exams of 4-view digital mammograms were retrospectively collected from two institutions. All cancer exams were proven by biopsy. Benign exams were proven by biopsy or at least 1 year of follow-up mammography, and normal exams were proven by at least 1 year of follow-up mammography. 90,637 exams of training data (16,086 cancer, 31,237 benign, and 43,314 normal exams) and 5,554 exams of test data (1,692 cancer, 2,780 benign, 1,082 normal cases) were used for developing the DIB-MMG. Sensitivity, specificity, and AUC of the final DIB-MMG on the test data were 82.6%, 93.3%, and 0.94, respectively. Total 120 exams of mammograms (38 cancer and 82 non-cancer exams) were independently collected for reader study, and five radiologists participated. For each exam, readers first read the exam without the help of DIB-MMG and Task-1) annotate the most suspicious lesion with DMIST 7-pt scores and Task-2) decide recall or not per breast. After reading of each exam, readers modify their decision based on the heat-map of DIB-MMG which denotes the likelihood of malignancy.

RESULTS

Per-breast standalone performance of DIB-MMG for 120 exams was 0.942 of AUC in Task-1, and 89.7% of sensitivity, 89.6% of specificity in Task-2. Average performance of five radiologists without DIB-MMG was 0.807 of AUC in Task-1, and 70.8% of sensitivity, 86.2% of specificity in Task-2. With DIB-MMG, the average performance was improved to 0.879 of AUC (p=0.024) in Task-1, and 79.5% of sensitivity, 86.5% of specificity in Task-2. Fig.1 shows exemplary DIB-MMG heat-maps.

CONCLUSION

This retrospective reader study showed the potential of DIB-MMG as a diagnosis support tool for radiologists in breast cancer screening. Further clinical validation with prospective study is needed.

CLINICAL RELEVANCE/APPLICATION

DIB-MMG is purely based on data-driven features from a large-scale mammography data instead of manually designed features of conventional computer-aided detection (CAD) algorithms. With further clinical validation, DIB-MMG can be practically used as a diagnosis support tool for radiologists in breast cancer screening.

SSK02-05 Generative Neural Network Inserting or Removing Cancer into Mammograms Fools Radiologists and Deep Learning Alike: Example of an Adversarial Attack

Wednesday, Nov. 28 11:10AM - 11:20AM Room: E451B

Participants
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PURPOSE

To investigate whether a cycle-consistent generative adversarial network (CycleGAN) can insert or remove cancer-specific features into mammographic images in a realistic fashion.

METHOD AND MATERIALS

From two publicly available datasets (BCDR and INbreast) 680 mammographic images from 334 patients were selected, 318 of which exhibited potentially cancerous masses, and 362 were healthy controls. We trained a CycleGAN, using two pairs of generator and discriminator networks to convert cancerous breast images to healthy and back, and vice versa for the controls, without the need for paired images. The network, implemented in TensorFlow, was trained for 40 epochs on an augmented dataset enlarged ten-fold by random rotation, scaling, and contrast perturbations. To investigate how realistic the images appear, we randomly selected 20 image pairs of original and generated images, and 10 single images of each category (60 images in total). The images were presented to three radiologists (5 and 3 years of experience, and PGY-5 resident) who rated them on a 5-point Likert-like scale and had to indicate whether the image was real or generated/modified. The readout was analysed with a receiver-operating-characteristics (ROC) analysis, performance was expressed as area under the ROC curve (AUC).

RESULTS

For the most experienced radiologist, the modifications introduced by CycleGAN reduced diagnostic performance, with the AUC dropping from 0.85 to 0.63 (p=0.06), respectively, while the two less experienced ones seemed unaffected at a lower baseline performance (AUC 0.75 vs. 0.77 and 0.67 vs. 0.69). None of the radiologists could reliably detect which images were real and which were modified by CycleGAN (AUC 0.50-0.66).

CONCLUSION

CycleGAN can inject or remove malignant features into mammographic images while retaining their realistic appearance. These artificial modifications may lead to false diagnoses.

CLINICAL RELEVANCE/APPLICATION

Modern adversarial attacks may go undetected by humans as well as deep learning algorithms, and could be used in cyber warfare. It is vital to secure healthcare devices and information systems against such attacks mediated by neural networks.

SSK02-06 Deep Learning for Detection of Breast Cancer and Negative Screening Exams Using an In-House Million Mammogram Dataset

Wednesday, Nov. 28 11:20AM - 11:30AM Room: E451B

Participants
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PURPOSE

Breast cancer is the second leading cause of cancer death in women in the US. Screening mammography is effective for early detection, however suffers from unnecessary recall imaging and biopsies. Deep learning shows promise in medical image recognition tasks, but requires large-scale, robustly-annotated datasets. We expand upon our previously described end-to-end process of constructing a million mammogram dataset using routine clinical data and present results of two preliminary deep learning models for cancer detection and the identification of true negative images.

METHOD AND MATERIALS

923,685 DICOM images and 37,730 free-text pathology reports were used to generate an in-house database labeled with ground-truth pathology results.The first deep learning model was created for cancer detection only in biopsy proven specimens - the most difficult subset of data as each image contained a suspicious finding. The model was comprised of two components: patch-based pre-training and end-to-end fine tuning. Training set size was 34,390 images (12,251 positive, 22,139 negative), and test set size was 6,778 images equally split.The second model was designed to have a high NPV for screening and diagnostic studies. An attention-based object detection network was used, with potential abnormalities identified by a region-proposal network and resolved by a separate head classifier network. The model was trained with 359,574 images (4,738 positive, 354,837 negative).

RESULTS

The first model achieved an AUC of 0.81, sensitivity of 0.764, and specificity of 0.797. The second model when tested on 100 positive and 100 negative cases achieved an AUC of 0.90, sensitivity of .866, and specificity of .873 . If the test cases were

changed to a more clinically relevant distribution of 99% benign and 1% cancer, the AUC increased to 0.96.

CONCLUSION

We demonstrate the efficacy of deep learning for mammography in both cancer detection and the identification of negative studies. Future work includes enrichment of the dataset with further clinical data such as history of breast cancer, prior surgeries, and hormone replacement therapy. We also aim to improve model performance and efficiency through novel model architectures.

CLINICAL RELEVANCE/APPLICATION

We develop novel deep learning models for mammography using routine clinical data from a single institution with the potential to decrease recall imaging and unnecessary biopsies.

SSK02-07 Improved Cancer Detection using Artificial Intelligence: A Retrospective Evaluation of Missed Cancers on Mammography

Wednesday, Nov. 28 11:30AM - 11:40AM Room: E451B

Participants
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PURPOSE

To determine whether artificial intelligence-based (AI) software can be used to improve radiologists' sensitivity in breast cancer screening and detection.

METHOD AND MATERIALS

A set of 2-D Digital Mammograms originally interpreted with R2 ImageChecker CAD (Hologic, Sunnyvale, CA) and performed between October 2011 to March 2017 was collected from a community facility. Of the 317 cancer patients with available prior mammograms, 139 had retrospective findings, and 90 of those were deemed actionable. A blinded retrospective study was performed with a panel of seven radiologists comprised of false negative actionable mammograms obtained up to 5.8 years prior to diagnosis and 32 normal studies. Each radiologist viewed the cases without and then with benefit of cmAssist TM (CureMetrix, La Jolla, CA) AI based computer-aided detection (AI-CAD) flags and neuScore TM (quantitative AI-based probability for malignancy of flagged lesions, 1-100 scale). Reader decision making changes in true and false positive recalls with and without AI were analyzed.

RESULTS

All radiologists showed a significant improvement in their cancer detection rate (CDR) with the use of AI-CAD and neuScore ($p = 0.0069$, C.I. = 95%). With the assistance of AI software, the sensitivity of less experienced general radiologists improved to a level higher than a fellowship-trained academic mammographer. The readers detected between 25% and 71% (mean 51%) of the early cancers without assistance. With AI software results,, overall reader CDR was 41% to 76% (mean 62%). Overall, there was less than 1% increase in the readers' false positive recalls with use of the AI software.

CONCLUSION

There was a statistically significant improvement in radiologists' sensitivity for cancer detection in this enriched data set of primarily false negative mammograms with the benefit of the AI-CAD with neuScore. The percentage increase in CDR for the radiologists in the reader panel, ranged from 6% to 64% (mean 27%) with the use of AI-CAD, with negligible increase in false positive recalls.

CLINICAL RELEVANCE/APPLICATION

This study shows a measurable, significant benefit for radiologists in mammography interpretation with the use of artificial intelligence (AI) based computer-aided detection software with quantitative scoring. The use of AI in clinical practice may potentially expedite workflow, enhance earlier detection of cancer, and reduce false negative mammograms.

SSK02-08 Data-Driven Imaging Biomarker for Breast Cancer Screening in Digital Breast Tomosynthesis

Wednesday, Nov. 28 11:40AM - 11:50AM Room: E451B

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PURPOSE

To assess feasibility of a data-driven imaging biomarker in digital breast tomosynthesis (DIB-DBT) using the deep learning technology and evaluate its potential for detection of breast cancer.

METHOD AND MATERIALS

We retrospectively collected 49,577 exams of 4-view digital mammograms (MMG) and 1,196 exams of 4-view digital breast tomosynthesis images (DBT) from a single institution. We also collected 41 (10 cancer, 16 benign, 15 normal) exams of 4-view DBT retrospectively from another institution for external validation. 49,577 exams of MMG consists of 47,719 (5,599 cancer, 17,971 benign, and 24,149 normal) and independent 1,858 (619 cancer, 620 benign, 619 normal) exams of training and validation data, respectively. 1,196 exams of DBT consists of 996 (822 cancer, 40 benign, 134 normal) and independent 200 (120 cancer, 30 benign, 50 normal) exams of training and validation data, respectively. Previously, we assessed the feasibility of DIB-MMG as a screening tool for breast cancer detection in mammograms through external validation and pilot reader study. Thus, we exploit DIB-MMG for developing DIB-DBT in this study. Training of DIB-DBT consists of two stages - semi-supervised pre-training with partially-annotated large-scale MMG followed by fully-supervised fine-tuning with fully-annotated small-scale DBT. Residual network for image recognition is used as a baseline model. Diagnostic accuracy of DIB-DBT was assessed using receiver operating characteristic analysis.

RESULTS

Area under the curve (AUC) on the internal validation dataset of DIB-DBT with and without the pre-training stage of DIB-MMG was 0.9227 and 0.9081, respectively. AUC of the external validation dataset of DIB-DBT with and without the pre-training stage of DIB-MMG was 0.9710 and 0.9232, respectively.

CONCLUSION

This study showed the feasibility of DIB-DBT as a screening tool for breast cancer detection in DBT. This research also showed the potential of DIB-MMG as a base model for DIB-DBT. Further clinical validation of DIB-DBT is needed for using it as a reliable screening tool for breast cancer screening.

CLINICAL RELEVANCE/APPLICATION

With further clinical validation, DIB-DBT could be practically used as a second-reader to help radiologists detecting and diagnosing breast cancer in DBT efficiently.

SSK02-09 Improved Performance of Machine Learning-Based Analysis of Mammography by Using Digital Breast Tomosynthesis Versus 2D Mammography

Wednesday, Nov. 28 11:50AM - 12:00PM Room: E451B

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PURPOSE

Digital Breast Tomosynthesis (DBT) has been shown to be clinically superior to both full-field digital mammography and synthetic two-dimensional mammography (2D) for breast cancer detection. However, few studies to date have compared machine learning (ML) algorithmic performance in DBT versus 2D in large data sets. Technically, the much larger size of a DBT acquisition could actually be a hindrance for training convolutional neural networks (CNNs), for example via overfitting. Such technical issues could in turn imply impracticality of ML for DBT or a need for much larger training datasets. We sought to implement CNNs for both DBT and synthetic 2D X-ray mammograms and compare their performance.

METHOD AND MATERIALS

We compiled two separate datasets consisting of de-identified images and linked reports, collected from multiple mammography centers following an IRB-approved protocol. Data originated from equipment from the same manufacturer across all sites, and included presentation DBT and synthetic 2D images. We developed a novel CNN architecture and trained this model on the first dataset consisting of 22,000 DBT studies (323 cases of confirmed malignancy), where radiology reports and MQSA outcome data were used as estimates of ground truth. To simulate a more realistic evaluation scenario, the CNN was then tested on the second dataset collected from a different center. Using a test set of 1,750 screening DBT studies (94 confirmed cancers), receiver operating characteristic (ROC) curves and the corresponding area-under-the-curve (AUC) were calculated on both the full DBT study, and on just the synthetic 2D data alone.

RESULTS

AUC values for performance on the test dataset were: 2D: 0.894. DBT: 0.915. ($p < 0.01$ for difference between 2D and DBT on the full test dataset). At typical operating points (sensitivity 0.75 to 0.90) this corresponds to an average 19.6% relative decrease in model callback rates for the model (e.g., at sensitivity=0.8, from ~15% to ~11%).

CONCLUSION

ML can be applied successfully to DBT and results in improved performance over synthetic 2D mammography.

CLINICAL RELEVANCE/APPLICATION

Machine learning could play an important role in screening mammography, not only for traditional 2D mammography, but also when used with DBT; thus, ML is not in conflict with DBT but complementary and could further improve breast cancer screening performance.

SSK03

Cardiac (CT, MRI and PET: General Topics)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S102CD

CA CT MR NM

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

SSK03-01 Predictive Value of Cardiac CT, Cardiac MR, and Transthoracic Echocardiography for Cardioembolic Stroke Recurrence

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PURPOSE

To determine the sensitivity, specificity, and predictive value of cardiac CT angiography (cCTA), cardiac MR (CMR), and transthoracic echocardiography (TTE) for stroke recurrence in patients with suspected cardioembolic stroke.

METHOD AND MATERIALS

163 patients (55% men, 61.9±16.9 years) with suspected cardioembolic stroke who underwent TTE, CMR, or cCTA between January 2013 and May 2017 were retrospectively analyzed. The presence of left atrial thrombus, left ventricular thrombus, complex aortic plaque, cardiac tumors, and valvular vegetation was evaluated. The patient electronic medical records were used to determine if the patient suffered a recurrent stroke. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for each imaging modality and the diagnostic accuracy was compared using receiver operating characteristic analysis.

RESULTS

cCTA was performed in 82 patients, CMR in 81 patients, and TTE in 151 patients. 28 recurrent strokes occurred (cCTA- n=14; CMR- n=14; TTE- n=26). The sensitivity, specificity, PPV and NPV were: 14%, 79%, 12.5%, and 81.5% for CMR; 28.5%, 88.2%, 33.3%, and 85.7% for cCTA; and 11.5%, 88.8%, 17.6%, and 82.8% for TTE. There was no significant difference in diagnostic accuracy between CMR (0.53, 95% CI [0.42, 0.64]), cCTA (0.56, 95% CI [0.43, 0.69]), and TTE (0.50, 95% CI [0.43, 0.57]).

CONCLUSION

cCTA, CMR, and TTE demonstrated comparably high specificity and NPV for the exclusion of cardioembolic stroke recurrence.

CLINICAL RELEVANCE/APPLICATION

The comparable performance of cCTA, CMR, and TTE in predicting recurrent cardioembolic stroke allows physicians to choose a preferred imaging modality for patients with suspected cardioembolic stroke.

SSK03-02 Quantitative Assessment of Myocardial Infarction with Computed Tomography (CT) Using a Bolus Contrast Injection Scheme: Comparison Between Extravascular Contrast Distribution Volume (ECDV) and Extracellular Volume Fraction (ECV)

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S102CD

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PURPOSE

Myocardial viability can be assessed with CT by delineating the infarcted tissue with a higher degree of contrast retention in the late phase after bolus injection of iodinated contrast. In this study, we investigated the effectiveness of two metrics for the quantification of late iodine enhancement in myocardium for viability assessment.

METHOD AND MATERIALS

Reperfused acute myocardial infarction was induced in four farm pigs with 1-hr occlusion of the left anterior ascending artery (LAD) with a balloon catheter, and CT studies were performed within 2 weeks after the interventional procedure. After bolus injection of contrast at 3 mL/s and 0.7 mg/kg followed by saline flush, a 4-phase dynamic acquisition covering 10 min was performed with a GE Healthcare Revolution CT scanner at 100 kV, 100 mA, 280 ms/rot: 1st phase: 22 axial scans every 1-2 diastoles; 2nd: 6 scans every 15 s; 3rd: 4 scans every 30 s; 4th: 6 scans every 60 s. Dynamic images were analyzed with a model-based deconvolution approach, with the modified Johnson-Wilson-Lee tracer kinetic model used to describe the contrast exchange among the cellular and interstitial and vascular spaces in myocardium to derive ECDV in ml/g. The difference images were also generated by subtracting the images acquired at 10 min post contrast injection by the baseline images to obtain enhancement in the myocardium (ΔHUmyo) and left ventricular blood pool (ΔHUblood). ECV was then calculated as (1-Hematocrit)·(ΔHUmyo/ΔHUblood). ECDV and ECV in normal (LCx territory) and infarcted myocardium (LAD territory) were compared.

RESULTS

Mean ECV in normal and infarcted myocardium were 0.27±0.11 and 0.52±0.11 respectively. The corresponding mean ECDV calculated from the dynamic images covered up to 3 min post contrast injection were 0.28±0.07 ml/g and 0.60±0.10 ml/g respectively. Infarcted myocardium exhibited a higher percentage increase in ECDV from normal myocardium (114%) compared to ECV (93%).

CONCLUSION

ECDV may be a more sensitive marker of myocardial viability compared to ECV due to the larger difference exhibited between the normal and infarcted tissues, and can be measured with only 1/3 of the time required for ECV (3 min vs. 10 min post contrast injection).

CLINICAL RELEVANCE/APPLICATION

With bolus contrast injection, ECDV measurement could provide a faster and more reliable assessment of myocardial viability after acute myocardial infarction compared to conventional ECV measurement.

SSK03-03 Feasibility of Myocardial Extracellular Volume Fraction Quantification Using Dual-Energy CT

Wednesday, Nov. 28 10:50AM - 11:00AM Room: S102CD

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PURPOSE

To assess the feasibility of Dual Energy CT (DECT) to derive myocardial extracellular volume (ECV) and detect ECV differences without the need for a true non-contrast scan compared to Single Energy CT (SECT) results.

METHOD AND MATERIALS

A total of 35 patients were included in this IRB-approved, HIPAA-compliant study; 8 control patients, 17 infarct patients (focal fibrosis), and 10 cardiomyopathy patients (diffuse fibrosis). All scans were acquired using a 2nd or 3rd generation dual source CT system. A true non-contrast and delayed acquisition were used to calculate SECT-ECV, while only the delayed acquisition in dual energy mode and derived virtual non-contrast images were used to calculate DECT-ECV. In the control and diffuse fibrotic groups, a region of interest (ROI) encompassing the entire left ventricular myocardium was used to calculate ECV. Two ROIs were placed in the focal fibrotic group; one in normal myocardium and one in fibrotic myocardium.

RESULTS

The median ECV was 33.4% (IQR, 30.1-37.4) for the SECT approach and 34.9% (IQR, 31.2-39.2) for the DECT approach (p =

0.401). For both SECT-ECV and DECT-ECV, focal fibrotic and diffuse fibrotic tissue had significantly higher ECV values compared to normal myocardium (all p < 0.021). No systematic bias was observed between SECT and DECT measurements, with limits of agreement calculated at ± 9.4% (p = 0.348). The DECT acquisition had a lower radiation dose than the SECT scan by 1.1 mSv (p < 0.001), which was likely caused by the absence of the true non-contrast acquisition in the DECT approach.

CONCLUSION

Measurement of ECV with only a delayed acquisition is feasible using the DECT approach. The DECT approach provides similar results at a lower radiation dose compared to a SECT protocol.

CLINICAL RELEVANCE/APPLICATION

This study demonstrates the feasibility of DECT for myocardial ECV measurements using only a delayed acquisition, thus eliminating the need for a true non-contrast scan and consequently reducing radiation dose.

SSK03-04 Accuracy of Myocardial Blood Flow Quantification with Dual-source CT: Validation in Human Using 15O-Water PET

Wednesday, Nov. 28 11:00AM - 11:10AM Room: S102CD

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PURPOSE

Myocardial CT perfusion has emerged as a potential method for absolute quantification of myocardial blood flow (MBF). However, there is no standardized technique for CT MBF quantification, and dual-source CT MBF values have never been compared against positron emission tomography (PET), which is an established technique for non-invasive quantification of MBF. The aim of this study was to assess the accuracy and usefulness of absolute MBF values quantified with dual-source CT by comparing them with those quantified with 15O-water PET.

METHOD AND MATERIALS

Dynamic CT perfusion and 15O-water PET were performed in 26 patients (70+/-9 years, 22 male) with known/suspected coronary artery disease with a median interval of 48 days (interquartile range: 29-73 days). Hyperemic MBF in AHA 16 segments were quantified with a dual-source CT and its dedicated software (Force/VPCT body, Siemens). For the quantification of hyperemic MBF using 15O-water PET, non-commercial software (Carimas) was used. Comparison of hyperemic MBF quantified by CT and PET was performed on segment (n=377), vessel (n=77), and patient (n=26) levels after exclusion of 7 segments out of FOV and 32 segments with transmural myocardial infarction.

RESULTS

CT results showed excellent linear correlation with PET results at segment (r=0.87, p<0.0001), vessel (r=0.91, p<0.0001), and patient level (r=0.93, p<0.0001). Area under the receiver-operating characteristics curve for detecting reduced MBF (<2.3 mL/min/g) on 15O-water PET was 0.88, 0.91, and 0.92 at segment, vessel, and patient level, respectively. Although CT demonstrated significantly lower hyperemic MBF than PET (1.16 ± 0.29 mL/min/g vs 2.46 ± 1.56 mL/min/g, p<0.0001), there was good per-vessel sensitivity (79.5%), specificity (92.1%), negative predictive value (81.4%) and positive predictive value (91.2%) for diagnosing reduced PET-derived MBF with a CT-derived MBF cutoff value of 1.09 mL/min/g.

CONCLUSION

Hyperemic MBF quantified by CT demonstrated excellent correlation with MBF estimated by 15O-water PET, and yielded high diagnostic accuracy for detecting abnormal perfusion.

CLINICAL RELEVANCE/APPLICATION

CT MBF quantification has potential to provide objective assessment of perfusion abnormality in patients with known or suspected CAD with high accuracy comparable to 15O-water PET.

SSK03-05 Relationship Between Epicardial Adipose Tissue and Coronary Vascular Function in Patients with Normal Myocardial Perfusion by 82Rb PET/TC

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S102CD

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PURPOSE

We assessed the relationship between epicardial adipose tissue (EAT) and coronary flow reserve (CFR) in patients with suspected or known coronary artery disease (CAD) and normal myocardial perfusion imaging (MPI).

METHOD AND MATERIALS

The overall population consisted of 272 subjects referred for the evaluation of suspected or known CAD to stress-rest 82Rb PET/CT and showing normal MPI. CAC score was measured according to the Agatston method. Using unenhanced CT images for CAC, EAT volume was measured (cm3). The ln(CAC+1) score and lnEAT transformation were used to reduce heteroscedasticity. Myocardial perfusion was assessed using standardized segmentation of 17 myocardial regions. The summed stress, summed rest and summed difference scores were automatically calculated. Myocardial perfusion was considered normal when the summed stress score was <3. Absolute myocardial blood flow (MBF) was computed (in milliliters per minute per gram) from the dynamic rest and stress imaging series. CFR was defined as the ratio of hyperemic to baseline MBF; CFR 2 was considered reduced.

RESULTS

In the overall population, 95 (35%) patients showed reduced and 177 (65%) normal CFR. Compared to patients with normal CFR, those with reduced CFR were older (60±11 vs. 67±9, P<0.05) and showed higher values of ln(CAC+1) (3.9±3 vs. 4.7±3, P<0.05) and lnEAT volume (4.5±1 vs. 4.7±.1, P<0.05). At univariable logistic regression analysis age, ln(CAC+1) and lnEAT resulted significant predictors of reduced CFR. At multivariable analysis, only age and lnEAT volume were independently associated with reduced CFR (hazard ratio 1.05 and 1.89 and 95% confidence interval 1.02-1.08 and 1.01-3.54, P<0.005). The addition of lnEAT to clinical data significantly increased the global chi-square of the model (from 23.8 to 28.6, P<0.05) in predicting reduced CFR.

CONCLUSION

In patients with suspected and known CAD and normal myocardial perfusion, age and EAT are strongly associated with reduced CFR confirming that visceral fat depot may directly influence coronary vascular function. Thus, EAT evaluation may play a major role in the identification of coronary vascular dysfunction in patients with normal perfusion.

CLINICAL RELEVANCE/APPLICATION

In patients with suspected and known CAD and normal myocardial perfusion, age and EAT are associated with impaired CFR confirming that visceral fat may directly influence coronary vascular function.

SSK03-06 Beyond CT-Fractional Flow Reserve (FFR): Non-Invasive Assessment of Instantaneous Wave Free Ratio (iFR), Coronary Flow Reserve (CFR) and Hyperemic Stenosis Resistance Index (HSR) from CTA

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S102CD

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PURPOSE

Although FFR can be assessed by CTA, patient management in the cathlab uses eg, iFR to avoid pharmacologic stress, or CFR and HSR to assess other factors associated with increased risk of major adverse cardiac events, such as microvascular disease or endothelial dysfunction. Estimating these metrics from CTA requires matched baseline and hyperemic simulations (ie, stress simulated using results obtained from rest simulation), which no technology to date provides. We sought to determine if coupling rest/stress computational fluid dynamics (CFD) simulations from CTA is feasible, and whether resulting metrics agree with known relationships of those metrics to reference-standard FFR.

METHOD AND MATERIALS

Rest-stress hemodynamics from CTA were performed for 50 patients with invasive FFR in intermediate lesions in <90d of CTA. Rest CFD was performed using only CTA data (myocardial mass, Murray's law). Stress CFD was then performed by coupling the epicardial arteries to a microvascular resistance model using the resistances estimated by the rest CFD for each myocardial territory. Hemodynamic metrics were calculated at the same location as invasive FFR as follows: CT-FFR=stress P/aortic stress P; CT-iFR=rest P/aortic rest P; CT-CFR from average peak velocity (APV), CFR=stress APV/rest APV; and CT-HSR=(aortic stress P-stress P)/stress APV. Correlation to FFR and receiver operating characteristic area-under-the-curve (AUC) to predict FFR<=0.8 was determined for each metric.

RESULTS

Target lesion DS was 46.8±8.7%, and 40% had FFR<=0.8. Pearson correlations against invasive FFR of CT-FFR, CT-IFR, CT-CFR and CT-HSR were r=0.70, 0.69, 0.35, and -0.71, respectively (all p<0.01). Diagnostic accuracy to detect FFR<=0.8 was 0.87 (95%CI:0.77-0.98), 0.86 (95%CI:0.75-0.97), 0.72 (95%CI:0.56-0.88), and 0.9 (95%CI:0.8-0.99), respectively. These match reported relationships between invasive FFR and iFR, CFR and HSR (eg, Pearson r~0.75 for iFR and r~0.34 for CFR compared to FFR, and AUC of FFR to predict significant HSR of ~0.94).

CONCLUSION

Coupling baseline and hyperemic simulations enables key physiologic parameters dependent on both pressure and flow to be estimated non-invasively from standard retrospective CTA.

CLINICAL RELEVANCE/APPLICATION

Evaluation of coronary artery disease by CTA can non-invasively assess coronary physiology beyond FFR, delivering key physiologic

information that is used in clinical decision making for patients with angina

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Frank J. Rybicki III, MD, PhD - 2016 Honored Educator

SSK03-07 Feasibility of Coronary Flow and Velocity Measurement using 4D CTA Reconstruction

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S102CD

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PURPOSE

Commercially available CT scanners can achieve gantry rotation times of 0.3 s (~3 frames per second). However, the temporal resolution might not be sufficient to calculate blood flow and velocity in the coronary arteries, which are important for the diagnosis of coronary artery disease (CAD). Currently, ~1000 projection images are acquired during each gantry rotation. The purpose of this study was to determine the feasibility of a new reconstruction technique called 4D CTA, which calculates a 3D time frame for each projection image and therefore provides high temporal resolution for flow calculations in the coronary arteries.

METHOD AND MATERIALS

The previously described 4D DSA technique (Davis, 2013) was extended for the time-resolved 3D reconstruction of coronary arteries (CA). A pig study was retrospectively analyzed, where continuous axial CT acquisitions (64 slices) were performed with a 0.4 s gantry rotation time over a period of 50 s during intravenous contrast injection. A 3D image of the vasculature was reconstructed using a short scan (235 degrees) during diastole and the CA were manually segmented. A constrained back-projection was then performed for each projection image to create a 3D time frame. The reconstructed time attenuation curves were used to calculate the blood flow and velocity in the CA based on the mean transit time. The velocity and flow values were compared to values from literature and the flow conservation was determined.

RESULTS

In the first order branches, the average diameter, velocity and flow were 4.12 mm (3.28 mm), 110.43 mm/s (128 mm/s), and 1.44 ml/s (1.07 ml/s) respectively. The same measurements for the second order branches were 1.31 mm (1.70 mm), 63.34 mm/s (46.10 mm/s) and, 0.32 ml/s (0.10 ml/s) respectively. Values given in brackets are from literature as reported in Kassab et al. (1997) The flow conservation in the measured branches of the CA was 96.71 %.

CONCLUSION

Calculated coronary arterial velocity and flow correlated well with previously reported values from the literature suggesting that flow determination from 4D CTA is feasible. Additionally, the high flow conservation shows that the calculated values are consistent.

CLINICAL RELEVANCE/APPLICATION

The presented technique could provide both anatomical and functional information in diagnostic settings as well as cath labs using existing CT systems to detect pathologies of the coronary arteries.

SSK03-08 Deep Learning Reconstruction of Non-Contrast Magnetic Resonance Coronary Angiography at 3T Machine

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S102CD

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PURPOSE

Dedicated T2 preparation pulse have enabled non-contrast magnetic resonance coronary angiography (MRCA) at 3T system; however, the vascular contrast-to-noise ratio (CNR) is still inadequate for clinical use. The deep learning reconstruction (DLR) is a novel technique to improve the image quality. The purpose of this study was to investigate the effects of DLR on the image quality of 3T non-contrast MRCA.

METHOD AND MATERIALS

We enrolled 10 volunteers (2 female, mean age 48 years) with no known coronary artery disease. Non-contrast MRCA was performed on a 3T MR scanner (Galan 3T ZGO, Canon medical) with following parameters: 3D fast FE, TR/TE =5.3/1.9ms, flip angle = 12°, slice thickness = 1.7mm with ECG trigger and real time motion correction. DLR images at moderate level and high level were generated by using dedicated workstation. In the quantitative evaluation, we measured signal-to-noise ratio of 3 coronary vessels (proximal and distal segments). In the qualitative evaluation, the 2 observers graded the vessel visualization and artifacts on a 4-point scale (worst, 1; best, 4).

RESULTS

The CNR (original MRCA) was 31 ± 7 and 16 ± 5 in the proximal and distal vessel, respectively. The corresponding CNR (moderate-level DLR) was 46 ± 9 and 24 ± 10; and the CNR (high-level DLR) was 85 ± 20 and 45 ± 14. The visual scores for overall image quality and image noise were significantly better in DLR images than original images. The vessel sharpness scores were comparable among 3 reconstructions (3.4, 3.8, and 3.8 for original, moderate DLR, and high DLR, respectively). The visual scores for image noise/graininess was significantly better in DLR (2.4, 3.8, and 4.0 for original, moderate DLR, and high DLR, respectively).

CONCLUSION

Non-contrast MRCA at 3T using DLR provides higher CNR without degrading the vessel sharpness.

CLINICAL RELEVANCE/APPLICATION

The deep learning reconstruction technique contributes in improved visualization of coronary arteries in non-contrast MR coronary angiography, enabling noninvasive scrutiny of the heart.

SSK03-09 Clinical and Transthoracic Echocardiography Predictors of Non-Detectable Left Ventricular Thrombus: When Is Cardiac Magnetic Resonance Necessary

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S102CD

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PURPOSE

Currently, transthoracic echocardiography (TTE) remains the most commonly used technique for the identification of LV thrombi. However, not all thrombi are visualized with TTE. Therefore, the purpose of our study was to identify predictors of unsuccessful TTE thrombus visualization and to develop a risk score to stratify which patients may benefit from cardiac magnetic resonance (CMR) to reliably detect or exclude LV thrombus.

METHOD AND MATERIALS

We performed a retrospective search of our CMR database including 10300 patients and identified 118 patients with LV thrombus and a time interval between CMR and TTE of <72h. Univariate logistic regression analysis was used to assess the association between baseline characteristics and TTE parameters with the primary endpoint (i.e. unsuccessful LV thrombus visualization on TTE). Variables with P<0.10 at univariate analysis were included as covariates in the multivariate logistic regression analysis. Receiver-operating characteristic (ROC) curve analysis was performed to examine differences in performance of each variable for prediction of the primary endpoint. A two-sided P-value<0.05 was considered to represent a significant difference.

RESULTS

In multivariate analysis, body mass index (BMI), LV end-diastolic diameter (EDD), and mitral valve regurgitation (MVR) were identified as significant predictors of unsuccessful LV thrombus visualization by TTE (all P<0.001). ROC analysis showed BMI >=26.9 kg/m2, LVEDD >=52 mm, and MVR >=2/4 to be the optimal cutoff points for prediction of the primary endpoint. The combination of the independent predictors allowed generation of a gradient response risk score of unsuccessful LV thrombus visualization by TTE (0/3 present: 0% missed; 1/3 present: 33.3% missed; 2/3 present: 79.5% missed; 3/3 present: 100% missed) (P<0.001).

CONCLUSION

Individual clinical and TTE parameters can predict the sensitivity of TTE for the successful detection of LV thrombus in heart disease. By using the presented risk score, a cost-effective strategy may be implemented by selectively referring patients to CMR when these risk factors are present.

CLINICAL RELEVANCE/APPLICATION

Clinical and TTE parameters can predict unsuccessful detection of LV thrombus in heart disease. These findings may lead to a cost-effective referral of certain patients to CMR to rule out LV thrombus.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSK04

Cardiac (Valves Imaging and Intervention)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S103AB

CA CT IR VA

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

FDA Discussions may include off-label uses.

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Jonathon A. Leipsic, MD, Vancouver, BC (*Moderator*) Speakers Bureau, General Electric Company; Speakers Bureau, Edwards Lifesciences Corporation; Consultant, Heartflow, Inc; Consultant, Circle Cardiovascular Imaging Inc; Consultant, Edwards Lifesciences Corporation; Consultant, Neovasc Inc; Consultant, Samsung Electronics Co, Ltd; Consultant, Koninklijke Philips NV; Consultant, Arineta Ltd; Consultant, Pi-Cardia Ltd;
Robert C. Gilkeson, MD, Cleveland, OH (*Moderator*) Research Consultant, Riverain Technologies, LLC; Research support, Koninklijke Philips NV; Research support, Siemens AG; Research support, General Electric Company

Sub-Events

SSK04-01 Morphologic and Hemodynamic Characteristics of Low-Flow, Low-Gradient Aortic Stenosis: Cardiac CT and Echocardiography.

Participants
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Dong Hyun Yang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Aortic stenosis(AS) have a quite proportion of low-flow, low-gradient(LF/LG) AS, defined as small aortic valve area(AVA<1.0cm2) but a low mean pressure gradient(PG<40mmHg) and low flow(stroke volume<35ml/m2). Diagnosis of AS has been based on a valve area, mean PG and a peak flow velocity measured on echocardiography. However, there was a discrepancy between the measured AVA on cardiac CT and degree of AS on echocardiography. The purpose of this study was to evaluate the discrepancy between CT and echocardiography, and show the role of CT to detect LF/LG AS.

METHOD AND MATERIALS

Between June 2011 and Mar 2016, 465 patients with AS underwent CT for preoperative evaluation of aortic valve replacement. On CT, aortic annulus, AVA and aortic root size were measured. Clinical information including echocardiography findings was retrospectively collected. On echocardiography, severe AS was defined as peak velocity >4 m/s or mean PG <40mmHg. On CT, severe AS was defined as AVA <1.0 cm2. Patients were classified into four groups: Group 1) severe AS on both CT and echocardiography (n=282); Group 2) Severe AS on CT alone (n=49); Group 3) Severe AS on echocardiography alone (n=99); and Group 4) non-severe AS on both CT and echocardiography (n=35). Echocardiography and CT findings were compared among the groups.

RESULTS

AVA in both group 1 and 2 were similar (0.8 and 0.8cm2, respectively, P=0.99). However, in group 2, left ventricular ejection fraction (LVEF) (59.3 vs. 54.1%, P=0.02) and mean PG (67.5 vs. 28.5mmHg, P<0.001) ware significantly low compared to those in group 1, suggests LF/LG severe AS. Peak velocity was also smaller in group 2 (5.2 vs. 3.1m/s, P<0.001). LV mass index and B-type natriuretic peptide were no significant difference among the four groups.

CONCLUSION

In 32% of patients who required AVR due to AS, there was a discrepancy between the measured AVA on CT and degree of AS on echocardiography. Patients who showed peak velocity <4m/s or mean PG <40mmHg on echocardiography and AVA<1.0cm2 on CT show significantly lower EF, peak velocity, and mean PG, which suggests characters of LF/LG AS. CT may be useful to detect LF/LG AS.

CLINICAL RELEVANCE/APPLICATION

Since echocardiography is useful for functional evaluation of LV and CT can accurately measure the AVA, we can accurately evaluate the characteristics of AS using both modalities. The use of two modalities may help to risk stratify AS patients and to make therapeutic decision.

SSK04-02 Bioprosthesis Thrombosis After Transcatheter Aortic Valve Replacement: Cardiac Computed Tomography Findings

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S103AB

Participants
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PURPOSE

To evaluate post-transcatheter aortic valve replacement (TAVR) findings such as thrombosis and leaflet dysfunction using cardiac computed tomography.

METHOD AND MATERIALS

Among 397 post-TAVR patients, 133 patients underwent cardiac CT. After excluding immediate post-TAVR CT, 49 patients (23 CoreValve, 23 Sapien XT, and 3 Sapien 3) with CT obtained more than one month after TAVR were retrospectively reviewed. Leaflet opening limitation, bioprosthesis thrombosis, leaflet degeneration, and stent eccentricity were analyzed. Baseline immediate and follow-up echocardiography parameters were collected and analyzed.

RESULTS

Median intervals between TAVR and CT was 13 months (range: 9.4 - 24.5 months). Minimal subvalvular rim-like soft tissue thickening (n= 27, 55%) and mild thickening of leaflets (n=2, 4%) are detected, but the patients are asymptomatic without hemodynamic disturbance. Leaflet opening limitation is noted in 11 (22%, 7 mild, 3 moderate, and 1 severe reduction) patients, however, there was no correlation with echocardiography parameters. TAV thrombosis is noted in 9 (18%) patients. In the patients with TAV thrombosis, transvalvular peak velocity (2.9 vs. 2.5 m/sec) and pressure gradient (20.7 vs. 13.6 m/sec) are higher than the others, but without statistical significance (P<0.05). One patient who showed highest peak velocity and pressure gradient on echocardiography (5.4 m/sec and 71 mmHg) had extensive subvalvular and valvular soft tissue thickening on CT even though she have managed with intense anticoagulation. One infective endocarditis is occur. The smaller the size of the stent lumen at the valve level, the more the peak velocity and pressure gradient increases (r=-0.4, P=0.008).

CONCLUSION

Leaflet thrombosis, subvalvular soft tissue thickening and leaflet opening limitation following TAVR is not uncommon findings in patients who performed cardiac CT. Cardiac CT can demonstrate post-TAVR findings such as subvalvular soft tissue, valve thrombosis, leaflet opening limitation and stent lumen size.

CLINICAL RELEVANCE/APPLICATION

Although the majority of patients who present leaflet thrombosis, subvalvular soft tissue thickening or leaflet opening limitation following TAVR show subclinical conditions without hemodynamic disturbance on echocardiography, follow-up cardiac CT may help to detect early complications of TAVR.

SSK04-03 Dynamic Evaluation of 3D Mitral Annular Anatomy in Primary and Functional Mitral Regurgitation Patients Using Multiphase Cardiac CT: Implications for Trans-catheter Mitral Valve Replacement Planning

Wednesday, Nov. 28 10:50AM - 11:00AM Room: S103AB

Participants
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PURPOSE

To date, there is a relative lack of data regarding the use of CT to characterize dynamic geometry of the mitral valve (MV) in patients with MV disease. The aims of this study are: 1) to obtain 3D CT measurements of the mitral annulus throughout the cardiac cycle using a prototype mitral evaluation tool, and 2) to compare these measurements among patients with primary mitral regurgitation (PMR), functional (secondary) MR (FMR), and control patients without MR.

METHOD AND MATERIALS

Patients were retrospectively identified who underwent ECG-gated cardiac CT using a dual-source scanner (SOMATOM Definition, Siemens Healthcare). Multiphasic CT data was loaded into our prototype software. Multiple anatomical parameters were recorded in 3D space throughout the cardiac cycle (0-95%, at 5% increments), and included: annular circumference, planar surface area (PSA), anterior-posterior (A-P) or inter-commissural diameter, anterolateral-posteromedial (AL-PM) or septo-lateral diameter, and annular ellipticity. Comparisons were made among the three groups, with p<0.01 considered statistically significant.

RESULTS

A total of 145 subjects (age: 63.5±14.0 years, 64% males) were included in this study: 50 control, 50 with PMR, and 45 with FMR.

Mitral annular dimensions were significantly higher in the PMR group, followed by FMR and control groups, with circumference (144±11 vs. 131±14 vs. 117±8mm), PSA (1533±247 vs. 1229±269 vs. 1005±142mm2), A-P diameter (38±4 vs. 35±5 vs. 32±2mm), and AL-PM diameter (47±4 vs 41±4 vs. 39±3mm) (all p<0.001). Notably, different patterns were observed among the three groups regarding the change in annular dimensions across cardiac phases, with FMR maintaining relatively similar size while control and PMR both had substantial size changes, but with maximal and minimal sizes at different cardiac phases. However, no statistically significant difference was demonstrated for annular ellipticity among control versus pathological groups (p>0.01).

CONCLUSION

Multiphase cardiac CT affords assessment of mitral annular dynamicity in response to various types of MV disease. The dramatic variability in annular dimensions across the cardiac cycle demonstrates the significance of obtaining multiphasic 3D measurements.

CLINICAL RELEVANCE/APPLICATION

Multiphase ECG-gated cardiac CT offers dynamic, pre-procedural evaluation of complex 3D mitral valve geometry for catheter-guided prostheses in patients with various types of mitral valve disease.

SSK04-04 Differentiation of Pannus From Other Prosthetic Valve Abnormalities Using Computed Tomography Texture Analysis

Wednesday, Nov. 28 11:00AM - 11:10AM Room: S103AB

Participants
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PURPOSE

The purpose of this study was to determine whether quantitative computed tomography (CT) texture analysis features can differentiate the cause of prosthetic valve obstruction (PVO) in patients who had undergone prosthetic valve replacement.

METHOD AND MATERIALS

We retrospectively included 46 subprosthetic masses in 39 patients who were clinically suspected prosthetic valve dysfunction and underwent cardiac CT scan from March 2010 to December 2017. The cause of PVO was assessed by redo-surgery and follow-up imaging findings as standard reference, and classified as pannus, thrombus or vegetation. CT texture analysis was performed with drawing region-of-interests of subprosthetic mass using an in-house texture analysis software and features such as first-order statistics, size and volume, and gray-level co-occurrence matrix (GLCM) features were extracted. Features on texture analysis were compared between two groups (pannus vs. thrombus or vegetation) using Mann-Whitney U test. Logistic regression analysis was performed to investigate association between quantitative CT features and pannus formation.

RESULTS

Of 46 subprosthetic masses, there were 19 cases with pannus, 14 cases with thrombus, and 13 cases with vegetation. Patients with pannus tended to be female, and had higher mean and standard deviation of CT attenuation, percentile value of the cumulative histogram (Perc25, 50, 75, 90, 95), and GLCM features (moments and contrast), and smaller volume, with statistical significance (P<0.05).On multivariate logistic regression analysis, mean CT attenuation (OR: 5.71; 95% CI: 0.48, 68.43; p=0.1691), volume (OR: 5.52; 95% CI: 0.88, 34.59; p=0.068), GLCM moments and GLCM contrast (OR: 6.00; 95% CI: 0.72, 50.40; p=0.0987 and OR: 12.07; 95% CI: 1.31, 110.90; p=0.0277) of subprosthetic mass were significantly associated with pannus.

CONCLUSION

Quantitative features on CT texture analysis may help differentiating pannus from thrombus or vegetation in patients with suspected PVO.

CLINICAL RELEVANCE/APPLICATION

Quantitative CT texture analysis can differentiate pannus from other causes of prosthetic valve obstruction and may diminish the subjectivity of visual analysis.

SSK04-05 CT Virtual Endoscopic Findings of Bicuspid Aortic Valve in Patients with Severe Aortic Stenosis: Comparison with Surgical Diagnosis

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S103AB

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PURPOSE

CT has been known to have high diagnostic accuracy for bicuspid aortic valve (BAV). However, CT findings of BAV remain unclear,

CT has been known to have high diagnostic accuracy for bicuspid aortic valve (BAV). However, CT findings of BAV remain unclear. The aim of our study was to evaluate diagnostic characteristics of CT findings for BAV compared with surgical diagnosis as the reference standard.

METHOD AND MATERIALS

This retrospective study included 112 consecutive patients with severe aortic stenosis who underwent preoperative cardiac CT, followed by surgical aortic valve replacement (57% woman, mean age, 70 years [range, 27-92]). All CT images were acquired using retrospective ECG-gated helical scan, from the aortic arch to the heart. Optimal stationary systolic and diastolic phase images were reconstructed at the slice thickness of 0.5 mm, and surgical-view virtual endoscopic images were reconstructed on a workstation. CT findings included shape of orifice (oval or the letter 'Y') and the number of leaflet (2 or 3) on systolic images, and balance of leaflet size (central angle of >= 150¬° or 120-149° in the largest leaflet) and the number of commissure (2 or 3) on diastolic images. For each CT findings, oval orifice, 2 leaflets, central angle of >= 150° or 2 commissures were defined as BAV.

RESULTS

BAV was surgically found in 37% (41/112) of patients. Accuracy, sensitivity, specificity and area under the curve (AUC) (95% confidence interval) for the detection of BAV were as follows; number of leaflets, 0.86 (0.80-0.87), 0.98 (0.91-1.00), 0.79 (0.69-0.83) and 0.88 (0.82-0.93); orifice shape, 0.93 (0.87-0.96), 0.93 (0.82-1.00) 0.93 (0.87-0.99) and 0.93 (0.86-0.96); central angle, 0.92 (0.86-0.95), 0.76 (0.59-0.88), 0.98 (0.95-1.00) and 0.87 (0.79-0.93); and number of commissures, 0.87 (0.81-0.87), 0.63 (0.46-0.78), 1.00 (1.00-1.00) and 0.82 (0.73-0.88), respectively. Although there was no difference in accuracy (p = 0.147 by Cochran's Q test), sensitivity of the number of commissure or specificity of number of leaflet were the lowest among the CT findings (adjusted $p < 0.05$ for all by post-hoc Dunn's test with Bonferroni correction, respectively). AUC of number of commissure was lower than orifice shape and central angle ($p < 0.05$ for both by DeLong's test).

CONCLUSION

Although CT findings have high accuracy for detection of BAV, number of commissure showed lower sensitivity and AUC, and number of leaflet showed lower specificity.

CLINICAL RELEVANCE/APPLICATION

Knowledge of morphological CT characteristics of BAV may help diagnosis in patients with severe aortic valve stenosis.

SSK04-06 3D Printing of the Aortic Annulus Based on Cardiovascular Computed Tomography: Preliminary Experience in Pre-Procedural Planning for Aortic Valve Sizing

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S103AB

Participants
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PURPOSE

to determine reliability and reproducibility of measurements of aortic annulus in 3D models printed from cardiovascular computed tomography (CCT) images.

METHOD AND MATERIALS

Retrospective study on the records of 20 patients who underwent aortic valve replacement (AVR) with pre-surgery annulus assessment by CCT and intra-operative sizing by Hegar dilators (IOS). 3D models were fabricated by fused deposition modelling of thermoplastic polyurethane filaments. For each patient, two 3D models were independently segmented, modelled and printed by two blinded "manufacturers": a radiologist and a radiology technician. Two blinded cardiac surgeons performed the annulus diameter measurements by Hegar dilators on the two sets of models. Matched data from different measurements were analyzed with Wilcoxon test, Bland-Altmann plot and within-subject ANOVA.

RESULTS

No significant differences were found among the measurements made by each cardiac surgeon on the same 3D model (p=0.48) or on the 3D models printed by different manufacturers (p=0.25); also, no intraobserver variability (p=0.46). The annulus diameter measured on 3D models showed good agreement with the reference CCT measurement (p=0.68) and IOH sizing (p=0.11). Time and cost per model were: model creation 10-15 min; printing time 60 min; post-processing 5min; material cost 1 euro.

CONCLUSION

3D printing of aortic annulus can offer reliable, not expensive patient-specific information to be used in the pre-operative planning of AVR or TAVI.

CLINICAL RELEVANCE/APPLICATION

3D models of aortic annulus printed from CCT may offer a reliable, not expensive, patient-specific pre-operative planning opportunity: they provide the final user with a unique interactive platform for both visual and tactile experiences, which are critical

for simulation of the procedure, but are not available in imaging data per se.

SSK04-07 Improving the Diagnostic Performance of 18F-FDG PET/CT in Prosthetic Heart Valve Endocarditis

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S103AB

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PURPOSE

18F-Fluorodeoxyglucose (FDG) Positron-Emission Tomography/Computed Tomography (PET/CT) was recently introduced as a new tool for the diagnosis of prosthetic heart valve (PV) endocarditis (PVE). Previous studies reporting a modest diagnostic accuracy may have been hampered by unstandardized image acquisition and assessment, as well as several confounders. The aim of this study was to improve the diagnostic performance of FDG PET/CT in patients suspected of PVE by identifying and eliminating possible confounders, using both visual and standardized quantitative assessments.

METHOD AND MATERIALS

In this multicentre study, 160 patients with a PV who underwent FDG PET/CT for suspicion of PVE, as well as 77 patients with a PV who underwent FDG PET/CT for other indications (negative control group), were included. Their scans were reassessed by two independent observers blinded to all clinical data, both visually and quantitatively on EARL reconstructions. Confounders were identified using a binomial regression model, and subsequently eliminated.

RESULTS

Visual assessment of FDG PET/CT had a sensitivity/specificity/PPV/NPV for PVE of 74%/91%/89%/78%, respectively. Low inflammatory activity (CRP <40mg/L) at the time of imaging and use of surgical adhesives during PV implantation were significant confounders, while recent valve implantation was not. After elimination of significant confounders, diagnostic performance values of the visual assessment increased to 91%/95%/95%/91%. As a semi-quantitative measure of FDG uptake, an EARL-standardized SUVratio of >=2.0 was a 100% sensitive and 91% specific predictor of PVE.

CONCLUSION

Both visual and quantitative assessment of FDG PET/CT have a high diagnostic accuracy in patients suspected of PVE. FDG PET/CT should be implemented early in the diagnostic work-up to prevent negative confounding effects of low inflammatory activity (e.g. due to prolonged antibiotic therapy). As a quantitative measure of FDG uptake, an EARL-standardized SUVratio of >=2.0 is a 14 100% sensitive and 91% specific predictor of PVE. Recent valve implantation was not a significant predictor of false positive interpretations, but surgical adhesives used during implantation were.

CLINICAL RELEVANCE/APPLICATION

FDG PET/CT should be implemented early in the diagnostic work-up to prevent negative confounding effects of low inflammatory activity.

SSK04-08 Aortic Regurgitation in Hypertrophic Cardiomyopathy: A Cardiac Magnetic Resonance Study

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S103AB

Participants
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PURPOSE

We sought to investigate the prevalence, mechanism and risk factors of AR in patients with HCM by cardiac magnetic resonance(CMR).

METHOD AND MATERIALS

This is an retrospective study of 105 consecutive patients (49±16 years, 70% male) with HCM who underwent CMR between April to November, 2017. Cardiac morphological, functional paremeters and AR were evaluated by multi-plane cine images and velocity-encoded phase contrast images.Patients were divided into 2 groups by AR. The clinical and CMR characteristics were compared between the 2 groups, and predictors of AR assessed on multivariable logistic regression analysis.

RESULTS

AR was identified in 38 (36%) HCM patients including 25 (66%) with left ventricle outflow tract obstruction (LVOTO). AR was also more prevalent in obstruction group than that in non-obstruction group (52% vs. 23%, *p*=0.002). Patients with AR showed older age (58± 11 vs. 45±16 years, *P*<0.001), the higher prevalence of hypertension, mitral regurgitation (MR) and aortic valve thickening (55% vs. 33%, *P*=0.03; 90% vs.61%, *P*=0.006 and 40% vs. 9%, *P*<0.001, respectively). The distance of interventricular septum that protruded into the LVOT(D1), anterior mitral leaflet (AML) and left atrial diameter were greater and LVOT effective width (D3) were shorter in patients with AR than without it (13.5± 4.4 vs.10.6±4.0 mm, *P*=0.001; 25.5± 3.6 vs. 23.5±4.1mm, *P*=0.013 and 43.6± 8.6 vs. 39.1± 8.4mm, *P*=0.01; 10.2±5.3 vs. 13.7±5.9mm, *P*=0.003, respectively). On multivariable logistic regression analysis, the independent risk factors of AR were LVOTO and age.

CONCLUSION

This study has demonstrated that AR is not an uncommon consequence secondary to HCM. Age and LVOTO are the most probably risk factors of this pathophysiology consequence.

CLINICAL RELEVANCE/APPLICATION

(dealing with CMR) 'AR is a quite common comorbidity of HCM especially in patients with LVOTO . An earlier and better control of blood pressure and relieving LVOTO are required as early as possible to delay the progress of aortic valvular degeneration.'

SSK04-09 T1 Mapping as a Predictor for Persisting Valvular Cardiomyopathy in Patients with Chronic Aortic Regurgitation After Aortic Valve Repair

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S103AB

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PURPOSE

Left ventricular (LV) dysfunction is associated with poor prognosis in patients presenting with chronic aortic regurgitation. Unfortunately, LV-dysfunction often persists even after successful aortic valve (AV) repair. We aimed to evaluate the value of native T1 mapping by cardiac MRI as a predictor of valvular cardiomyopathy in patients with severe aortic regurgitation.

METHOD AND MATERIALS

31 consecutive patients (mean age 49.5±11.5 years, 52% men) with severe bicuspid (n=18) or tricuspid (n=13) aortic valve regurgitation and without previous history of coronary artery disease underwent 1.5 Tesla cardiac MR imaging. Native T1 mapping was performed using a modified Look-Locker inversion-recovery (MOLLI) sequence for quantification of diffuse interstitial myocardial fibrosis prior to AV repair and correlated with echocardiographic LV parameters before and after surgery.

RESULTS

Mean native T1 relaxation time of myocardium was 1025±44 ms (range: 898-1109 ms). There was no significant correlation between native T1 and preoperative LVEF (r=-0.1, p=0.6), LVEDD (r=-0.2, p=0.4), LVESD (r=-0.03, p=0.9), LVEDV (r=-0.02, p=0.9) and regurgitation fraction (r=-0.17, p=0.6). Fourteen patients (45%) had a postoperative decrease in LVEF more than 10% as compared to preoperative LVEF values. These fourteen patients showed significantly longer preoperative native T1 as compared to native T1 of patients with preserved postoperative LVEF (1056 ± 32 ms vs. 1019 ± 40 ms, p=0.03).

CONCLUSION

Native T1 mapping might be a promising predictor of postoperative LVEF decrease after AV repair for chronic severe aortic regurgitation.

CLINICAL RELEVANCE/APPLICATION

T1 mapping before aortic valve repair may guide and optimize aortic valve repair surgery in the future.

SSK05

Science Session with Keynote: Chest (Artificial Intelligence/Deep Learning)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: N227B

AI CH

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

Participants
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Sub-Events

SSK05-01 Chest Keynote Speaker: AI and Machine Learning in Thoracic Imaging

Participants
Bram Van Ginneken, PhD, Nijmegen, Netherlands (*Presenter*) Stockholder, Thirona BV; Co-founder, Thirona BV; Research Grant, Varian Medical Systems, Inc; Research Grant, Canon Medical Systems Corporation

SSK05-02 Application of Deep Learning for Risk Stratification of Pulmonary Nodules

Wednesday, Nov. 28 10:40AM - 10:50AM Room: N227B

Participants
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PURPOSE

The low dose CT (LDCT) screening criteria used in National Lung Screening Trial (NLST) has a 26.6% false positive rate at baseline. Even when updated more stringent Lung RADS criteria was retrospectively applied to the NLST data, the false positive rate remained at 12.8%. Deep learning, a form of artificial intelligence, has the potential to improve risk stratification of pulmonary nodules. The purpose of this study is compare the performance of deep learning vs. radiologists in the risk stratification of pulmonary nodules.

METHOD AND MATERIALS

264 patients with one solid nodule reported in NLST database up to 20mm (mean±standard deviation: 7.5±3.4mm) in size (223 benign, 41 malignant) were retrospectively selected from the NLST baseline LDCT (T0). All malignant nodules were confirmed pathologically and benign nodules were diagnosed based on pathology or clinical follow-up by NLST investigators. The nodules were semi-automatically segmented using our in-house software. 3D deep convolutional networks (CNN) was used for the deep learning classification of malignancy based on 64x64x64 input patch bounding intramodular and perinodular areas. 4-fold cross-validation was performed. Data augmentation by scaling and rotating was used to increase the number of training dataset. Two radiologists who were blinded to the diagnosis reviewed the cases independently and scored the nodules based on Lung RADS criteria. Scores 1 and 2 were considered negative and scores >= 3 were considered positive.

RESULTS

The selected cohort was 62.0±5.1 year-old-patients at T0 (150 male and 114 female). The average accuracy, sensitivity, and specificity of the review of radiologists were 0.67, 0.73, and 0.67, respectively. 4-fold cross validation result of deep learning was 0.88, 0.90, and 0.88 in the same terms of accuracy, sensitivity, and specificity. Especially, the false positive rate showed significant improvement from 0.33 to 0.12, which represents to reduce false positive cases from 73 to 27, using CNN.

CONCLUSION

Deep learning achieved improved sensitivity, specificity, and accuracy in risk stratification of pulmonary nodules compared with radiologists.

CLINICAL RELEVANCE/APPLICATION

Deep learning can improve the accuracy in risk stratification of pulmonary nodules compared with radiologists. This has the potential of achieving earlier cancer detection and reducing unnecessary work up in the lung screening population.

Honored Educators

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educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Elliot K. Fishman, MD - 2012 Honored EducatorElliot K. Fishman, MD - 2014 Honored EducatorElliot K. Fishman, MD - 2016 Honored EducatorElliot K. Fishman, MD - 2018 Honored Educator

SSK05-03 Deep Learning with Convolutional Neural Network for the Differentiation of Pathologic Grades in Lung Adenocarcinomas

Wednesday, Nov. 28 10:50AM - 11:00AM Room: N227B

Participants
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PURPOSE

To investigate the diagnostic performance of a deep learning method with a convolutional neural network (CNN) for the differentiation of pathologic grades in lung adenocarcinomas (ADs) manifesting as solitary lung nodules.

METHOD AND MATERIALS

This clinical retrospective study comprised preoperative CT image sets of lung ADs pathologically confirmed to be one of three grades (grade A, patterns with low metastatic potential [AIS, MIA, and lepidic-predominant]; grade B, patterns with intermediate metastatic potential [acinar and papillary]; and grade C, patterns with high metastatic potential [solid and micropapillary]). Supervised training was performed using 26,321 CT images (2390 sets) obtained between 2014 and 2016 (a total of 1066 image sets; 278, 718, and 70 nodules for grades A, B, and C, respectively; 609 enhanced and 457 non-enhanced). Image sets were augmented (rotated, parallel-shifted, strongly enlarged, and horizontal flipped images were generated from the original images) by a factor of 4 in images from grade A tumors and by a factor of 8 from grade C tumors. A CNN composed of 151 convolutional, two maximum pooling, and one fully connected layers was tested using independent 1268 image sets (762 enhanced and 506 non-enhanced) obtained between 2007 and 2013 (578 men and 690 women; mean age, 62.7 years ± 10.1; mean mass size, 23.5 mm ± 14.4; 400, 709, and 159 lung ADs of grades A, B, and C, respectively). Accuracy in categorizing lung ADs using the CNN model and the area under the ROC curve (AUC) for differentiating grades A vs. B+C, grade A vs. B, grade A vs. C, and grade B vs. C were calculated.

RESULTS

For the differentiation of grades A vs. B+C, diagnostic accuracy was 79.1% and AUC was 0.77 in the test data. For differentiating grades A vs. B, A vs. C, and B vs. C, diagnostic accuracies were 73.4%, 78.8%, 70.1% and AUCs were 0.77, 0.91, and 0.62, respectively.

CONCLUSION

Deep learning with CNN demonstrated high diagnostic performance in differentiating the pathologic grade of lung ADs.

CLINICAL RELEVANCE/APPLICATION

The CNN model can be useful in differentiating the pathologic grade of lung ADs, however, further study is warranted to correlate patients' prognoses with the output of CNN.

SSK05-04 Deep Machine Learning for Automatic Analysis of Chest X-Rays: Effect of Clinically Relevant Pathology Class Label Definition

Wednesday, Nov. 28 11:00AM - 11:10AM Room: N227B

Participants
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PURPOSE

To quantitatively analyze the effect of radiologically relevant pathology class label definition on deep machine learning results for automatic analysis of chest x-rays.

METHOD AND MATERIALS

With >100,000 frontal-view chest radiographs, the ChestX-ray14 data (Wang et al, 2017) is currently the largest publicly available annotated dataset for automatic chest x-ray analysis. Annotations consist of one or more of 14 thoracic pathology labels, e.g. Consolidation (C), Infiltration (I), Pneumonia (P) and 11 others. As radiologists cannot distinguish between C, I and P based on imaging findings alone, the stratification of these 'Opacity' entities into separate classes suggests a non-existent crispness of reported pathology class labels. To circumvent this key limitation of the ChestX-ray14 dataset and to investigate its effect on machine learning performance, we resampled data belonging to the 3 'Opacity' and 'No findings' classes, resulting in a 2-class classification problem with 63,000 chest x-rays. Images were resized to 10242 without preserving aspect ratio. Ensuring strict training/test (80%/20%) data separation, we fine-tuned a pre-trained ResNet-34 convolutional neural network with batch normalization, cross-entropy loss function, and last layer sigmoid activation. We also performed classification for all 14 individual pathology labels using the full dataset. Diagnostic accuracy was quantified using Area Under the receiver operating characteristics

Curve (AUC).

RESULTS

For 'Opacity/No Findings' classification, we obtained AUC=0.78. This is close to the best performance obtained for original labels I, C, P with AUCs of 0.72, 0.81, 0.73, respectively. For the remaining 11 class labels, AUCs were comparable to, and for some labels, slightly better than the best published results of current state-of-the art methods (Rajpurkar et al 2017).

CONCLUSION

Our results suggest that radiologically relevant pathology label definition is important for training deep machine learning systems for automatic chest x-ray analysis, as it can influence their performance. Merging visually indistinguishable pathology classes can address a key limitation of the ChestX-ray14 data by alleviating the effect of 'structured noise'.

CLINICAL RELEVANCE/APPLICATION

It is critical that the datasets being used for training artificial intelligence recapitulate the characteristics of datasets encountered in a radiology setting as closely as possible.

SSK05-05 Evaluating the Use of a Deep Learning Algorithm for Radiology Quality Assurance in Out-Patient Chest X-Ray Reporting

Wednesday, Nov. 28 11:10AM - 11:20AM Room: N227B

Participants
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PURPOSE

To evaluate the accuracy of a deep learning algorithm - 1. To assist with screening of chest X-rays in the wellness check/primary care setting with predominantly normal X-rays 2. To help optimize the quality assurance (QA) process by selecting X-rays for review

METHOD AND MATERIALS

For this retrospective study, we used 3945 de-identified chest X-rays with the accompanying radiologist reports, randomly selected from the natural distribution of scans from adult patients attending OPD for a wellness check at 5 urban centers. Language processing algorithms were used to extract an initial ground truth of either 'normal' or 'abnormal' from the report impressions. A commercial deep learning-based chest X-ray screening system was then evaluated versus this ground truth. X-rays with a discordance between the original radiology report and the algorithm output were re-read by a panel of 3 radiologists. The majority opinion of the 3 radiologists was used as a new ground truth, to evaluate accuracy on this discordant set.

RESULTS

3274 of 3945 (82.9%) X-rays were normal, based on the original radiology report. Algorithm accuracy on the original dataset was 80%, with an AUC of 0.8, sensitivity of 0.63 and specificity of 0.83 on the detection of abnormal X-rays. Of the 789 discordant X-rays, 405were read by the panel of 3 radiologists. On this discordant dataset, the 3 radiologist-consensus agreed with the algorithm results in 64.9% of the cases, and with the original radiology report in the remaining 35.1%.

CONCLUSION

Among the discordant scans, the consensus ground truth was closer to the algorithm results than to the original report. Deep learning algorithms can effectively select chest X-rays for review during radiology quality control

CLINICAL RELEVANCE/APPLICATION

Artificial intelligence algorithms can be used for automated selection of chest X-rays for review during the radiology QA process, potentially increasing its effectiveness.

SSK05-06 Performance Validation of a Deep Learning-Based Automatic Detection Algorithm for Major Thoracic Abnormalities on Chest Radiographs

Wednesday, Nov. 28 11:20AM - 11:30AM Room: N227B

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PURPOSE

To evaluate the performance of a deep learning-based automatic detection (DLAD) algorithm for major thoracic abnormalities

To evaluate the performance of a deep learning-based automatic detection (DLAD) algorithm for major thoracic abnormalities including malignant pulmonary nodules/masses, tuberculosis, pneumonia, and pneumothorax on chest radiographs (CRs) in comparison with physicians.

METHOD AND MATERIALS

DLAD was developed using a 27-layer deep convolutional neural network. External validation of its diagnostic performance was conducted using 2 separate datasets from 2 institutions (normal: abnormal = 97:103 and 100:84). For comparison with physicians, an observer performance test was conducted using 1 of the datasets including 15 physicians (5 non-radiology physicians, 5 board-certified radiologists, 5 thoracic radiologists). All physicians reviewed each CR twice, without and with DLAD, and determined the presence of clinically significant thoracic abnormalities on a 5-point scale. Performance measurements were done using area under the receiver operating characteristic (ROC) curves for image-wise classification and area under the alternative free-response ROC curves for lesion-wise localization.

RESULTS

Image-wise classification performances of DLAD for abnormal CRs were 0.983 and 0.993 and lesion-wise localization performances were 0.974 and 0.985 on the two external validation datasets. Without DLAD, average classification performances of non-radiology physicians, board-certified radiologists, and thoracic radiologists were 0.813, 0.896, and 0.932, and average localization performances were 0.781, 0.870, and 0.907, respectively. DLAD demonstrated significantly higher performance in image-wise classification and lesion-wise localization compared with all reader groups (all *P*s <0.05). With DLAD, physicians' diagnostic performances were significantly improved in classification (0.904, 0.939, 0.958; all Ps <0.05) and localization (0.873, 0.919, 0.938; all *P*s <0.05) in all reader groups.

CONCLUSION

DLAD demonstrated excellent performance in image-wise classification and lesion-wise localization on CRs with major thoracic abnormalities, outperforming physicians, and enhancing the physician's diagnostic performance when used as a second reader.

CLINICAL RELEVANCE/APPLICATION

Our DLAD algorithm can accurately classify abnormal CRs and localize abnormal findings, and has the potential to improve diagnostic accuracy, patients' safety, and clinical workflow efficacy.

SSK05-07 Deep Learning-Based Automatic Detection Algorithm for the Detection of Major Thoracic Abnormalities on Chest Radiographs

Wednesday, Nov. 28 11:30AM - 11:40AM Room: N227B

Participants
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PURPOSE

To develop a deep learning-based automatic detection (DLAD) algorithm for major thoracic abnormalities including nodule/mass, tuberculosis (TB), pneumonia and pneumothorax on chest radiographs (CRs) using a large-scale CR dataset and evaluate its diagnostic performance.

METHOD AND MATERIALS

We collected a total of 89,832 CRs comprising 54,221 normal CRs and 35,641 abnormal CRs with major thoracic abnormalities including malignant pulmonary nodules/masses (n=13,925), pulmonary TB (n=6,798), pneumonia (n=6,903) and pneumothorax (n=8,015). Thereafter, all CRs were randomly split into three datasets; training dataset (n=84,072; 53,393 normal and 30,679 abnormal CRs), validation dataset (n=750; 300 normal and 450 abnormal CRs), and test dataset (n=750; 300 normal and 450 abnormal CRs). DLAD was designed using deep convolutional network consisting of 27 layers and 12 residual connections, and trained with 71,376 label-only CRs and 12,696 annotated CRs for which 15 thoracic radiologists marked the locations of the individual abnormalities. Diagnostic performance of the DLAD was investigated using receiver-operating characteristic (ROC) curve analysis for per-CR classification performance and jackknife alternative free-response receiver-operating characteristic (JAFROC) curve analysis for per-lesion detection performance. All CRs in the validation and test datasets were annotated by 5 out of 15 thoracic radiologists, and the final determination of the location of each abnormality was made by majority decision.

RESULTS

In the test dataset, DLAD showed an area under the ROC curve (AUC) of 0.9811 for per-CR classification performance and an area under the JAFROC curve of 0.9656 for per-lesion detection performance. The AUCs and JAFROCs of each disease category were 0.9674 and 0.9494 for malignant pulmonary nodule/mass, 0.9902 and 0.9742 for tuberculosis, 0.9854 and 0.9740 for pneumonia, and 0.9937 and 0.9800 for pneumothorax, respectively.

CONCLUSION

Our deep learning-based automatic detection algorithm demonstrated excellent, cutting-edge performances both in terms of differentiating normal and abnormal CRs and localizing individual abnormalities on CRs.

CLINICAL RELEVANCE/APPLICATION

DLAD can augment the diagnostic performance of radiologists both in terms of image-wise diagnosis and lesion-wise detection, thereby improving diagnostic accuracy, patients' safety, and work-flow efficacy.

SSK05-08 Participants

"Change" versus "No-Change": Can Machine Learning Driven Algorithm Detect Stability or Change in Chest Radiographs?

Wednesday, Nov. 28 11:40AM - 11:50AM Room: N227B

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PURPOSE

Chest radiograph is the most commonly performed imaging; changes, or lack thereof, of radiographic findings have tremendous implications on patient care. We compared accuracy of machine learning (ML) algorithm (Qure AI) and thoracic radiologists for assessing stability or change in findings over serial chest radiographs.

METHOD AND MATERIALS

We parsed the publicly available, de-identified, frontal-view chest radiographs from the NIH to identify 300 baseline and follow-up radiographs from 150 adult patients both with and without change in radiographic findings. Two thoracic radiologists reviewed all 300 radiographs to establish ground truth for radiographic findings [such as pleural effusions (EF), lung opacities (LO), hilar prominence (HP), and cardiomegaly (CM)]. All radiographs were processed with Qure AI ML to generate prediction scores and heat maps for each finding. Then, two different thoracic (test R1 and R2) radiologists independently recorded their findings, unaware of the ground truth and ML findings. Data were analyzed to determine accuracy and area under curve with free-choice receiver operating characteristics (FROC) analyses.

RESULTS

Respective percentage changes in findings on follow-up radiographs for EF, CM, HP and LO were 15% (21/138), 9% (13/150) , 5% (8/150), 25 % (33/132) for ground truth; 20%(28/138), 13%(20/150), 12% (18/150), 27% (36/132) for R1; 19%(26/138), 7% (11/150), 4.7%(7/150), 25% (33/132) for R2; and 25%(34/138), 23% (34/150), 23% (35/150), 40% (53/132) for ML. The AUC of ML algorithm for detecting lack of change in findings were 0.867 (EF), 0.904 (C), 0.872 (HP), 0.742 (LO). Accuracy of ML for detecting change in radiographic findings was also high with corresponding AUC of 0.804 (EF), 0.923 (C), 0.839 (HP), 0.758 (LO). Although both test radiologists had AUC similar to ML for stable radiographic findings, their AUC [0.867-0.878 (EF), 0.815-0.904 (CM), 0.635-0.872 (HP), 0.742-0.854 (LO) for change in findings were lower compared to corresponding AUC for ML.

CONCLUSION

ML algorithm can accurately predict stability and change in radiographic findings on follow up radiographs. Its accuracy varies across different types of findings, and is highest for cardiomegaly and lowest for lung opacities.

CLINICAL RELEVANCE/APPLICATION

ML can enable stratification of chest radiographs on basis of change or stability of findings, thus expediting interpretation of radiographs with important changes.

Honored Educators

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SSK05-09 Assessment of Endotracheal Tube Position on Chest Radiographs using Deep Learning

Wednesday, Nov. 28 11:50AM - 12:00PM Room: N227B

Participants
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PURPOSE

Assess the efficacy of deep learning in determining endotracheal tube (ETT) position on chest radiographs.

METHOD AND MATERIALS

23,079 de-identified frontal chest radiographs with an ETT were split into 12 categories, which included bronchial insertion, and distance from the carina at 1.0cm intervals (e.g. 0.0-0.9cm, 1.0-1.9cm...) and lastly >=10cm. Ground truth ETT position was determined by two board certified radiologists (original author and a second radiologist for QA confirmation). Images were split into

training (80%, 18467 images), validation (10%, 2306 images), and test (10%, 2306 images). The ETT was re-measured on 100 random images from the test data to assess inter-observer variability. The pretrained Inception V3 convolutional neural network was utilized to a) predict ETT distance from the carina in cm and b) categorize images as low ETT (< 2cm of carina), satisfactory (2-7cm above carina), or high (>= 7cm above carina). Image normalization and auto-cropping about the carina was performed prior to model training. Real-time data augmentation was employed, and an ensemble of 10 Inception V3 models was used in the final classification. Receiver operating characteristic (ROC), area-under-the-curves (AUC), sensitivity and specificity on test data were used to assess the models.

RESULTS

The predicted ETT distance from carina had a mean difference of 0.79cm (±0.56) from the ground truth, and the two radiologists had a mean difference of 0.44cm (±0.44). On the test data, the AUC was 0.97 (95%CI: 0.96-0.98) for differentiating ETT<2cm from carina from all others. The AUC was 0.96 (95%CI: 0.95-0.98) for differentiating high ETT>=7cm from all others. 4 bronchial insertions and ETT 0-0.9cm from carina were missed of 385 true positives (sensitivity: 99.0%). There were 86 false positives of 1921 true negative cases (specificity: 95.5%). However, threshold cases near a category were sometimes missed; for example, 43 cases of 1-1.9cm above carina were misclassified as >=2cm above carina, usually as 2-3cm above carina. Similarly, threshold cases of 6-6.9cm were predicted as 7-7.9cm above carina or vice-versa. The sensitivity of the model drops to 87.8% when including these threshold cases as misclassified.

CONCLUSION

Deep learning shows promise in assessing ETT position and predicts postion within 1cm in most cases.

CLINICAL RELEVANCE/APPLICATION

Automatic identification of ETT position may reduce time to identification of critical placement.

SSK06

Science Session with Keynote: Gastrointestinal (Colorectal Imaging)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S502AB

CT GI MR OI

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

Participants
Marc J. Gollub, MD, New York, NY (*Moderator*) Nothing to Disclose
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Gaurav Khatri, MD, Dallas, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSK06-01 Gastrointestinal Keynote Speaker: Rectal Cancer Imaging

Participants
Marc J. Gollub, MD, New York, NY (*Presenter*) Nothing to Disclose

SSK06-02 Feasibility Study of Dual-Energy Spectral CT for Differentiating Rectal Cancers with and Without Vascular Invasion

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S502AB

Participants
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PURPOSE

The purpose of this study was to investigate the potential value of dual-energy CT (DECT) in differentiating vascular invasion rectal cancer from non-vascular invasion rectal cancer.

METHOD AND MATERIALS

90 consecutive untreated patients (56 men, 34 women; mean age, 62.95 years) were enrolled and underwent DECT before biopsy. DECT image metrics including iodine (water) concentration (IC) and effective atomic number (eff-Z) were measured. Data were analyzed statistically by the independent-samples t test and were correlated with pathological findings.The receiver operating characteristics (ROC) analysis was also carried to evaluate the efficacy of these parameters for differentiating rectal cancers with or without vascular invasion.

RESULTS

Pathological results showed that there were 41 vascular invasion rectal cancer and 49 non-vascular invasion rectal cancer.The IC values of the vascular invasion rectal cancer in the venous phase were 2.42±0.55mg/ml, significantly higher than that of the non-vascular invasion rectal cancer with 2.13±0.52mg/ml ($P<0.05$). The eff-Z of the vascular invasion rectal cancer in the venous phase was 17.85±3.731, which was also higher than that of the non-vascular invasion rectal cancer with 16.19±3.638 ($P<0.05$). However, there were no significant differences in those parameters in the arterial phase ($P>0.05$). Based on the ROC curves, the optimal cut off value for the IC was 2.25mg/ml which yielded a sensitivity of 70.7% and a specificity of 67.3% for differentiating rectal cancers with or without vascular invasion.

CONCLUSION

It is feasible to differentiate a vascular invasion rectal cancer from the non-vascular invasion rectal cancer using dual energy CT, especially the iodine concentration measurement in the venous phase.

CLINICAL RELEVANCE/APPLICATION

Dual energy CT appears to be an efficient CT technique for a possible method to evaluate vascular or non-vascular invasion of rectal cancer.

SSK06-03 Low Anterior Resection Syndrome (LARS): Imaging Characteristics of Rectal Cancer and Anorectal Anatomy

Wednesday, Nov. 28 10:50AM - 11:00AM Room: S502AB

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PURPOSE

To identify risk factors associated with LARS severity based on the imaging characteristics of rectal cancer and anorectal anatomy defined by magnetic resonance imaging (MRI) pre-operation.

METHOD AND MATERIALS

Between August 2016 and August 2017, patients who had pathological-proved rectal cancer and underwent low anterior resection (LAR) were collected in this retrospective study. Patients need to be followed-up at least 9months after operative. All patients were divided into non-major LARS group and major LARS group based on LARS score. The tumor morphological characteristics were measured and recorded as the following: the distance between tumor and anal margin, the distance between tumor and puborectal muscle, the length of tumor involvement, the tumor stage, the lymph nodes stage, and circumferential resection margin. In addition, morphological characteristics of rectal-anal canal were measured and recorded, including anorectal angle (ARA), levato-anal angle (LAA), levator plate angle, thickness of internal anal sphincter, levator plate angle(°), thickness of rectal wall(mm), thickness of obturator internus(mm), thickness of external anal sphincter (mm), thickness of internal anal sphincter(mm), thickness of puborectal muscle(mm), and thickness of illiosacrum muscle(mm). The differences of measurement between non-major and major LARS groups were analyzed by t-test and x2-test.

RESULTS

Thirty-three patients were enrolled in the final cohort including 22 patients (66.7%) with non-major LARS (score 0-20) and 11 patients (33.3%) with major LARS (score 30-42, n=11). The distances of tumor and anal margin and the distance of tumor and puborectal muscle of patients with major LARS was significantly lower than patients with non-major LARS (<= 7cm, P =0.017 and <= 5 cm P=0.009). The LAA and the ARA of patients with major LARS were larger than patient with non-major LARS and significances were seen (>=100°, P=0.049 and >=125°, P=0.025).

CONCLUSION

The lower tumor, larger ARA and LAA was identified as risk factors may be associated with major LARS for patients with rectal cancer after Low Anterior Resection.

CLINICAL RELEVANCE/APPLICATION

Identification of risk factors associated with LARS severity by MRI pre-operation may help surgeons change the strategy of operation to avoid LARS and, therefore, the life quality of patients may be improve after surgery.

SSK06-04 Preoperative Staging for Rectal Cancer: Comparison of Whole Body MR-PET and Standard Protocol

Wednesday, Nov. 28 11:00AM - 11:10AM Room: S502AB

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PURPOSE

To measure the concordance of rectal cancer clinical staging between whole body MR-PET including dedicated liver and rectal MRI (WB MR-PET) and the current standard care protocol (chest/abdominopelvic CT and rectal MRI).

METHOD AND MATERIALS

This IRB-approved prospective study enrolled 71 patients (M:F = 43:28, mean age 60.9 years) with newly diagnosed mid to lower rectal cancer. Clinical staging and effective dose were compared between standard protocol and WB MR-PET protocol according to AJCC 7th staging. In addition, incidence of further study recommendation and incidental findings were recorded.

RESULTS

Regarding with the presence of metastasis, two protocols were consistent in 67.6% (48/71), and discordant in 4.2% (3/71). In the remaining 28.2% (20/71), standard protocol did not conclude presence or absence of metastasis or extent of metastasis (IVa or IVb) due to indeterminate lesions in lung, liver, or retroperitoneal lymph nodes. In these patients, standard protocol recommended followings for lesion characterization: chest CT follow up in 20% (4/20), liver MRI in 20% (4/20), PET-CT in 45% (9/20) and liver MRI with chest CT follow up for multiple indeterminate lesions in 15% (3/20). In these 20 patients, WB MR-PET protocol suggested presence or absence of metastasis in 25% (5/20) and 75% (15/20), respectively. Compared with clinical follow-up results within 6 months, 14 of 15 patients with WB MR-PET negative findings did not show metastasis. In 5 patients with WB MR-PET positive

findings, all liver lesions were correctly classified, but one false positive and one false negative cases for lung nodules were observed. There were 13 cases with incidental findings including incidentally detected tonsillar cancer with neck lymph node metastasis (n=1) and incidentally detected Warthin's tumor in the parotid gland (n=1). Effective dose was significantly lower in WB MR-PET than standard protocol (6.18±1.06 mSv vs. 10.70±5.45 mSv, P<0.0001).

CONCLUSION

WB MR-PET protocol showed low discrepancy rate with the standard protocol for metastasis evaluation in patients with rectal cancer and it served as problem-solving modality for indeterminate lesions.

CLINICAL RELEVANCE/APPLICATION

Compared with the standard protocol, WB MR-PET with dedicated rectal and liver MRI may facilitate the staging work-up with less inconvenience in a short period.

SSK06-05 Application of Dynamic Dual-Energy CT Imaging In Colorectal Cancer for Assessing the Correlation Between Blood Perfusion and Iodine Uptake on 320-Row Multidetector CT

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S502AB

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PURPOSE

To evaluate the characteristics of blood perfusion and iodine uptake in colorectal cancer using dynamic dual-energy imaging on 320-row CT.

METHOD AND MATERIALS

29 patients with colonic adenocarcinoma diagnosed by colonoscopy were enrolled. Each patient was scanned for 10 dual-emerge acquisition phases, with 3-second intervals for 1 to 7 phases, 5-second intervals for 8 to 10 phases, and total scanning time was 53s. Iodine map and perfusion map were generated, and iodine uptake peak (IUP), arterial flow (AF, ml/min/100ml), blood volume (BV,ml/100ml) and permeability (ml/min/100ml) of tumor were measured.

RESULTS

The IUP, AF, BV and permeability of tumor were 71.46±2.19, 158.26±80.40, 17.33±17.80, 60.14±20.59, respectively. The IUP of tumor was significantly associated with the AF (r=0.440, P<0.05) and BV (r=0.382, P<0.05) There was no significant correlation between IUP and permeability(P>0.05). The average DLP of dynamic dual-energy CT imaging was 1104 mGy•cm with an effective radiation dose of 16.56 mSv.

CONCLUSION

Dynamic dual-energy CT imaging can generate dynamic iodine map and perfusion map at the same time. The correlations of iodine uptake peak and perfusion parameters AF and BV of colorectal cancer are significant.

CLINICAL RELEVANCE/APPLICATION

Dynamic dual-energy CT imaging of coloractal cancer provides iodine uptake and perfusion data in just one scan. It can be used to evaluate the hemodynamic characteristics of colorectal cancer and provide more diagnostic information for the clinical doctors.

SSK06-06 Predictors of Surgical Outcome, DFS and OS in Mid and Low Rectal Cancer Undergoing Laparoscopic Resection After Neoadjuvant Chemoradiation Therapy: Impact of Pretreatment and Re Staging MRI

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S502AB

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PURPOSE

To assess (1) the impact of restaging MRI as a predictor of surgical difficulties and survival and (2) the diagnostic accuracy of re-staging MRI against final pathological assessment.

METHOD AND MATERIALS

Between 1/2010 and 1/2016, patients with histologically proven locally advanced (AJCC stages I to IIIc) rectal cancer of the mid or lower third of the rectum, who underwent MRI including DWI before (pre-treatment MRI) and after neo-adjuvant chemo-radiotherapy (re-staging MRI) followed by either elective laparoscopic anterior resection (LAR) with total mesorectal excision or laparoscopic abdominoperineal (L-APR) resection were included. Pelvimetry was performed on pre-treatment MRI providing transverse, sagittal, angles and surface measures. On pre and post-treatment MRI, T stage, N stage and EMVI status were assessed. On re-staging MRI, the MR tumor regression grade score (mrTRG) was determined. Sensitivity, specificity, PPV and NPV of restaging MRI for mrTRG prediction were assessed. Binary, multimodal, or linear regression analyses were performed to assess predictors of surgical difficulties (i.e., estimated on operative time, blood loss, and conversion rate) and surgical success (i.e., postoperative complications and successful resection rate).

RESULTS

170 patients (mean age 59±13) were included. Tumor volume and tumor height on re-staging MRI were associated respectively with operative time and blood loss. Conversion was predicted by tumor volume, interischial distance and pubic tubercle height. A circumferential resection margin> 2 mm was found as a protector of postoperative complications and unsuccessfull resection. The quality of the surgical resection was found as a predictor of overall and disease-free survival. On re-staging MRI, the PPV of ymrT for ypT0 stage, ypT1/T2 stages, and ypT3/T4 staging was 83%, 55.7% and 68.8% respectively. The PPV of ymrN for ypN0 and ypN+ staging was 87.7% and 62.5% respectively. The sensitivity, specificity, PPV, and NPV of ymrEMVI was respectively 68.4%, 78.8%, 28.8% and 95.2%. The sensitivity and specificity of tumor regression grade (mrTRG) 1 to identify pathologic complete response was 76.9% and 89.3%, respectively, with a PPV of 68.2% and NPV of 92.8%.

CONCLUSION

Pelvimetry and re-staging MRI may be useful to predict surgical difficulties and surgical outcomes.

CLINICAL RELEVANCE/APPLICATION

Pelvimetry and re-staging MRI can predict outcome in rectal cancer.

SSK06-07 The Tram Track Sign and the Railroad to Complete Response after Neoadjuvant Therapy in Rectal Cancer

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S502AB

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PURPOSE

To measure the diagnostic performance of the tram track sign for the identification of sustained complete response (SCR) after neoadjuvant therapy on re-staging magnetic resonance (MR) T2-weighted imaging (T2-WI) in patients with locally advanced rectal cancer.

METHOD AND MATERIALS

Institutional review board approval was obtained for this retrospective study and patient informed consent requirement was waived. Fifty-eight consecutive patients with locally advanced rectal cancer who underwent neoadjuvant therapy were enrolled. Two radiologists blindly and independently reviewed restaging pelvic MRs and analyzed 3 features: a distinct morphologic pattern of tumour response - the tram track sign (TTS) -characterized by the presence of 2 hypointense rims at previous tumour location separated by a variable amount of homogeneously intermediate or high signal intensity on T2-WI; the relative proportion of intermediate signal intensity on T2-WI; and the relative proportion of high signal intensity on high b-value diffusion-weighted images (DWI). Endoscopic response grading from the same timepoint was retrieved. Qui-Square test was employed in search for any associations between SCR and TTS, T2-WI, DWI or endoscopy. Interrater agreement of MR parameters was estimated using Cohen´s Kappa statistic (k).

RESULTS

TTS was significantly associated with SCR, with specificity=0.97/0.97, sensitivity=0.52/0.64, PPV=0.93/0.94, NPV=0.73/0.78 and AuROC=0.78/0.83, for observers 1/2, respectively. DWI was significantly associated with SCR for observer 2, with specificity=0.76, sensitivity=0.60, PPV=0.65, NPV=0.71 and AuROC=0.69. No significant differences were found for T2-WI or endoscopy. Interobserver agreement was substantial for TTS (k=0.69), moderate for DWI (k=0.46) and poor for T2-WI (k=0.17).

CONCLUSION

The tram track sign is a specific and reliable tool for the early identification of SCR after neoadjuvant therapy in rectal cancer. Its diagnostic performance exceeds that of endoscopy and conventional T2-WI and DWI assessment.

CLINICAL RELEVANCE/APPLICATION

The tram track sign may outperform standard T2-WI, DWI and endoscopic assessment in the early identification of sustained complete response after neoadjuvant therapy in rectal cancer.

SSK06-08 Diffusion-Weighted MR-Volumetry and High-Resolution MR-Volumetry Association with Lymphovascular Invasion and N-Stages in Resectable Rectal Cancer

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S502AB

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PURPOSE

Purpose: To determine whether diffusion-weighted imaging (DWI)-volumetry and high-resolution T2-weighted imaging (T2WI) MR-volumetry could predict lymphovascular invasion (LVI) and N-stages in resectable rectal cancer.

METHOD AND MATERIALS

Materials & Methods: 50 consecutive patients with rectal cancer who underwent radical surgery in 1-week after DWI and high-resolution T2WI were retrospectively identified. Gross tumor volume (GTV) was evaluated on DWI and high-resolution T2WI. Univariate and multivariate analyses were performed to determine whether GTV could predict LVI and lymph node metastasis (LNM). Mann-Whitney U test was performed to compare GTV among N-stages. Cutoffs of GTV were investigated using area under the receiver operating characteristic curve (AUC) analysis for predicting LVI and N-stages.

RESULTS

Results: DWI-GTV and T2WI-GTV increased with LVI (r=0.750 and 0.710,P<0.0001,respectively) and increasing of N stage(r=0.780 and 0.755,P<0.0001,respectively). Univariate analysis showed DWI-GTV and T2WI-GTV could predict LVI (P<0.0001). Multivariate analyses indicated only DWI-GTV as an independent risk factor of LVI (P=0.005, odds ratio=1.207) and LNM (P=0.005, odds ratio=1.420). The Mann-Whitney U test showed DWI-GTV and T2WI-GTV could distinguish N0 from N1, N0 from N1-2, N0-1 from N2 (P<0.0001). DWI-GTV could predict LVI (cutoff,11.05cm3;AUC,0.899), and distinguish N0 from N1 (cutoff,10.86cm3;AUC,0.865), N0 from N1-2 (cutoff,10.46cm3;AUC,0.934), N0-1 from N2 (cutoff,17.7cm3;AUC,0.932). T2WI-GTV could predict LVI (cutoff,13.74cm3;AUC,0.877), and distinguish N0 from N1 (cutoff,12.25cm3;AUC,0.827), N0 from N1-2 (cutoff,13.36cm3; AUC,0.911), N0-1 from N2 (cutoff,20.43cm3; AUC,0.927).

CONCLUSION

Conclusion: High-resolution T2WI-GTV and DWI-GTV of resectable rectal cancer were correlated well with the LVI and LNM, but the latter is a potentially more promising non-invasive technique that can help predict the preoperative LVI and distinguishing N-stages.

CLINICAL RELEVANCE/APPLICATION

Diffusion-weighted MR-volumetry of resectable rectal cancer are correlated well with the lymphovascular invasion and lymph node metastasis, and is recommended as a potentially more promising non-invasive technique for predicting the preoperative lymphovascular invasion and distinguishing N-stages.

SSK06-09 Comparison of Polyp Surface Tagging Performance of Barium plus Diatrizoate Meglumine/Diatrizoate Sodium Solution versus Barium plus Iohexol during CT Colonography

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S502AB

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PURPOSE

The detection of polyps at CT colonography (CTC), especially serrated adenomas, is contingent on polyp surface tagging. The purpose of this study is to investigate differences in surface tagging performance of barium when combined with either diatrizoate meglumine/diatrizoate sodium solution (DM-DS) versus iohexol.

METHOD AND MATERIALS

A retrospective review was conducted of 338 polyps detected at CTC with two different tagging regimens: barium plus either DM-DS or iohexol. The degree of coating of each polyp was graded on a 0-4 scale (no coating to heavy coating) and correlated to polyp histologic subtype and tagging agent. Polyp histology was classified into: hyperplastic, sessile serrated or non-serrated adenoma. Performance of coating scores were analyzed with univariate logistic regression and Wilcoxon rank sum tests.

RESULTS

338 polyps were included, 255 tagged with DM-DS and 83 with iohexol. Across all polyps, coating score of SSA (3±2) was significantly higher than in NSA (1± 3) (p<.0001). However, the coating score was only significantly higher for SSA compared with NSA within the DM-DS group (3±2 versus 1±2) (p<.0001). No statistical difference was seen for the iohexol group (3±1 versus 1±3) (p=.0603). Using all polyps (and in sub-analysis of DM-DS and iohexol groups) there was a statistically significant difference in tagging of SSA (N=70) versus benign HP (N=71) (p < .0001). Of note, there is a significantly higher percentage of serrated adenomas compared with all adenomas (30.8%, 61/198) detected in the DM-DS group compared with iohexol group (15.3%, 9/59)

(p=.0185).

CONCLUSION

CT colonography using both an iodine and barium oral tagging regimen allows for detection of polyps by the presence of surface tagging. We demonstrated that DM-DS demonstrates a significantly higher coating score of serrated adenomas when compared with non-serrated adenomas. Although a similar difference was seen for iohexol, it was not statistically significant. Of concern, there is a significantly higher percentage of serrated adenomas (as compared to all adenomas) detected in the DM-DS group. This may suggest a lower sensitivity for serrated adenomas with iohexol.

CLINICAL RELEVANCE/APPLICATION

Combined with barium, DM-DS results in greater surface tagging of serrated compared with nonserrated adenomas. Although no difference in tagging was seen, Iohexol resulted in lower SSA detection.

Honored Educators

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SSK07

Gastrointestinal (Liver Diffuse Disease, Steatosis)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S402AB

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

SSK07-01 Assessment of Fatty Liver Disease Using Twin Beam Dual-Energy CT Derived Fat Fraction

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PURPOSE

The aim of this study was to compare parameters of liver fat quantification derived from single source twin beam dual energy computed tomography (deCT) and magnetic resonance imaging (MRI).

METHOD AND MATERIALS

We retrospectively analyzed 50 patients (28 male, 22 female, mean age 65 years) who underwent both abdomino-pelvic twin beam deCT (SOMATOM Definition Edge, Siemens, Germany) and abdominal MRI examinations. Region of interests were drawn on CT and MRI in each liver segment. The fat fraction (FF) and the virtual unenhanced attenuation values (VUE) derived from portal-venous phase deCT were quantified using commercially available software (Syngo.via, Siemens, Germany) and compared to the changes in signal intensity (SI) on in-phase (SIIP) and out-of-phase images (SIOP), as well as the signal intensity on the fat only images (SIF) (DIXON sequence). A p-value less than 0.05 was considered to indicate statistical significance.

RESULTS

456 of 459 liver segments were included in this analysis. 188 segments were classified as steatotic according to MRI. The FF in steatotic segments averaged 13.5±11% compared to 2.2±7.9% in non-steatotic segments ($p<0.001$). The FF was significantly correlated to the VUE attenuation vales ($r=-0.94$), changes in SIIP to SIOP ($r=0.62$), as well as SIF ($r=0.5$) ($p<0.001$). The color coded FF map readily indicated diffuse of focal fatty liver disease.

CONCLUSION

Quantitative analysis of liver fat fraction using single source twin beam dual energy computed tomography shows a strong correlation to the standard imaging parameters of fatty liver disease.

CLINICAL RELEVANCE/APPLICATION

Fatty liver disease should be reported due to increased risk for developing e.g. cirrhosis. Since steatosis can be easily missed on portal venous phase CT, deCT derived liver FF analysis improves the evaluation of liver parenchyma.

SSK07-02 Quantification of Fat in Hepatocellular Carcinoma (HCC) Using Multimaterial Decomposition (MMD) Analysis of Fast-Kilovolt-Peak Switching Dual-Energy CT Data: Comparison with Chemical Shift MR Imaging

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S402AB

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PURPOSE

Recent study showed that the multimaterial decomposition (MMD) analysis can accurately quantify hepatic fat in dual-energy CT (DECT) data. However, intratumoral fat quantification in hepatocellular carcinoma (HCC) by the MMD algorithm has not been evaluated yet, although there are some differences in component materials between liver parenchyma and HCC. The purpose of the study was to quantify HCC fat with the MMD algorithm using DECT, comparing with chemical shift MRI.

METHOD AND MATERIALS

Thirty-one consecutive patients having HCC (22 males; 9 females, mean age 66.5 ± 7 years) underwent non-enhanced and four-phases dynamic contrast-enhanced DECT (80 and 140 kVp) and MRI before liver surgery. Fat volume fraction (FVFDECT) images were generated by using the MMD algorithm on DECT data to quantify HCC fat and liver fat. Additionally, fat fraction (FFMRI) were measured for HCC and liver on dual-echo sequence using 1.5 or 3T MRI. The correlation between FVFDECT and FFMRI was evaluated using Pearson's correlation test. Real non-contrast-enhanced FVFDECT were compared with four-phases contrast enhanced FVFDECT to prove the reproducibility of MMD by using one-way ANOVA.

RESULTS

FVFDECT and FFMRI exhibited moderate correlations for HCC in all phases (r = 0.51, 0.47, 0.42, 0.47, 0.45, respectively; all P <0.05), and strong correlations for liver parencyma in all phases (r = 0.68, 0.65, 0.71, 0.72, 0.72, respectively; all P <0.05). Those correlation coefficients were significantly higher in the liver than in HCC for each phase (P = 0.005, 0.004, <0.001, <0.001, <0.001, respectively). FVFDECT did not differ significantly in all comparisons of scan phases regarding HCC fat or liver fat quantification by one-way ANOVA (P = 0.41, 0.81, respectively).

CONCLUSION

The MMD algorithm quantifying intratumoral fat in DECT images is reproducible across scan phases. However, correlation between FVFDECT and FFMRI was significantly lower for HCC than that for liver parenchyma.

CLINICAL RELEVANCE/APPLICATION

The MMD algorithm might eliminate the need for non-contrast CT scan to measure FVF because of its reproducibility, however, it is needed further technological improvement to quantify HCC fat.

SSK07-03 Non-Invasive MR Index for the Detection of Non-Alcoholic Steatohepatitis (NASH) in Patients with Non-Alcoholic Fatty Liver Disease (NAFLD)

Wednesday, Nov. 28 10:50AM - 11:00AM Room: S402AB

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PURPOSE

To evaluate feasibility of MRI to predict NASH and to develop non-invasive MR index for the detection of NASH in patients with NAFLD

METHOD AND MATERIALS

This prospective study was approved by our IRB and the written informed consent was obtained from each patient. 47 patients with NAFLD who were scheduled to undergo or underwent US-guided parenchymal liver biopsy within 6 months were included. Biopsy specimens were graded according to SAF scoring system - semi-quantitative score of Steatosis (0-3), Activity [lobular inflammation (0-2)+ballooning (0-2)], and Fibrosis (0-4) - as NASH group (steatosis score>=1, activity score>=2, any fibrosis score) and non-NASH group. All patients underwent gadoxetic acid-enhanced MRI including MR spectroscopy (MRS), MR elastography (MRE), and T1 mapping. The diagnostic performance of MRS, MRE and T1 mapping for grading steatosis, activity, and fibrosis was evaluated by using ROC curve analysis. Non-invasive MR index, combination of liver signal fat fraction (FF), liver stiffness (LS) value, and T1 relaxation time, was developed for the prediction of SAF score using linear regression analysis. R-squared (R2) was obtained by plotting the predicted value against the observed value. The optimal cut-off value of SAF score differentiating NASH group from non-NASH group was determined using ROC curve analysis. Using the cut-off value, the diagnostic performance of MR index for the detection of NASH was evaluated.

RESULTS

20 NASH patients and 27 non-NASH patients were included. Using MRS, MRE, T1 mapping, the mean AUC for grading steatosis, fibrosis, and activity was 0.870, 0.951, and 0.664, respectively. Non-invasive MR index combining FF, LS value, and T1 relaxation time was -3.819 + 0.037 × FF + 1.4 × LS value + 0.004 × T1 relaxation time. R-squared (R2) was 0.67. Cut-off value of SAF score differentiating NASH group from non-NASH group was 6. Using the cut-off value, MR index provided sensitivity of 84.2% and specificity of 82.1% for detecting NASH in patients with NAFLD.

CONCLUSION

Non-invasive MR index combining FF, LS value, and T1 relaxation time have high diagnostic performance for detecting NASH in patients with NAFLD.

CLINICAL RELEVANCE/APPLICATION

Liver biopsy, a current gold standard for differentiating NASH from simple steatosis, has several drawbacks including invasiveness

Liver biopsy, a current gold standard for differentiating NASH from simple steatosis, has several drawbacks including invasiveness, sampling error, and cost. Non-invasive MR index may help detect NASH in patients with NAFLD.

SSK07-04 Association between Hepatic Magnetic Resonance Elastography-Based Mechanical Properties and Histologic Measures in Adults with Nonalcoholic Fatty Liver Disease without Liver Fibrosis

Wednesday, Nov. 28 11:00AM - 11:10AM Room: S402AB

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PURPOSE

To investigate the association between hepatic magnetic resonance elastography (MRE)-based mechanical properties and histology in adults with known or suspected nonalcoholic fatty liver disease (NAFLD) with histology-confirmed absence of liver fibrosis.

METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant, cross-sectional secondary analysis of prospective clinical trials included adults who underwent liver biopsy to assess known or suspected NAFLD and had no liver fibrosis histologically. Subjects were included who had undergone 2D, or both 2D and 3D MRE, and hepatic proton density fat fraction (PDFF) imaging at 3T. Mechanical properties included magnitude of the shear modulus ('shear stiffness') (|G*|), and for 3D MRE, also storage modulus (G'), loss modulus (G"), shear attenuation and damping ratio ($\zeta = G''/2G'$). Histologic features were scored (Nonalcoholic Steatohepatitis Clinical Research Network system). The association between mechanical parameters, and steatosis, inflammation, and ballooning was assessed using Wilcoxon-Mann-Whitney tests or Kruskal-Wallis tests. Spearman's correlation analyses were performed to assess association between mechanical parameters and age, BMI, and PDFF. Adjustment for multiple comparisons was not applied as this was an exploratory study.

RESULTS

89 subjects met the inclusion criteria (52 women; mean age 49 yrs; mean body mass index [BMI] 31 kg/m2), 77 of whom also had 3D MRE. |G*| measured by 2D MRE and G' measured by 3D MRE were significantly higher for patients with inflammation grade >=2 vs. grade <=1 (2.58±0.61 vs. 2.27±0.29 kPa, p=0.033 and 0.42±0.12 vs. 0.36±0.11 kPa, p=0.042, respectively). Hepatic G' and G" by 3D MRE and |G*| by both 2D and 3D MRE increased with age; correlation coefficients ranged from 0.25 to 0.31 (all p<0.03). No 2D or 3D hepatic MRE mechanical parameter had a significant association with BMI, MRI-PDFF, steatosis, or ballooning (p>=0.10).

CONCLUSION

In patients with known or suspected NAFLD but with histology-confirmed absence of liver fibrosis, moderate to severe inflammation is associated with elevated hepatic shear stiffness measured by 2D MRE and loss modulus measured by 3D MRE. In this series, increasing age is associated with higher shear stiffness and hepatic storage and loss moduli.

CLINICAL RELEVANCE/APPLICATION

MRE-measured biomarkers show promise for detecting significant inflammation before the onset of fibrosis in NAFLD.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Richard L. Ehman, MD - 2016 Honored Educator

SSK07-05 Long-Term and Short-Term Repeatabilities of Hepatic Proton Density Fat Fraction Measurements across Field Strengths: Human and Phantom Studies

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S402AB

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PURPOSE

To assess the long- and short-term repeatabilities of MR-based proton density fat fraction (PDFF) measurements across MR field strengths in nonalcoholic fatty liver disease (NAFLD) subjects and a phantom.

METHOD AND MATERIALS

A phantom consisted of 10 test tubes containing 3-50% of lard underwent MR-PDFF scans on 1.5T (Signa HDxt; GE) and 3.0T (Discovery 750 W; GE) units within a day and a 14-day interval, in addition to MR spectroscopy. For clinical scan, 20 prospectively-enrolled clinically NAFLD patients underwent the same MR-PDFF scans. All subjects were asked to refrain from consuming excessive fatty meal or alcohol during the recess. A commercially available PDFF pulse sequence (IDEAL IQ, GE) was used for all scans. To estimate PDFF, two radiologists independently drew 1 cm2 circular region of interests on each Couinaud segment. The repeatability of PDFF measurements was assessed by within-subject coefficient of variation (wCV). The correlation of PDFF measurements and field strengths was evaluated.

RESULTS

In the phantom, MRS- and PDFF-measured FF showed excellent correlation in both 1.5T and 3.0T (r2=0.906 and 0.927). PDFF-measured FF across field strengths showed strong correlation (r2=0.996) with mean difference of 1.1% and 95% limits of agreement ranging ± 0.1 on Bland-Altman analysis. Within-day and two-week wCVs were 0.3-0.6% and 1.6% for 1.5T, 0.1-0.3% and 2% for 3.0T, 2.9-5.9% and 4.2-4.7% for across field strengths. In human, the mean ± SD of the BMI and PDFF at 3.0T was 27.5 kg/m2 ± 5.2 and 15.6% ± 11.4 (range, 2.72-42.3%). PDFF-measured FF across field strengths showed strong correlation, with r2=0.995 and 0.996 for the same day, and 0.98 and 0.99 for two weeks interval. Within-day and two-week wCVs were 0.7-0.9% and 4.6% for 1.5T, 1.5-2.2% and 4.6% for 3.0 T, and 3.4-3.7% and 5.2-5.5% for across field strengths. Interobserver agreement for pooled PDFF measurement was excellent with intraclass correlation coefficient reaching 0.99.

CONCLUSION

MR-PDFF measured FF is highly reproducible across field strengths, readers, and 2-week interval. Based on the phantom and clinical scans, FF change in proportion of >5% indicates a true change in a longitudinal follow-up across field strengths.

CLINICAL RELEVANCE/APPLICATION

MR-PDFF scan is a reliable method for the longitudinal follow-up of NAFLD patients regardless of MR field strengths. Interval FF change in proportion of >5% indicates a true change across field strengths.

SSK07-06 Prediction of Hepatic Steatosis Using Sonographic Features

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S402AB

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PURPOSE

Eight sonographic imaging features have been proposed to assess hepatic steatosis on conventional ultrasound (CUS). However, there is little guidance on applying these features towards a composite assessment. The purpose of this study is to explore the use of decision rules for assessing hepatic steatosis using sonographic features.

METHOD AND MATERIALS

This is a prospective study of adult patients with known or suspected hepatic steatosis. CUS images were acquired using a standardized protocol (Siemens S3000, 6C1HD transducer). Each patient was included twice in the image bank. Eight radiologists independently graded 8 features on ordinal scales (large hepatic vein blurring, main right portal vein blurring, anterior posterior right portal vein blurring, liver-kidney contrast, posterior beam attenuation, diaphragm definition, focal fat sparing, and liver echotexture) and overall impression of steatosis severity. Seven readers were academic faculty with liver ultrasound expertise, and one was a fourth year resident. Intra-reader agreement was computed using repeat exams. Features with highest agreement were selected as predictors for biopsy-based steatosis (dichotomized into grades 0 and 1 vs. grades 2 and 3) using a Classification and Regression Tree (CART) analysis. The classification accuracy of the decision rule was compared to that of the overall impression in predicting steatosis severity.

RESULTS

40 patients (16 male, 24 female; mean age 55 ± 12 years) were included. The features with the highest reader agreement included in the CART regression were large hepatic vein blurring, liver-kidney contrast, posterior beam attenuation, and focal fat sparing. The CART used only large hepatic vein blurring, and achieved 74% accuracy (59% sensitivity, 86% specificity) for grade 2 or 3 steatosis. The radiologists' overall impression achieved 68% accuracy (83% sensitivity, 57% specificity). There was no significant difference in accuracy.

CONCLUSION

Large hepatic vein blurring may be the sonographic feature most predictive of hepatic steatosis. Accuracy was comparable to that of the radiologists' overall impression, and achieved higher specificity at the cost of lower sensitivity.

CLINICAL RELEVANCE/APPLICATION

Large hepatic vein blurring may be the sonographic feature most predictive of histological hepatic steatosis. If validated in future studies, additional emphasis should be placed on this feature during clinical practice.

SSK07-07 Quantification of Steatosis Using an Ultrasound Generated Hepato-Renal Index (HRI)

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S402AB

Participants
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PURPOSE

Hepatorenal index (HRI) has been shown by Marshall et al (AJR Am J Roentgenol 2012; 199:997-1002) to be an effective, noninvasive ultrasound tool to screen patients for the presence of > 5% hepatic steatosis. The aim of this study was to further refine this HRI tool in order to stratify patients according to their degree of liver steatosis (< 5%, between 5%-20%, and > 20% steatosis).

METHOD AND MATERIALS

We carried out a retrospective review of 174 consecutive patients from 2015-2017 who had abdominal ultrasounds and a subsequent random liver biopsy within a month. The HRI was calculated and compared with the percent steatosis as assessed by histology.

RESULTS

HRI of 1.57 corresponded with > 20% steatosis with a sensitivity of 0.92, specificity of 0.83, negative predictive value of 0.96 and positive predictive value of 0.73. The HRI value of >5% steatosis was updated to 1.41 and corresponded with a sensitivity of 0.94,

specificity of 0.96, negative predictive value of 0.93, and positive predictive value of 0.96.

CONCLUSION

HRI can accurately place patients into categories of less than 5%, between 5%-20%, and greater than 20% steatosis.

CLINICAL RELEVANCE/APPLICATION

HRI is non-invasive, cheap tool which is free of side effects that can be used to accurately follow changes in steatosis over time and determine if therapeutic interventions are being successful and if disease is progressing or regressing.

SSK07-08 Non-Invasive Ultrasonographic Index for the Detection of Non-Alcoholic Steatohepatitis (NASH) in Patients with Non-Alcoholic Fatty Liver Disease (NAFLD)

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S402AB

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PURPOSE

1. To evaluate feasibility of US for the prediction of NASH in patients with NAFLD2. To compare diagnostic performance between index using shear wave elastography (SWE) with hepatic/renal echo intensity ratio (H/R ratio) and index using transient elastography (TE, FibroScan®) with controlled attenuation parameter (CAP) for the detection of NASH in patients with NAFLD

METHOD AND MATERIALS

This retrospective study was approved by our IRB and the requirement for informed consent was waived. 55 patients with NAFLD who underwent US-guided parenchymal liver biopsy, SWE with H/R ratio, and TE with CAP were included. Biopsy specimens were reviewed for histologic grading and NAFLD Activity Score (NAS) - the unweighted sum of scores for steatosis (0-3), lobular inflammation (0-3), and hepatocellular ballooning (0-2) - was calculated based on the NASH-CRN criteria. Patients were classified according to the NAS as NASH group (NAS>=5) and non-NASH group (NAS<5). The diagnostic performance of SWE, TE, H/R ratio, and CAP for grading fibrosis and steatosis was evaluated using ROC curve analysis with obtaining the AUC. Using linear regression analysis, indices were developed for the prediction of NAS using SWE with H/R ratio and TE with CAP, respectively. The diagnostic performance was evaluated and compared between two indices using ROC curve analysis.

RESULTS

24 NASH and 31 non-NASH patients were included. The AUC for grading >=G2 and >=G3 steatosis were 0.879 and 0.842 using H/R ratio, and 0.604 and 0.563 using CAP. The AUC for grading >=F1, >=F2, >=F3, and >=F4 fibrosis were 0.653, 0.747, 0.861, and 0.816 using SWE, and 0.742, 0.824, 0.858, and 0.880 using TE. Index using SWE with H/R ratio was $2.374 + 0.091 \times SWE + 0.356 \times H/R$ ratio (Index 1). Index using TE with CAP was $5.251 + 0.035 \times TE - 0.005 \times CAP$ (Index 2). In ROC curve analysis, index 1 showed higher tendency of AUC than index 2 (0.767 vs. 0.655, p=0.13) with corresponding sensitivity of 62.5% and specificity of 80.7%.

CONCLUSION

Index using SWE with H/R ratio have higher diagnostic performance than index using TE with CAP although statistically insignificant.

CLINICAL RELEVANCE/APPLICATION

Liver biopsy, which is a current gold standard for differentiating NASH from simple steatsosis, has several disadvantages including invasiveness, sampling error, and cost. Non-invasive US index using SWE and H/R ratio may help predict NASH in patients with NAFLD.

SSK07-09 Viscosity and Viscoelasticity Measurement in Patients with Nonalcoholic Fatty Liver Disease Using Shear Wave Ultrasound Elastography

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S402AB

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PURPOSE

To investigate the usefulness of the shear wave (SW) speed (related to viscoelasticity), dispersion slope (related to viscosity), and attenuation value (related to the degree of steatosis) obtained using a new ultrasound (US) elastography system in patients with histologically confirmed nonalcoholic fatty liver disease (NAFLD).

METHOD AND MATERIALS

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). These parameters were compared against liver histopathologic findings such as fibrosis, ballooning, lobular inflammation, and steatosis as assessed by the NAFLD Activity Score in 24 patients diagnosed with NAFLD.

RESULTS

In univariate analysis, SW speed was significantly correlated with fibrosis (Spearman's rank correlation coefficient: $\rho=0.77$, $P<0.01$) and ballooning ($\rho=0.59$, $P<0.01$). Dispersion slope was significantly correlated with lobular inflammation ($\rho=0.58$, $P<0.01$), ballooning ($\rho=0.53$, $P<0.01$), and fibrosis ($\rho=0.46$, $P=0.02$). Attenuation value was significantly correlated with steatosis ($\rho=0.71$, $P<0.01$). In multivariable analysis with histologic features as independent variables, SW speed was significantly correlated with fibrosis ($P<0.05$), and dispersion slope was significantly correlated with lobular inflammation ($P<0.05$). However, attenuation value was not significantly correlated with steatosis ($P=0.07$).

CONCLUSION

SW speed is more useful than dispersion slope for predicting the degree of fibrosis, and dispersion slope is more useful than SW speed for predicting the degree of necroinflammation.

CLINICAL RELEVANCE/APPLICATION

Dispersion slope, which reflects viscosity, may provide additional pathophysiological insight into NAFLD.

SSK08

Gastrointestinal (Dual-Energy CT Techniques)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S404CD

BQ CT GI

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

SSK08-01 Application of Dual-Energy Spectral CT in the Quantitative Study of Blood Flow in Cirrhotic and Healthy Livers

Participants
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PURPOSE

To evaluate the application of material decomposition technique in spectral CT imaging in the quantitative study of blood flow in patients with liver cirrhosis and patients with healthy liver.

METHOD AND MATERIALS

30 patients with liver cirrhosis diagnosed clinically were enrolled as the study group while 30 abdominal patients whose liver and portal vein enhancement examination were normal as a control group.All patients underwent Spectral CT imaging and iodine-based material decomposition (MD) images were reconstructed. The iodine concentration (IC) was measured in five liver lobes (Caudate, left lateral, left inner, right anterior and right posterior) in both the arterial phase (AP) and portal venous phase (VP) on the iodine-based MD images. The average and total iodine concentrations of the liver were calculated, as well as the arterial iodine fraction (AIF=ICAP/ICVP) and the portal venous iodine concentration (PVIC=ICVP - ICAP). These parameters between the two groups were statistically compared by using independent sample t test.

RESULTS

The iodine concentrations in the five liver lobes in patients with liver cirrhosis were the same in AP ($P>0.05$), but the iodine concentrations of study group in portal venous phase were statistically lower than those of the control group ($P<0.05$). The average IC (6.02±2.12mg/ml) and total IC (33.74±10.84mg/ml) in the liver parenchyma in AP of liver cirrhosis were statistically the same as those in the control group (5.85±1.79 and 33.04±9.28mg/ml) ($P>0.05$); while the average IC (19.42±3.28mg/ml) and the total IC (99.83±16.65mg/ml) in VP of liver cirrhosis were lower than those in the control group (22.82±3.83 and 117.27±19.45mg/ml) ($P<0.05$) (Table 1). The AIF values were the same for the two groups, while the portal venous iodine concentrations in liver cirrhosis were lower than the control group ($P < 0.05$) (Table 2).

CONCLUSION

The material decomposition technology in Spectral CT can be used to assess the change and difference of blood flow between liver cirrhosis and healthy liver.

CLINICAL RELEVANCE/APPLICATION

The material decomposition technology in Spectral CT may be used to provide more evidence for early diagnosis of liver cirrhosis.

SSK08-02 Influence of Radiation Dose on Quantitative Tumor Measurements Using a Dual-Source, Single-Energy CT Acquisition

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S404CD

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Guerbet SA; Research Grant, Nemoto Kyorindo Co, Ltd; Speakers Bureau, Bracco Group; Royalties, Wolters Kluwer nv
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PURPOSE

To determine the effect of different dose levels on quantitative tumour measurements from one dual-source, single-energy CT (DSCT) acquisition.

METHOD AND MATERIALS

A total of 23 patients with 39 metastatic liver lesions were enrolled in this HIPAA-compliant and IRB approved study. Patient underwent a clinically indicated DSCT of the abdomen with reconstruction of seven radiation dose levels (25%, 37.5%, 50%, 63.5%, 75%, 88.5% as well as a 100% corresponding to a diagnostic CT dose level scan [mean CTDIvol 10.4mGy]) by using different combination of projection data of the two tubes from a single DSCT acquisition. CT data were reconstructed using a second-generation iterative reconstruction algorithm. For each dose level, unidimensional measurements of tumor size according to RECIST 1.1 criteria were obtained by four independent and blinded readers using a conventional manual approach, as well as a semi-automated approach using two commercially available lesion segmentation tools (Syngo.Via, Siemens Healthineers and Mint lesion, Mint Medical GmbH). All readers repeated lesion measurements after 4 weeks for measurement of intra-reader variability. The measurements obtained at 100% dose served as the reference standard for each reader.

RESULTS

There was an excellent intra-reader correlation of r2=0.93 (range: 0.93 - 0.94 for all readers) with an intra-reader measurement error of 7.2% 7.9% (range 4.9%-8.6%). For the 25% dose level datasets the inter-reader measurement error was statistically significantly higher compared to the 75% datasets, for both the readers and semi-automatic software algorithms ($p<0.0252$). Of note, the overall intra-reader measurement error (7.2% 7.9%) was significantly higher than the overall measurement error for different dose levels (6.3% 6.3%) ($p=0.001$).

CONCLUSION

Our data suggest that reductions in radiation dose up to 72.5% may not significantly affect manual and semi-automated unidimensional measurements of tumor size. Intra- and inter-reader variability affected unidimensional measurements of tumor size statistically significantly more than a decrease radiation dose.

CLINICAL RELEVANCE/APPLICATION

CT scans with a dose level of 37.5% allow for a high reproducible and accuracy of quantitative tumour measurements, potentially reducing cumulative radiation exposure of oncological staging CTs.

SSK08-05 Virtual Monoenergetic Images from Spectral Detector CT for Visualization of Hypodense Liver Lesions: Contrast Blooming Vice Versa-Proof of Concept in a 3D-Printed Phantom and Evaluation in Patients

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S404CD

Awards
Student Travel Stipend Award

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PURPOSE

There is a well-known boost of iodine associated-attenuation in low keV virtual monoenergetic images (VMI_low) which is frequently used to improve visualization of lesions and structures that take up contrast media (e.g. hemangiomas, hypervascular metastases or vessels in CT-angiography). This study aimed to evaluate this contrast vice versa: Does improved attenuation of the liver parenchyma allow for improved visualization of little or none-enhancing lesions?

METHOD AND MATERIALS

For the phantom portion a 3D-printed phantom mimicking the shape of a human liver exhibiting a lesion in its center was designed and printed. Both, parenchyma- and lesion-mimic were filled with iodine-solutions of different concentrations exhibiting an attenuation of 80, 100, 120 HU for parenchyma- and 0, 40, 60 HU for lesion-mimics. Further, a total of 75 patients with MRI or follow-up proven cysts and/or hypodense metastases was included. Imaging was performed on a spectral detector CT scanner (SDCT) and VMI of 40-120 keV as well as conventional images (CI) were reconstructed. Regions of interest were placed in lesion and parenchyma (-mimics) on CI and transferred to VMI. Signal- and contrast-to-noise ratio were calculated. Data was statistically assessed using ANOVA with Tukey's posthoc to adjust for multiple comparisons.

RESULTS

In phantoms, S/CNR was significantly higher in VMI_low. A cyst (0HU lesion mimic) in highly attenuating liver parenchyma (120HU) on CI yielded a CNR of 6.4±0.8; using 40keV images, mildly hypodense lesions in poorly attenuating liver parenchyma exhibited a similar CNR (5.8±0.9; $p<=0.05$). The same tendency was observed in patients, again cysts in CI yielded similar values as metastases in VMI_low (4.4±1.2 and 3.9±1.8, respectively, $p<=0.05$).

CONCLUSION

The improved attenuation of the liver outweighs increasing in attenuation of the lesion itself. Hence, VMI_low from SDCT allow for an improved visualization of hypodense focal liver lesions exploiting the concept of contrast blooming vice versa.

CLINICAL RELEVANCE/APPLICATION

Low keV VMI should be considered when screening after focal liver lesions, irrespective of the expected imaging characteristic.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Nikhil H. Ramaiya, MD - 2017 Honored Educator

SSK08-06 Quantification of the Liver-Iron Fraction Using Spectral CT Imaging and Material Decomposition Technique: A Vitro Experiment Study

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S404CD

Participants
Tingting Xie JR, MD, Shenzhen, China (*Presenter*) Nothing to Disclose
Guanxun Cheng, Shenzhen, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Our first goal was to build in vitro liver-iron model in order to provide a phantom for iron content quantification in study. The second goal was to evaluate the feasibility and accuracy of using spectral imaging and material decomposition techniques for iron density quantification to provide a basis for the precise iron quantification in clinical use.

METHOD AND MATERIALS

Liver-iron mixture samples were prepared as described. A total of six homogeneous liver-iron mixed samples with a iron content of 0, 3.125, 6.25, 12.5, 25, 50 mg/mL. 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 200mA, 320mA, 485mA respectively. After the CT scan reconstructed imaging data were processed with GSI imaging analysis software package for material decomposition and characterization. Iron concentration (on iron-water bases,Unit:mg/mL) was measured. The difference of measured iron concentration(VIC) between 3 groups of tube currents was analyzed by one-way ANOVA. A linear regression was performed to analyze the relationship between the VIC and the actual iron concentration.

RESULTS

(1) We had successfully developed models in vitro for iron content quantification. (2) There was no significant difference in VIC between 3 tube current groups,P=0.999, F=0.001. (3) The model showed good linear relationship between the measured iron concentration and actual iron concentration. And the linear correlation equation was y=2.177x-2.820, R^2 = 0.995, P<0.001, F=3186.883.

CONCLUSION

(1) Spectral imaging and material decomposition techniques were demonstrated to provide accurate and reliable measurement of iron content for liver-iron model, which will contribute to the development of clinical iron content quantification assays. (2) The quantification of the liver-iron fraction was not affected by radiation dose.

CLINICAL RELEVANCE/APPLICATION

This study demonstrated the feasibility of using CT spectral imaging and material decomposition techniques to precisely quantify the iron concentrations. The advantages of this quantitative method are non-invasive, high accuracy, without additional scanning, and the technique can be used to guide the treatment of relieving iron overload in hereditary hemochromatosis and acquired hemochromatosis, and assist the diagnosis of canceration of liver cirrhosis nodules.

SSK08-07 The Influence of Liver Fat Deposition on the Quantification of the Liver-Iron Fraction Using Spectral CT Imaging and Material Decomposition Technique: A Vitro Experiment Study

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S404CD

Participants
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PURPOSE

Our first goal was to build in vitro liver iron- fat deposition model in order to provide a phantom for iron content quantification in study. The second goal was to evaluate the feasibility and accuracy of using spectral imaging and material decomposition techniques for iron density quantification under the condition of simultaneous fat deposition and iron deposition in the liver.

METHOD AND MATERIALS

Liver-iron-fat mixture samples were prepared as described. A total of 18 samples(3 groups) of homogeneous liver-iron mixed samples with iron concentration gradient of 0, 10, 20, 30, 40, 50 mg/mL were prepared(group A, B and C), group A, B and C added fat with volume percentage of 10%, 30%and 60% respectively. All samples were scanned on a GE Revolution CT scanner using GSI mode with rapid tube voltage switching between 80-140 kVp, tube current 485mA. After the CT scan reconstructed imaging data were processed with GSI imaging analysis software package for material decomposition and characterization. Iron concentration (on iron-fat bases) measured with consistent regions of interest (ROIs) and statistical analysis. A linear regression was performed to analyze the relationship between the measured iron concentration and the actual iron concentration.

RESULTS

(1) We had successfully developed liver iron- fat models in vitro. The designed iron concentration range covered clinical iron content in liver, and the fat volume ratio of 10%, 30% and 60% simulated the mild, moderate and severe fatty liver respectively. (2) The model showed good linear relationship between the measured iron concentration and actual iron concentration. And the linear correlation equation were yA=0.575x-11.222,(R^2= 0.927, P=0.005, F=52.038), yB=0.848x-2.303(R^2 = 0.884, P=0.011, F=31.481), yC=0.788x-9.998(R^2= 0.949, P=0.003, F=76.068).

CONCLUSION

(1) Spectral imaging and material decomposition techniques were demonstrated to provide accurate and reliable measurement of iron content for liver-iron-fat model. (2) Fat affect the results of measured iron concentration.

CLINICAL RELEVANCE/APPLICATION

This study demonstrated the feasibility of using CT spectral imaging and material decomposition techniques to precisely quantify the iron concentrations under the condition of simultaneous fat deposition and iron deposition, and can be used to guide the treatment of relieving iron overload in hereditary hemochromatosis and acquired hemochromatosis.

SSK08-08 Dual Energy CT Iodine Maps for Response Assessment in Colorectal Liver Metastases (CLM) Treated With a Multikinase Inhibitor (MKI) with Anti-Angiogenic Activity

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S404CD

Participants
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PURPOSE

To assess changes in quantitative CT iodine maps in patients with CLM treated with a MKI with known anti-angiogenic activity and to assess their relationships with treatment outcomes.

METHOD AND MATERIALS

After IRB approval, 28 patients with CLM were prospectively consented and underwent dual energy CT studies on a Siemens SOMATOM CT scanner before and at 8 weeks after treatment. Iodine maps were generated from 3 mm dual energy CT images acquired in the arterial and portovenous phases. In each patient, regions of interest were drawn around a target hepatic metastasis to record the average iodine uptake before and after treatment, as well as the absolute and percentage change in iodine uptake after treatment. Results were compared between responders and non-responders, defined by RECIST 1.1 and clinical criteria. The diagnostic performance of CT iodine uptake for identifying responders was assessed by ROC analysis, and the relationship to overall survival (OS) was evaluated by Kaplan-Meier analysis.

RESULTS

Of the 28 patients, 16 patients were responders and 12 non-responders. Across the entire cohort, a significant decrease in the median averaged iodine uptake after treatment in arterial (17.06 vs. 7.86, p<0.0002) and portovenous phases (20.34 vs. 14.06, p<0.0001) was observed. However, there was no significant difference in the mean absolute or percentage decrease in iodine uptake on arterial (-6 vs -4.5, p=0.82 and -65 vs -38, p=0.22) or portovenous (-8.4 vs -6.1, p=0.10 and -41 vs -28, p=0.17) phase between the two groups. A -33.6% reduction in iodine uptake showed 68.8% sensitivity and 81.8% specificity for identifying responders, but this threshold showed no relationship with OS (36 vs. 29 weeks, p=0.3278).

CONCLUSION

A significant decrease in iodine uptake was observed across the study cohort on arterial and portovenous phase CT after anti-angiogenic therapy. Notwithstanding with small numbers, a significant difference in CT iodine uptake between responders and non-responder was not observed thus the technique cannot be used to inform treatment decisions at this stage.

CLINICAL RELEVANCE/APPLICATION

Dual energy CT iodine maps can not yet be used for response assessment in colorectal liver metastases treated with anti-angiogenic agents.

SSK08-09 How Reliable are CT-Based Measurements of Iodine Concentration? A Comparison of the Minimum Detectable Concentration Difference Among Single-Source and Dual-Source Dual-Energy CT

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S404CD

Participants
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PURPOSE

To assess the impact of scan- and patient-related factors on the error and the minimum detectable difference in iodine concentration among a wide range of different imaging conditions for second- and third-generation single-source fast kV-switching and dual-source dual-energy CT (DECT).

METHOD AND MATERIALS

Lesions of nine iodine concentrations (0.2 - 4 mgI/mL) were emulated in a 3D-printed phantom of medium and large size. Each combination of concentration and size was scanned in dual-energy mode on four different second- and third-generation single-source (SS) fast-kV switching and dual-source (DS) DECTs. Radiation doses were 7, 10 mGy (medium size) and 10, 13, 16 mGy (large size). Iodine maps were reconstructed with FBP and vendor-specific iterative reconstruction algorithms. ROI measurements of iodine concentration were made from each reconstructed iodine map with an automated script (243,000 total measurements). Absolute error of iodine quantification (E) was calculated. Multivariate regression models determined the influence of CT scanner condition, iodine concentration, phantom size, radiation dose, and reconstruction algorithm on E. Minimum detectable difference in iodine concentration, Dmin, was estimated for each pair of imaging conditions (including inter- and intra-condition comparisons). For a given pair of imaging conditions, Dmin was defined as the minimum difference in iodine concentration in which measured differences corresponded to true differences 95% of the time.

RESULTS

The iodine quantification error E was significantly lower in third-generation compared to second-generation DECT platforms ($P<0.001$). E significantly increased with increasing phantom size and decreasing radiation dose for all CT scanner conditions ($P<0.001$). Iodine concentration only significantly affected E for SS DECT ($P<0.001$). The minimum intra- and interconditional detectable difference in iodine concentration depended on patient- and scan-related factors and ranged from 0.4 mgI/mL to 1.5 mgI/mL

CONCLUSION

Patient- and scan-related factors have a significant impact on the error and minimum detectable difference in iodine concentration within and among second- and third-generation SS fast kV-switching and DS DECT.

CLINICAL RELEVANCE/APPLICATION

To inform radiologists about the impact of patient- and scan-related factors and the high error range of DECT-based iodine quantification when patients are imaged under different conditions.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSK09

Genitourinary (Renal Masses)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: N226

CT GU MR OI

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

Participants
Atul B. Shinagare, MD, Boston, MA (*Moderator*) Advisory Board, Arog Pharmaceuticals, Inc; Research Grant, GTx, Inc
Erick M. Remer, MD, Cleveland, OH (*Moderator*) Travel support, Bracco Group

Sub-Events

SSK09-01 Application of Deep-Learning Neural Network Model in Differentiation of Clear Cell Renal Carcinoma from Benign Oncocytoma Lesions

Participants
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PURPOSE

To use feature representations based on deep convolutional neural network in differentiating Clear Cell Renal Cell Carcinoma (ccRCC) from Oncocytoma lesions on MRI T2-weighted images.

METHOD AND MATERIALS

94 ccRCCs from 31 patients (12 males, 19 females) and 37 Oncocytoma lesions from 9 patients (6 males, 3 females) were identified from an institutional urologic oncology database. Weighted-T2 MR images taken within 6 months prior to surgery were selected for analysis. Lesions were segmented on every slice. Local square ROIs around each lesion were extracted and resized to 224x224 as neural network inputs. Deep residual network ResNet-101 pre-trained on ImageNet dataset was then used as feature extractor without fine-tuning. Using feature representations from ResNet, the corresponding lesion slices were then classified into either ccRCC or Oncocytoma using Support Vector Machine. Performance was reported based on five-fold cross-validation classification results. Accuracy at the lesion level was calculated based on the majority (> 50%) of correctly predicted class for all the slices in one lesion. If the number of correctly predicted slices is equal to the number of incorrectly predicted slices, then the entire lesion is considered to be incorrectly classified.

RESULTS

Out of a total of 407 slices, our model showed an overall accuracy of 78.62% in detecting Oncocytoma from Clear Cell RCCs. At the lesion level, 80 out of 94 (85%) ccRCC lesions and 23 out of 37 (62%) of oncocytoma lesions were correctly identified. The model showed an overall accuracy of 78.63%.

CONCLUSION

Deep Learning with CNN showed promising diagnostic performance in differentiation of Oncocytoma lesions from Clear Cell RCC.

CLINICAL RELEVANCE/APPLICATION

Our training model can be used as support information in the differential diagnosis between Oncocytoma and Clear Cell.

SSK09-02 Semantic Modeling of Fat Poor Angiomyolipoma (fp-AML) on Multiphase Contrast-Enhanced CTs

Wednesday, Nov. 28 10:40AM - 10:50AM Room: N226

Participants
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PURPOSE

To investigate the efficacy of noninvasive models in which clinical and radiographic descriptors were fused to differentiate the fp-AMLs from clear cell renal cell carcinoma (ccRCCs) in multiphase contrast-enhanced CT images.

METHOD AND MATERIALS

With IRB approval, we retrospectively collected patients at two academic hospitals (A and B) from Jan. 2006 to Dec. 2016 in Guangdong, China. All patients were clinically diagnosed with one suspicious ccRCC on multiphase contrast-enhanced CT acquired at least 30 days before surgical resection. Histopathologic data was served as ground truth. For model selection, we collected 118 cases (13 of 20 fpAMLs diameter <= 4cm and 46 of 98 ccRCCs diameter <= 4cm) at hospital A. An experienced radiologist identified the locations of lesions by examining all available information including the CTs and clinical reports, and provided descriptors of the lesion shapes, gray-level information as well as lesion margins. Twenty-four features including 5 clinical (gender, age, red blood cell in urine, white blood cell in urine, and symptom) and 19 radiographic descriptors were used. LASSO was used for feature selection and fp-AML prediction. To evaluate the efficacy of the developed fp-AML model, an independent set of 63 cases including 15cases (13 diameter <= 4cm) fp-AMLs and 48 (22 diameter <= 4cm) ccRCCs were collected from hospital B. Four additional radiologists independently provided the radiographic descriptors on multiphase CTs as well as the binary diagnostic decision of each lesion for baseline comparison.

RESULTS

On test set, the diagnosis accuracies of four readers were 0.74, 0.73, 0.71 and 0.90 while the models' achieved 0.81, 0.83, 0.87 and 0.92, respectively. Comparing to baselines, the improvements with models were 9.5%,13.7%, 22.5% and 2.2%, respectively. For small lesions (diameter <= 4cm), the readers' accuracies were 0.57, 0.60, 0.57 and 0.89 while the models' were 0.74, 0.71, 0.83 and0.91, correspondingly. The improvements were 29.8%, 18.3%, 45.6% and 2.2%, respectively.

CONCLUSION

Multiple reader study found that the semantic model improved the diagnostic accuracies of fp-AMLs and the bigger improvement were observed for small lesion.

CLINICAL RELEVANCE/APPLICATION

The noninvasive diagnosis of fp-AMLs from ccRCCs is a challenging task in clinical practice. The semantic modeling has the potential to improve the diagnostic accuracy of fp-AMLs.

SSK09-03 Comparison of Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Contrast-Enhanced Ultrasound (CEUS) in the Evaluation of Unclear Renal Lesions: A 10-Year Single Center Experience

Wednesday, Nov. 28 10:50AM - 11:00AM Room: N226

Participants
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PURPOSE

To compare the sensitivity and specificity of contrast-enhanced ultrasound (CEUS), computed tomography (CT) and magnetic resonance imaging (MRI) in the evaluation of unclear renal lesions to the histopathological outcome.

METHOD AND MATERIALS

A total of 255 patients with a single unclear renal mass with initial imaging studies between 2005 and 2015 were included. Patient ages ranged from 18 to 86 with (mean age 62 years; SD ± 13). CEUS (255 patients), CT (88 out of 255 patients; 34.5%) and MRI (36 out of 255 patients; 14.1%) were used for determining malignancy or benignancy and initial findings were correlated with the histopathological outcome. Out of the 255 renal masses a total of 212 lesions were malignant (83.1%) and 43 were benign (16.9%). Diagnostic accuracy was tested by using histopathology as the gold standard.

RESULTS

CEUS showed a sensitivity of 99.1% (95% confidence interval (CI): 96.7%, 99.9%), a specificity of 80.5% (95% CI: 65.1%, 91.2%), a positive predictive value (PPV) of 96.4% (95% CI: 93.0%, 98.4%) and a negative predictive value (NPV) of 94.3% (95% CI: 80.8%, 99.3%). CT showed a sensitivity of 97.1% (95% CI: 89.9%, 99.6%), a specificity of 47.4% (95% CI: 24.4%, 71.1%), PPV of 87.0% (95% CI: 77.4%, 93.6%) and a NPV of 81.8% (95% CI: 48.2%, 97.7%). MRI showed a sensitivity of 96.4% (95% CI: 81.7%, 99.9%), a specificity of 75.0% (95% CI: 34.9%, 96.8%), a PPV)of 93.1% (95% CI: 77.2%, 99.2%) and a NPV of 85.7% (95% CI: 42.1%, 99.6%). Out of 212 malignant lesions 130 clear cell renal carcinomas, 59 papillary renal cell carcinomas, 7 chromophobe renal cell carcinomas, 4 combined clear cell and papillary renal cell carcinomas and 12 other malignant lesions were diagnosed. Out of 43 benign lesions 10 angiomyolipomas, 3 oncocytomas, 8 benign cysts and 22 other benign lesions were diagnosed. Using CEUS, 10 lesions were falsely identified as malignant or benign: 8 lesions were false positive and 2 lesions false negative. The 8 false-positive lesions included 5 oncocytomas or angiomyolipomas and 3 Bosniak category III cystic lesions.

CONCLUSION

CEUS is an useful method which can be additionally used to clinically differentiate between malignant and benign renal lesions. CEUS shows a comparable sensitivity, specificity, PPV and NPV to CT and MRI.

CLINICAL RELEVANCE/APPLICATION

CEUS can be easily performed during clinical routine for the evaluation of unclear renal lesions as a complementary imaging method.

SSK09-04 Diagnosis of Fuhrman Nuclear Grade in T1a Clear Cell Renal Cell Carcinomas on MRI: Can We

Accurately Differentiate High Grade from Low Grade Disease to Better Guide Management?

Wednesday, Nov. 28 11:00AM - 11:10AM Room: N226

Awards
Student Travel Stipend Award

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PURPOSE

Multi-parametric (mp) MRI is accurate to diagnose clear cell renal cell carcinoma (cc-RCC). T1a cc-RCC is typically treated radically; however, low-grade tumors may be candidates for active surveillance. Fuhrman nuclear grading (FNG) of cc-RCC with biopsy is not accurate and this study evaluated mp-MRI to differentiate low from high-grade cc-RCC.

METHOD AND MATERIALS

42 consecutive solid <4cm cc-RCC with mp-MRI before nephrectomy between 2013 and 2017 (low-grade=FNG 1 [N=4] or 2 [N=27] and high-grade=FNG 3 [N=11]) were identified. Size, apparent diffusion coefficient (ADC), enhancement wash-in and wash-out (WI/WO) ratios and, chemical-shift signal-intensity index (SI-index) were measured. Subjectively, two blinded radiologists assessed for: 1) intracellular lipid (SI drop on opposed-phase MRI), 2) hemorrhage and 3) homogeneity. Discrepancies were resolved by consensus. Comparisons were performed using logistic regression and Chi-square and accuracy assessed using ROC.

RESULTS

Mean lesion size was 24 ± 7 (13-39) mm with no difference by FNG (p=0.45). 35.5% (11/31) low-grade tumors showed intracellular lipid compared to 9.1% (1/11) high-grade tumors (p=0.009). Agreement was moderate (K=0.65). SI-index was higher in low grade tumors (9.8 ± 34.4 versus 5.2 ± 19.9), p=0.283. Hemorrhage and homogeneity did not differ between groups (p>0.05). Mean ADC was higher in low-grade tumors (0.860 ± 0.142 versus 0.787 ± 0.229 mm2/sec) with significant differences observed for 10th centile ADC (p<0.001). WI index was higher in low-grade tumors for corticomedullary (p=0.019) and nephrographic phase (p=0.027) with no differences in WO. Presence of lipid was specific for diagnosis of low-grade disease (90.9% [58.7-98.8]) with low sensitivity (35.5% [19.2-54.6]). Logistic regression model combining presence of intracellular lipid, SIindex, ADC and WI yielded area under curve=0.79 (CI 0.62-0.96) with better accuracy (p=0.007, improved sensitivity=75.0% but lowered specificity=73.7%) compared to subjective assessment of lipid content alone.

CONCLUSION

Intracellular lipid in T1a clear cell RCC on MRI is highly specific for low-grade disease but with low sensitivity. Combining presence of lipid with ADC, SI-index and enhancement features improved accuracy of diagnosis.

CLINICAL RELEVANCE/APPLICATION

Multi-parametric MRI is accurate to differentiate low-grade and high-grade solid T1a clear cell tumors which may better inform management decisions.

SSK09-05 Radiogenomic Association Study Between PET/MR Imaging Features and Regional Histological and Gene Expression Status of Primary Clear Cell Renal Cell Carcinoma

Wednesday, Nov. 28 11:10AM - 11:20AM Room: N226

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PURPOSE

To discern potential associations between various imaging features and regionally altered histological and gene expression status of primary clear cell renal cell carcinomas (ccRCC) using a hybrid positron emission tomography/magnetic resonance (PET/MR) system.

METHOD AND MATERIALS

Between 2012 and 2013, eighteen ccRCC patients underwent presurgical PET/MR imaging. Ten histologically-confirmed ccRCC were included for subsequent analysis. Twenty-three regions-of-interest (ROIs) within primary tumors were pre-surgically defined using PET/MR images. Tissue samples of these ROIs were obtained during nephrectomy and sent for histological and microarray analyses.

Four images dataset, including Dixon fat and water images, dynamic contrast enhancement (DCE) from MR imaging and standard uptake value (SUV) from PET, were coregistered, and then radiomic imaging features were extracted from the pre-defined ROIs. Associations between these radiomic features, SUV, and 12 key selected genetic expressions of ccRCC were analyzed using sparse canonical correlation analysis.

RESULTS

Our study highlighted that combined structural and functional information from MRI and PET provides significant moderate to strong correlations between radiomic features and 8 of the selected genetic expressions, including FBP-1, BAP1, VHL, MUC4, PECAM1, PBRM1, TSC1, and MUC1 (P = 0.041). PET provides the highest loadings for the explanations of the radiomic correlations of expressions of PECAM1, while DCE in expressions of FBP-1, VHL, and PBRM1, and Dixon images in expressions of BAP1, MUC4, and TSC1.

CONCLUSION

Our study revealed the associations between PET/MR image features and regional variation of relevant biological features, underscoring the potential utility of PET/MR for discerning regional genetic variability in ccRCC.

CLINICAL RELEVANCE/APPLICATION

PET/MR identifies associations between radiomic features and genetic expressions. Knowledge on radiogenomic associations facilitates non-invasive mapping of tumor heterogeneity and selection of personalized treatments.

SSK09-06 Radiologically-Defined Tumor Necrosis in Clear Cell Renal Cell Carcinoma as a Surrogate of Pathologically-Defined Tumor Necrosis, Staging, and as a Size-Independent Prognostic Biomarker

Wednesday, Nov. 28 11:20AM - 11:30AM Room: N226

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PURPOSE

Pathologically defined tumor necrosis (PDTN) in clear cell renal cell carcinoma (ccRCC) has been considered as a prognostic factor. We aimed to measure radiologically-defined tumor necrosis (RDTN) of ccRCC and explore its association with PDTN, stage/grade, and with survival outcomes in a multi-institutional cohort.

METHOD AND MATERIALS

183 patients with ccRCC form The Cancer Genome Atlas (TCGA) with available contrast enhanced CT imaging were included in this study. Quantitative imaging methods were used to measure the volume of non-enhancing component of ccRCC (representing necrotic volume) based on the change of attenuation values of each tumor pixel between pre-contrast and postcontrast imaging. The percent of tumor necrosis ((necrotic volume/whole ccRCC volume) x 100) was used as a size-independent variable to represent RDTN. Associations of RDTN with pathological stage/grade were tested using Wilcoxon signed-rank test and with survival outcomes using Kaplan-Meier's curves and Cox regression analyses.

RESULTS

Median RDTN was 8% (interquartile range 3% - 17%) in this cohort. RDTN was higher in ccRCC with PDTN than those without (11% versus 7%; p-value= 0.042). There was no significant association between RDTN and pathological grading (p-value= 0.057). However, RDTN was higher in patients with AJCC pathological stage II, III, and IV in comparison with stage I (11% versus 5%; p-value<0.001). Patients with higher RDTN (>=median) had higher incidence of cancer recurrence after resection (Log-rank test p-value<0.001) and higher incidence of cancer-specific mortality (Log-rank test p-value<0.001). Controlling for age at diagnosis and stage of disease in a multivariable Cox-regresion model, patients with higher RDTN continued to have higher cancer recurrence and worse cancer-specific survival (Odds Ratios= 4.6 and 2.8; p-values= 0.003 and 0.020).

CONCLUSION

RDTN in ccRCC can be a surrogate to pathologically defined TN. Additionally, RDTN is associated with pathological staging and an important independent prognosticator.

CLINICAL RELEVANCE/APPLICATION

Radiologically-defined tumor necrosis in clear cell renal cell carcinoma conveys additional clinically-relevant information regarding tumor stage and prognosis.

SSK09-07 Developing a Sex-Specific Stratification System for Renal Cell Carcinoma Patients Using CT-Based Abdominal Fat and Muscle Quantification and Tumor Molecular Phenotyping

Wednesday, Nov. 28 11:30AM - 11:40AM Room: N226

Participants

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PURPOSE

Imaging biomarkers of metabolism such as tumor glucose uptake, patient muscle mass, and patient visceral fat have the ability to predict outcomes in cancer patients. Recent evidence has demonstrated sex differences in these metabolic measurements both on the imaging and the molecular levels. We wanted to determine if muscle mass and visceral fat measured by CT and molecular profiling of tumor glycolytic metabolism could be combined to develop a multiparametric sex-specific stratification system for RCC patients.

METHOD AND MATERIALS

This study included 222 patients with clear cell RCC included within The Cancer Genome Atlas (TCGA) and Cancer Imaging Archive (TCIA). The abdominal fat and glycolytic subtyping of patients were performed and used as published previously [PMID: 29558292] and combined with muscle quantification in this study. Abdominal fat was segmented into visceral, subcutaneous, and total fat areas as well as the normalized relative visceral fat area (visceral fat/total fat ratio, or rVFA). Glycolytic gene expression profiling of the tumors using TCGA data was used to metabolically classify the tumors. CT-based muscle mass and density measurements of the psoas muscle at L3 were performed. Biomarker optimization analyses were conducted to identify imaging metric thresholds that maximally stratified the patients based upon overall survival (OS).

RESULTS

The average psoas muscle area measured more in men than women (1171 vs 679.5 mm2) [p<0.0001]. The average psoas muscle density also measured more in men than women (41.1 vs 38.5 HU) [p=0.045]. Increased muscle area (>442 mm2 for women and >784 mm2 for men) was associated with increased OS (men p=0.002, women p=0.001). However, increased psoas density (>48.1 HU) was prognostic only for women; in this cohort, only 1/11 women died compared to the <48.1 HU group that experienced 29/66 deaths [p=0.02]. Combining rVFA, glycolysis and muscle area resulted in the identification of three sex-specific survival groups (Figure 1). Although all three variables contributed to female stratification (p<0.0001), male stratification was driven by glycolysis and muscle area (p=0.001).

CONCLUSION

Abdominal CT measurement of muscle and fat in tandem with molecular features of tumors predicts sex-specific outcomes in RCC patients.

CLINICAL RELEVANCE/APPLICATION

Sex differences in patient and tumor metabolism may provide a new risk-stratification system for patients with clear cell RCC.

Honored Educators

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SSK09-08 Baseline CT Texture Feature of Metastatic Clear Cell Renal Cell Carcinoma Correlates with Sunitinib Therapy Response

Wednesday, Nov. 28 11:40AM - 11:50AM Room: N226

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PURPOSE

Our study aimed to analyze tumor's baseline CT texture features and evaluate the correlation with first-line Sunitinib therapy response in metastatic clear cell renal cell carcinoma patients.

METHOD AND MATERIALS

Jan 2013 to July 2016, 48 metastatic RCC patients who received first line Sunitinib undertook abdominal CT scan before treatment. Forty-two patients were included. Clinical information (age, gender, surgery, MSCKK score and Heng's score, metastasis) and pathological information (tumor diameter, Fuhrmann grade, tumor thrombus) were collected. We collected 30 unenhanced CT images, 30 corticomedullary phase CT images and 36 nephrographic phase CT images from these patients. 2D CT texture parameters were generated from the image with the largest tumor diameter using histogram analysis and spatial gray-level dependence matrices (GLCM and RLM), respectively. Patients were divided into respond group (CR+PR) and non-respond group (SD+PD) according to RECIST criteria. We compared the CT texture feature, clinical and pathological parameters between two groups. We further assess the CT texture parameters with progression-free survival (PFS) using Kaplan-Meier analysis and Cox regression model.

RESULTS

Age, gender, tumor diameter and clinical prognostic scores (MSKCC and Heng's score) had no difference between respond and non

Age, gender, tumor diameter and clinical prognostic scores (MSKCC and Heng's score) had no difference between respond and non-respond group. Gray-level nonuniformity (GLN) from unenhanced and corticomedullary phase CT in respond group was significantly smaller than non-respond group ($p<0.05$). Logistic regression showed that GLN from unenhanced ($p<0.05$, OR 0.98(0.97, 0.99)) and corticomedullary phase CT ($p<0.05$, OR 0.96(0.94, 0.99)) independently associated with therapy response. GLN from unenhanced CT had AUC of 0.76($P<0.05$, sensitivity 84.2%, specificity 63.6%); GLN from corticomedullary phase CT had AUC of 0.77 ($P<0.05$, sensitivity 73.7%, specificity 73.7%). Cox regression model showed that both GLN from unenhanced ($p<0.05$, HR 1.008(1.003,1.013)) and corticomedullary phase CT($p<0.05$, HR 1.012(1.002,1.022)) had significant correlation with PFS.

CONCLUSION

For metastatic patients who received Sunitinib therapy, baseline CT texture parameter Gray-length nonuniformity reflecting tumor heterogeneity correlate with therapy response and PFS.

CLINICAL RELEVANCE/APPLICATION

CT texture parameter reflecting tumor heterogeneity has the potential to predict targeted therapy response before treatment in metastatic clear cell renal cell carcinoma.

SSK09-09 Role of Non-Target Disease and New Lesions as Defined by RECIST 1.1 in Determining Radiological Progression in Renal Cell Carcinoma

Wednesday, Nov. 28 11:50AM - 12:00PM Room: N226

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PURPOSE

Progression free survival (PFS) based on RECIST 1.1 (R1.1) is still the most accepted primary end point for Phase III trials in renal cell carcinoma. Guidelines to assess tumor response based on changes in target lesions (TG) are quantifiable and established. However, guidelines to assess tumor response based on non-target (NT) or new lesions (NL) are qualitative and subject to inter-observer variation. The purpose of our study was to retrospectively assess the most common criteria for determination of progressive disease (PD) assessed using R1.1 and how these progression events impact PFS.

METHOD AND MATERIALS

We conducted a secondary analysis of a cohort of patients enrolled in a Phase III global multi-center open label trial who were randomized 1:1 to open label anti-VEGFR tyrosine kinase inhibitor (TKI) therapies. All patients had previously progressed after having received prior VEGFR therapy and had measurable disease at screening (SCR). A chest CT, and either a CT or MRI of the abdomen and pelvis were acquired at SCR and every 8 weeks and interpreted at an imaging core laboratory for PD using R1.1. Kaplan-Meier plots, Holm's multiple comparisons and log-rank tests were performed to compare the median PFS for each R1.1 measurement assessment.

RESULTS

We analyzed 395 subjects with a mean age of 60.7 years (SD ± 10.0). The mean number of follow-up visits was 4.9 (SD ± 1.8) with a mean of 6.59 (SD ± 3.70) months enrolled. PD was determined by growth of target (TG) lesions in 126 (32%) subjects (median PFS (mPFS) 5.44 months, IQR 3.87) appearance of a new lesion (NL) in 105 (27%) subjects (mPFS 3.61 months, IQR 3.60), and unequivocal progression of a non-target (NT) lesion in 73(18%) subjects (mPFS 2.79 months, IQR 3.54). The remaining subjects had PD determined by a combination of assessments: 33 (8%) by TG+NT (mPFS 3.54 months, IQR 3.70), 27(7%) by NT +NL (mPFS 3.74 months, IQR 2.48), 23(6%) by TG +NL (mPFS 3.64 months, IQR 5.38), and 8(2%) by TG+NT+NL (mPFS 4.52 months, IQR 4.98).

CONCLUSION

TG disease contributed to PD determination in less than 50% of patients and NT and NL were the most common criteria that defined PD, with a significant decrease in PFS compared to those patients who had PD determine by TG alone.

CLINICAL RELEVANCE/APPLICATION

In R1.1 assessment of metastatic RCC, both NT and NL alone, or in combination, are the dominant contributors to PD and may need updated R1.1 guidelines for NT and NL progression

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SSK10

Genitourinary (PI-RADS)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: N228

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

Participants
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Sub-Events

SSK10-01 Can 3+1=5? Evaluation of Dynamic Contrast Enhanced (DCE)-MRI "Upgraded" PI-RADS Version 2 Assessment Category 3 Peripheral Zone Observations: Should Size Impact the Final Assessment Category?

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PURPOSE

PI-RADS v2 peripheral zone (PZ) observations considered indeterminate on diffusion-weighted imaging (assessment category 3) can be upgraded by 1 when showing early, focal and asymmetric hyper-enhancement on DCE-MRI. It is unclear whether upgraded category 3 PZ observations measuring >15 mm should be scored as category 4 or 5 lesions. This study evaluates DCE-MRI upgraded PI-RADS v2 PZ observations compared to other category 4 and 5 lesions and compares upgraded observations stratified by size when correlated to extra-prostatic extension (EPE), seminal vesicle invasion (SVI) and Gleason score (GS).

METHOD AND MATERIALS

With IRB approval, 230 men with mp-MRI before radical prostatectomy (RP) between 2013 and 2017 and with mp-MRI-RP maps confirming location of PZ dominant tumor foci were evaluated. Two blinded radiologists assigned PI-RADSv2 scores at independent review, then, both radiologists later jointly reviewed observations which were upgraded by abnormal DCE-MRI and discrepancies were resolved by consensus. Size of tumors was measured on axial T2-weighted MRI. Comparisons were performed using ANOVA and Chi-square.

RESULTS

9.1% (21/230) of tumors were upgraded by DCE, with size of upgraded tumors13 ± 5 (6-24) mm. Upgraded tumors had lower EPE (52.4% [11/21]) and SVI (4.8% [1/21]) versus non-upgraded PIRADSv2 score 4 or 5 tumors (EPE 67.5% [141/209], SVI 22.0% [46/209]), p=0.16 and 0.06. 85.7% (18/21) of upgraded tumors had Gleason score (GS)=7 with 14.3% (3/21) GS >7. Assigning PI-RADSv2 score to upgraded lesions based on size, 23.8% (5/21) would be score 5 (size 16-24mm) and the remaining 76.2% (16/21) score 4. All five score 5 upgraded tumors (100% [5/5]) had EPE, 25% (1/5) had SVI and 40% (2/5) had GS >7. In upgraded lesions measuring <15 mm, 31.3% (5/16) had EPE, none had SVI and only one patient had GS >7.

CONCLUSION

Peripheral zone tumors which are upgraded by DCE-MRI are less aggressive compared to non-upgraded score 4 and 5 tumors with lower rates of EPE, SVI and GS>7. In upgraded tumors measuring >15 mm, an assessment category of 5 is appropriate due to higher rates of EPE, SVI and high-risk Gleason score compared to upgraded tumors measuring <15 mm.

CLINICAL RELEVANCE/APPLICATION

DCE-MRI upgraded PZ tumors are less aggressive than non-upgraded score 4 or 5 tumors; however, DCE-MRI upgraded peripheral zone observations measuring >15 mm should be assigned assessment category 5.

SSK10-02 Optimizing MRI-Based Size Thresholds for Prostate Cancer Lesions: Peripheral Zone Cancers are More Predictable than Transition Zone Tumors

Wednesday, Nov. 28 10:40AM - 10:50AM Room: N228

Participants
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PURPOSE

To evaluate if thresholds based on tumor size on MR Imaging can successfully stratify prostate cancers by their aggressiveness separated by their zone of origin. Goal was improve the currently applied PI-RADS 4 vs. 5 differentiation criterion.

METHOD AND MATERIALS

The MRI datasets of 152 patients who underwent 3 T MRI imaging and subsequent systematic and MRI/TRUS-fusion biopsy were re-read in a fully informed setting by three radiologists. All patients hat prostate cancer confirmed on histopathology. All retrospectively identifiable tumors were measured on T2 for lesions originating in the transition zone and on DWI for lesions from the peripheral zone and tabulated against their respective Gleason grade.

RESULTS

151 lesions were measurable in peripheral zone (n=111) and transition zone (n=40) with the following distribution: Gleason 3+3: 36, 3+4: 29, 3+5: 1, 4+3: 36, 4+4: 37, 4+5: 11, 5+5: 1. Looking at different size thresholds, rates of aggressive cancers (defined as Gleason 3+4 and above) in the peripheral zone were 75% (threshold=0.5 cm), 77% (threshold=1.0 cm), 87% (threshold=1.5 cm), 90% (threshold=2 cm) and 100% (threshold=2.5 cm). In the transition zone rates of aggressive cancer were 55% (threshold=0.5 cm), 57% (threshold=1 cm), 55% (threshold=1.5 cm), 57% (threshold=2.0 cm) and 86% (threshold=2.5 cm), 100% were reached at a threshold of 3 cm. Ten lesions were located in the anterior stroma, which were excluded due to small subgroup numbers.

CONCLUSION

Size thresholds can be used to stratify prostate cancer to some extent. Considering peripheral zone and transition zone separately, there was a clearer separation of clinically significant/aggressive tumors in peripheral zone cancers compared to transition zone cancers. Conversely, even low threshold lesions of 0.5 cm and below can harbor clinically significant cancers. Future versions of PI-RADS should therefore consider different cut-offs for peripheral zone and transition zone cancers. Furthermore, additional criteria - other than size - could add value to the differentiation between PIRADS 4 and 5. A clear separation as in BI-RADS 4a-c (2-9%, 10-50%, 50-95%) on the basis of size seems currently unfeasible.

CLINICAL RELEVANCE/APPLICATION

Adopting different size cut-offs for transition zone and peripheral tumors could be warranted. Additional characteristics - other than size - will likely be needed to stratify between PI-RADS 4 and 5 lesions.

SSK10-03 PI-RADS v2 based Characteristics of Missed Prostate Cancer Lesions on 3T Multiparametric-MRI Based on 518 Patients using Whole Mount Histopathology Reference

Wednesday, Nov. 28 10:50AM - 11:00AM Room: N228

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PURPOSE

To determine the characteristics of missed prostate cancer (PCa) lesions on 3TmpMRI using a whole mount histopathology (WMHP) as a standard of reference.

METHOD AND MATERIALS

With IRB approval & HIPAA compliance, the study cohort comprised 518 consecutive men who underwent robotic prostatectomy between Dec 2009 & May 2017. Clinical, 3TmpMRI (T2-weighted imaging, diffusion-weighted imaging (DWI), & dynamic contrast-enhanced (DCE) imaging) & WMHP features were analyzed. A structural report system, based on PI-RADS v2, was used. MRI detected lesions were matched with previously finalized WMHP in a joint session by a genitourinary radiologist and pathologist. MRI lesion detection rate was calculated. After the multidisciplinary sessions, patients without any detected PCa lesion in 3TmpMRI, but with at least one lesion >1 cm on WMHP, were retrospectively reviewed & assigned a PI-RADS v2 score.

RESULTS

In 518 patients with 1085 PCa foci on WMHP, 51.9% (563) lesions were missed & 48.1% (522) detected. Of the 563 missed lesions, 71.4% & 21.7% were graded as GS=3+3 & GS=3+4 respectively, while only 4.4% & 2.5% were graded as GS=4+3 & GS=8-10. The proportion of PCa with GS>7 was significantly lower among missed tumors compared to detected ones(p=0.001). Missed foci were

significantly smaller than detected ones in both overall (0.9 ± 0.7 cm vs. 2.1 ± 0.9 cm) & index (1.5 ± 0.8 cm vs 2.0 ± 0.9cm) lesion subcohorts(p =0.001). Of overall & index missed lesions 34.4% & 71.2% were >1 cm. In 13.7% (71/518) of patients without an MR detected lesion, a total of 151 lesions were detected on WMHP, of which 70(47 %) were >1cm . On retrospective review of these lesions, 42.8% (30), 18.5% (13), 20% (14), 10%(7), 7%(5), were PI-RADS V2 1, 2, 3, 4 & 5 respectively. Evaluation of 27% (19) of these lesions was limited by hemorrhage or susceptibility artifact or geometric distortion. Overall, 5.9% (31/518) of patients with clinically significant (CS) PCa lesions were totally missed in 3TmpMRI.

CONCLUSION

On 3TmpMRI, most missed PCa lesions were small & low grade. Although there were some large & high grade missed lesions on 3TmpMRI, the number of missed patients with CS lesion were small & detection for these patients was excellent.

CLINICAL RELEVANCE/APPLICATION

Number of missed patients with CS lesion were small and detection for these patients was excellent. 3T MRI can be use for every patients with PCa suspicious perior to biopsy and surgery.

SSK10-04 Yield of Concurrent Systemic Biopsy During MRI-Guided Targeted Biopsy According to PI-RADS Version 2 in Patients with Suspicious Prostate Cancer

Wednesday, Nov. 28 11:00AM - 11:10AM Room: N228

Participants
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PURPOSE

Few studies have reported the value of concurrent systemic biopsy during MRI-guided targeted biopsy according to PI-RADS version 2 (v2). We aimed to investigate the yield of concurrent systemic biopsy during MRI-guided targeted biopsy based on PI-RADS v2 interpretations in patients with suspicious prostate cancer (PCa).

METHOD AND MATERIALS

285 consecutive patients with suspicious PCa who performed initial (n = 154) or repeated prostate biopsies (n =131) were enrolled in this retrospective study. All patients underwent prebiopsy 3-T multiparametric MRI, and performed MRI-transrectal ultrasound (TRUS) fusion targeted biopsy regarding PI-RADS v2 category 3-5 lesions and concurrent systemic standard biopsy. Detection rates of all PCa and clinically significant cancer (CSC) were evaluated based on the index lesion in each patient. Biopsy-based definition of CSC was Gleason score (GS) >= 3 + 4.

RESULTS

In all 351 target lesions (peripheral zone [PZ] = 215, transition zone [TZ] = 130, and both = 6), distributions of PI-RADS category 3, 4, and 5 lesions were 86, 177 and 88, respectively. Detection rates of all PCa and CSCs were 39.6% (139/351) and 29.6% (104/351), respectively. As each PI-RADS scoring, detection rates of all PCa and CSCs were 7% and 4.7% for category 3, 36.2% and 24.3% for category 4, and 78.4% and 64.8% for category 5. Regarding each PI-RADS category 4 and 5 lesion, CSC detection rates in PZ were 64.7% (33/51) and 92.9% (26/28), while detection rates of insignificant PCa in TZ were 23.1% (3/13) and 28.6% (10/35). In 49 patients (17.2%), systemic biopsy contained the highest GS cancer compared to targeted biopsy: 22 patients with positive targeted and positive systemic biopsy, and 27 patients with negative targeted biopsy and positive systemic biopsy. Of 88 patients with PI-RADS category 5 lesions, 15 (17%) had the highest GS cancer in systemic biopsy: PZ (n = 6), TZ (n = 8) and both (n = 1).

CONCLUSION

When performing a MRI-guided targeted biopsy based on PI-RADS v2, concurrent systemic biopsy cannot be abandoned in patients with suspicious PCa due to potential harboring more aggressive cancer.

CLINICAL RELEVANCE/APPLICATION

Although MRI-guided targeted biopsy regarding PI-RADS v2 category 4 or 5 lesion demonstrates excellent detection rates of all PCa and CSCs, concurrent systemic biopsy should be performed because of potential harboring more aggressive cancer.

SSK10-05 PI-RADS 3/Total Lesion Ratio is Associated with Clinically-Significant Prostate Cancer in Patients with Equivocal Risk Lesions on Multi-Parametric Magnetic Resonance Imaging

Wednesday, Nov. 28 11:10AM - 11:20AM Room: N228

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PURPOSE

Prostate imaging reporting and data system (PI-RADS) category 3 (P3) provides an equivocal assessment of prostate cancer. We aimed to investigate multi-parametric magnetic resonance imaging (mpMRI) parameters including the ratio of P3-to-total regions of interest (ROI) that may assist in identifying patients with P3 lesions harboring clinically-significant prostate cancer (csPCa).

METHOD AND MATERIALS

We retrospectively queried our institutional mpMRI-ultrasound fusion (targeted) biopsy database to identify patients without a prior diagnosis of prostate cancer and with at least one P3 lesion on mpMRI who underwent targeted biopsy during Feb 2015-Oct 2017. mpMRI findings were assessed, including prostate and P3 volumes, number of ROIs, and P3-to-total ROIs ratio (P3 lesion volume/total ROIs volumes). Logistic regression and receiver operating characteristics curves with area under the curve (AUC) were used to assess the ability of clinical and mpMRI characteristics to predict csPCa, defined as any Gleason score (GS)>=7 cancer or GS 6 cancer in >2 cores or >50% of any positive core from targeted biopsy of the P3 lesion.

RESULTS

Of 132 men with at least one P3 lesion, 31 (23.4%) had csPCa on the biopsy of P3 lesions. Patients with csPCa in P3 lesions had smaller prostate volumes (p=0.002), lower P3/total ROIs ratios (p=0.002), and higher numbers of total ROIs (p=0.009). Compared with patients who had a P3/total ROIs ratio >0.58, men with ratios <0.58 were more likely to be diagnosed with csPCa in a P3 lesion (53.3% vs 12%, p<0.001). Using a threshold of 0.58, P3/total ROIs ratio was 69% sensitive and 79% specific for csPCa in a P3 lesion. On multivariable analysis, smaller prostate volume (OR 1.04, 95%CI 1.01-1.07, p=0.02) and lower P3/total ROIs ratio (OR 1.04, 95%CI 1.01-1.07, p=0.03) were associated with an increased risk of csPCa in P3 lesions. P3/total ROIs ratio and prostate volume (both AUC 0.70) were superior to prostate-specific antigen (PSA) density (AUC 0.66) for the prediction of csPCa in P3 lesions.

CONCLUSION

P3/total ROIs ratio and prostate volume outperformed PSA density in and were associated with detecting csPCa in P3 lesions. P3/total ROIs ratio could be used to avoid 79% of unnecessary biopsies of a P3 lesion in men with multiple ROIs on mpMRI.

CLINICAL RELEVANCE/APPLICATION

PI-RADS 3/total ROIs ratio might have a potentially significant clinical implication in the setting of equivocal-risk lesions on mpMRI.

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SSK10-06 Interobserver Agreement of PI-RADS v2 Lexicon Among Radiologists with Different Levels of Experience

Wednesday, Nov. 28 11:20AM - 11:30AM Room: N228

Participants
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PURPOSE

To determine the interobserver agreement of the PI-RADS version 2 lexicon.

METHOD AND MATERIALS

Retrospective IRB approved study. Eight radiologists, with different levels of experience and blinded to clinical data and original multiparametric MRI reports, evaluated a total of 160 lesions, 130 from peripheral zone (PZ) and 30 from transition zone (TZ). On T2w imaging, signs of definite extraprostatic extension or invasive behavior were assessed, for both TZ and PZ lesions. For TZ lesions, the following additional features on T2w imaging were assessed: circumscribed versus obscured margins, encapsulation, heterogeneous versus homogeneous, moderately hypointense and lenticular shape. On DWI and ADC map, the following features were assessed, for both PZ and TZ: focal versus indistinct, marked hyperintensity on high-b-value DWI, and marked hypointensity on ADC map. Finally, on DCE images the readers assigned presence or absence of early enhancement in the lesion/region of the lesion.

RESULTS

Of the five features evaluated on PZ lesions, only definite extraprostatic extension or invasive behavior on T2w had good agreement (AC1= 0.80). All other features (focal versus indistinct on ADC map and DWI, marked hyperintensity on high-b-value DWI, marked hypointensity on ADC map, and presence or not of early enhancement in the lesion/region of the lesion on DCE) had fair agreement (AC1= 0.32 to 0.40). Of the eight features evaluated on TZ lesions, two had good agreement: definite extraprostatic extension or invasive behavior (AC1= 0.77) and moderately/marked hypointensity on T2w (AC1= 0.67). Four features had moderate agreement: encapsulation and lenticular shape on T2w, focal (not indistinct) on ADC map and DWI, and marked hypointensity on ADC map (AC1= 0.45 to 0.60). The four other features had fair agreement: heterogeneous (not homogeneous) and circumscribed (not obscured) margins on T2w, marked hyperintensity on high-b-value DWI, and presence or not of early

enhancement in the lesion/region of the lesion (AC1= 0.30 to 0.38).

CONCLUSION

PI-RADS v2 lexicon ranged from fair to good interobserver agreement. The best agreements were observed for definitive EPE or invasive behavior on T2w on PZ and TZ.

CLINICAL RELEVANCE/APPLICATION

To evaluate the reproducibility of PI-RADS v2 lexicon is essential for clinical use.

SSK10-07 Comparison of Multi and Single Zonal True Positive Index Prostate Cancer Lesions with 3T Multiparametric MRI and Whole Mount Histopathology Correlation in 408 Patients

Wednesday, Nov. 28 11:30AM - 11:40AM Room: N228

Participants
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PURPOSE

To investigate the clinical, 3T multiparametric MRI (3T mpMRI) and histopathologic characteristics of multi and single zone true positive index prostate cancer (PCa) lesions with whole mount histopathology (WMHP) as reference standard.

METHOD AND MATERIALS

In this HIPAA-compliant, IRB-approved study, we evaluated a cohort of 408 men with both 3T mpMRI and WMHP before and after robotic prostatectomy from 12/2009 to 10/2017. A genitourinary (GU) radiologist and GU pathologist matched all WMHP PCa lesions with PI-RADSv2 based detected lesions on 3T mpMRI. The clinical, MRI and WMHP characteristics of true positive index lesions between multi zone (present in both transition (TZ) and peripheral zone (PZ)) and single zone (present in either TZ or PZ) PCa lesions were determined and compared using Chi-square and Mann-Whitney U test in SPSS v24.

RESULTS

Patients' mean age was 62.2±7 years with median PSA of 6.3 (IQR 4.25). 9.3% (38/408) of the lesions were located in both TZ and PZ, 19.4% (79/408) in TZ and 71.3% (291/408) in PZ. Tumor size was slightly but significantly (P=0.002) higher for multi zone lesions (median 2.5cm) compared to TZ lesions (median 2.3cm) and PZ lesions (median 2.1cm). PSA was significantly higher (P= 0.001) in multi zone (7.7 ng/ml) and TZ PCa lesions (7.65 ng/ml) compared to PZ lesions (6 ng/ml). Multi zone lesions had a significantly higher proportion of PI-RADSv2 score 5 (55.3%) compared to TZ lesions (44.3%) and PZ lesions (33.7%) (p<0.001). Other parameters such as PSA density, prostate volume, tumor grading (Gleason score) and staging were similar between single and multi zone lesions.

CONCLUSION

Although multi zone PCa lesions may have more aggressive 3T mpMRI and clinical characteristics, however the grading and staging of the tumors on WMHP are similar to single zone lesions.

CLINICAL RELEVANCE/APPLICATION

Multi zone PCa lesions are associated with more aggressive clinical and MRI features with similar pathologic characteristics compared to single zone PCa lesions.

SSK10-08 Are Qualitative or Quantitative Analysis of DCE the Key to Success in the Grading and Detection of Prostate Cancer?

Wednesday, Nov. 28 11:40AM - 11:50AM Room: N228

Participants
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PURPOSE

The primary purpose of this study was to evaluate the performance of (semi-)quantitative analysis of dynamic contrast-enhanced MRI (DCE) in the detection of prostate cancer (PCa) in comparison to qualitative analysis. The secondary purpose of this study was to find out if any of the methods could distinguish clinically significant PCa from insignificant PCa.

METHOD AND MATERIALS

DCE data of 103 consecutive patients with multi-parametric MRI (T2WI, DWI, DCE) and subsequent MRI-(in-bore)-biopsy of the prostate were retrospectively analyzed. Qualitative analysis of DCE (after PIRADS v2 criteria), semiquantitative analysis (curve type after PIRADS v1 criteria) and quantitative (Ktrans, kep after Tofts) analysis of in total 206 lesions (87 cancer positive and 119 benign lesions) were performed. Cancer detection, discrimination of significant cancer, and localization was assessed and compared to histopathologic findings.

RESULTS

Subdivided in peripheral zone (PZ) and transition zone (TZ) Ktrans ($p<0.01$; $p=0.04$) and Kep ($p=0.04$, $p<0.01$) were significantly different between PCa and benign lesions. The PI-RADS v2 overall score could discriminate PCa and benign lesions in both, PZ and TZ ($p<0.01$), whereas PI-RADS single scores of DCE could differentiate PCa better in PZ ($p<0.01$) than in TZ ($p=0.5$). None perfusion parameter could differentiate between insignificant and significant (>=3+4=7) PCa ($p=0.5$-0.8).

CONCLUSION

PI-RADS v2 criteria for DCE discriminate well between benign lesions and PCa in the peripheral zone. Qualitative (curve type) and quantitative parameters (Ktrans, Kep) provide no additional improvement in PCa detection compared to PI-RADS scoring alone. DCE-MRI alone did not allow differentiation between significant and insignificant PCa.

CLINICAL RELEVANCE/APPLICATION

DCE and PI-RADS v2 criteria enable an improvement of PCa detection especially in the peripheral zone, central zone, and anterior stroma; therefore DCE should not be omitted for primary PCA detection. With limitations quantitative analysis can detect PCa, but the additional diagnostic relevance of quantitative parameters is limited. PI-RADS criteria for DCE in transition zone needs to be optimized for PCa detection.

SSK10-09 Is Biopsy Justified in Prostate Patients Assigned to PI-RADS Category 3?

Wednesday, Nov. 28 11:50AM - 12:00PM Room: N228

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PURPOSE

To systematically analyze patients with PI-RADS-3-lesions (called 'equivocal' according to PI-RADS v2) in multiparametric prostate MRI (mp-MRI) and MR-targeted plus systematic transrectal ultrasound-guided (TRUS-GB) biopsies as reference standard.

METHOD AND MATERIALS

One hundred and twenty consecutive patients assigned to PI-RADS assessment category 3 after mp-MRI (T2WI, DWI, DCE-MRI) at 3T and subsequent targeted MRI/US fusion-guided (FUS-GB) plus systematic 12-core TRUS-GB were retrospectively included in this study. As endpoints prostate cancer (PCa) detection rates, distribution of Gleason scores, location of PCa, and risk stratification by subgroup analyses were defined.

RESULTS

PCa was detected in 13 of 118 patients (detection rate 11%) including five patients with a Gleason score (GS) >=3+4=7 (4.2%). 1.4% of the lesions within the transition zone (3/212) and 9.4% within the peripheral zone (6/64) were positive for PCa. Patients with PCa showed in 54% MRI patterns of peripheral prostatitis combined with diffuse stromal hyperplasia. Prostate volume was significantly lower in PCa patients ($p=0.015$), whereas differences in PSA levels were not statistically significant ($p=0.87$). PSA density was higher in patients with PCa (0.19 vs. 0.12 ng/ml/ml).

CONCLUSION

PCa with a GS >=3+4=7 can be detected in mp-MRI with a high degree of certainty. In patients assigned to PI-RADS category 3 low-grade PCa (GS 3+3=6) can occur, but GS >=4+3=7 PCa is very unlikely. Therefore, primarily follow-up MRI is justified in these patients to avoid overtreatment of clinically insignificant PCa. In patients with a combination of MRI aspects of extensive prostatitis and diffuse stromal hyperplasia, low prostate volume, and/or high PSA density biopsy might be considered.

CLINICAL RELEVANCE/APPLICATION

Patients with PI-RADS 3 lesions can safely be managed by follow-up MRI as "test-of-time" approach without immediate biopsy, especially if lesions are located in the transition zone. This recommendation may apply specifically to patients with low PSA density and without MRI features of peripheral prostatitis combined with diffuse stromal hyperplasia.

SSK11

Health Service, Policy and Research (Value, Outcomes and Risk)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S104A

ED HP 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

SSK11-01 Financial Implications of Oral Contrast Administration Prior to Abdominopelvic CT for Non-Traumatic Abdominal Pain in the Emergency Department: A Time-Driven Activity-based Costing Analysis

Participants
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PURPOSE

To quantify the time and monetary cost associated with oral contrast administration prior to abdominopelvic CT for patients with non-traumatic abdominal pain in the emergency department (ED). A secondary aim was to assess the cost savings associated with a new institutional policy change for oral contrast administration in this population.

METHOD AND MATERIALS

A HIPAA-complaint, IRB-approved time-driven activity-based costing analysis was performed using both prospective time-studies and retrospective data obtained in a quaternary care center. Retrospective data spanned a 1-year period (1/1/2016-12/31/2016). A process map was generated. Exam volume-related data, labor costs, and material costs were determined and applied to a base-case model. Univariate and multivariate sensitivity analyses were conducted. Multivariate analysis was used to estimate the cost savings associated with a policy change eliminating oral contrast for patients with BMI >=25, no prior abdominal surgery <=30 days, and no inflammatory bowel disease.

RESULTS

The baseline oral contrast utilization rate was 86% (4,541/5,263). The annual base-case cost estimate for oral contrast administration was $155,173. In multivariate analyses, this ranged from $20,034 - $672,469. The model was most sensitive to volume of cases requiring oral contrast and passive ED costs during contrast consumption. The median time cost of oral contrast consumption was 33 minutes (IQR: 23-43 minutes) for barium sulfate suspension and 62 minutes (IQR: 43-81 minutes) for diatrizoate meglumine-sodium. Applying parameters from the new policy change reduced the annual cost by 52% (cost saving: $73,709).

CONCLUSION

Time and monetary costs associated with oral contrast administration prior to abdominopelvic CT in the ED should be balanced with its potential diagnostic benefits to ensure high-quality patient care and healthcare cost stewardship. Our multi-departmental collaborative policy change is estimated to halve hospital costs associated in ED oral contrast administration.

CLINICAL RELEVANCE/APPLICATION

Time and monetary costs associated with oral contrast administration prior to abdominopelvic CT in the ED should be balanced with diagnostic benefits to ensure high-quality patient care and healthcare cost stewardship.

SSK11-02 Testing for Verification Bias in Reported Malignancy Risks for Side-Branch Intraductal Papillary Mucinous Neoplasms: A Simulation Modeling Approach

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S104A

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PURPOSE

To test for the possibility that published malignancy risks for side-branch intraductal papillary mucinous neoplasms (SBIPMN) are overestimates, likely due to verification bias.

METHOD AND MATERIALS

We tested for possible verification bias using simulation modeling techniques. First, in age-defined hypothetical cohorts of one million persons, we projected the frequency of pancreatic ductal adenocarcinoma (PDAC) arising from SBIPMNs over five years using published estimates of their prevalence (4.4%) and rate of malignant transformation (1.9%). Second, we projected the total number of PDAC cases in corresponding cohorts over the same time horizon using national cancer registry data (SEER). For each cohort, we determined if the percentage of all PDAC cases that arose from SBIPMNs (i.e., of SBIPMN-associated PDAC cases) was clinically plausible, invoking an upper limit of 10% to define plausibility, as estimated from the literature. Model assumptions and parameter uncertainty were evaluated in sensitivity analysis.

RESULTS

Across all cohorts, percentages of SBIPMN-associated PDAC greatly exceeded 10%. In the base case (mean age=56 years), 88% of PDAC cases arose from SBIPMNs (874/989). In the oldest cohort evaluated (mean age=75 years), this estimate was 82% (1,549/1,882). In a secondary analysis, we found that if an upper limit threshold of 10% for SBIPMN-associated PDAC was imposed, the model-predicted rate of malignancy for SBIPMN would be <0.21% over a five-year time horizon, substantially lower than most literature-based estimates.

CONCLUSION

Our results suggest that reported malignancy risks associated with SBIPMNs are likely to be overestimates, and imply the presence of verification bias.

CLINICAL RELEVANCE/APPLICATION

Our results highlight the uncertainty surrounding the natural history of SBIPMNs and underscore the importance of each patient's individual circumstance when making decisions regarding follow-up or treatment of SBIPMN.

SSK11-03 Automatic Evaluation of Routine Computed Tomography Scans for Prediction of Osteoporotic Fractures

Wednesday, Nov. 28 10:50AM - 11:00AM Room: S104A

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PURPOSE

Osteoporotic (OP) fractures cause major morbidity and mortality. The clinical importance of fracture risk predictors such as FRAX is well established, and they are integrated into treatment guidelines. However, FRAX is underutilized due to lack of physician time, awareness, and availability of the 18 required inputs. The study's purpose is to establish whether OP fracture risk scores can be produced automatically from routine CTs using an artificial-intelligence based algorithm, and to compare their predictive ability to that of FRAX.

METHOD AND MATERIALS

Members of a healthcare provider aged 50-90, who underwent routine chest or abdomen CTs prior to July 2012 (index date), were divided to train and test sets. An algorithm scored each CT for bone mineral density (BMD) and presence of vertebral compression fractures. Five-year fracture risk scores were assessed as of the index date by: FRAX (module without DXA), CT (based on the algorithm markers and metadata of age and sex), and combined FRAX-CT. Models' discrimination was evaluated using area under the ROC curve (AUC), by comparing the models' outputs to major OP and hip fracture incidence during a 5-years follow-up period (until 2017). Missing FRAX inputs were completed using 10 imputed data sets. Significance was evaluated using 500 bootstrap samples per data set.

RESULTS

A total of 48,227 individuals were analyzed, of these, 5,106 (10.6%) and 1,901 (3.9%) suffered major OP and hip fractures during follow-up, respectively. Missing values occurred in 1.17% of the population. Compression fractures were identified in 7,521 (15.6%) CTs and abnormally low BMD was identified in 8,196 (17.0%). The AUCs of the FRAX, CT and combined models were 68.7%, 70.2% and 71.5% for major OP fractures, and 75.1%, 75.3% and 77.0% for hip fractures, respectively. All AUC differences were significant except those between the FRAX and CT models for hip fractures.

CONCLUSION

Fully automatic screening for OP fracture risk using routinely acquired CT scans achieves discrimination which is at least as good as the well-established FRAX model. If data for all FRAX inputs is available, the CT algorithmic score may be incorporated to further improve its predictive ability.

CLINICAL RELEVANCE/APPLICATION

OP fracture prediction scores can be added automatically to CT reports, and help identify people at high risk for fractures, who are currently missed due to under use of traditional prediction tools.

SSK11-04 Natural Language Processing at Work! Is There a Difference Between LI-RADS Category 3 to Category 5 Progression Assessment Between CT versus MR? A Retrospective Analysis of 1,887 Patients Who Underwent 5,082 Radiologic Exams for HCC Surveillance

Wednesday, Nov. 28 11:00AM - 11:10AM Room: S104A

Awards
Student Travel Stipend Award

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PURPOSE

Using the Liver Imaging Reporting and Data System (LI-RADS), our purpose is to identify the proportion of liver lesions with indeterminate probability of hepatocellular carcinoma (HCC) (LI-RADS 3) which progress to high likelihood of HCC (LI-RADS 5) using a large patient cohort to compare the differences in progression between computed tomography (CT) versus magnetic resonance (MR) imaging.

METHOD AND MATERIALS

This is a retrospective, single-center, longitudinal study of 1,887 patients who underwent a total of 5,082 radiologic examinations for HCC surveillance. Examinations included CT and MR studies identified from 2010-2017 (CT 36.4%, MR 61.6%). The dates of imaging studies, modality type, and associated LI-RADS category assignments were automatically extracted from the original examination reports using natural language processing techniques. We calculated the proportions of lesions initially classified as LI-RADS Category 3 which progressed to LI-RADS Category 5 on both CT and MR.

RESULTS

On MR, a LI-RADS Category 3 lesion was 1.5 times more likely to be upgraded to LI-RADS Category 5 compared to CT (114/379 upgraded on MR vs. 43/217 upgraded on CT, $p<0.01$). While only 20% of CT LI-RADS Category 3 were upgraded to a LI-RADS Category 5, 30% of MR CT LI-RADS Category 3 were upgraded to a CT LI-RADS Category 5.

CONCLUSION

Our data suggests that MR is more likely to upgrade a LI-RADS Category 3 to LI-RADS Category 5 as compared to CT. Improved characterization of lesions definitely representing HCC (LI-RADS Category 5) has the potential to lead to earlier diagnosis and provide lead time for subsequent treatment optimization for these patients.

CLINICAL RELEVANCE/APPLICATION

Using natural language processing, 5,082 CT/MR liver protocol studies were analyzed. MR is more likely to upgrade a LI-RADS Category 3 lesion to Category 5 compared to CT and can provide additional lead time for treatment optimization.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Puneet Bhargava, MD - 2015 Honored Educator

SSK11-05 Reducing the Volume of Low-Value Outpatient MRI Joint Exams in Patients >55 Years of Age

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S104A

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PURPOSE

Knee pain is the most common orthopaedic indication for MRI, and is frequently caused by meniscal tears. Such tears increase in prevalence in the presence of osteoarthritis (OA), with one study showing that, of patients with significant OA, 63% with knee pain and 60% without symptoms have MRI evidence of meniscal tear. If surgery is required in patients with co-existent OA, it should be for joint replacement, which is evaluated with plain X-rays. Therefore, there are a considerable number of patients with significant OA that would not benefit from MRI. We attempt to determine if evaluation of OA via recent X-rays can reduce inappropriate MRI use in patients >55 years of age. Additionally, in our jurisdiction, CT arthrograms are used as surrogate tests for knee internal derangement because of long MRI wait times. Therefore, we attempt to determine if there will be a decrease in knee CT arthrograms as well.

METHOD AND MATERIALS

Our intervention required recent X-rays (within one year) for patients >55 years of age who were scheduled for outpatient MRI of the knee/hip/shoulder. A working group agreed upon red flags (i.e. neoplasm, infection) for which MRI would be indicated regardless. Through review of radiographs on PACS/digital media and use of the validated Kellgren-Lawrence (KL) OA scale, radiologists assessed the degree of OA, and thus the need for advanced imaging. A finding of significant OA (KL >2) without red flags would preclude MRI. Monthly averages of MRI and CT arthrogram requisitions were measured before (33 months) and following our intervention (14 months).

RESULTS

Post-intervention, the average monthly number of MRI requisitions decreased from 61 to 56 ($P = 0.070$) compared with the baseline. If MRI wait time is taken into consideration (9 months), the monthly average decreased to 40. The proportion of protocoled cases that were avoided was 17% (38/227). The average monthly number of knee CT arthrogram requisitions decreased from 21 to 12 ($P = 0.004$) following the intervention.

CONCLUSION

We were able to decrease the number of MRI and knee CT arthrogram exams in patients over 55 years of age with joint pain by implementing an evaluation for OA via recent X-ray imaging.

CLINICAL RELEVANCE/APPLICATION

Recent X-ray evaluation for osteoarthritis can prevent unnecessary MRI and is recommended for patients who are over 55 years of age and have joint pain.

SSK11-06 Second Thoughts: Emergency Clinicians See Value in Secondary Interpretations

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S104A

Awards
Student Travel Stipend Award

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PURPOSE

As technological improvements have lead to increased transportability of imaging, and as facilities have begun to realize the costs, both in terms of liability and time, of offering curbside consults on outside imaging, many large institutions now offer complete secondary read radiology reports and attempt to monetize such efforts. But are clinicians ordering these secondary reads simply as part of their intake process, or is there any real benefit to the emergency physicians and trauma surgeons who obtain these secondary reports? This study seeks to evaluate the benefit of secondary reads, and how clinicians navigate issues regarding payment, reimaging and managing conflicting reports.

METHOD AND MATERIALS

An anonymous electronic survey regarding secondary interpretations and associated issues was circulated to 58 attending emergency physicians and trauma surgeons at Yale-New Haven Hospital. There were 26 responses, representing a 44.8% response rate.

RESULTS

80.8% of respondents requested secondary interpretations either always or most of the time. Over half of respondents cited trust in the house radiologist interpretation over the outside radiologist as the primary reason they requested secondary reads. 92.3% and 84.6% of respondents felt that the ability to obtain second interpretations improves patient care and facilitates disposition, respectively. Furthermore, 88.5% of respondents reported a reduced need to obtain additional imaging due to secondary reads. When presented with conflicting interpretations 65.4% of respondents rely on the in house interpretations while 26.9% consider obtaining further imaging. 96.2% of respondents were uncertain about whether insurance covered secondary reads, but 73.1% would continue to order them regardless.

CONCLUSION

Not only were secondary reads heavily utilized by respondents, but they were felt to influence patient care and aid in disposition,

suggesting that secondary reads have real clinical import. Most felt secondary interpretations reduced the need for more imaging even when presented with conflicting reads, suggesting benefits in resource utilization and minimization of radiation. Finally, most respondents would still request secondary interpretations despite being unaware if insurance covered these interpretations.

CLINICAL RELEVANCE/APPLICATION

This study should be of interest to all radiologists working at institutions which offer or are considering providing secondary reads.

SSK11-07 Emergency Radiology: An Underappreciated Source of Liability Risk

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S104A

Participants
Jeffrey D. Robinson, MD, MBA, Seattle, WA (*Presenter*) Consultant, HealthHelp, LLC; President, Cleareview, Inc;
Robert P. DeConde, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Neerav R. Mehta, MD, Swarthmore, PA (*Abstract Co-Author*) Partner, Clearview, Inc Co-founder, NeuroCAD, LLC

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PURPOSE

Many studies examine the malpractice risk of radiologists in general, focusing on factors such as the type of error, modality and organ system. However, no publication has focused attention on the patient status as a differentiating factor. This study estimates the relative risk of liability action arising between inpatient, outpatient and emergency department exams.

METHOD AND MATERIALS

90 consecutive malpractice claims referred to a radiology-specific malpractice consulting company were reviewed. The site of service for the exam at issue was identified as Inpatient (IP), Outpatient(OP) or Emergency Department (ED). The Medicare Part B claims file was queried to establish the relative frequency of exams performed in each of these settings for 2016. A chi-squared test was used to compare the distributions of malpractice to Medicare claims. The odds ratio of legal action was calculated using the Medicare data as a proxy for the relative number of exams performed in the US for each patient status.

RESULTS

There were 12 IP, 33 OP and 45 ED malpractice claims. In 2016, Medicare beneficiaries claimed 29,124,475 IP, 78,430,930 OP and 22,356,328 ED exams. The distribution of patient status for malpractice claims differed from the Medicare claims file with a Chi-squared statistic of 67.9 ($p<<0.01$). The odds ratio of a malpractice claim was 4.89 (95%CI 2.58 - 9.24) for ED exams compared to IP, 4.78 (95%CI 3.05 - 7.50) compared to OP exams, and 0.98 (95%CI 0.51 - 1.90) for IP compared to OP exams.

CONCLUSION

This initial examination suggests that Emergency Radiology as it is currently practiced presents an increased risk of a malpractice claim compared to other aspects of the practice of radiology.

CLINICAL RELEVANCE/APPLICATION

Radiology practice groups might wish to consider forming a core radiology section whose members have interest, expertise and/or fellowship training in Emergency Radiology.

SSK11-08 Fully Automated Computer-Aided Detection Implementation in The Emergency Department for Detection of Pulmonary Nodules on CT: Effect on Workflow and Diagnostic Accuracy

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S104A

Participants
Amirhossein Mozafarykhamseh, MD, Chicago, IL (*Presenter*) Grant, Siemens AG
Tugce Agirlar Trabzonlu, MD, Chicago, IL (*Abstract Co-Author*) Grant, Siemens AG
Pamela J. Lombardi, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
Rishi Agrawal, MD, Chicago, IL (*Abstract Co-Author*) Speakers Bureau, Boehringer Ingelheim GmbH
Vahid Yaghmai, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To assess the feasibility and added value of implementing fully automated computer-aided diagnosis (CAD) for detection of pulmonary nodules on CT angiography studies in emergency setting.

METHOD AND MATERIALS

We retrospectively reviewed a dataset of 48 emergency patients who underwent computed tomography pulmonary angiography (CTPA) for pulmonary embolism (PE) in September 2017. A cardiothoracic radiologist with 6 years experience (RAD1) and a third year radiology resident (RAD2) reviewed the scans separately to detect pulmonary nodules without CAD followed by CAD. CAD detection rate of nodules was also evaluated in the same reading session. CAD nodule detection was fully automated and required no additional processing time by RAD or technologist. The time spent by RAD to evaluate the image sets was measured for each case. Fisher`s exact test and T-test were used to determine the differences between the rate of detection between the readers and the CAD.

RESULTS

CAD significantly increased the rate of RAD1 detection by 27% (2.23 vs. 1.75 nodule/scan, $P<0.05$). CAD significantly increased the rate of RAD2 detection by 34% (2.52 vs. 1.88 nodule/scan, $P<0.05$).

CONCLUSION

Routine utilization of CAD in the emergency setting is feasible and can improve detection rate of pulmonary nodules significantly.

CLINICAL RELEVANCE/APPLICATION

Computer aided detection can be considered as a useful adjunct tool which can optimize pulmonary nodule detection in emergency department CT scans.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Vahid Yaghmai, MD - 2012 Honored EducatorVahid Yaghmai, MD - 2015 Honored EducatorVahid Yaghmai, MD - 2017 Honored Educator

SSK11-09 Initial Experience with Silent Mode CDS

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S104A

Awards
Student Travel Stipend Award

Participants
Jessica G. Fried, MD , Philadelphia, PA (*Presenter*) Nothing to Disclose
Charles E. Kahn JR, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Hanna M. Zafar, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The Protecting Access to Medicare Act of 2014 (PAMA) requires referring physicians to use clinical decision support (CDS) when ordering advancing imaging procedures. We sought to identify opportunities to improve use of radiology order entry CDS.

METHOD AND MATERIALS

All advanced diagnostic imaging orders placed at a 590-bed level II trauma teaching hospital were tracked silently in the CDS: clinicians were prompted to select a study indication from a drop-down menu at the time of order-entry that mapped to AUC categories, but no feedback was given to the ordering clinician. All orders placed in the first 30 days after CDS deployment were mapped to an AUC category. Orders which could not be categorized were reviewed manually to determine if an indication existed.

RESULTS

Of 39,533 advanced diagnostic imaging orders, 23,267 (59%) were not mapped to an indication. Most unmapped orders (16,440/23,267, 71%) used free-text study indications rather than the drop-down menu. Emergency Medicine (3,877/16,440, 24%) and Hematology/Oncology (3,410/16,440, 21%) had the highest free-text entry rates. Exams with the highest free text entry rates were CT Abdomen/Pelvis with IV contrast (1,693/16,440, 10%) and CT Head without IV contrast (1,527/16,440, 9%). Manual review of free-text study indications revealed that 3,132/3,220 (97%) could easily be matched to a single mapped indication in the CDS. The remaining one-third of orders that could not be mapped (6,827/23,267, 29%) reflected issues related to software build and best practice alert configuration.

CONCLUSION

Nearly two-thirds of advanced diagnostic imaging orders placed in the first month CDS was implemented could not be mapped to AUC; this was mainly due to free-text entry of study indication rather than use of drop down menus, although (97%) of free text entries could easily be matched to a single mapped indication in the CDS.

CLINICAL RELEVANCE/APPLICATION

Opportunities for improvement of electronic imaging decision support systems to support CMS PAMA can be identified prior to deployment through piloting of the system in a silent-mode setting.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Charles E. Kahn JR, MD - 2012 Honored EducatorCharles E. Kahn JR, MD - 2018 Honored Educator

SSK12

Molecular Imaging (New Tracers)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S504CD

MR MI

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

FDA Discussions may include off-label uses.

Participants
Benjamin Larimer, PhD, Charlestown, MA (*Moderator*) Co-founder, Cytosite Biopharma Inc; Consultant, Cytosite Biopharma Inc; Stockholder, Cytosite Biopharma Inc
Christopher C. Riedl, MD, New York, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSK12-01 Standardized Uptake Value Atlas: Physiological and Abnormal 68Ga-RM2 Uptake in Patients with Prostate Cancer

Participants
Lucia Baratto, Stanford, CA (*Presenter*) Nothing to Disclose
Heying Duan, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Akira Toriihara, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Negin Hatami, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Sonya Y. Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Tomomi Nobashi, MD,PhD, Palo Alto, CA (*Abstract Co-Author*) Nothing to Disclose
Andrei Iagaru, MD, Emerald Hills, CA (*Abstract Co-Author*) Research Grant, General Electric Company

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PURPOSE

To describe the distribution and range of physiological uptake of 68Ga-RM2 in patients with prostate cancer and to evaluate the spectrum of abnormal uptake using standardized uptake values (SUVs).

METHOD AND MATERIALS

We retrospectively reviewed images of 20 prostate cancer patients who performed either an 68Ga-RM2 PET/CT for primary diagnosis and staging (n=7) or 68Ga-RM2 PET/MRI for a biochemical recurrence (n=13). Two nuclear medicine physicians evaluated images using an AW workstation (GE Healthcare). SUVmax and SUVmean were measured in 24 normal anatomical structures for each patient. 68Ga-RM2 uptake values of each organ was classified as "none" if SUVmean value was less than of the aortic blood pool, "mild" if SUVmean was greater than SUVmean of aortic blood pool, but less than 2.5, "moderate" if SUVmean was between 2.5 and 5 and "intense" if SUVmean was greater than 5. Areas of focal increased 68Ga-RM2 uptake were also collected.

RESULTS

The highest activity was observed in bladder and renal collecting system, related to urinary excretion of radiotracer. The highest physiologic uptake was present in the pancreas (SUVmax 62.38±13.74). Uptake in the kidney cortex, duodenum and esophagus was mostly classified as mild (average SUVmax of 3) and only few times as moderate. Uptake in the in the stomach wall, rectum and adrenal was mostly classified as not significant (average SUVmax of 2.5) and only few times as mild. Brain, adrenals, liver, spleen, bone, gluteal muscle and fat had not significant uptake. Sixteen avid foci of 68Ga-RM2 uptake were detected in 9 patients. Uptake was identified in the prostate bed (n=6), abdominopelvic and mediastinal lymphnodes (n=5 and n=2, respectively), skeleton (n=2) and lungs (n=1).

CONCLUSION

We presented data on patterns of physiological 68Ga-RM2 uptake in normal tissues with the aim of creating an atlas to improve the interpretation accuracy of 68Ga-RM2 PET scan. Our data also confirmed that 68Ga-RM2 is a promising tracer for the assessment of GRPr expression in prostate cancer patients. Further evaluation in a larger cohort are needed to confirm these data.

CLINICAL RELEVANCE/APPLICATION

68Ga-RM2 is a promising radiotracer for prostate cancer imaging. Atlas of 68Ga-RM2 would improve accuracy of imaging interpretation.

SSK12-02 A Fluorescent Glucose Analogue for Selective Imaging of Sodium-Dependent Glucose Transporters in Breast Cancer

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S504CD

Participants
Richard Agnes, PhD, Cleveland, OH (*Presenter*) Nothing to Disclose

Rodney J. Ellis, MD, Pepper Pike, OH (*Abstract Co-Author*) Nothing to Disclose
Raymond F. Muzic Jr, PhD, Cleveland, OH (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV
Bryan J. Traughber, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Sodium-dependent glucose transporters (SGLTs) are emerging as biomarkers as well as a potential imaging and therapeutic target in a variety of human malignancies. Recently, we have developed a fluorescent glucose analog with a near infrared fluorophore attached at the carbon-6 position (6FGA) and have reported its cell uptake in cancer cells in vitro. With a goal towards clinical application, we are further characterizing 6FGA for cancer imaging including cell uptake mechanisms, transporter selectivity, and conditions for small animal imaging.

METHOD AND MATERIALS

6FGA was synthesized using click chemistry between 6-azido-glucose and alkyne cyanine 5.5. To assess SGLT-driven cellular uptake, MDA-MB-231 triple-negative breast cancer lines were incubated with 6FGA for 20 minutes in various conditions, including in the presence and absence of SGLT (phlorizin), SGLT2 (dapagliflozin), and GLUT (cytochalasin B) inhibitors as well as in presence and absence of the cotransported sodium ion. 6FGA cellular uptake was examined using confocal microscopy. 6FGA uptake in vivo in murine xenograft tumors that were grown and sectioned to 1 millimeter slices was examined by fluorescence imaging.

RESULTS

Western blots confirmed the expression of SGLT1 and SGLT2. In cell uptake studies, 6FGA accumulation in MDA-MB-231 cells was reduced by SGLT and SGLT2 but not by GLUT inhibitors. Further confirming the SGLT-driven uptake, 6FGA accumulation did not occur when the SGLT co-transported sodium ion was absent from the medium. The uptake in tumor slices was consistent with that in the cell studies in that it increases over time and did not wash out.

CONCLUSION

6FGA is emerging as promising tool for investigating SGLT in cancer cells and tumor tissues. Our preliminary cell uptake studies suggest that 6FGA uptake is mediated through SGLTs. Initial studies with tumor slices suggests feasibility and optimal conditions for in vivo imaging of tumor model in small animals.

CLINICAL RELEVANCE/APPLICATION

6FGA is a model towards designing new tracers for PET imaging to improve detection and treatment for SGLT cancers such as triple negative breast and metastatic prostate.

SSK12-04 Quantitative Magnetic Particle Imaging of Transplanted Ferumoxytol-Labeled Stem Cells

Wednesday, Nov. 28 11:00AM - 11:10AM Room: S504CD

Participants
Hossein Nejadnik, MD, PhD, Stanford, CA (*Presenter*) Nothing to Disclose
Prachi Pandit, PhD, Alameda, CA (*Abstract Co-Author*) Stockholder, Magnetic Insight Inc; Employee, Magnetic Insight Inc
Olga Lenkov, BSC, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Arian Pourmehdi Lahiji, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Ketan Yerneni, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Heike E. Daldrup-Link, MD, Palo Alto, CA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate, if ferumoxytol (Feraheme) can be used for in vivo detection and quantification of stem cell transplants with magnetic particle imaging (MPI).

METHOD AND MATERIALS

Mesenchymal stem cells (MSCs) were labeled with ferumoxytol (Feraheme) or ferucarbotran (Resovist/Vivotrax) and underwent magnetic particle imaging (MPI), magnetic resonance imaging (MRI), prussian blue staining and inductively coupled plasma (ICP) spectrometry. Unlabeled, ferumoxytol, and ferucarbotran-labeled MSCs were implanted in calvarial defects of eight mice and underwent MPI, MRI and histopathology. The iron concentration calculated according to the MPI signal intensity and T2* relaxation times of the three different groups were compared using an analysis of variance (ANOVA) with Bonferroni correction, and a $p<0.05$.

RESULTS

Compared to unlabeled controls, ferumoxytol and ferucarbotran labeled MSC showed significantly increased iron content, MPI signal and MRI signal. The ferumoxytol MPI signal was approximately 4x weaker compared to ferucarbotran at equimolar concentrations ($p=0.0003$) and approximately 1.5 times weaker for labeled cells when using optimized labeling protocols ($p=0.002$). In vivo, the MPI signal of ferumoxytol-labeled MSC decreased significantly between day 1 and day 14 ($p=0.0124$). This was confirmed by histopathology where we observed a decrease in Prussian blue stain of MSCs at the transplant site. The MRI signal of the same transplants did not change significantly during this observation period ($p=0.93$).

CONCLUSION

Ferumoxytol nanoparticles can be used for in vivo detection of stem cell transplants with MPI and provide quantitative information not attainable with MRI.

CLINICAL RELEVANCE/APPLICATION

Clinically applicable ferumoxytol can be detected with MPI, allowing accurate in vivo detection and quantification of labeled stem

cells, which is an important basis for clinical translation of MPI.

SSK12-05 18F-Labeled Magnetic Nanoparticles for the Assessment of Early Anti-angiogenic Therapy Effects in Triple Negative Breast Cancer Xenografts

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S504CD

Participants
Yanshu Wang, Shanghai, China (*Presenter*) Nothing to Disclose
Huanhuan Liu, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
Jinning Li, BMedSc, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To investigate the positron emission tomography/magnetic resonance imaging (PET/MRI) dual-modality imaging probe 18F-RGD-PAA-USPIO for the in vivo monitoring of avß3-integrin expression as biomarker of anti-angiogenic therapy effects in breast cancer xenografts model.

METHOD AND MATERIALS

A multimodal imaging agents 18F-RGD-PAA-USPIO nanoparticles was synthesized and tested in vitro and in vivo.Mice bearing MDA-MB-231 subcutaneous tumors were treated with bevacizumab or placebo(n=10/group,intraperitoneal injections of bevacizumab or a volume-equivalent placebo solution at the dose of 10 mg/kg every other day for 4 times). Tumor volumes were assessed with caliper measurements everyday.The animals were imaged with 18F-RGD-PAA-USPIO,the target-to-background ratio (TBR, VOImaxtumor/VOImeanmuscle,ΔTBR=TBRday7-TBRday0) and ΔT2 value(ΔT2=T2pre-contrast-T2post-contrast,ΔΔT2=ΔT2day7-ΔT2day0) were served as semiquantitative measure to determine the effect of bevacizumab.Imaging results were validated by ex vivo multiparametric immunohistochemistry with regard to microvascular density (CD31) and proliferation(Ki-67).

RESULTS

18F-RGD-PAA-USPIO did not cause cellular toxicity in MDA-MB-231 cell lines.Both small-animal PET and T2-weighted MRI show integrin specific delivery of 18F-RGD-PAA-USPIO. No intergroup difference in tumor volume development between day 0 and day 7 was observed (p=0.118).18F-RGD-PAA-USPIO binding was significantly reduced after bevacizumab compared with the control group shown both in PET/CT (ΔTBR,-0.65 ± 0.43 vs 0.66 ± 1.04,p=0.032) and MRI imaging (ΔΔT2,9.56 ± 4.14 vs 4.92 ± 6.10,p<0.01).Correspondingly,immunohistochemistry revealed a significantly lower microvascular density (CD31,15.19 ± 7.58 vs 42.90 ± 16.81,p<0.01), tumor cell proliferation (Ki-67,420.60 ± 113.67 vs 702.30 ± 119.62,p<0.01) in the therapy compared with the control group.

CONCLUSION

18F-RGD-PAA-USPIO can be use to monitor and evaluate the therapeutic effects of anti-angiogenesis agents on breast cancer model.

CLINICAL RELEVANCE/APPLICATION

(to dealing with PET/MRI) the multimodal imaging agents, 18F-RGD-PAA-USPIO,which are capable of simultaneously providing both PET and MRI information, can expand the applicability of PET/MRI dual modality imaging system.

SSK12-07 Fractional Excretion and Biodistribution of the Manganese-Based MRI Contrast Agent Mn-PyC3A in Rats

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S504CD

Participants
Eric Gale, Charlestown, MA (*Abstract Co-Author*) Co-founder, Reveal Pharmaceuticals; Stockholder, Reveal Pharmaceuticals
Ian Ramsay, BS, Charlestown, MA (*Abstract Co-Author*) Nothing to Disclose
Peter D. Caravan, PhD, Charlestown, MA (*Presenter*) Research Grant, Pfizer Inc;

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PURPOSE

To determine the fractional excretion and biodistribution of manganese at 1 day and 7 days following injection of the manganese-based MRI contrast agent Mn-PyC3A in rats.

METHOD AND MATERIALS

All experiments were performed in accordance with the National Institutes of Health's Guide for the Care and Use of Laboratory Animals, 8th Edition, and were approved by the institutional animal care and use committee of Massachusetts General Hospital. [52Mn]Mn-PyC3A was prepared from an aliquot of a 0.5 M solution of Mn-PyC3A that was mixed with 3 mCi of 52MnCl2 (beta+, t1/2 = 5.56 d) at pH to 3.0. After stirring for 30 min, the pH was adjusted to 8.0 with N-methyl-D-glucamine and returned to the bulk 0.5 M solution. [52Mn]Mn-PyC3A (2.0 mmol/kg, 100 - 300 µCi) was administered via tail vein to Wistar Rats. Rats, equal numbers of males and females, were housed in metabolic cages and euthanized after 1 d (N=10) or 7 d (N=8), and the organs were harvested and 52Mn quantified by gamma counter. The fractional excretion into urine and feces was also determined.

RESULTS

One day after [52Mn]Mn-PyC3A injection, 0.36±0.11 percent of the injected dose (%ID) remains in the rat and this drops to 0.052±0.042% after seven days. These values are an order of magnitude lower than reported Gd-retention following injection of gadolinium based contrast agents (GBCAs) (Tweedle, Invest. Radiol 1995;30(6):372-380). [52Mn]Mn-PyC3A is eliminated

84.9±4.9% into the urine and 15.1±4.9% into the feces. Mass balance indicated that 97.5±3.9 %ID was recovered from the excreta, tissues, and GI contents 1 d after injection.

CONCLUSION

Mn-PyC3A is >99.6% eliminated from rats one day after, and >99.9% eliminated seven days after intravenous injection. Mn-PyC3A shows extremely low levels of metal retention after administration.

CLINICAL RELEVANCE/APPLICATION

Mn-PyC3A has been proposed as a Gd-free alternative for contrast enhanced MRI. Before clinical translation, it is important to establish whether there is manganese ion accumulation. These studies indicate that Mn-PyC3A is rapidly and efficiently eliminated from the body and prompt further development of this new contrast agent.

SSK12-08 A pH-sensitive Manganese Core Nanoparticle as the Tumor Targeting MR Contrast Agent: Comparison with Gd-DTPA in a Mouse Model

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S504CD

Participants
Jiali Li, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose
Zhen Li, MD, PhD, Wuhan, China (*Presenter*) Nothing to Disclose
Daoyu Hu, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose
Yaqi Shen, PhD, MD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

A novel manganese core nanoparticle designed as pH-sensitive MR contrast agent (L-EGCG-Mn), confirmed the tumor targeting properties in a mouse model. In vitro and in vivo MR properties were compared with Gd-DTPA.

METHOD AND MATERIALS

This study was approved by the local Animal Ethics Committee. The physicochemical properties of L-EGCG-Mn were characterized by dynamic light scattering, transmission electron microscopy(TEM), and near infrared fluorescence small animal living imaging. A serial of different concentration of L-EGCG-Mn dispersed in phosphate buffered saline(PBS) with different pH (pH=7.4, 6.8, 5.5) and Gd-DTPA solutions were evaluated at a 3 T MRI scanner, and the relaxivities (r1 and r2) were obtained for comparison in vitro-analysis. A total of eight Hepatoma-22 cells implanted mice (5 for L-EGCG-Mn;3 for Gd-DTPA) were scanned at a 3.0 T MRI with an animal coil. MR images of pre- and 30min, 1h, 2h, 4h after injection of L-EGCG-Mn and Gd-DTPA were acquired. The signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of tumor were calculated.

RESULTS

The particle size of L-EGCG-Mn was 277.4±5.5 nm and the zeta potential of it was -13.56±1.91mV, the negative zeta potential indicating a good biocompatibility. TEM images confirmed that L-EGCG-Mn incubated in pH=5.5 PBS expanded faster than that in pH=6.8 PBS. And the r1(r2) relaxivity of L-EGCG-Mn increased from 1.8(10.1) to 6.4(22.9) $mM^{-1} \cdot s^{-1}$ when the pH values decreased from 7.4 to 5.5, which was higher than Gd-DTPA (r1=4.7, r2=5.4 $mM^{-1} \cdot s^{-1}$). In H22 model mice, L-EGCG-Mn had significantly higher average CNR and SNR compared with Gd-DTPA for all acquired time point ($P < 0.05$ for all).

CONCLUSION

L-EGCG-Mn had promising pH sensitivity and superior enhancement properties, compared with Gd-DTPA in H22 model mice and vitro relaxivity analysis.

CLINICAL RELEVANCE/APPLICATION

L-EGCG-Mn with tumor-microenvironment changeable relaxivity may be an alternative to Gd-DTPA and overcome controversy regarding gadolinium-associated toxicity and retention in the clinical.

SSK12-09 First-Pass CMR Perfusion Imaging with a Novel Manganese Chelate Contrast Agent in Myocardial infarction: Comparison with Gd-DTPA

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S504CD

Participants
Lingyi Wen Jr, MD, Chengdu, China (*Presenter*) Nothing to Disclose
Zhigang Yang, MD, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
Huayan Xu, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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Yingkun Guo, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To evaluate the feasibility of novel Mn2+ chelate to quantify myocardial perfusion in myocardial infarction (MI), by comparison with Gd-based First-pass perfusion MRI.

METHOD AND MATERIALS

We designed and synthesized an aza-semi-crown pentadentate chelator that formed manganese (Mn2+) complexes as a novel MRI contrast agent. MI was induced in 6 rabbits by permanent occlusion of left circumflex coronary artery. After 7days post-surgery, cine MRI, T1WI, T2WI, first-pass perfusion MRI were performed on a 3.0T clinical MRI scanner (Achieva, Philips, Andover, MA) with a clinical 8-channel knee coil. Dynamic signal changes on first-pass perfusion MRI was acquired using segmented turbo-FLASH sequence with 80 dynamic acquisitions. Three contiguous short-axis images was obtained after intravenous injection of gadolium (Gd-DTPA, Magnevist, Berlin, Germany) at 0.15 mmol/kg and Mn2+ chelate successively. A 120-minute washout period proceeded

between administration of contrast agents to ensure independent enhancement pattern. Short-axis cine images were analyzed for assessment of left ventricular (LV) volumes, ejection fractions (EF), first-perfusion images for slope, max signal intensity, time to peak, time to 50% max with dedicated software (Cmr42,Circle Cardiovascular Imaging Inc.,Calgary, Canada). The correlation between methods was evaluated with two-variable linear regression analysis, with Pearson correlation.

RESULTS

All rabbits survived after MRI scanning without significant differences in heart rate, LV end-diastolic volume, end-systolic volume and EF between baseline and after injection of Gd or Mn ($p>0.05$). First-pass perfusion MRI identified infarcted myocardial segments when compared with normal myocardial segments. When compared with normal myocardial segments, the slope, max signal intensity of infarcted myocardial segments decreased significantly, time to peak and time to 50% max extended (all $p<0.05$). All the perfusion parameters of infarcted and normal myocardial segments correlated well between Gd-based and Mn-based perfusion imaging (all $p<0.05$, $r=0.43-0.72$).

CONCLUSION

Our novel Mn2+ Chelate contrast agent is safe and reliable to visualize myocardial perfusion in myocardial infarction.

CLINICAL RELEVANCE/APPLICATION

Although still in the preclinical stage, the novel Mn2+ Chelate contrast agent may be useful for assessment of myocardial perfusion in myocardial infarction.

SSK13

Musculoskeletal (Advances in MR Imaging)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: N229

MR MK

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

Participants
Christine B. Chung, MD, La Jolla, CA (*Moderator*) Nothing to Disclose
Gregory Chang, MD, New York, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSK13-01 Lower Leg Muscle Activation during Walking and Running: Quantitative Muscle-specific Assessment of Microvascular Perfusion with Intravoxel Incoherent Motion (IVIM) MR Imaging

Participants
Pia M. Jungmann, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose
Christian W. Pfirrmann, MD, MBA, Forch, Switzerland (*Abstract Co-Author*) Nothing to Disclose
Christian Federau, Basel, Switzerland (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Little is known about muscle activation patterns during walking and running. Blood flow to skeletal muscles depends on the metabolic activity. Aim of this study was to non-invasively assess specific muscle activation of the lower limb after walking and running by using Intravoxel Incoherent Motion (IVIM) perfusion MRI.

METHOD AND MATERIALS

3T MR IVIM diffusion-weighted images of the lower extremities of 8 healthy female volunteers (mean age 27.5±5.7 years) were acquired at rest and immediately after walking and running, respectively. For IVIM measurements, a transverse monopolar pulsed gradient fat suppressed spin echo (SE) EPI sequence was used (9 b-values from 0 to 1000s/mm2, 3 orthogonal directions). In addition, anatomical transverse T1-weighted turbo SE images were acquired at rest. Entire muscles of the pelvis, thigh and lower leg were segmented. IVIM perfusion parameters f, D* and fD* and the diffusion coefficient D were obtained after standard two-steps fitting of the IVIM bi-exponential signal equation. Descriptive statistics, paired t-tests, multiple regression models and Pearson's correlations were used for statistical analyses.

RESULTS

Mean heart rates were 63±3min-1 at rest, 113±14min-1 during walking and 166±14min-1 during jogging. Microvascular blood-flow related fD* correlated significantly with heartrate while walking and running, respectively ($P<0.05$). Mean fD* of all muscles was significantly higher after running (2.18±0.98*10-3mm2/s, $P<0.001$) and after walking (1.99±0.80*10-3mm2/s, $P<0.001$) compared to rest (1.65±0.83*10-3mm2/s). Perfusion increase was gradual and most pronounced for the lower leg muscles (fD* increase of 60.8% after walking, 137.3% after running compared to rest, $P<0.001$) and for the feet muscles (78.4% and 181.4%, $P<0.001$) (Figure). Abductor muscles showed a higher microvascular perfusion than adductor muscles; quadriceps muscles showed a higher perfusion than hamstrings ($P<0.05$).

CONCLUSION

Non-invasive IVIM MRI is able to quantitatively measure local microvascular muscle perfusion in order to detect muscle activation patterns after walking and running.

CLINICAL RELEVANCE/APPLICATION

IVIM is a promising modality to non-invasively assess muscle physiology. It may potentially be of use to monitor changes in physiological microvascular muscle perfusion after training and to detect pathological muscle recruitment patterns.

SSK13-02 Evaluation of Role of Diffusion Weighted Imaging (DWI), Apparent Diffusion Coefficient (ADC) and Chemical Shift Imaging (CSI) in Distinguishing Benign versus Malignant Vertebral Body Lesions with Histopathological Correlation

Wednesday, Nov. 28 10:40AM - 10:50AM Room: N229

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PURPOSE

To evaluate the role of qualitative DWI, qualitative CSI: quantitative DWI(ADC values) and quantitative CSI(Signal Intensity Ratio - SIR values) in the differentiation of benign and malignant vertebral lesions.

METHOD AND MATERIALS

44 patients of all age group of both sexes showing presence of vertebral fractures on MRI were included in study. We used the biopsy results or results of clinical and radiologic follow up for at least 6 months, as the gold standard to classify the vertebral fractures as benign or malignant. The presence of high SI of vertebral fractures on DWI were considered as diffusion restricting. ADC values acquired, by placing ROI in ADC maps over the areas within the vertebral fractures that were showing abnormal signal intensities on T1, T2 weighted and STIR. The SI of vertebral fractures were compared in in-phase and out-of-phase image and loss of signal on out-of-phase image was evaluated. Quantitative analysis was done by calculating SIR values of opposed-phase to in-phase, by placing ROI over the areas within the vertebral fractures on the in-phase images and corresponding areas on the out-of-phase images(that were of abnormal SI on T1, T2 weighted and STIR sequences). SIR = SI opposed-phase / SI in-phase.

RESULTS

Qualitative DWI resulted in sensitivity of 92.9%, specificity of 20%, PPV of 35.14%, NPV of 85.71% and accuracy of 43.2%. The mean ADCs for the benign (1.37 ± 0.22) compression fracture group were significantly higher than the malignant (0.94 ± 0.17) group, and ADC cutoff value of 1.085 resulted in sensitivity of 85.7%, specificity of 83.3%, PPV of 70.59%, NPV of 92.59% and accuracy of 84.1%. Qualitative CSI resulted in sensitivity of 92.9%, specificity of 53.3%, PPV of 48.15%, NPV of 94.12% and accuracy of 65.9%. The mean SIRs for the benign (0.67 ± 29) compression fracture group were significantly lower than SIR values for the malignant (1.12 ± 0.15) group and SIR cutoff value to be 0.97 was identified with sensitivity of 92.9%, specificity of 90%, PPV of 81.25%, NPV of 96.43% and accuracy of 90.9%.

CONCLUSION

Quantifying the loss of signal on out-of-phase imaging and quantifying diffusion on ADC maps, can be used in differentiation between benign and malignant vertebral compression fractures.

CLINICAL RELEVANCE/APPLICATION

Quantitative DWI and quantitative chemical shift imaging can differentiate between benign and malignant vertebral fractures and is recommended as part of a MR study.

SSK13-03 Asymmetric Muscle Recruitment of the Back during Exercise in Patients with Scoliosis Demonstrated with Intravoxel Incoherent Motion (IVIM) MR Perfusion Imaging: Preliminary Results

Wednesday, Nov. 28 10:50AM - 11:00AM Room: N229

Participants
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PURPOSE

It is thought that patients with scoliosis overuse the back muscle in the convexity of their scoliosis, which might worsen their condition. Because muscle activity increases local blood flow, muscle recruitment can be mapped using MR perfusion imaging. The purpose of this work was to study the muscular recruitment of back muscle during Roman chair exercise in patients with scoliosis using Intravoxel Incoherent Motion (IVIM), an imaging technique which extracts local and quantitative perfusion information from a diffusion weighted MRI sequence, without the need for an injection of a contrast agent.

METHOD AND MATERIALS

4 patients (3/1 f/m,20±4y) with scoliosis (Cobb angle 28±2°, range [25-30°]) were scanned at 3T first after observing a period of rest of 20 min, and then immediately after performing a symmetric back muscle exercise on a Roman chair, holding a 4kg dumbbell with both hands in the middle of the thorax, until exhaustion (72±2s). The IVIM diffusion-weighted sequence consisted of a spin-echo with echo planar readout and monopolar pulsed gradients with 16 b-values ranging from 0-900s/mm2. The IVIM bi-exponential signal equation model was fitted using a C++ implementation of a standard two steps algorithms. A region of interest was drawn in the paraspinal muscles at the level of the convexity of the scoliosis on both sides. Statistical significance was assessed using paired Student t-test.

RESULTS

At rest, microvascular blood-flow related IVIM fD* was found larger in the paraspinal muscles on the side of convexity (5.8±1.1x10-3mm2/s) compared to the concavity (4.3±1.5x10-3mm2/s), but the difference was not significantly (p=0.11). After Roman chair muscle exercise, fD* increased significantly in the paraspinal muscles (p=0.001), and fD* was significantly larger in the paraspinal muscles on the side of convexity (7.7±0.8x10-3mm2/s) compared to the concavity (5.3±1.0x10-3mm2/s,p=0.001).

CONCLUSION

The preliminary data of this study demonstrates an asymmetric microvascular muscle perfusion pattern in the muscle of the back after exercise in patient with scoliosis.

CLINICAL RELEVANCE/APPLICATION

This study helps clarifying muscular recruitment of back muscle during exercise in patients with scoliosis, and could help to improve current physiotherapeutic and surgical treatment approaches.

SSK13-04 Diffusion Weighted Imaging of Musculoskeletal Infections: Quantitative ADC Analysis of Lower Extremity Superficial and Deep Infections

Wednesday, Nov. 28 11:00AM - 11:10AM Room: N229

Awards
Student Travel Stipend Award

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PURPOSE

This study investigates the value of diffusion weighted imaging (DWI) and apparent diffusion coefficient (ADC) in the differential diagnosis of musculoskeletal infections and determines the region of interest (ROI) values for cellulitis, soft tissue abscess, osteitis, osteomyelitis and intraosseous abscesses in the lower extremity.

METHOD AND MATERIALS

The MRIs of sixty-two patients with musculoskeletal inflammation and/or infection were retrospectively evaluated through measurement of ROIs on DWI and ADC at the site of disease. Imaging was conducted between 2014 and 2017 with inclusion criteria of: adults 18-100 years, no metal in the field of view, extremity MRI scans with DWI imaging, and established reference standards of biopsy, surgery, and follow-up results. Patient cases were placed into six categories of infection: soft tissue edema, soft tissue cellulitis, soft tissue abscess, osteitis, osteomyelitis, and osteomyelitis with abscess. Diagnosis was based on a combination of pathology reports and clinical correlation (lab values, patient care notes, treatment regimen, time to resolution of symptoms). ROIs were measured by three readers trained by an experience musculoskeletal radiologist at the region of interest with minimum area of 1cm2. Statistical analysis of data was performed to measure inter-reader agreement with ICC and significance of ROI measurements on ADC with ANOVA to test for differences between the six categories of infection. The Bonferroni adjustment was applied to adjust the p value for multiple comparisons.

RESULTS

The mean ADC value of osteitis is 1.58 compared to 1.41 for osteomyelitis and 0.78 for intraosseous abscess with statistically significant difference ($p < 0.02$). Similarly, mean ADC value of soft tissue cellulitis is 1.70 and soft tissue abscess is 0.73 with statistically significant difference ($p < 0.001$). Intra-reader agreement was excellent with ICC of 0.93 and 0.96 between the three readers.

CONCLUSION

DWI and ROI measurements on ADC can reliably distinguish between osteitis, osteomyelitis and intraosseous abscess, as well as soft tissue abscess and soft tissue cellulitis.

CLINICAL RELEVANCE/APPLICATION

DWI and ADC measurements can distinguish between musculoskeletal infections and are recommended as part of the MRI studies and evaluation of these conditions.

SSK13-05 Diffusion MRI of Human Patellar Tendon: Initial Experience

Wednesday, Nov. 28 11:10AM - 11:20AM Room: N229

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PURPOSE

The patellar tendon (PT) is essential for knee extension. Patellar tendinopathy causes persistent anterior knee pain and occurs in ~14% of recreational athletes. Despite the high prevalence, no consensus treatment exists. PT microstructure and microcirculation play crucial roles in the progression of tendinopathy and tendon repair. Diffusion tensor imaging (DTI) and intravoxel incoherent motion (IVIM) imaging can assess the microstructure and microcirculation characteristics of biological tissue. However, the application of conventional diffusion MRI protocols to PT is challenged by short T2/T2* values (~2ms) and the long TE (~60ms) requirement. In this study, a stimulated-echo based short TE (~15ms) diffusion protocol (ste-RS-EPI), originally developed for Achilles tendon, was applied to PT of healthy subjects. After validation, this technique can be readily adopted to assess treatment response in patellar tendinopathy.

METHOD AND MATERIALS

Six healthy subjects were recruited for this IRB approved study on a Siemens Prisma 3T magnet. Stimulated-echo diffusion

preparation with readout-segmented EPI (ste-RS-EPI) was adopted. To further boost tendon MR signal, magic angle effect was exploited by positioning PT ~55 degrees w.r.t. B0 direction. PT fractional anisotropy (FA), radial diffusivity (RD), axial diffusivity (AD), and mean diffusivity (MD) maps were generated with DTI Studio. PT diffusion coefficient (D), pseudo-diffusion coefficient (D*), and perfusion fraction (fp) were calculated using standard bi-exponential fit to the IVIM signal. The product of D* and fp was used as an indicator of intra-tendinous blood flow.

RESULTS

Ste-RS-EPI images achieved high signal and good image quality for the PT. The measured DTI and IVIM parameters (diffusivities in units of ×10-3 mm2/s) in the PT were: AD (1.54±0.09), RD (1.01±0.06), MD (1.19±0.07), FA (0.29±0.02), fp (4.6±1.2%), and D*×fp (36.6±6.9).

CONCLUSION

This preliminary study demonstrated the feasibility of the ste-RS-EPI DTI and IVIM protocols to assess patellar tendon microstructure and microcirculation. The estimated DTI and IVIM parameters in control subjects may serve as a baseline for subsequent studies on patients with clinical and subclinical patellar tendinopathy.

CLINICAL RELEVANCE/APPLICATION

The ste-RS-EPI DTI and IVIM techniques may be used for evaluation of tendinopathy and to quantitatively assess pathophysiological changes that occur as a result from various treatments.

SSK13-06 Diffusion Tensor Imaging With Quantitative Evaluation of Sciatic Nerve within the Pelvis in Patients with Non-Contributory Lumbar Spine Magnetic Resonance Imaging in Radiculopathy: Preliminary Results

Wednesday, Nov. 28 11:20AM - 11:30AM Room: N229

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PURPOSE

Diffusion tensor imaging with quantitative evaluation of sciatic nerve within the pelvis in Patients with non-contributory lumbar spine magnetic resonance imaging in radiculopathy: preliminary results.

METHOD AND MATERIALS

This prospective institutional review board-approved study included 32 consecutive patients (11 males and 21 females; mean age of 41.2, range 19-52 years) studied between October 2016 and February 2018. The study population included 32 patients suffering from sciatica pain with negative lumbar MRI. All patients underwent DTI sequence of the pelvis (TR/TE 5800/97 ms; b=1000; slice thickness 3,5 mm; directions=20) by using a 1.5T scanner (Siemens Aera). DTI data were postprocessed on a dedicated offline workstation by two radiologists (25 and 11 years of experience, respectively) blinded to clinical data. Each radiologist placed two ROI on the nerve roots at three different levels within the pelvis on both side, and the mean value was used for further analysis. Clinical findings served as standard of reference. Diagnostic accuracy values of the FA numbers by using receiver operator curves (ROC) and relative area under the curve (AUC) were calculated. Inter-observer and intra-observer agreement were calculated with k-statistics. Continuous and categorical variables were evaluated by using t test and x2 or Fisher exact test, as appropriate. A value of $p<0.05$ was considered statistically significant

RESULTS

The lumbar nerve roots were visualized and FA values were calculated in all subjects. The FA values were significantly different between suffering nerve roots (178± 48; range 146-285) and spared side (296± 52; range 221-412) with a p value <0.001. The ROC curve analysis revealed an AUC of 0.816 (95% confidence interval: 0.682-0.874). By using a FA of 220 as cutoff to identify suffering nerve roots, the sensitivity, specificity, PPV and NPV and accuracy of DTI sequences were and 81.8, 95.4, 90.0, 91.3 and 90.9%, respectively. The interobserver and intraobsever agreement were near perfect (k=0.83 and k=0.81, respectively)

CONCLUSION

DTI can quantitatively demonstrate the presence of suffering sciatic nerve roots within the pelvis.

CLINICAL RELEVANCE/APPLICATION

DTI can quantitatively evaluate compressed nerve roots of sciatic nerve in patients with negative lumbar MRI. This sequences could be used to guide the identification of nerve compression site within the pelvis by means of a tailored MR study

SSK13-07 Comparison of Proton Density Fat Fraction, Simultaneous R2*, and Diffusion Weighted Image for Assessment of Focal Vertebral Bone Marrow Lesions

Wednesday, Nov. 28 11:30AM - 11:40AM Room: N229

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PURPOSE

To investigate proton density fat fraction (PDFF), R2* and apparent diffusion coefficient (ADC) estimation for assessing focal vertebral bone marrow lesions.

METHOD AND MATERIALS

We retrospectively reviewed 182 spine MRIs performed in 119 patients with focal vertebral bone marrow lesions from November 2016 to February 2018. The lesions were divided into bone metastases and focal benign vertebral bone marrow lesions. The protocol consisted of routine clinical sequences followed by IDEAL-IQ and diffusion-weighted (DW) magnetic resonance (MR) imaging with 1.5T MR unit (Signa HDxt, GE Healthcare, Waukesha, WI). PDFF and R2* were performed using a quantitative chemical shift-based water-fat separation method known as IDEAL-IQ with a multi-echo gradient echo sequence. ADC (b = 0 and 800 s/mm2) was calculated with a monoexponential fitting of the DW image data. PDFF, R2*, and ADC were compared using the Mann-Whitney U test. Receiver operating characteristic (ROC) curve analysis was performed to assess the diagnostic performances for differentiating metastasis from benign vertebral bone marrow lesions.

RESULTS

In the comparison of diagnostic performance among parameters, the PDFF (AUC = 0.960; 95% confidence interval [CI], 0.921, 0.984) showed a significantly larger AUC as compared to the R2* (AUC = 0.667; 95 % CI, 0.593 - 0.735) and ADC (AUC = 0.754; 95 % CI, 0.685 - 0.815) value. The optimal cut-off value of fat fraction for predicting focal malignant vertebral bone marrow lesions was 9.0 %; at this threshold, sensitivity was 97.30 % and specificity was 91.55 %. All the PDFF, R2*, and ADC values sequences were in almost perfect agreement (r values > 0.8)

CONCLUSION

Our study shows that PDFF measurement can enable in differentiating focal vertebral bone marrow lesions, and may be more useful than DW MR imaging.

CLINICAL RELEVANCE/APPLICATION

PDFF can be the excellent diagnostic performance in differentiating focal vertebral bone marrow lesions and this examination recommend in the evaluation of suspected bone metastases.

SSK13-08 Quantitative Analysis with 3T Multiparametric MR imaging: Differentiation between Benign and Malignant Soft Tissue Tumors

Wednesday, Nov. 28 11:40AM - 11:50AM Room: N229

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PURPOSE

To determine the reliability and accuracy of 3T multiparametric magnetic resonance (MR) imaging in the differentiation between benign and malignant soft tissue tumors.

METHOD AND MATERIALS

This retrospective study was approved by the institutional review board and informed consent was waived. Sixty-eight patients with pathologically confirmed soft tissue tumors (35 benign and 33 malignant) who underwent 3T standard MR imaging, intravoxel incoherent motion (IVIM) diffusion-weighted MR imaging (DWI), and dynamic contrast-enhanced (DCE) MR imaging were enrolled with exclusion of lipoma and well-differentiated liposarcoma. IVIM parameters (true diffusion coefficient, D; pseudodiffusion coefficient, D*; perfusion fraction, f), apparent diffusion coefficient (ADC), and DCE parameters (transfer constant, Ktrans; rate constant, Kep; extravascular extracellular volume fraction, Ve; initial area under time-signal intensity curve, iAUC) were calculated by Syngovia software. All parameters were compared using Student's t test and multivariate logistic regression analysis. The receiver operating characteristic (ROC) curve with areas under the curve (AUC) was obtained.

RESULTS

ADC and D were significantly lower in malignant tumors than benign tumors (1181.6±484.7 vs 1472.3±349.1 μm^2/sec; 1152.2±505.0 vs 1414.9±373.8 μm^2/sec; P<.05, respectively). Ktran, Kep, Ve, and iAUC were significantly different between malignant tumors and benign tumors (211.3±158.2 vs 92.4±67.0 10^3/min; 775.9±528.9 vs 311.5±230.4 10^3/min; 31.7±17.3 vs 43.9±28.2 %; 23.3±14.6 vs 11.8±9.0 %, P<.05, respectively). The best discriminative parameters for prediction of malignant tumors versus benign tumors were ADC (odds ratio [OR]: 0.991, P=.046), Kep (OR: 1.004, P=.003) and iAUC (OR: 1.064, P=.048). The AUCs of ADC alone, ADC combined with Kep, and ADC combined Kep and iAUC were 0.738, 0.816, and 0.848, respectively.

CONCLUSION

ADC, Kep, and iAUC may be reliable and accurate parameters for the differentiation between benign and malignant soft tissue tumors at 3T multipamametic MR imaging.

CLINICAL RELEVANCE/APPLICATION

Multiparametric MR imaging is reliable and accurate in the differentiation between benign and malignant soft tissue tumors.

SSK13-09 Fat Suppression for Ultrashort Echo Time (UTE) Imaging Using Single Point Dixon Method

Wednesday, Nov. 28 11:50AM - 12:00PM Room: N229

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PURPOSE

Use of fat saturation (FS) pulses with UTE sequences can improve short T2 contrast but reduce short T2 signal, and two point Dixon (2p-Dixon) method can misestimate fat due to short T2* decay. We propose single point Dixon (1p-Dixon) method to suppress fat for high contrast UTE imaging of short T2 tissues.

METHOD AND MATERIALS

1p-Dixon technique directly decomposes fat and water from complex MR signals after correcting phase errors due to field inhomogeneity (Ma. JMRI 2008). The proposed method utilizes dual echo 3D UTE imaging, where UTE is followed by the 2nd TE (TE2), chosen flexibly. Fat is estimated by applying 1p-Dixon to the non-UTE image at TE2, and used to suppress fat in the UTE image. In-vivo experiments were performed in 3T (GE-MR750) with two healthy volunteers (left knee of male aged 36 and left ankle of male aged 26). Parameters for knee imaging were as follows: flip angle=15degree, TE1/TE2/TR=32μs/2.7ms/20ms, voxel size=0.6x0.6x3mm scan time=3min50sec. Parameters for ankle imaging were set same as above except: TE2 =2.9ms, voxel size=0.5x0.5x3mm scan time=5min30sec.

RESULTS

Since 2p-Dixon does not consider signal decay between UTE and TE2, the short T2* decay is misinterpreted as a contribution of fat signal partially nulling water signal. Therefore, in the knee imaging fat signal in tendon and bone was misestimated by 2p-Dixon method, while the 1p-Dixon method was not affected by the short T2* signal decay. Compared with FS, 1p-Dixon based approach showed strong signal intensity in the patellar and Achilles tendon with less spatial variation in the fat suppressed UTE images, while the UTE images with FS pulse exhibited lower intensity in the tendons with gradually varying signal. The pattern of signal variation in the UTE images with FS was very similar to the water images at TE2 where most of short T2 (especially bound water) signal already decayed, which implies broad-spectrum short T2 components were partially affected by the FS pulse.

CONCLUSION

We demonstrated feasibility of 1p-Dixon based fat suppression in UTE imaging, which has the advantage of flexible echo spacing and accurate fat estimation over 2p-Dixon. Moreover, the proposed method preserves short T2 (especially bound water) signal significantly better than FS method.

CLINICAL RELEVANCE/APPLICATION

The proposed method has potential to aid with various types of morphological and quantitative UTE imaging, such as T2* mapping or UTE-MT modeling.

SSK14

Nuclear Medicine (Lymphoma, Sarcoma and Melanoma)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S505AB

BQ CT NM

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

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Sub-Events

SSK14-01 Incremental Value of Interim 18F-FDG PET/CT over CT-Scan for Early Response Evaluation in Patients with Hodgkin Lymphoma Treated with Immune Checkpoint Inhibitors

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PURPOSE

Anti-Programmed Death 1 (anti-PD1) antibody triggers new patterns of response and progression in patients with Hodgkin lymphoma (HL). We aimed to evaluate the incremental value of interim 18F-FDG PET/CT over CT scans in patients treated by anti-PD1.

METHOD AND MATERIALS

We retrospectively analyzed patients treated by anti-PD1 from 2013 to 2017. Concomitant 18F-FDG PET/CT and CT scans were acquired at baseline and upon treatment. A pair of radiologists classified blindly and independently patients as immune-responding or immune-refractory based on the first evaluation, using the International Harmonisation Project Cheson 2014 criteria and the Lymphoma Response to Immunomodulatory therapy Criteria (LYRIC) (2016 revised criteria).

RESULTS

Forty-four consecutive HL patients were included. Forty-four interim 18F-FDG PET/CT and CT scans were acquired at a median time of 3.7 months after anti-PD1 initiation. Radiologists classified patients as immune-responding or immune-refractory on both 18F-FDG PET/CT and CT-scan in 55.7% and 35.2% of cases, respectively. Radiologists experienced a significant incremental value of 18F-FDG PET/CT in 8.0% (95%CI: 3.3%-15.7%) of patients, whom were reclassified as immune-refractory (2.3%) or immune-responding (5.7%). Additionally, 18.2% (95%CI: 10.8%-27.8%) of patients were reclassified from PR on CT-scan to CR on PET.

CONCLUSION

CT-scan alone can reliably be used for response assessment in patients with HL treated with anti-PD1: radiologists correctly classified patients as immune-responding or immune-refractory in 92% of cases. However, interim 18F-FDG PET/CT showed clear incremental value to reclassify immune-responding patients from partial response to complete response, which is crucial for risk-adapted strategies.

CLINICAL RELEVANCE/APPLICATION

Interim 18F-FDG-PET/CT in HL patients treated with anti-PD1 supplied incremental value over CT-scan by reclassifying patients to immune-responding or complete response. This concept is crucial for risk-adapted therapeutic strategy.

SSK14-02 Impact of FDG-PET/CT on the Staging, Management and Outcomes of Patients with Presumed Limited Stage Hodgkin's Lymphoma and Aggressive Non-Hodgkin's Lymphoma

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S505AB

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PURPOSE

To determine the impact of positron-emission tomography/ computed tomography (PET/CT) on the staging, management and outcomes of patients with apparent limited-stage (LS) Hodgkin's lymphoma (HL) or aggressive non-Hodgkin's lymphoma (aNHL) being treated with curative intent.

METHOD AND MATERIALS

This single arm, prospective multicenter registry included patients with apparent LS HL or aNHL based on clinical data and CT, or with equivocal CT findings for advanced stage, being considered for curative-intent therapy. Pre-PET/CT treatment plan was compared to actual treatment received. Outcomes at 1 year post first line therapy included survival and second-line therapy initiation. These were compared to a historical control pool staged with CT alone. Administrative data sources were used to obtain and control for baseline characteristics using propensity score matching and regression adjustment. Outcomes were assessed using adjusted Cox proportional hazards regression and propensity score matching.

RESULTS

PET/CT upstaged 58/330 (17.6%) patients with HL and 92/520 (17.7%) patients with aNHL. Change in planned mode of therapy was seen in 119/266 (44.7%) patients with HL and 131/334 (39.2%) with aNHL ($p<0.00001$ for both). There was a lower 1-year mortality for aNHL patients with LS on PET compared to those with LS on CT (for propensity score matched cohort: HR, 0.34; 95% CI: 0.15, 0.74; $p=0.0072$). For patients with HL, no significant difference was found in survival or second-line therapy initiation at 1 year.

CONCLUSION

PET/CT upstaged >17% of patients with presumed LS aggressive lymphoma to advanced stage and planned management was altered in a significant proportion of patients. Patients with confirmed LS aNHL after PET/CT treated with curative intent had significantly better survival compared to the cohort of LS determined by CT.

CLINICAL RELEVANCE/APPLICATION

1. PET has a significant impact on the management of patients with HL and aNHL. 2. Patients with presumed limited stage aNHL on PET/CT treated with curative intent had a significantly better survival at one year compared to patients with presumed limited stage as determined by CT. 3. These results support the recent recommendation of the International Conference on Malignant Lymphoma in Lugano for the utilization of PET in the staging of patients with aggressive lymphoma.

SSK14-03 Altered Liver FDG Uptake in Lymphoma Patients with Chemotherapy Associated Hepatic Steatosis on PET/CT

Wednesday, Nov. 28 10:50AM - 11:00AM Room: S505AB

Participants
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PURPOSE

To evaluate the prevalence of hepatic steatosis in lymphoma patients after chemotherapy; to reveal whether lymphoma patient with chemotherapy associated hepatic steatosis (CAHS) will change liver FDG uptake on PET/CT, compared to their baseline and to further study the relation between liver FDG uptake and severity of fatty liver.

METHOD AND MATERIALS

88 of 1647 lymphoma patients had been diagnosed fatty liver during or after chemotherapy from December 1, 2014, to June 30, 2017. 176 FDG PET/CT scans of the 88 lymphoma patients were reviewed retrospectively. These 88 lymphoma patients all had a normal liver before chemotherapy and then got hepatic steatosis after chemotherapy. Each patient had performed two PET/CT scans: baseline and post-chemotherapy. Paired t test was used to compare BMI, blood glucose (BG), liver SUVmax (SUVmax-l), liver average SUV (SUVave-l), liver SULmax (SULmax-l), aorta SUVmax (SUVmax-a), aorta average SUV (SUVave-a) and aorta SULmax (SULmax-a) between baseline and post-chemotherapy. CAHS was divided into three groups: mild-grade, moderate-grade, and severe-grade. The relationship within or between groups was assessed.

RESULTS

The prevalence of CAHS in lymphoma patients of our hospital was about 88/1647 (5.3%). After chemotherapy, 28 of 88 (31.8%) patients had increased liver SUVs, whereas 60 of 88 (68.2%) patients showed decreased liver SUVs. There were significant differences of mean liver SUVs between baseline and CAHS (baseline versus CAHS; SUVmax-l, 2.84±0.57 vs 2.57±0.64, P<0.00; SUVave-l, 2.17±0.43 vs 1.95±0.51, P=0.001; SULmax-l, 2.24±0.40 vs 2.0±0.41, P<0.001). BG had a slight decrease after chemotherapy (baseline versus CAHS, 5.5±1.2 vs 5.2±1.0, P=0.01). No difference was identified when the mean aorta SUVs and BMI for baseline were compared with those for CAHS (P>0.05). The patients with severe-grade of CAHS had significant lower liver SUV values, compared to those with mild-grade (P<0.05). And BMI showed no difference among the three groups of CAHS.

CONCLUSION

Increase of liver FDG uptake coexists with decrease. The severer the fatty liver is, the more likely the liver FDG uptake declines. The altered liver SUV due to CAHS might affect the response assessment and prognostic evaluation for lymphoma patients.

CLINICAL RELEVANCE/APPLICATION

(dealing with 18F-FDG PET/CT)'18F-FDG PET/CT is a powerful imaging technique and has become the standard for staging and response assessment of FDG-avid lymphomas'.

SSK14-04 Is Dual-Time Point 18F-FDG PET/CT Valuable for Differentiating Goitrous Hashimoto's Thyroiditis from Primary Thyroid Lymphoma?

Wednesday, Nov. 28 11:00AM - 11:10AM Room: S505AB

Participants
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PURPOSE

Goitrous Hashimoto's thyroiditis (HT) occasionally shows diffusely increased F-18 fluorodeoxyglucose (FDG) uptake in the thyroid that it mimics primary thyroid lymphoma (PTL) on FDG-PET/CT i,ages. The aim of the study was to determine whether delayed imaging of FDG-PET/CT was valuable in differentiating PTL from HT.

METHOD AND MATERIALS

53 patients with HT, who were suspected of PTL due to enlarging goiter, underwent dual-time-point (60 ± 5min and 120± 10min after FDG injection) PET/CT scan using FDG combined with neck ultrasound (US) and US-guided core needle biopsy. Specimen of core needle biopsy was subjected to immunohistochemical staining (CD20,CD3,CD79a,Ki-67, etc.) along with H-E staining. Re-arrangement of igH was also analyzed by PCR. In addition to visual assessment based on 5-point scale from The Lugano classification, the maximum standardized uptake value for the thyroid at the early image (SUV-E) and that at the delayed image (SUV-D) for the thyroid were determined. In addition, SUV increment (ΔSUV) was calculated by subtracting SUV-E from SUV-D. Those parameters were compared between patients with PTL and those with HT.

RESULTS

Pathological diagnosis was PTL in 36 (MALT lymphoma 31, DLBCL 5) and was HT in 17. 11 patients with PTL was excluded from analysis because they had either nodular FDG uptake in the thyroid or abnormal uptake in extrathyroidal area. The remaining 25 patients with PTL and all patients with HT showed diffusely increased thyroid FDG uptake on both the early and the delayed PET/CT images. There was no statistically significant difference between PTL and HT in 5-PS (early 4.4 vs. 4.2. delayed 4.1 vs. 4.0) as well as SUV-E and SUV-D (9.02 vs. 7.51, 8.28 vs. 6.54). 7 of 25 patients (28%) with PTL had plus values of ΔSUV while none but one (6%) with HT had plus value of ΔSUV. When plus value of ΔSUV was considered as a sign for PTL, PPV, NPV, and accuracy for PTL was 88%. 47%, and 55%, respectively.

CONCLUSION

Neither visual nor semi-quantitative analysis of dual tome-point FDG-PET/CT was helpful in differentiation HT from PTL among enlarging goiter. Needle biopsy may be the best strategy in differential diagnosis of HT with enlarging goiter.

CLINICAL RELEVANCE/APPLICATION

Addition of delayed imaging does not improve diagnostic performance of FDG-PET/CT in diffusely increased thyroidal uptake in enlarging goiter.

SSK14-05 Utility of Integrated 18F-FDG PET/MRI for Response Assessment of Isolated Limp Perfusion in Patients with Soft-Tissue Sarcomas

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S505AB

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PURPOSE

To evaluate the diagnostic potential of simultaneously obtained PET- and MR-datasets for therapy response assessment of isolated limp perfusion with TNF-alpha and melphalan (TM-ILP) in patients with soft-tissue sarcomas.

METHOD AND MATERIALS

A total of 32 patients with histopathological confirmation of a soft-tissue sarcoma were prospectively enrolled for an integrated 18F-FDG PET/MRI examination before (1st scan) and after (2nd scan) neoadjuvant TM-ILP. In each examination morphological (tumor size) and metabolic (SUVmax, SUVpeak) parameters of the tumors were determined. Two readers analysed the datasets and assessed treatment response based on RECIST 1.1 and PERCIST criteria. Results from subsequent tumor resection served as reference standard and therapy response was determined based on the tumour regression grading scale of Salzer-Kuntschik.

RESULTS

Based on the reference standard, a total of 25 patients were classified as partial responder (PR) and 7 patients as stable disease (SD). Calculated mean values of the maximum tumor diameter, SUVmax and SUVpeak in patients with stable disease amounted to 62.4 ± 42.4mm, 11.1 ± 7.9 and 9.1 ± 6.2 before and 59.5 ± 50.3mm, 8.4 ± 5.3 and 6.7 ± 5.1 after treatment. The respective values in the responder group were 78.1± 65.6mm, 11.9 ± 7.4 and 9.6 ± 6.1, before and 71.1 ± 65.9mm, 5.1 ± 3.1 and 3.9 ± 2.4 after treatment. Based on RECIST criteria, 25 patients were classified as SD and 6 patients as PR, whereas 1 patient showed progressive disease (PD). PERCIST criteria categorized 11 patients as SD, 20 patients as PR and one patient as PD. In accordance with PERCIST, a significantly higher number of patients (n = 23, 71.9%) could be correctly categorized as SD/PR, when compared to RECIST (n = 9, 28.1%; $p < 0.005$).

CONCLUSION

Our results demonstrate the significant discrepancy in morphological and metabolic response and underline the diagnostic superiority of 18F-FDG PET data over MRI for response assessment of neoadjuvant ILP in sarcoma patients.

CLINICAL RELEVANCE/APPLICATION

18F-FDG PET/MRI might enable more accurate therapy response assessment of isolated limp perfusion in patients with soft-tissue sarcomas when compared to MRI alone.

SSK14-06 Evaluation of 18F-FDG-PET/CT for Response Assessment in Patients with Advanced Melanoma Treated with Immune Checkpoint Inhibitors

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S505AB

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PURPOSE

Treatment with immune checkpoint inhibitors (ICI) have improved outcomes for patients with advanced melanoma. The aim of this retrospective study was to characterize the findings on 18F-FDG PET/CT that predict response in these patients.

METHOD AND MATERIALS

Ninety-seven patients with advanced melanoma treated with ICI were identified, with 70 having baseline (PET0) and interim 18F-FDG PET/CT studies (PET1, median 84 and range 19 to 181 days after cycle 1). Of these, 34 were treated with ipilimumab alone (N=17) or combined with nivolumab (N=17, analyzed together as the ipi cohort) and 36 with pembrolizumab (pembro cohort) alone. AutoPERCIST software was used to determine the SULpeak and SUVmax of the hottest lesion on each scan. Clinical assessment at the last office visit determined responders (R- partial response, stable, or no disease) and nonresponders (NR- progression) at a median 9.5 (range 0 to 61) months after PET1 for the ipi cohort and 5.5 months (range 0 to 20) for the pembro cohort. Repeated measures analysis of variance (SigmaPlot 12.5, Systat Software, Inc.) determined differences between PET0 and PET1 metrics among response categories by cohort. The Mann-Whitney rank sum test assessed for differences in the % change in each metric between response categories.

RESULTS

Thirteen R and 21 NR were identified in the ipi cohort and 26 R and 10 NR in the pembro cohort. Within the ipi R cohort, SULpeak (PET0 6.8±5.1, PET1 1.2±2.4, p=0.002) and SUVmax (PET0 9.9±7.0, PET1 2.0±4.3, p=0.002), were significantly different. The PET1 SULpeak (13±12, p=0.007) and SUVmax (19±19, p=0.006) of the NR was also significantly different from the R PET1 values. For the pembro NR cohort, SULpeak (PET0 6.2±5.3, PET1 10±8.7, p=0.017) and SUVmax (PET0 9.5±9.1, PET1 14±12, p=0.033) were significantly different, and the pembro R PET1 SULpeak (2.0±3.6, p<0.001) and SUVmax (3.4±6.0, p<0.001) were also significantly different from NR PET1 values. The % change in all metrics was significantly different between R and NR in both treatment cohorts.

CONCLUSION

Changes in the SULpeak and SUVmax of the hottest lesion on interim 18F-FDG PET/CT studies may be useful in predicting responders to ICI.

CLINICAL RELEVANCE/APPLICATION

Higher SULpeak and SUVmax values and lower % decrease in these parameters on interim 18F-FDG PET/CT scans during ICI treatment are predictors of poor treatment response.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Richard L. Wahl, MD - 2013 Honored Educator

SSK14-07 Is 18F-FDG PET/MR Including DWI an Alternative to Sentinel Lymph Node Biopsy in Initial N-Staging in Patients with Malignant Melanoma?

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S505AB

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PURPOSE

To compare 18F-fluordesoxyglucose positron emission tomography / computed tomography (18F-FDG PET/CT), 18F-FDG PET / magnetic resonance (18F-FDG PET/MR) as well as 18F-FDG PET/MR and diffusion weighted imaging (DWI) with sentinel lymph node biopsy (SLNB) in initial lymph node staging in patients with malignant melanoma.

METHOD AND MATERIALS

In this retrospective study, 52 patients with malignant melanoma (female: n=30, male: n=22, mean age 50.5y) that underwent 18F-FDG PET/CT and consecutive 18F-FDG PET/MRI including DWI prior to lymphoscintigraphy with single photon emission computed tomography / CT (SPECT/CT) and consecutive SLNB were included. By two readers, the status of the sentinel lymph nodes detected by SPECT/CT (benign/malignant) was assessed on 18F-FDG PET/CT, 18F-FDG PET/MR as well as 18F-FDG PET/MR and DWI images. In all modalities, increased tracer uptake in comparison to the background was considered as a sign of malignancy. In PET/MR, morphological criteria were considered as additional signs of malignancy. In 18F-FDG PET/MR and DWI, all of the aforementioned criteria and diffusion restriction were considered as signs of malignancy. Discrepancies were resolved in a consensus reading. Histopathologic results served as a reference standard to calculate sensitivity, specificity as well as positive (PPV) and negative predictive values (NPV).

RESULTS

In all patients, a total of 87 sentinel lymph nodes were detected by lymphoscintigraphy and SPECT/CT. According to histopathology, lymph nodes were metastatic. We found a sensitivity, specificity, PPV and NPV of 17.7%, 95.6%, 50.0% and 82.3% for PET/CT and of 23.5%, 96.9%, 66.7% and 82.3% for PET/MR. Additional DWI was available in 56 lymph nodes and led to two additional false positive findings, thus decreasing specificity of PET/MR and DWI.

CONCLUSION

Due to its low sensitivity and specificity, 18F-FDG PET/MR cannot be considered an alternative to SLNB in initial N-Staging in patients with malignant melanoma even if additional DWI is performed.

CLINICAL RELEVANCE/APPLICATION

18F-FDG PET/MR is inferior to SLNB in N-Staging in patients with malignant melanoma. Therefore, neither 18F-FDG PET/MR nor 18F-FDG PET/MR and DWI will be able to replace SLNB in clinical routine.

SSK14-08 Prognostic Value of 18F-FDG PET/CT in Intralesional Interleukin-2 Therapy for Cutaneous Metastatic Melanoma

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S505AB

Participants
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PURPOSE

Intralesional interleukin-2 (IL-2) therapy is an effective treatment for cutaneous metastatic melanoma even in cases refractory to multiple treatment modalities. 18F-FDG PET/CT is a valuable tool for diagnosis, staging and surveillance of melanoma, but its role in therapy assessment is unclear given the strong local inflammatory response in injected sites. This study investigates the prognostic value of 18F-FDG PET/CT for assessment of intralesional IL-2 in cutaneous metastatic melanoma.

METHOD AND MATERIALS

13 patients (10M/3F, 23 - 96 years) with Stage IIIC/IV cutaneous metastatic melanoma or stage IIB disease not amenable to surgical intervention had a total of 31 PET/CT scans performed at baseline, interim and completion time points while receiving variable injections of intralesional IL-2 (range, 1 - 20; mean 7.8) at variable doses (range 5 - 22 million units; mode 7) . PET/CT scans were evaluated using maximum SUV (SUV max) and a 5 point scale (5PS): 1, no uptake; 2, uptake <= mediastinum; 3, uptake > mediastinum <= liver; 4, uptake moderately < liver; 5, uptake markedly > than liver. The 5PS was dichotomized to

negative (score 1, 2, and 3) or positive (score 4 and 5). The Kaplan-Meier (KM) method with log-rank test and Cox-regression analysis were performed.

RESULTS

Of the 31 scans, 17 were positive and 14 were negative. SUV max range, 1.3 -20.6 g/ml. Follow-up range, 8 - 51 months (median 15). Baseline scans with higher SUV max had a significantly lower PFS with hazard ratio (HR) of 1.55 (95% CI 1.001-1.33, p=0.048). KM curves demonstrated a trend of improved OS with lower SUVmax at baseline (p=0.11). Positive scans at completion trended toward lower OS with HR of 2.74, (p=0.48). The progression-free survival (PFS) was worse for positive groups at completion, HR of 12.12 (95%CI 1.22-120.49, p=0.03), with significant separation in KM curves (Log-rank, p=0.008).

CONCLUSION

18F-FDG PET/CT SUV max at baseline and qualitative therapy assessment at completion time points during intralesional IL-2 can predict PFS and show potential to predict OS, with larger sample size, in patients with cutaneous metastatic melanoma.

CLINICAL RELEVANCE/APPLICATION

A baseline PET/CT prior to intralesional IL-2 adds prognostic value. Additionally, using a qualitative therapy assessment method such as the 5PS increases the prognostic value of 18F-FDG PET/CT for therapy response in intralesional IL-2 treatment for cutaneous metastatic melanoma.

SSK14-09 Opportunistic Screening of FDG-PET/CT Reveals Undiagnosed Low Bone Mass in Patients Being Evaluated for Oncology Purposes

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S505AB

Participants
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PURPOSE

To assess the prevalence of undetected low bone mineral density (BMD) in a cohort of patients undergoing PET/CT with opportunistic quantitative computed tomography (QCT).

METHOD AND MATERIALS

A retrospective survey was conducted to identify PET/CT studies obtained between Oct/2015 and Jan/2016 in a Biograph 64 scanner (Siemens). CT images were processed with the QCT Pro software (Mindways). A calibration CT scan was obtained in the same PET/CT scanner using the asynchronous Model 4 QCT Phantom. Two radiologists and a trained research technician performed the analyses of trabecular BMD at vertebral bodies L1 and L2. The American College of Radiology (ACR) criteria was used for diagnosing low BMD. Total BMD of femoral necks were measured on DXA-equivalent images (CTXA) of the hips and used to generate FRAX-scores for calculating absolute fracture risks. We obtained clinical data from institutional medical records. Requirement for signed informed consent was waived by the IRB.

RESULTS

Sixty-nine studies were identified, two studies excluded due to severe scoliosis and one excluded due to Schmörl node affecting the analysis. The final cohort comprised 66 subjects (20F/46M, mean age: 53.8, SD: 12.1). Mean coefficient of variation (CV) for trabecular BMD in L1-2 between the 3 readers was 1.2%. Distribution of subjects according to ACR category is shown in Table 1. Thirty-two percent (21/66) of subjects showed low lumbar spine BMD on QCT. Twenty-four percent (5/21) of subjects with low BMD on QCT had a prior DXA scan, all of which showing low BMD. None of the subjects with normal BMD on QCT had a prior DXA scan. Femoral neck BMD was assessed with CTXA in 20 of 66 subjects by one radiologist and the research technician. Mean CV between the readers was 6.1%. Fifteen percent (3/20) of the subjects had at least a 3% risk of hip fracture within 10 years. Only 33.3% (1/3) of these subjects had a prior diagnosis of low BMD.

CONCLUSION

Low BMD was an under recognized condition in our sample. Future analysis will correlate metabolic activity (FDGuptake) with bone mass.

CLINICAL RELEVANCE/APPLICATION

PET/CT provides a unique opportunity to screen patients for occult low BMD by leveraging the quantitative capabilities of CT. Identification of subjects at risk for future osteoporotic fractures may not only improve outcomes, but also decrease downstream costs.

SSK15

Neuroradiology (Stroke Imaging and Intervention)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: E350

CT ER NR

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

Participants
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Sub-Events

SSK15-01 Distance to Thrombus in Stroke Due to Large Vessel Middle Cerebral Artery Occlusion

Participants
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PURPOSE

Endovascular thrombectomy (EVT) is supported by Level IA evidence for middle cerebral artery (MCA) M1 occlusion stroke, yet more distal occlusions lead to challenges in decision making. In stroke patients with large vessel MCA occlusion, distance to thrombus (DT) can be measured from the carotid T. We determined the value of DT in the context of established clinical and imaging parameters.

METHOD AND MATERIALS

We selected patients with isolated MCA occlusions (M1-M3) and follow-up-confirmed stroke. Two independent, blinded readers evaluated imaging. DT was measured as the distance from the carotid T to the proximal end of the thrombus on coronal CT angiography images. Established clinical and imaging parameters were assessed. Linear and ordinal regression analyses were performed to identify independent associations.

RESULTS

The study population of 162 patients had a median DT of 14.0 mm (interquartile range: 8.0-24.0mm). Dichotomizing the study population by median DT, patients with DT<=14.0 mm showed significantly higher median admission National Institutes of Health Stroke Scale scores (14 vs 9, p<0.001; NIHSS), no significant difference in median final infarction volumes (31 mL vs. 23 mL, p=0.224), but worse median modified Rankin Scale (mRS) scores at discharge (4 vs 3, p=0.004) and 90 days (5 vs 2, p=0.037). Patients with shorter DT had worse median non-contrast Alberta Stroke Program Early CT Scores (8 vs 9, p<0.001; NCCT-ASPECTS) and more frequently underwent EVT. When adjusted for age, sex, admission NIHSS, NCCT-ASPECTS, thrombolysis, EVT and DT, linear regression analyses revealed only significant associations of admission NIHSS (b=0.229, p=0.006) and NCCT-ASPECTS (b=-0.357, p<0.001) with final infarction volumes. In similarly adjusted ordinal regression analyses on clinical outcomes, only admission NIHSS was an independent predictor of discharge mRS (b=0.144, p<0.001) and 90-day mRS (b=0.137, p=0.004).

CONCLUSION

In this comprehensive analysis on the value of DT in acute stroke, DT was outperformed by existing imaging parameters for morphologic outcome prediction and had no independent predictive value for clinical outcomes.

CLINICAL RELEVANCE/APPLICATION

In stroke imaging, DT is a quantifiable occlusion parameter yet carries no independent predictive value. However, DT could be used to standardize selection for randomized EVT trials on M2 occlusions.

SSK15-02 MRI or CT Before Recanalization in Acute Ischemic Stroke: Impact on Clinical Workflow: Results from the THRACE Randomized Controlled Trial

Wednesday, Nov. 28 10:40AM - 10:50AM Room: E350

Awards
Student Travel Stipend Award

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PURPOSE

To compare clinical workflow and functional outcome in acute ischemic stroke patients screened by Magnetic Resonance Imaging (MRI) or Computed Tomography (CT).

METHOD AND MATERIALS

Data were analyzed from THRACE, a multicenter, randomized, controlled trial that evaluated the efficacy of mechanical thrombectomy in addition to intravenous tissue-plasminogene activator (IV-tPA) in patients with acute ischemic stroke and proximal occlusion. Recruiting centers were free to use their routine MRI or CT stroke protocol before randomization. Brain imaging was performed within 4h of stroke onset. Workflow times were obtained from the trial database and extracted from Digital Imaging and Communications in Medicine (DICOM) metadata. All patients or their legal representative provided written informed consent.

RESULTS

403 patients were included: 300 based on MRI and 103 on CT. Median baseline National Institutes of Health Stroke Scale score was 18 in both groups. Time interval (median, interquartile range) from stroke onset to imaging was similar (MRI: 114 min (89-139); CT: 108 min (88-140); P = .23). MRI scan duration was overall longer (MRI: 13 min (10-16); CT/CT angiography: 9 min (7-12); P < .001), irrespective of the imaging protocol (without perfusion-weighted imaging [MRI: 12 min (10-15); CT: 7 min (2-11); P < .001] or with perfusion-weighted imaging [MRI: 16 min (15-19); CT: 10 min (8-13); P < .001]. Time from stroke onset to IV-tPA (MRI: 150 min (121-179); CT: 150 min (123-180); P = .31) and onset to entry in angiography suite (MRI: 200 min (170-250); CT: 213 min (180-246); P = .57) did not differ between groups. In the endovascular treatment arm, imaging modality of inclusion was not associated with unfavorable outcome (modified Rankin Score scale > 2) in multivariate analysis (MRI: odds ratio 0.72; 95% confidence interval: 0.33 - 1.54; P = .40).

CONCLUSION

In the THRACE trial, use of MRI at the acute phase of ischemic stroke did not delay treatment nor was associated with poorer functional outcome than CT after endovascular treatment.

CLINICAL RELEVANCE/APPLICATION

Efficient workflow allows to use MRI as a screening tool for stroke patients, without delay to treatment nor negative impact on clinical outcome.

SSK15-03 Focal Thinning in Remote Cortical Layers via Degeneration of Connecting Fibers Correlates with Clinical Outcome in Lacunar Infarct Patients

Wednesday, Nov. 28 10:50AM - 11:00AM Room: E350

Awards
Student Travel Stipend Award

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PURPOSE

Ischemic infarcts have been observed to exert structural effects distant from the acute lesion itself, in remote, connected cortex. We aimed to extend this knowledge by exploring with in-vivo T1-relaxation 3T-MRI, surface-based cortical thickness analysis and tractography if (i) in patients with chronic lacunar infarct, involving the corticospinal tract, the cortical layers of the connected primary motor cortex are differently affected, and if (ii) these differences correlate with clinical symptomatology.

METHOD AND MATERIALS

Our cohort included patients (n=20) with history of chronic lacunar infarct, involving the posterior limb of the internal capsule or the corona radiata, with residual motor deficit, and healthy controls (n=15). T1-component probability maps, dividing the cortex into 5 laminar Gaussian-classes (noted L1-L5) were calculated, and tractography with lacunar infarcts as the seed areas to reconstruct the corticospinal tracts (CSTs) were performed.

RESULTS

Results demonstrated focal cortical thinning in the connected primary motor cortex (M1) and specifically only in its deepest L5-class compared to the non-affected mirrored cortex (P<0.001 and P=0.0001, respectively). There was loss of microstructural integrity of the affected CST connecting the lacunar infarct to the M1 with significantly increased mean diffusivity (MD) and decreased fractional anisotropy (FA) compared to the non-affected hemisphere (P=0.002 and P=0.0002, respectively). Increased MD and decreased FA were associated with focal thinning in M1 and in its deepest L5-class in the affected compared to the non-affected hemisphere (MD: P=0.07 and P=0.05, respectively; FA: P=0.02 and P=0.005, respectively). No significant difference was found between the laminar thickness pattern of the bilateral M1 or the microstructural integrity of the bilateral CSTs for the healthy subjects. Clinical scores were significantly correlated with microstructural damage of the CST and with thinning of both M1 and its deepest L5-class (P<0.05).

CONCLUSION

Our results support the concept of secondary neurodegeneration of Betz cells in layer V of connected M1, following a lacunar infarct affecting the CST, with a novel finding that the majority of the cortical thinning occurs in the deepest cortex.

CLINICAL RELEVANCE/APPLICATION

The severity of clinical symptoms is significantly correlated with the microstructural damage of the CST and with the connected M1 atrophy pattern.

SSK15-04 Clinical Decision Support Based on Automated Non-Contrast CT Density Measurements in Patients with Acute Ischemic Stroke

Wednesday, Nov. 28 11:00AM - 11:10AM Room: E350

Participants
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PURPOSE

To examine the clinical value of automated non-contrast CT (NCCT) density measurements in Alberta Stroke Program Early CT Score (ASPECTS) regions to support decision making in acute ischemic stroke.

METHOD AND MATERIALS

From a cohort of 1644 consecutive patients admitted for suspected stroke, we included patients with follow-up-confirmed middle cerebral artery infarction and available NCCT and CT perfusion (CTP) data. ASPECTS region density was assessed using automated software (Figure 1A). Relative Hounsfield units (rHU) were defined as the ratio of ipsilesional by contralesional region density. Extent of ischemic core was measured on CTP maps. Regression coefficients from a linear regression analysis on the association of regional rHU and infarction core volume were used as weighting factors to calculate a composite rHU score of all regions. Receiver operating characteristics (ROC) analyses were performed to test this score's discriminative value regarding time from symptom onset (TFSO) <=4.5h, current CTP trial selection criteria, and subacute stroke complications on follow-up imaging.

RESULTS

In total 121 patients were included. The composite rHU score resulted in significant classification of patients with TFSO<=4.5h (area under the curve [AUC]=0.721, p=0.018). Moreover, the score was able to classify patients who meet CTP selection criteria of ischemic core size <70mL and target mismatch >1.8 (AUC=0.759, p<0.001). The score discriminated between patients with and without subsequent space-occupying edema development (AUC=0.771, p<0.001). ROC curves are shown in Figure 1B. The score could not classify patients by occurrence of hemorrhagic infarction or parenchymal hematoma (both p>0.05).

CONCLUSION

The composite rHU score on NCCT allowed significant classification of patients with thrombolysis-eligible symptom onset times and current CTP imaging criteria for extended time window thrombectomy selection. The score also identified patients with subsequent space-occupying edema development.

CLINICAL RELEVANCE/APPLICATION

Automated NCCT density measurements have the potential to act as observer-independent imaging biomarkers that could support decision making in patients with unknown TFSO or in centers in which CTP is not available.

SSK15-05 Does IV-tPA Induce Thrombus Migration? A Retrospective Study Comparing Bridging Therapy and Thrombectomy Alone

Wednesday, Nov. 28 11:10AM - 11:20AM Room: E350

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PURPOSE

Thrombus migration (ThrMi) before mechanical thrombectomy (MT) is an epiphenomenon in acute ischemic stroke (AIS) treatment with few available data. The aim of this study is to evaluate ThrMi prior to MT in a bridging protocol (tPA-MT group) and stand-alone MT (MT group).

METHOD AND MATERIALS

205 consecutive AIS patients treated by MT (tPA and no tPA) were retrospectively analyzed. Distance between vessel origin and beginning of the thrombus on MRI (3D time of flight and/or contrast enhanced magnetic resonance angiography sequences) and digital-substracted-angiography (DSA) were measured in millimeters using a curve tool and the same anatomical parameters. DSA pixels were converted in millimeters by measuring 3 large vessels diameters in MRI and determining the ratio from pixels to millimeters.

RESULTS

129 patients were included in tPA-MT group, with ThrMi in 36.4%, and 76 patients in MT group, with ThrMi in 6.6% ($p<0.0001$). In tPA-MT group, 27 (20.9%) patients had a moderate migration between 5-10 millimeters, 11 (8.5%) patients had a distal migration of more than 10 millimeters or to another segment and 9 (7%) presented recanalization defined by spontaneous TICI score>=2B. In MT group, 69 (90.8%) patients had no ThrMi, moderate ThrMi in 6.6%, thrombus' extension in 2.6%; no patient presented distal migration or recanalization. The two groups had the same clinical prognosis (bleeding event at 48hours, NIHSS at discharge, mRS and death at 3 months). Number of device passes to reach thrombectomy was 1.40 (±1.39) in tPA-MT group, 1.63 (±1.09) in MT group, $p=0.061$.

CONCLUSION

IV thrombolysis seems to promote thrombus migration, present in 36.4% of patients in tPA-MT group compared to 6.6% of patients in MT group. This study adds more data concerning IV thrombolysis effects on AIS treatment when MT is also involved.

CLINICAL RELEVANCE/APPLICATION

(dealing with acute ischemic stroke) 'Before performing mechanical thrombectomy, the possibility of a thrombus migration favored by prior thrombolysis is an important data for neurointerventionalists.'

SSK15-06 Public Health and Cost Consequences of Treatment Delays in Endovascular Thrombectomy for Stroke Based on HERMES Collaboration Data

Wednesday, Nov. 28 11:20AM - 11:30AM Room: E350

Awards
Trainee Research Prize - Resident

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PURPOSE

The benefit that endovascular thrombectomy (EVT) offers to stroke patients with large vessel occlusions is highly time-dependent. Our aim was to determine the lifetime quality of life and cost consequences of delaying EVT administration for patients, the healthcare system, and the society.

METHOD AND MATERIALS

A Markov model estimated lifetime quality-adjusted life years (QALY) of EVT-treated patients and associated costs based on stroke onset to arterial puncture time (model structure in Figure 1). The analysis was performed from a United States perspective with two cost frameworks: 1) healthcare costs and 2) societal costs, which include productivity losses and costs of informal care given by family members. Input parameters were based on best available evidence (Table 1), including patient data from the 7-trial HERMES collaboration (ESCAPE, EXTEND-IA, MR CLEAN, REVASCAT, SWIFT PRIME, PISTE, THRACE; Figure 2). In addition to diminished functional outcomes with later EVT, the model also projects that a proportion of patients becomes EVT-ineligible over

time. The lead analysis was conducted for stroke onset at 65 years. Probabilistic sensitivity analysis was performed.

RESULTS

Lifetime QALYs decreased for every hour of time delay until arterial puncture (Figure 3A). Within the first 6 hours of onset, every hour of delay resulted in an average loss of 0.69 QALYs. The healthcare and societal costs of each QALY yielded by EVT increased for every hour of time delay (Figure 3B). Within the first 6 hours of onset, every hour of delay increased the cost of QALYs yielded by EVT by $5,310/QALY in healthcare costs and by $7,914/QALY in societal costs. Within the first 3 hours of onset, a treatment delay of 2 hours - the amount typically associated with drip-and-ship compared to mothership care delivery - would result in an average loss of 1.7 QALYs per patient. In addition, this delay would result in an extra of about $10,000/QALY gained incurred by the healthcare system and $15,000/QALY gained incurred by the society.

CONCLUSION

Every hour of treatment delay in EVT for stroke reduces a patient's QALYs by almost three-quarters of a year and substantially increases healthcare and societal costs per QALY.

CLINICAL RELEVANCE/APPLICATION

Investments in healthcare policies and procedures to improve the efficiency of pre-hospital triage and in-hospital workflow for earlier treatment of stroke patients are likely highly cost-saving.

SSK15-07 Association Between Wall Characteristics of Atherosclerotic Middle Cerebral Artery with High-Resolution Magnetic Resonance Imaging and Infarction Pattern

Wednesday, Nov. 28 11:30AM - 11:40AM Room: E350

Participants
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PURPOSE

To study the characteristics of atherosclerotic middle cerebral vascular wall by using 3.0 T high-resolution magnetic resonance imaging (HRMRI), explore the association between the characteristics of vascular wall and cerebral infarction, and predict the mechanism of infarction.

METHOD AND MATERIALS

Thirty-two patients with atherosclerotic patients were retrospectively enrolled and intracranial artery HRMRI was peformed. HRMRI protocol included a 3D T1 weighted technique known as inversion-recovery (IR) prepared SPACE. The plaque morphology, distribution, enhancement, stenosis degree and reconstruction index (positive reconstruction) of the middle cerebral artery were analyzed. Characteristics of acute infarct on diffusion weighted imaging (DWI) were categorized according to the number (single or multiple infarcts)and the pattern of cerebral infarcts(cortical,border zone, or perforating artery territory infarcts). The relationship between wall characteristics and infarction patterns was evaluated.

RESULTS

In the Thirty-two patients with acute infarction, twenty-one patients had multiple acute cerebral infarcts and eleven showed single acute cerebral infarcts. Border zone infarcts were the most common (16, 76.2%) among multiple acute infarcts. Eleven single infarcts were subcortical deep penetrating artery infarcts (11,100%). Thirty(93.8%) plaque were eccentric. Seven plaques (63.6%) in penetrating artery infarcts were located at the upper wall among single acute infarcts. Twelve plaques(75.0%) in border zone infarcts were located at the ventral wall among multiple acute infarcts. There was no significant difference in clinical data and laboratory examination of patients with single and multiple infarcts($P>0.05$). The percentage of plaques located on the ventral wall, plaques with strong enhancement, pattern of PR reconstruction and degree of stenosis of the lumen in the multiple infarction were all significantly higher than those in the single infarction ($P<0.05$).

CONCLUSION

The strong enhancement plaque is associated with its vulnerability in the patients with intracranial MCA atherosclerosis. PR or obvious lumen stenosis were associated with artery to artery embolism. HR MRI provides insights into intracranial atherosclerosis, and predicting infarction patterns.

CLINICAL RELEVANCE/APPLICATION

HRMRI can provide insights into intracranial atherosclerosis, and predict infarction patterns.

SSK15-08 Deep Learning Based Quantitative Diagnosis of Ischemic Stroke on CT

Wednesday, Nov. 28 11:40AM - 11:50AM Room: E350

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To evaluate a deep learning based tool for quantitative and objective CT diagnosis of acute ischemia, benchmarked on a large population with CT/MR correlation.

METHOD AND MATERIALS

After IRB approval, all patients with suspected ischemia in a five-year interval (January 2013 to 2018) receiving a non-contrast head CT followed by MR within 48 hours were identified. For each patient, DWI was co-registered to CT after brain extraction. For all MR exams, regions of reduced diffusion were segmented by a custom deep learning algorithm and confirmed through visual inspection. A hybrid 3D/2D object localization network based on the faster R-CNN architecture was implemented using a feature pyramid backbone (Figure 1A-D). A region proposal network identified potential regions of infarct, and a separate head network quantified the primary CT findings of acute ischemia: gray-matter hypoattenuation and mass effect (Figure 1E-F). Network outputs are represented on a normalized scale from 0 to 1 based on finding severity. After training, population statistics for hypoattenuation and mass effect were used to create a nomogram of stroke risk.

RESULTS

A total of 4,382 patients with short-interval CT/MR were identified, 831 of which had DWI-confirmed ischemia, yielding 326,394 images across 8,764 exams for analysis. As quantified by the neural network, degree of hypoattenuation (0.68 vs. 0.21; $p < 0.001$) and mass effect (0.59 vs. 0.11; $p < 0.001$) was more severe in patients with ischemia vs. controls. A nomogram based on deep learning quantification of these findings predicted ischemia with AUC, accuracy, sensitivity, specificity, PPV and NPV of 0.823, 0.815, 0.729, 0.835, 0.508 and 0.929 respectively. By varying the thresholds for diagnosis, algorithm sensitivity/PPV for ischemia detection ranged between 0.91/0.14 to 0.33/0.89.

CONCLUSION

A deep learning tool is presented for completely objective assessment of hypoattenuation and mass effect in the setting of acute ischemia. A deep learning based nomogram of stroke risk as a function of these two variables yields a powerful and flexible tool for ischemia detection. Arguably, prediction errors from this entirely objective approach may primarily be attributed to limitations in CT technology.

CLINICAL RELEVANCE/APPLICATION

A deep learning enabled nomogram of stroke risk based on quantitative image findings yields a powerful and flexible tool for completely objective diagnosis of acute ischemia on CT.

SSK15-09 The Significant Difference of Plaque Characteristics in Middle Cerebral Artery between Ischemic Stroke Patients with Positive and Negative Penumbra Area: A Study of Intracranial Vessel Wall Imaging

Wednesday, Nov. 28 11:50AM - 12:00PM Room: E350

Participants
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PURPOSE

The purpose of this study was to investigate the difference of plaque characteristics in middle cerebral artery assessed by High-resolution Vessel Wall Imaging (HRVWI) between patients with positive and negative penumbra area , and to identify the risk factors affected penumbra volumes.

METHOD AND MATERIALS

Sixty-seven patients (44 males; age, 59.33 ± 10.57 years) with severe stenosis in the unilateral middle cerebral artery were enrolled. Patients were assigned to two groups: Positive Penumbra (PP group) and Negative Penumbra (NP group). MRI data were collected on a 3T Siemens MAGNETOM Trio Tim, including High-Resolution T1-SPACE, and DSC-PWI. The plaque characteristics in MCA was measured in the T1-SPACE, and all the cross-sectional image slices of a stenotic MCA on T1-SPACE were analyzed, and plaque characteristics was calculated as follows: outer vessel wall area (OWA) , lumen area (LA) and wall area (WA). Other extended parameters include normalized wall index (NWI), arterial remodeling , plaque length, configuration and enhanced behavior. The Mismatch volume was acquired using the RApid processing of PerfusIon and Diffusion (RAPID) software. Independent sample t test, Kruskal-Wallis H test and Chi-square test was performed in the difference of plaque characteristics in PP group and NP group. The relationship between the plaque characteristics and penumbra volume was calculated with Spearman's correlation or Kruskal-Wallis H test.

RESULTS

The results showed that eccentric plaques were observed 10 (37.04%) in PP group and 32 (80.00%) in NP group, which means significant difference was found between two groups ($\chi 2=12.72$, $p<0.001$). There were no significant difference between two groups in WA ($p=0.761$), NWI ($p=0.572$), expansive remodeling ($p=0.427$), diffused plaque distribution ($p=0.370$) and enhancement ($p=0.262$). Patients with diffused plaque length had larger penumbra volume comparing with the focal one in PP group ($Z=-2.754$, $p=0.005$).

CONCLUSION

Plaque with eccentric distribution in MCA is a remarkable sign to predict the presence of penumbra. Based on the patients with positive penumbra, plaque with diffused plaque length hint the larger penumbra volume, which could be rescued by timely treatment.

CLINICAL RELEVANCE/APPLICATION

Plaque with eccentric distribution in MCA can predict the presence of penumbra area, and plaque with diffused length hint the larger penumbra volume, which could be rescued by timely treatment.

SSK16

Neuroradiology (Functional Neuroimaging)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: E351

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

SSK16-01 Functional Segmentation of Resting-State Brain Networks by Using Mutual Connectivity Analysis with Non-Metric Community Detection Methods

Participants
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PURPOSE

To explore functional network identification using Mutual Connectivity Analysis (MCA) on resting-state functional MRI (rsfMRI) using non-metric community detection (CD) methods.

METHOD AND MATERIALS

We present the MCA computational framework to construct an affinity matrix characterizing mutual nonlinear predictability between each pair of voxel time-series in rsfMRI. The goal of MCA is to establish the degree of dynamic coupling between two time-series based on their ability to locally predict each other. Here, generalized radial basis function neural networks are used as non-linear time-series predictors. To recover their community structure, the resulting affinity matrices are subject to non-metric clustering using different CD approaches, namely the Louvain Method (LM), Agglomerative Clustering (AC) and Topographic Mapping of Proximity (TMP). We test our method on rsfMRI (1.5T, TR=0.5s, TE=40ms, 512 acquisitions) of four subjects, in which images from a finger tapping motor stimulation task were acquired as well. After pre-processing with motion correction and time-series detrending, recovered networks were compared with the localization aid from the motor stimulation task by computing the Dice Coefficient (DC) and the Area Under receiver operator characteristic Curve (AUC) in order to quantitatively evaluate the agreement between actual and recovered motor cortex network segmentations.

RESULTS

All three non-metric CD methods were able to recover bilateral motor cortices and the supplementary motor area with DC values of 0.57 (LM), 0.50 (AC), and 0.60 (TMP), respectively. High segmentation quality was confirmed by AUC values of 0.79 (LM), 0.86 (AC) and 0.85 (TMP), where statistically significant differences between the CD methods in their ability to perform functional motor cortex segmentation were not observed at a $p<0.05$ level.

CONCLUSION

Our results suggest that affinity matrices obtained using the model-free non-linear MCA approach can capture valuable information regarding the underlying brain network functional connectivity structure from rsfMRI data. Using this information, non-metric CD techniques can successfully perform functional segmentation of connected brain regions.

CLINICAL RELEVANCE/APPLICATION

Functional connectivity network identification at a rsfMRI voxel scale resolution using MCA can contribute to developing imaging biomarkers for diagnosis and therapy management of neurologic diseases.

SSK16-02 Functional Connectivity Measured By Functional Resting State MRI in Glioma Patients: Association with WHO Grade and Clinical Parameters

Wednesday, Nov. 28 10:40AM - 10:50AM Room: E351

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PURPOSE

Gliomas diffusely infiltrate the brain. We hypothesized that this could lead to disturbances in functional connectivity. We developed an individual measure for altered functional connectivity and aimed to establish association of this novel marker with aggressiveness of the tumor as indicated by WHO grade and IDH mutation status as well as clinical parameters, specifically neurocognitive performance and overall survival.

METHOD AND MATERIALS

34 patients with de-novo gliomas were prospectively included and resting state functional MRI (rsfMRI) data as well as 3D anatomical reference data were obtained at 3 Tesla. Neurocognition was tested using the Montreal Cognitive Assessment test. We developed a standardized score to evaluate the abnormality of functional connectivity by comparing each patient's data to data obtained from 1000 healthy individuals. Abnormality was quantified at each voxel of the brain, resulting in an individual measure for abnormality (abnormality score, AS). Statistical analysis was conducted adjusting for tumor volume, age and signal-to-noise ratio of the rsfMRI data.

RESULTS

13 patients were diagnosed with WHO grade II tumors, 6 with WHO grade III and 15 with WHO grade IV. 17 patients had IDH1/2-mutations. We found that AS is significantly associated with WHO grade: patients with grade III and IV displayed higher AI than patients with grade II ($p<0.01$), with the strongest association seen in the non-lesional hemisphere ($p=0.0294$). Additionally, AS was significantly increased in patients with IDH-wildtype gliomas, again with strongest effects in the non-lesional hemisphere ($p=0.013$). Neurocognitive performance and AI was significantly correlated, this was most pronounced in the lesional hemisphere. 6 patients died within the follow-up period. We observed a trend towards association of overall survival with AI.

CONCLUSION

AS is a novel method to investigate functional connectivity on an individual basis. Especially in the non-lesional hemisphere, AI is significantly associated with WHO grade and IDH mutation status and correlates significantly with neurocognitive performance. Individual AS maps show the potential of this technique to gain information beyond conventional structural MRI.

CLINICAL RELEVANCE/APPLICATION

AI can detect widespread disturbances in functional connectivity which reach beyond the tumor visible on conventional MRI. AI might therefore be used to assess disease burden in glioma patients.

SSK16-03 Tumor-Induced Functional Reorganization of Language and Voxel-Based Morphometry of the Cortex: A Possible Window on Stemcells-Driven Plasticity

Wednesday, Nov. 28 10:50AM - 11:00AM Room: E351

Awards
Trainee Research Prize - Resident

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PURPOSE

Cortical thickening has been related to the process of learning in humans. fMRI has previously shown functional plasticity in patients with brain tumors. In this study, we retrospectively investigated the correlation between cortical morphometry and fMRI language activation in the non-dominant hemisphere of right-handed patients who have left brain tumors invading the Broca's area. Our aim was to test if tumor-induced language reorganization displayed a corresponding cortical thickening

METHOD AND MATERIALS

Patients with the following criteria were included: right handed, left tumor invading Broca's area, available fMRI, no previous irradiation, no surgery-related artifacts. The patients were divided in 2 groups by language dominance, assessed by hemispheric and Broca's laterality index. In a second analysis, we divided the patients with atypical language dominance by the results of intra-operative direct cortical stimulation of the inferior frontal gyrus. Structural data was analyzed to measure cortical thickness (or volume) with the FSL-VBM (Voxel-Based Morphometry) tool and compared between the groups

RESULTS

26 patients were included (13 left dominant, 13 atypical language dominant). VBM demonstrated a significant thickening of the right Broca's area analogue in patients with atypical language ($p<0.05$). The patients with neurosurgically-proven reorganization showed increased volume of the right hippocampal gray matter ($p<0.05$) and cortical gray matter in SMA and right insula ($p<0.05$)

CONCLUSION

Increased right-side Broca's area activation showed a corresponding cortical thickening. In the adult brain, structural plasticity is driven by the stem-cell located in the periventricular zone and the hippocampal perigranular zone (PGZ). The increased PGZ volume in patients with language reorganization to the right side may suggest that the compensatory increase in fMRI activation and the increased volume of the right language-related cortical structures is mediated by stem cells originating in the PGZ

CLINICAL RELEVANCE/APPLICATION

Our results address the mechanism of tumor-induced language reorganization, which may partly compensate the language deficits, by displaying cortical thickening of the right language areas and PGZ

SSK16-04 Cerebral Perfusion is Altered by Real-Time fMRI Neurofeedback-Directed Self-Regulation of the Primary Auditory Cortex

Wednesday, Nov. 28 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

To determine the effects of real-time functional magnetic resonance imaging neurofeedback training (fMRI-NFT) of the primary auditory cortex (A1) on quantified cerebral perfusion (i.e., cerebral blood flow, CBF).

METHOD AND MATERIALS

18 healthy volunteers with hearing loss <40dB underwent 5 experimental sessions conducted using a 3T MRI. The first session started with a baseline measure of resting CBF using a 3D pseudo-continuous arterial spin labeling sequence. Next, fMRI-NFT was carried out by first implementing a single run of a simple auditory task with blocks of white noise stimulation with no auditory stimulation. Then, 2 runs of neurofeedback were completed where subjects were asked to relax and lower the displayed A1 activity in the presence of continuous white noise. The second, third, and fourth sessions only contained fMRI-NFT. On the fifth session, a final measure of CBF followed fMRI-NFT. A control group consisting of 8 subjects performed the same procedures except sham neurofeedback was yoked from the experimental group. The average deactivation in the target ROI was extracted from each fMRI-NFT run as a representative measure of A1 self-regulation performance. CBF maps were created from the raw ASL data using proton density maps and a single-compartment perfusion model. The CBF maps were registered to a reference space. Permutation testing compared the changes in CBF between groups on a voxel-wise basis using 1,000,000 permutations. The permutation test results were cluster-corrected for multiple comparisons.

RESULTS

A repeated-measures ANOVA revealed significant main effects of group ($p = 0.029$) and training ($p = 0.0175$) on A1 self-regulation performance. Those subjects most successful reportedly adopted mindfulness tasks associated with directed attention. The permutation analysis identified several regions with greater increased CBF in the experimental group including the left temporal lobe, bilateral parietal lobe, and bilateral frontal gyrus.

CONCLUSION

For the first time, changes in resting CBF have been observed following fMRI-NFT. CBF is coupled with metabolic activity and, thus, fMRI-NFT is likely altering resting metabolic rates which could be important in the treatment neurologic disorders such as chronic tinnitus.

CLINICAL RELEVANCE/APPLICATION

Our study indicates that fMRI neurofeedback may provide an innovative approach to augment resting metabolic activity which can be altered in neurologic disorders.

SSK16-05 Investigation of Functional Networks Changes Using Degree Centrality in Heavy Smokers

Wednesday, Nov. 28 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

To investigate the value of degree centrality (DC), a novel resting-state fMRI parameter, in voxel-wise whole-brain functional networks analysis in heavy smokers and mild smokers as compared with that in non-smokers.

METHOD AND MATERIALS

20 heavy smokers, 12 mild smokers, and 70 non-smokers served as normal controls were recruited,aged 20 to 55 years old, with an average (36.8±2.5) years old. Their cognitive functions were evaluated by the fagerstrom test for nicotine dependence(FTND)and other clinical scales. The resting-state BOLD-fMRI datawere acquired and preprocessed. Analysis of DC map changes between the two smoking groups and the control group were performed by two sample t test. (threshold at $P<0.05$).

RESULTS

Compared with the control group, heavy smokers showed significantly reduced DC value in cerebrum, frontal lobe, pons, left posterior cingulate and left brainstem, increased DC value was observed in fusiform gyrus and temporal lobe. In mild smokers,

significantly reduced DC value was found in right superior occipital gyrus, left superior temporal gyrus and right angular gyrus.

CONCLUSION

Changes of DC value occurred in some region of brain in the two smoking groups when compared with the control group. It was indicated that DC, as a novel resting-state fMRI parameter in the voxel-wise whole-brain functional networks, might be an appealing alternative approach for further study on pathologic and neuropsychological states of heavy smokers.

CLINICAL RELEVANCE/APPLICATION

Changes of DC value occurred in some region of brain in the two smoking groups when compared with the control group. It was indicated that DC, as a novel resting-state fMRI parameter in the voxel-wise whole-brain functional networks, might be an appealing alternative approach for further study on pathologic and neuropsychological states of heavy smokers.

SSK16-06 Identification of Eloquent Cortex for Presurgical Planning Using Independent Component Analysis of Resting-State fMRI

Wednesday, Nov. 28 11:20AM - 11:30AM Room: E351

Participants
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PURPOSE

In this study, presurgical patients with brain tumors were imaged. Task activation and resting-state ICA maps for motor and language networks were generated for all subjects and compared for spatial overlap.

METHOD AND MATERIALS

Subjects: 28 subjects undergoing presurgical planning were included in this study (18M/10F; 53 (±15) years old; heterogeneous pathologies, grade IV glioblastoma most common).MRI Acquisition: Task and resting-state fMRI scans were collected using a 3T Philips Ingenia MR scanner. Resting-state EPI parameters: TR/TE/FA = 2s/28ms/90, 64x64 matrix, 3.75x3.75x3.5 mm, 39 slices, 300 timepoints. Resting-state data were collected with eyes closed on all subjects. A single finger-tapping motor task and a verb generation task were acquired for functional activation localization in the motor and language networks, respectively.Data analysis: Motor and language task activation maps were generated using DynaSuite Neuro software (InVivo Diagnostic Imaging), thresholded at 0.05 significance. Resting-state network maps were generated using FastICA. For each subject, the ICA maps with highest spatial correlation with the task activation map were selected as winning network, with secondary components also inspected.Spatial overlap of the activation maps with the resting state networks was calculated. The Dice coefficient of spatial similarity was also calculated.

RESULTS

Testing state maps show good definition of the motor network, in agreement with the task activation maps; the second ICA component in some subjects added additional motor network information.The calculated motor task activation overlap with the resting state network was high across all subjects (0.73±0.14), but the Dice coefficient was low (0.29±0.14), indicating the resting-state networks contain the majority of task activation, but also extend farther spatially. The resting-state language ICA network has a high spatial overlap with the verb task activation (0.83±0.17).

CONCLUSION

Th resulting resting-state maps compared well to task activation maps, with high percent of spatial overlap, without requiring an external task, with both motor and language networks identified from a single resting-state scan.

CLINICAL RELEVANCE/APPLICATION

This work examines identification of eloquent cortex using network identification in resting-state fMRI, which may complement and extend current clinical practice of using task fMRI.

SSK16-07 fMRI Guided Personalization of Cortical Parcellation Maps

Wednesday, Nov. 28 11:30AM - 11:40AM Room: E351

Participants
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PURPOSE

To personalize the 3D cortical parcellation of T1w MRI volumes to increase intra-parcel functional homogeneity by means of co-registered fMRI guidance.

METHOD AND MATERIALS

Inspired by the Demons Algorithm (Med. Image Anal., 2(3), pp 243-260,1998), we propose an iterative 3D deformation of the cortical parcellation map of a given subject, constrained to the cortex, to maximize the pairwise intra-parcel correlation coefficients (CCs) of fMRI BOLD signals (B). The co-registered T1w MRI, fMRI and (148 parcel, P) Destrieux cortical parcellation map are the inputs. The iterations are driven by a vector-field, F(rij), normal to boundary (rij) of Pi and Pj, and zero elsewhere. F is computed according to a local cost that takes into account the change in intra-parcel functional homogeneity and parcel volume change (ΔV). The former uses the CCs between the local signal, B(rij), and the parcel representative signals (Bi, Bj) defined as the in-parcel B that is closest to the left principal singular vector of the matrix composed of parcel's B's. The latter is added with a

multiplicative factor λ. We used FreeSurfer and FSL for all co-registration and parcellation steps. We tested the algorithm on 5 normal subjects for λ=0 and 0.25, by measuring the mean of pairwise CCs between in-parcel B's and the mean B per parcel, before and after the algorithm, for each subject. Statistical significance is assessed with paired t-test of CCs per parcel per subject and mean values over subjects is reported. The mean of subject-wise minimum and maximum parcel volumes (Vmin, Vmax) are reported together with the percentage of parcels with ΔV>20%.

RESULTS

The initial mean intra-parcel CC of 0.43±0.04 was increased to 0.52±0.04 (0.51±0.04) with mean p-value 1.21e-5 (4.50e-5) for λ=0 (0.25). The mean [Vmin/Vmax] (mm3) was changed from [282.8/15747.1] to [592.7/10467.9] ([582.5/11136.8]) with 64% (57%) of parcels having ΔV>20% for λ=0 (0.25).

CONCLUSION

The proposed functionally homogeneizing personalization of cortical parcellations showed a statistically significant improvement in intra-parcel correlations accompanied by a decrease in parcel volume variation. Volume constraint with λ=0.25 does not affect the final intra-parcel CCs while limiting the volume change.

CLINICAL RELEVANCE/APPLICATION

fMRI guided personalization of 3D cortical parcellation maps significantly improves intra-parcel functional homogeneity, and can potentially improve brain network models.

SSK16-08 Sex Differences in Resting-State Cerebral Activity Alterations in Internet Gaming Disorder

Wednesday, Nov. 28 11:40AM - 11:50AM Room: E351

Participants
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PURPOSE

Although evidence has shown that the prevalence rates of Internet gaming disorder (IGD) differ between males and females, no study has examined whether such sex differences extend to brain function. This study aimed to explore the sex differences in resting-state cerebral activity alterations in IGD.

METHOD AND MATERIALS

Thirty male participants with IGD (IGDm), 23 female participants with IGD (IGDf), and 30 male and 22 female age-matched healthy controls (HC) underwent resting-state functional MRI. Maps of the amplitude of low-frequency fluctuation (ALFF) and functional connectivity (FC) were constructed. A two-factor ANCOVA model was constructed using SPM8, with sex (Male, Female) and diagnosis (IGD, HC) as the between-subject factors. When interaction effects occurred, post hoc pair-wise comparisons were performed using two-sample t-tests within the interaction masks. We used the Barratt Impulsiveness Scale-11 (BIS-11) to assess the behavioural inhibition function of the IGD participants. The correlations of the psychological scores with the ALFF and FC values were assessed using partial correlation analyses.

RESULTS

The ALFF values in the orbital part of left superior frontal gyrus (SFG) significantly decreased specifically in IGDm, which were negatively correlated with BIS-11 scores. IGDm also demonstrated lower connectivity between the orbital part of the left SFG and the posterior cingulate cortex, the right angular gyrus, and the right dorsolateral prefrontal cortex than HCm. Furthermore, IGDm had lower seed connectivity between the orbital part of the left SFG and the PCC than ICDf.

CONCLUSION

Our findings suggest that sex-specific regional- and network-level alterations exist in IGD, and the altered ALFF values in the SFG represent a clinically relevant biomarker for the behavioural inhibition function of IGDm.

CLINICAL RELEVANCE/APPLICATION

These neuroimaging findings can provide a comprehensive understanding of the neural basis of the sex-specific alterations in IGD.

SSK17

Physics (MR: Applications)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: E353B

BQ MR 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

SSK17-01 Quantitative Evaluation of Semimembranosus and Vastus Medialis in Knee Osteoarthritis by IDEAL

Participants
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PURPOSE

Iterative decomposition of water and fat with echo symmetry and least-square estimation (IDEAL) imaging has shown potential in assessment of degenerative changes in muscle. The purpose of this research was to evaluate changes in vastus medialis (VM) and semimembranosus (SM) .

METHOD AND MATERIALS

Eighty-one individuals were enrolled for measurement of water and fat IDEAL values in SM and VM. All of whom were divided into Group A consisting of 33 participants with no knee related symptoms, and Group B with 48 participants who had degenerative changes in their knees. IDEAL values of water and fat along with the area of the respective muscle were measured. Each measurement was taken in two different axial sections, the first was measured in the level of the superior border of the patella and second, in the level immediately after the superior border of patella. Independent T test was used to analyse the means of the IDEAL values (p value <0.05)

RESULTS

The IDEAL values for water and fat in VM and SM were greater in Group B with superiority in fat. Means of fat in VM of Group A was 121.56±41.92 and of Group B was 195.92±78.73. Likewise, means of fat in SM of Group A and B were 140.48±43.66 and 222.92±79.7, respectively. The area of VM in Group A and B appeared to have a significant difference rather than SM. Both VM and SM showed significant differences in fat of Group B. (p value=0.00)

CONCLUSION

Water and fat IDEAL values were found to be higher in degeneration group for both muscles with obvious increment in fat. Significant change in the area of VM was observed in degeneration group.

CLINICAL RELEVANCE/APPLICATION

IDEAL can be considered as a useful quantitative method for evaluation of fatty degeneration with severity in knee osteoarthritis.

SSK17-02 Manganese Dioxide-Based Nanoparticles for MR Imaging and Photothermal Anti-Cancer Therapy

Wednesday, Nov. 28 10:40AM - 10:50AM Room: E353B

Participants
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PURPOSE

Facile synthesis a manganese dioxide (MnO2)-based MRI contrast agent and in vivo evaluation of its photothermal breast cancer therapy.

METHOD AND MATERIALS

Bovine serum albumin (BSA)-MnO2-melanin-like-polymernanoparticle (BMD NP) was obtained via KMnO4-initiated in situ dopamine-polymerization induced self-assembly in the presence of BSA, and its size and r1 relaxivity were carefully measured. Mice injected with 4T1 breast cancer for MR imaging were randomly assigned into two groups; BMD NP and control group (DTPA-Gd). Images were acquired before injection and at 30, 60, 90, and 120 min post injection and then signal-to-noise ratio (SNRpost/SNRpre) at the tumor ring were quantitatively calculated. Mice bearing same tumors were randomized into the following four groups; BMD NP with/without photothermal therapy, PBS with/without photothermal therapy as control groups. The tumor sizes were measured and calculated every other day. All animal studies were performed in accordance with the guidelines established by the Institute for Experimental Animals of Zhejiang University.

RESULTS

BMD NP with a diameter of 60 nm and a high r1 relaxivity of 38.14 mM-1 s-1, which was incredibly 9 times higher than those of clinically used (Gd-DTPA). In vivo an obviously SNRpost/SNRpre at the tumor margin showed 1.57 times that of DTPA-Gd at 1h post injection, which provided detailed imaging features for precise diagnosis differentiation. The mice group treated both nanoparticle and irradiation exhibited excellent therapeutic efficacy in comparison the other three groups. The mice injected with BMD NP and irradiated by laser showed complete ablation without recurrence in 20 days, and the tumor-free period up to 60 days.

CONCLUSION

The BMD NP having excellent MRI contrasting capability and PTT efficacy plus its facile synthesis was a very promising theranostic agent for MRI-mediated photothermal anti-cancer therapy.

CLINICAL RELEVANCE/APPLICATION

The BMD NP exhibits MRI contrasting capability and photothermal anti-cancer therapy efficacy, which creates a novel theranostic methodology in evaluation and therapy of breast cancer.

SSK17-03 T1 Mapping for Myocardial Iron Overload in Thalassemia Major (TM) Patients: Time to Replace T2*

Wednesday, Nov. 28 10:50AM - 11:00AM Room: E353B

Participants
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CONCLUSION

T1 is possibly a better biomarker than T2, WB T2* and BB T2* to assess cardiac iron load at 3T.

Background

T2* at 1.5T is a clinically accepted biomarker for assessing cardiac siderosis. Cardiac T2* quantification at 3T is challenging due to increased artifacts & T2* shortening. Studies have shown that there is a linear relationship of T1 & T2 to T2* at 1.5 T & 3T indicating that T1 & T2 are potential alternative biomarkers. However, studies haven't explored the efficiency of these biomarkers in categorizing the severity of cardiac siderosis. In this study, we have explored the performance of T1,T2,white blood (WB) T2* & black blood (BB) T2* in categorizing in-vivo cardiac iron content at 3T.

Evaluation

Myocardial T1,T2, WB T2* & BB T2* maps of 103 patients with TM (age 20.5 ± 13.5 years, 46 females),obtained at 3T MRI scanner (Ingenia,Philips,Netherlands),were retrospectively analysed.The quantitative imaging protocol included ECG gated single breath-hold Modified Look-Locker Inversion recovery sequence for native T1,Double Inversion Recovery (DIR) prepared multi-echo gradient echo BB T2*, DIR prepared GraSE for T2 & multi-echo gradient echo WB T2*.The values were measured by manually selecting ROIs on cardiac septum in a single mid ventricular short axis slice. Patients were categorized based on severity of cardiac siderosis as per WB T2* equivalent values at 1.5T as follows: Normal: > 20 ms, Mild:12 ms - 20 ms, Moderate: 8 ms - 12 ms & Severe: < 8 ms. Tukey test results for significant difference in mean values for Normal, Mild, Moderate & Severe patient groups was performed for each of the four sequences. A p-value of 0.01 was set as significant.

Discussion

Results indicate T1 to be the best biomarker among T1,T2,WB T2* & BB T2* in categorizing the severity of cardiac siderosis at 3T. Studies have shown that there is a linear relationship between T1, T2, WB T2* & BB T2* at 1.5T & 3T. This study shows that T1,T2,WB T2* and BB T2* linearly correlate with each other, confirming that T1 & T2 are potential alternative biomarkers to T2* on 3T. It demonstrates the effectiveness of each of these biomarkers in categorizing the disease severity, of which T1 shows better sensitivity than the others.

SSK17-04 Accurate Bound Water T1 Measurement Using 3D adiabatic Inversion Recovery Ultrashort Echo Time (3D IR-UTE) Imaging with Complete Suppression of Pore Water in Cortical Bone Accurate T1 Measurement of Bound Water in Cortical Bone Using 3D Adiabatic I

Wednesday, Nov. 28 11:00AM - 11:10AM Room: E353B

Participants
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PURPOSE

To accurately measure the bound water T1 of cortical bone ex vivo and in vivo using 3D IR-UTE imaging on a clinical 3T scanner.

METHOD AND MATERIALS

Six human tibia bone specimens (43 to 91 years) and the tibial mid-shaft of five male volunteers (26 to 73 years) were studied. A 3D adiabatic IR-UTE sequence with different TRs and inversion times (TI) was used to accurately calculate the nulling point of pore water in cortical bone at each TR. For the specimens 6 TRs (150, 200, 250, 300, 400, 500ms) were chosen with 7 TIs at each TR to cover the likely nulling points of pore water. For the volunteer study f4 TRs (150, 200, 300, 400ms) were chosen with 5 TIs at each TR. Each IR-UTE acquisition was performed with dual echoes (TE=32μs/2.5ms), flip angle=20°, FOV=8-10cm, slice thickness=4-6mm, reconstruction matrix=128×128, number of slices=10. The equation S=S0[1+(Q-1)×e^(-TI/T1)-Q×e^(-TI/T1)]/(1-Q×cosθ×e^(-TI/T1)) was used to calculate the nulling point of pore water. The specimens and volunteers were then scanned at different TRs using the IR-UTE with the calculated TI for nulling point at each TR. The bound water T1 of cortical bone was calculated from the different TR/TI combinations. The experiments were performed on a 3T MRI system using a 30ml solenoid coil and a 1.5 inch surface coil respectively.

RESULTS

The calculated TIs for nulling were 60.2±3.4ms, 76.3±3.3ms, 91.1±3.5ms, 104.3±3.4ms, 128.5±5.0ms and 148.7±6.5ms for TRs from 150 to 500ms in the specimen group. The mean bound water T1 of the bone specimens was 104.5±6.7ms. For the volunteers the nulling point TIs were 64.2±8.8ms, 81±10.3ms, 121.2±25.2ms and 148.8±28.1ms for TRs from 150 to 400ms respectively. The mean bound water T1 of the volunteer tibias was 98±8.8ms. The figure shows pure bound water and nulled pore water images with excellent inversion recovery fitting (for the pore water nulling time) and bound water T1 fitting in a specimen and a volunteer.

CONCLUSION

Our technique allows accurate determination of bound water T1 by completely nulling pore water signals in cortical bone and the use of variable TR/TI combinations. Measurement of bound water T1 without contamination from pore water has not previously been possible.

CLINICAL RELEVANCE/APPLICATION

Accurate measurement of bound water T1 provides a new biomarker for the assessment of cortical bone integrity and may assist with water fraction mapping and MT modeling in the study of bone diseases such as osteoporosis.

SSK17-05 MRI "Pharmacokinetics" of Gd Deposition: Quantitative Analysis of Serial Monthly Administration of Triple? Dose Gadopentetate Dimeglumine in 26 Multiple Sclerosis Patients Involving 13 Consecutive Monthly Triple-Doses

Wednesday, Nov. 28 11:10AM - 11:20AM Room: E353B

Participants
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PURPOSE

Studies on gadolinium (Gd) deposition and retention in the brain are limited by the lack of systematic administration of Gd inherent to most retrospective studies. Our purpose was to examine subjects who had been enrolled in a prospective trial for monitoring response to MS treatment (Wolansky L et. al. ACTRIMS 2006, Chicago) and received consecutive monthly triple-doses of gadopentetate dimeglumine.

METHOD AND MATERIALS

The cohort consisted of 26 patients who received 13 consecutive monthly triple doses (0.3 mmol/kg) of gadopentetate dimeglumine. 'Plain-T1' MR images were obtained at each monthly visit and studied for potential deposition from the prior month's Gd administration. Subjects were imaged with T1-weighted, proton-density (PD) and T2-weighted MRI at 14 time points (M1, M2 to M14). Gd deposition and retention were studied by evaluating intensity changes over time in the dentate nucleus, pulvinar, putamen, pallidum, caudate and corpus callosum. For each patient, these were manually segmented on the PD and T2 images at M14 and automatically registered to the T1 image at M14 as were the 13 preceding T1 images. Intensities in the sub-cortical structures on the bias-corrected, registered T1 images were then normalized to the mean intensity of the CC using the segmented structures as a mask. Longitudinal trends in Gd deposition and retention over time were evaluated using a Walds Wolfowitz runs test on the median of the normalized intensities over all patients. We also examined the intensity of the corpus callosum normalized

with respect to cerebrospinal fluid (CSF).

RESULTS

The dentate nucleus, caudate and pallidum showed an increasing trend ($p < 0.05$) in normalized intensity with respect to the corpus callosum over the 14 months (0.0055/month, 0.0022/month and 0.0023/month) indicating Gd deposition and retention in these structures with time. Intensity changes in the corpus callosum relative to CSF were not significant.

CONCLUSION

These findings demonstrate the rate of Gd deposition and retention in the brain after triple-dose administration of gadopentetate dimeglumine, monthly, for over a year.

CLINICAL RELEVANCE/APPLICATION

Though not linked with symptoms, Gd deposition in the brain has caused safety concerns. This pharmacokinetic study provides further scientific insight into the rate of MRI detectable deposition.

SSK17-06 The Effect of DCE-MRI Scanning Parameters on Parenchymal Enhancement of the Breast

Wednesday, Nov. 28 11:20AM - 11:30AM Room: E353B

Participants
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PURPOSE

Background parenchymal enhancement (BPE) on breast DCE-MRI is increasingly used in cancer diagnosis, prognosis, and risk assessment. However, BPE, in particular quantitative measures, may be dependent on scanner and protocol, complicating pooling of results across studies. The purpose of this retrospective study was to explore the effect of differences in MRI protocol on parenchymal enhancement of the breast.

METHOD AND MATERIALS

We focused on contralateral parenchymal enhancement (CPE, Radiology 276.3(2015):675-685): CPE is the mean of the top-10% relative late enhancement in the parenchyma without lesions and has been associated with long-term survival. We performed simulations and tested these in four patient cohorts: the effect of flip angle (FA) and repetition time (TR) on CPE was simulated (Haacke, MRM 58.3(2007):463-472), and the effect of voxel size and slice thickness (resulting in differences in partial volume effect) was assessed by subsampling 50 scans from two databases (1.5T and 3T). Verification in clinical cohorts was done by comparing CPE distributions in four MRI cohorts: - cohort 1: 415 early breast cancer patients, 1.5T, FA=20°, TR=8.1ms, voxelsize=1.35x1.35x1.35mm - cohort 2: 100 advanced breast cancer patients, 1.5T, FA=20°, TR=8.1ms, voxelsize=1.21x1.21x1.69mm - cohort 3: 77 advanced breast cancer patients, 3T, FA=10°, TR=4.4ms, voxelsize=1.1x1.1x1.2mm - cohort 4: 150 women without breast cancer, 3T, FA=10°, TR=3.8ms, voxelsize=0.9x0.9x0.9mm

RESULTS

Analysis 1: Larger FA led to higher CPE, e.g. FA=15° at 1.5T yields CPE of 0.47 versus 0.23 at FA=5°. This was comparable at 3T. The opposite was observed for TR: larger TR yielded lower CPE. Analysis 2: Larger voxel size led to a decrease in CPE. Analysis 3: the distributions of CPE were not significantly different between the four cohorts (P=.496, KruskalWallis test) independent of scanner differences. Although FA and TR varied between datasets, the ratio between FA and TR was comparable.

CONCLUSION

We simulated the effect of MRI-protocol parameters on contralateral parenchymal enhancement in breast DCE-MRI. Although effects were present, implications for different cohorts appear to be limited when the ratio between flip angle and repetition time is comparable. This was confirmed by MRI scans of four different cohorts.

CLINICAL RELEVANCE/APPLICATION

Differences in MRI-protocol parameters should be taken into account when pooling parenchymal enhancement across studies.

SSK17-07 Acceleration of MR Imaging of Spine Using Compressed-SENSE: A Comparison with Existing Standard of Care Clinical Acquisition Methods

Wednesday, Nov. 28 11:30AM - 11:40AM Room: E353B

Participants
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PURPOSE

To objectively evaluate the impact of Compressed-SENSE (CSENSE), a novel acquisition technique that combines compressed sensing with parallel imaging (or SENSE), on acquisition time and image quality in MR imaging of the spine.

METHOD AND MATERIALS

Current standard of care clinical axial T1 and T2-weighted acquisitions of the cervical and lumbo-sacral spine were modified to obtain higher acceleration with CSENSE (CSENSE factor 1.3999). Twenty-six patients were scanned both, with and without CSENSE, on a 3.0 T wide-bore MRI (Ingenia, Philips Healthcare). The images were anonymised and shared with three specialist MRI radiologists blinded to the acquisition type. Both sets of images were rated on a scale of 1 to 5 for image quality and delineation of specific structures including vertebral bodies, lateral recess, neural foramina, facet joints, cauda equina, nerve roots, spinal cord and paraspinal muscles. Disc abnormalities, foraminal stenosis, nerve root compression and facet joint degeneration were also rated. Dicom metadata was analysed to assess scan time acceleration (ratio of original time to CSENSE time).

RESULTS

Interrater agreement on image quality was compared between the Normal and CSENSE scans via a multivariate non-parametric Hotelling's T2 test. There was no statistically significant difference between Normal and CSENSE scans in the 12 measures evaluated by each radiologist (alpha < 0.001 level). Further, the mean percentage observed agreement between Normal and CSENSE scans for all three measures across the radiologists was 93%. The average time acceleration achieved using CSENSE on axial T1 was 1.41 and on axial T2 was 1.36 and the average time saved was 58 seconds (29%) and 50 seconds (26%) respectively.

CONCLUSION

There is no difference in image quality between current standard of care and CSENSE-based T1 and T2 axial MRI scans of the spine. Compressed-SENSE in the spine can reliably replace current axial T1 and T2 acquisitions without loss in image quality and with significant reduction in scan time.

CLINICAL RELEVANCE/APPLICATION

The potential for CSENSE to accelerate MRI acquisition without hampering image quality will increase patient throughput and patient compliance in MR scanning.

SSK17-08 Daily Qualitative and Quantitative Assessment of Magnetic Resonance Fingerprinting Using the American College of Radiology and Alzheimer's Disease Neuroimaging Initiative Phantoms

Wednesday, Nov. 28 11:40AM - 11:50AM Room: E353B

Participants
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PURPOSE

Repeatability tests for robust T1/T2 measurements obtained from Magnetic Resonance Fingerprinting (MRF) based on inversion recovery requires approximately 5 hours. The goal of this study was to enable a 10-minute quality assurance protocol for MRF that could be employed on a daily basis prior to clinical studies. This involved investigating qualitative and quantitative measures of data consistency between multiple MRF scans and vendor/manufacturer supplied targets, demonstrated on in vitro Quality Assurance (QA) phantoms

RESULTS

MR signal intensity images for the ACR phantom from the SE and MRF acquisitions indicated similarity in contrast and resolution. The grid features indicated distortion due to gradient warps. The MRF implementation passed the positioning accuracy, ghosting and low contrast detectability as per the ACR guidelines. It failed tests with respect to resolution, slice thickness, geometric accuracy and signal uniformity. Relaxometric maps for the ADNI phantom from vendor supplied standard scans and MRF showed spatial correspondence. ROI analysis indicated variation of values within each ROI to be less than 13.5% whereas the variations in the repeats for each ROI was negligible. This indicated that the precision of measurements (T1) over repeats and spatial distribution of ROI were consistent. The accuracy of the measurements in the ROI varied as indicated significantly (<30% for T2, < 10% for T1) while the corresponding measures over repeats were consistent (< 1%). However, it must be noted that the ADNI phantom is primarily utilized for T1 measurements rather than T2. The MRF scans also involve variations due to the gridding reconstruction (such as the kernel size) of non-Cartesian k-space data. This is expected to impact the resolution, slice thickness and geometry accuracy tests. Incorporation of field maps into reconstruction may mitigate challenges with respect to signal uniformity, specifically in the context of spiral readouts and off-resonance challenges.

CONCLUSION

We have demonstrated a twelve minute QA protocol that could be used on a daily basis to enable measures of repeatability, accuracy and precision. We have utilized a VFA based T1- and FSE based T2-mapping schemes to enable shorter QA acquisition times. Prospective longitudinal data being currently pursued would enable insights into systemic errors and/or robustness of

implementation; thus providing higher confidence in MRF based studies at multiple sites. This is expected to aid in harmonization of MRF data between multiple sites and centers.

METHODS

An MRF implementation with 979 time points, 89 shot variable density spiral with 732 points was implemented on a GE 1.5T scanner. Spin Echo (SE) based structural imaging of the American College of Radiology (ACR) phantom was utilized for qualitative assessment with TR/TE = 500/20ms; 11 slices, 5mm slice thickness, in plane resolution of 1mm x 1mm. For comparison, MRF derived synthetic signal intensity data from the relaxation parameters was utilized. These were compared by two trained medical physicists with experience greater than five years. A 3D Fast Spoiled Gradient Recalled Echo Variable Flip Angle (2o, 5 o, 10 o, 20 o and 30 o) based T1 mapping with TR/TE = 6/1.4ms, 20 slices, 5mm slice thickness; and Fast Spin Echo based T2 mapping with eight echoes with TR/minimumTE = 1000/10ms with an echo spacing of 10.3ms, 20 slices, 5mm slice thickness were performed on the Alzheimer's Disease Neuroimaging Initiative (ADNI) Magphan EMR051 phantom (The Phantom Laboratory, NY) to obtain T1/T2 measurements. These were then compared to corresponding values determined by dictionary matched MRF scans that were repeated 5 times as part of test-retest experiments. Regions-of-interest (ROI) were drawn on specific spheres in the ADNI phantom to assess accuracy and precision of measurements. MATLAB (The Mathworks Inc., MA) based regression analysis was performed on conventionally obtained signal intensity images to determine T1/T2 maps. The total protocol time including the MRF scans was under twelve minutes.

PDF UPLOAD

http://abstract.rsna.org/uploads/2018/18015027/18015027_gi3k.pdf

SSK17-09 Simultaneous Measurement of T1, T2* and Fat Fraction for the Assessment of Non-Alcoholic Fatty Liver Disease

Wednesday, Nov. 28 11:50AM - 12:00PM Room: E353B

Participants
Nicholas Rubert, PhD, Chicago, IL (*Presenter*) Nothing to Disclose
Jie Deng, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

This study assessed the feasibility of measuring T1 and T2* in the livers of patients exhibiting steatosis using a breath-hold dual flip-angle 3D GRE Dixon sequence.

METHOD AND MATERIALS

Imaging was performed on a 1.5T scanner. The proposed sequence consisted of two consecutive acquisitions of a 6-echo 3D GRE sequence with flip angle of 5° then 15°. From the acquisition at 5°, fat fraction (FF) and T2* were estimated at each voxel with a regularized fat-water separation algorithm. T1 of fat and water components of a voxel were then estimated in a separate step. In this step, a non-linear least squares fit of the signals at both flip angles to an equation incorporating sequence TR and fat and water T1 was performed with FF and T2* fixed. Three experiments were used to verify the performance of the algorithm: 1) A non-fat phantom containing nine vials each with different T1 and T2* values, was imaged with an inversion recovery (IR) and the proposed method. Mean T1 in an ROI within each vial was compared between the IR and proposed method. 2) Two healthy volunteers were imaged with the proposed method three times in rapid succession. Mean FF, T2*, and T1 within large ROI's in the livers of the volunteers were compared between acquisitions. 3) Patients with hepatic fat infiltration were imaged with the proposed technique. Mean FF, T2*, and T1 within large ROI's in the livers of the patients were examined.

RESULTS

For the phantom experiments T1 in each of the 9 vials ranged from 353 to 1751 ms according to the IR method. Agreement with T1 by the proposed method was within 10% for all vials. For the repeatability study on healthy volunteers measurements of FF, T2*, and T1 all exhibited coefficient of variations of <6%. Among volunteers and patients, T1 was found to be uncorrelated with FF with R2 < .01 and weakly correlated with T2* with R2 of 0.47. FF in patients ranged from 3.2% to 34.2%, T1 from 342 to 956 ms, and T2* from 17 to 50 ms.

CONCLUSION

The proposed method demonstrates close agreement with IR measurements of T1 in a phantom and highly repeatable measurements among volunteers. T1 was found to yield independent information from either FF or T2* estimated in a routine Dixon imaging sequence.

CLINICAL RELEVANCE/APPLICATION

Liver T1 can be accurately estimated from a single breath-hold GRE MRI sequence when steatosis is present. T1 measurements may be useful for evaluation of inflammation and fibrosis in patients with NASH.

SSK18

Physics (CT: Image Quality)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: E353C

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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John M. Boone, PhD, Sacramento, CA (*Moderator*) Patent agreement, Isotropic Imaging Corporation Consultant, RadSite

Sub-Events

SSK18-01 Quantitative Impact of Denoising Strategies in Low-Dose CT

Participants
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PURPOSE

CT number accuracy at low dose levels has been found to be strongly biased. It was demonstrated that the stochastic noise associated with photon detection is the root cause of inaccurate CT number. The purpose of this work is to investigate the impact of three different denoising strategies to alleviate CT number inaccuracy in FBP-based CT: image domain denoising, sinogram domain denoising and raw counts domain denoising.

METHOD AND MATERIALS

Data acquisition was performed in a benchtop CT system, which included a CdTe-based photon counting detector. A Catphan phantom, containing inserts of known composition, was scanned at 60 kV and two different CTDIw levels: 1.5 and 15 mGy. The acquired data was reconstructed using FBP with ramp filter. Locally adapted denoising diffusion filter was applied to the lowest dose data set, in image, sinogram and raw counts domain. The contrast of Teflon and LDPE inserts was measured in averaged images across repetitions. FBP reconstruction of the average raw counts at the highest dose was considered as reference.

RESULTS

Experimental results from in this study corroborate that CT number estimates are inaccurate at low dose levels. As a consequence, the contrast of inserts relative to the background is overestimated. Particularly, the contrast of the analyzed inserts is doubled in the lowest dose scans. After adapted denoising, only the strategy to perform denoise in the raw counts domain was successful in restoring the reference contrast values.

CONCLUSION

Results in this study suggest that locally adaptive denoising is an adequate methodology to preserve the quantitative accuracy of low dose CT when performed in the pre-log projection domain.

CLINICAL RELEVANCE/APPLICATION

Healthy tissue and disease characterization often rely on both absolute CT number and relative contrast, for example: liver and pancreatic steatosis, acute cerebral venous sinus thrombosis, etc. Dose reduction efforts in CT must be guided by both imaging performance and quantitative capabilities.

SSK18-02 Task-Based Image Quality Assessment of X-ray CT Using Convolutional Neural Networks

Wednesday, Nov. 28 10:40AM - 10:50AM Room: E353C

Participants
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PURPOSE

The purpose of this study is the task-based image quality assessment of X-ray computed tomography.

METHOD AND MATERIALS

A phantom with contrast targets similar to lesions in a contrast enhanced liver (acrylic spheres, varying diameters, +30 HU) was repeatedly scanned with a computed tomography scanner. A board certified radiologist rated image patches containing the contrast targets with a confidence rating for the presence of the signal. Labeled image data were used to build several anthropomorphic model observers to predict the performance of the human observer: A neural network based on softmax regression (SR-MO) and a convolutional neural network (CNN-MO). Results were compared to a more traditional model observer, the channelized Hotelling observer (with Gabor channels and internal channel noise (CHOi)). The performance of the different model observers and the human observer were evaluated with a receiver operating characteristic curve analysis. The machine learning based model observers were trained with two different strategies: A) building a separate model for each lesion size; B) building one model that was applied to lesions of all sizes.

RESULTS

Machine learning based model observers as well as the CHOI and the human observer were highly correlated at each lesion size and dose level. With strategy A, Pearson's product-moment correlation coefficients r were 0.961 (95% confidence interval (CI): 0.863-0.989) for SR-MO and 0.974 (95% CI: 0.907-0.993) for CNN-MO. Mean absolute percentage differences (MAPD) between the model observer and the human observer were 1.1% for SR-MO and 1.0% for CNN-MO. With strategy B, r was 0.956 (95% CI: 0.845-0.988) for SR and 0.958 (95% CI: 0.854-0.989) for CNN. For CHOi, r was 0.971 (95% CI: 0.897-0.992). MAPD were 2.0% for SR-MO and 1.5% for CNN-MO. For the CHOi the MAPD was 1.9%.

CONCLUSION

Machine learning based model observers can accurately predict the performance of a human observer for all lesion sizes and dose levels in the evaluated signal detection task.

CLINICAL RELEVANCE/APPLICATION

Model observers are widely used in research regarding the development and optimization of medical imaging devices. Our results show that machine learning based model observers can accurately predict the performance of a human observer in a signal detection task for CT.

SSK18-03 DestreakNet: A Deep Convolutional Neural Network to Reduce Metal Streak Artifacts in CT Images

Wednesday, Nov. 28 10:50AM - 11:00AM Room: E353C

Participants
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PURPOSE

To design and train a deep convolutional neural network to reduce metal artifacts in CT images.

METHOD AND MATERIALS

Our network structure (DestreakNet) consists of two parallel streams, each with 20 residual units. In each residual unit, there are two convolution layers with batch normalization (BN) and rectified linear unit (ReLU) activation. The network is trained on the residual error between the input and output of the unit. The outputs of both streams are merged in the network's feature space, and then passed through nine more convolution layers to yield a final output. A mean squared error (MSE) and a perceptual loss function were both investigated for network optimization. All training, testing, and validation datasets were generated using CatSim, an industrial-grade CT simulator. Real data from the Visible Human Project were used to create voxelized phantoms of pelvic and spinal regions with and without metal implants. For initial correction, CT images were reconstructed using the state-of-the-art NMAR algorithm. The reconstructed images without metal were the ground truth and target of the network. From full-size images, approximately 150,000 patches of size 56x56 were extracted for training. Patches from the NMAR images were input to one network stream and patches from uncorrected CT images were input to the other to harness complimentary features simultaneously.

RESULTS

To validate the network performance, hip and spine images withheld from training were used. In a hip case, the image quality metrics including structural similarity index (SSIM) and peak signal-to-noise ratio (PSNR) were calculated for all images in reference to the artifact-free truth. The SSIM and PSNR were 0.2382 and 9.1830, respectively, for the initial uncorrected reconstruction image, 0.7014 and 18.8975 for the NMAR-corrected image, 0.8636 and 23.8582 for DestreakNet with MSE loss, and 0.8264 and 22.1685 for DestreakNet with perceptual loss.

CONCLUSION

Our network substantially reduced metal streak artifacts that remained in the CT image after initial correction by the NMAR algorithm.

CLINICAL RELEVANCE/APPLICATION

Our proposed data-driven metal artifact reduction method may provide sufficient image quality in radiation therapy planning, which requires accurate tumor characterization near implants for precise dose delivery.

SSK18-04 Patient-Specific Local Noise Power Spectrum Measurement via a Deep-Learning Generative Adversarial Network

Wednesday, Nov. 28 11:00AM - 11:10AM Room: E353C

Participants
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PURPOSE

With the increased use of low-dose CT techniques which are characterized for its highly shift-variant noise properties, the measurement of the noise power spectrum (NPS) has become challenging and time consuming since current solutions require multiple scans of a given clinical scenario. In this work, a deep-learning generative adversarial network (GAN) was developed to address this challenge and provide a fast and accurate way to measure patient-specific local NPS.

METHOD AND MATERIALS

GANs were utilized to learn a mapping from white noise input to output CT noise realizations with correct CT noise correlations from a single local uniform ROI. To achieve this, a two-stage training strategy was implemented. In the pre-training stage, repeated scans of a quality assurance phantom were performed to extract 1600 (64x64) local MBIR noise-only images used as labels to train the network. This network characterized the noise magnitude and correlation in labels and was able to generate 64x64 noise-only images with similar characteristics as the input. For the next stage, a single scan of an anthropomorphic phantom was used for fine-tuning, while repeated scans were used for validation. First, a 101x101 ROI was extracted from a single MBIR image, detrended, and augmented to obtain 128 (64x64) training labels and fine-tune the pre-trained GANs. To validate the GAN-generated noise images, their NPS was compared to the NPS from the physical ensemble of repeated scans in terms of overall RMSE, noise magnitude, and mean frequency across 30 trials. This patient-specific approach was applied to clinical data reconstructed with MBIR (same patient at two doses) to assess the estimated NPS in terms of noise magnitude and coarseness.

RESULTS

The overall RMSE between the GAN-generated NPS and the physical NPS was 0.83 HU2mm2. The mean percent discrepancy for their noise magnitude and mean frequency were 4.51% and 3.62%, respectively. The runtime for the fine-tuning stage was <100s and 1s to generate 250 noise images.

CONCLUSION

It was demonstrated that GANs can characterize CT noise in terms of magnitude and coarseness and generate multiple noise realizations with comparable characteristics from a single noise realization.

CLINICAL RELEVANCE/APPLICATION

A fast and accurate way to estimate patient-specific local NPS was provided and can be easily adapted to any given CT system. This is an essential step towards patient-specific image quality assessment.

SSK18-05 Multi-Kernel Synthesis for CT Images Using a Deep Convolutional Neural Network

Wednesday, Nov. 28 11:10AM - 11:20AM Room: E353C

Awards
Trainee Research Prize - Fellow

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PURPOSE

To produce a single synthetic image that combines the best qualities of images reconstructed with different kernels using a deep convolutional neural network (CNN).

METHOD AND MATERIALS

A CNN was trained from scratch to synthesize multiple input images, each produced with a different reconstruction kernel, into a single output image that exhibits improved image qualities (in terms of high sharpness and low noise levels) compared to each input individually. The CNN architecture was based on the ResNet design, and consisted of repeated blocks of residual units with a total of 32 convolutional layers. The CNN inputs consisted of three images produced by soft (B10), medium-sharp (B45), and sharp (B70) kernels that were stacked in the channel dimension. The CNN output was treated as a perturbation that was added to the sharp-kernel input, which reduced the required training time. The network was trained using supervised learning with both full-dose and simulated quarter-dose abdominal CT images. The simulated quarter-dose images obtained from different kernels were used as the

network input, and the corresponding full-dose images reconstructed with a sharp kernel were used as the ground truth to evaluate a mean-squared-error loss function. The network was trained on 500,000 example images of various sizes that were cropped from ten abdominal CT exams. After training, the performance was evaluated by comparing input and output images using a reserved set of full-dose abdominal, chest, and phantom CT scans that were not used in the network training.

RESULTS

The synthetic images improved the signal-to-noise ratio by 338% compared to the sharp kernel images, without observable blurring of sharp edges. No perceptible artificial texture was introduced that detracted from the natural appearance of the synthetic image. The algorithm was robust enough to be applied to multiple tissue types, including the bones, lungs, and liver.

CONCLUSION

An artificial neural network can be used to combine images from multiple reconstruction kernels into a single synthetic image that exhibits both low noise and a high degree of sharpness.

CLINICAL RELEVANCE/APPLICATION

CT Images from different reconstruction kernels can be merged using a neural network into a single image with superior qualities that can be used for reading multiple tissue types simultaneously.

SSK18-06 Correlation Between 2D Channelized Hoteling Observer in a Uniform Water Background and Human Observers in a Patient Liver Background for Low-Contrast Lesion Detection and Localization in CT

Wednesday, Nov. 28 11:20AM - 11:30AM Room: E353C

Participants
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PURPOSE

To investigate the correlation between 2D channelized Hoteling observer (CHO) performance in a uniform water background (with single-slice viewing mode) and human observer (HO) performance in a patient liver background (with multi-slice scrolling viewing mode) for a low-contrast liver lesion detection and localization task when lesion location is uncertain.

METHOD AND MATERIALS

Seven routine dose abdominal patient scans (mean CTDIvol 12.6 mGy) were retrospectively collected. Patient scans at half and quarter of routine dose were simulated using a projection-based noise insertion tool. An abdomen-sized water phantom was repeatedly scanned (n = 10) on the same scanner. Lesion models generated from real metastatic liver lesions (size 7, 9 and 11 mm, and contrast 15, 20, and 25 HU) were inserted into both phantom and patient images using a projection-based method. CT images were created using filtered-back-projection (FBP) and iterative reconstruction (IR). Region-of-interests (ROIs) around lesions were extracted to generate trials for CHO and HO studies. Centers of the ROIs were shifted to randomly distribute lesion locations in the ROIs. A 2D CHO with 12 Gabor channels was applied to phantom images. Two subspecialized radiologists (10 and 25 years of experience) performed HO studies on patient images. For each trial, they localized lesions by scrolling through multiple slices. The performance of CHO and HO was compared across 12 experimental conditions with varying dose, lesion characteristics, and reconstruction types. Area under the receiver operating characteristic (ROC) curve and localization ROC curve were used as figure of merits for CHO and HO performance.

RESULTS

2D CHO performance in phantom images correlated well with HO performance in patient liver images (Pearson correlation coefficients 0.960 ($p = 0.0023$) and 0.984 ($p = 0.0004$) for detection and localization, respectively) for all conditions . No statistically significant difference was observed in Bland-Altman agreement analysis.

CONCLUSION

It is possible to use a simple single-slice viewing CHO and uniform water phantom to assess performance for realistic CT detection and localization tasks in patient liver backgrounds.

CLINICAL RELEVANCE/APPLICATION

Single-slice 2D CHO with Gabor channels provides a convenient tool to evaluate diagnostic performance and optimize abdominal CT scanning protocols.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Michael L. Wells, MD - 2017 Honored Educator

SSK18-07 Can Deep Learning Unseat Iterative Reconstruction for Low-Dose CT?

Wednesday, Nov. 28 11:30AM - 11:40AM Room: E353C

Participants
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PURPOSE

Although widely applied in clinical practice, studies have reported that iterative reconstruction (IR) alters image appearance, and can adversely affect low contrast lesions. The purpose of this project is to systematically compare commercial/clinical iterative reconstructions by major vendors with FBP-reconstruction-based deep learning (FBP-DL) reconstruction for low-dose chest and abdomen CT exams.

METHOD AND MATERIALS

Our study included 80 low-dose chest and abdomen CT exams from three major CT vendors (de-identified). We created a neural network including 4 convolutional and 4 deconvolutional layers, each of the layers contains 32 filters except for the last layer with only 1 filter. For preserving image features, former feature-maps were reused at latter layers by three conveying-paths. The rectified linear unit was used for each layer. The network was optimized in the Wasserstein generative adversarial network framework with an additional perceptual loss. 128K normal- and low-dose FBP image patches from the MGH dataset were used in training our network. Image quality metrics including peak signal-to-noise ratio (PSNR) and structural similarity index (SSIM) were calculated for all the images in reference to the normal-dose FBP images. Also, a blinded reader study was designed to evaluate the image quality. Then, the Wilcoxon signed-rank test was used to compare FBP-DL with commercially available state-of-the-art IR techniques.

RESULTS

FBP-DL achieves a significantly better image quality and performance than commercially available IR images evaluated by PSNR and SSIM for all the selected vendors. Also, the reader study demonstrated that FBP-DL images had superior visibility of small and subtle structures with lower noise and less severe artifacts as compared to the IR counterparts. In addition to that, deep learning is computationally more efficient than IR.

CONCLUSION

The deep learning method has a great potential to outperform the commercial/clinical iterative reconstruction for low-dose CT. An integrated deep learning workflow from raw data to final images/radiomics is under active development.

CLINICAL RELEVANCE/APPLICATION

Emerging deep learning-based CT methods may provide a superior diagnostic performance in routine clinical applications.

SSK18-08 Reference-Based Image-Detail and Noise Texture Metrics for CT Image Quality Assessment

Wednesday, Nov. 28 11:40AM - 11:50AM Room: E353C

Participants
Sathish Ramani, Niskayuna, NY (*Abstract Co-Author*) Employee, General Electric Company
Lin Fu, PhD, Niskayuan, NY (*Abstract Co-Author*) Employee, General Electric Company
Bruno De Man, PhD, Niskayuna, NY (*Presenter*) Employee, General Electric Company

PURPOSE

Task-based image quality metrics are the gold-standard in evaluating and comparing the performance of imaging algorithms. Nevertheless, algorithm designers still benefit from lower-level more direct metrics reflecting the actual image presentation. Traditional noise and spatial resolution metrics are coming short for non-linear iterative reconstruction approaches. This work proposes quantitative metrics for separately assessing object-detail, artifact-level and noise texture based on a gold-standard reference.

METHOD AND MATERIALS

A phantom constructed from a freshly-cut turkey was scanned 117 times at 120 kV and 200 mA. FBP images were reconstructed and averaged over the scans to obtain a noise-free reference image Z, from which a noisy sinogram S was simulated. Model-Based Image Reconstruction (MBIR) images at varying regularization strengths, ß, were reconstructed from S. For an MBIR-image M, the object-detail metric was computed as a normalized covariance between M and Z. Artifact metric was computed as the normalized energy of the difference between M and its geometric-projection along Z. Histogram and spectral density shapes of the residue R=M-Z, were used to assess noise texture.

RESULTS

With increasing ß, noise decreased in M at the expense of loss of image features: the object-detail metric monotonically decreased correspondingly. Artifact metric exhibited a minimum and increased either way due to high noise at low ß or loss of image features at high ß. Histogram of R evolved from being broad with long tails (high noise at low ß) to being narrow (nearly no noise at high ß). The spectral density of R evolved from exhibiting high-frequency behavior (high noise at low ß) to being predominantly low-frequency in nature (noise with long spatial correlation at low ß).

CONCLUSION

The proposed metrics captured expected behavior of MBIR at varying strengths indicating their validity. These metrics can be helpful in judging preservation of image features and evaluation of artifact-level and noise texture for CT algorithm development and tuning.

CLINICAL RELEVANCE/APPLICATION

CT iterative reconstruction was introduced a decade ago and is continuing to be improved. The proposed image quality evaluation methods are useful for algorithm designers to achieve the best possible tuning of CT algorithms before clinical deployment.

SSK18-09 Task Based Image Quality in Virtual Monoenergetic Images Across 3 Generations of Scanner Models

Wednesday, Nov. 28 11:50AM - 12:00PM Room: E353C

Participants
Jayasai R. Rajagopal, BA, Durham, NC (*Presenter*) Nothing to Disclose
Yakun Zhang, MS, Durham, NC (*Abstract Co-Author*) Nothing to Disclose
Juan Carlos Ramirez-Giraldo, PhD, St Louis, MO (*Abstract Co-Author*) Employee, Siemens AG
Ehsan Samei, PhD, Durham, NC (*Abstract Co-Author*) Research Grant, General Electric Company; Research Grant, Siemens AG; Advisory Board, medInt Holdings, LLC; License agreement, 12 Sigma Technologies; License agreement, Gammex, Inc

For information about this presentation, contact:

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PURPOSE

To use task-based metrics to assess the impact of patient size, beam spectra separation, and radiation exposure on image quality for virtual monoenergetic images (VMIs) across three scanner platforms.

METHOD AND MATERIALS

This study used a commercially available phantom with iodine, soft tissue and calcium inserts (Gammex Multi Energy CT phantom). The phantom was configured with additional fat rings simulating five different sizes (20, 30, 35, 40, and 50 cm diameter). All scans used radiation exposures of 4, 8, 16, and 24 mGy, and were repeated on three DECT platforms from one manufacturer (Siemens Force, Flash and Edge). VMIs were reconstructed at 50, 70 keV and 150 keV. Noise and image texture in terms of average frequency of the noise power spectra (Favg) and the contrast-dependent spatial resolution in terms of the 50% amplitude of the iodine-task transfer function (F50) were calculated. A task-specific detectability index (d') was calculated for iodine inserts using a 5 mm Gaussian circular disk as the task.

RESULTS

The Favg and F50 decreased with increasing phantom size. For 100/150Sn kV on Force scanner, Favg was 0.31, 0.30, 0.27, and 0.25 mm^{-1} for the 20, 30, 35, 40 cm sizes; F50 was 0.43, 0.43, 0.37, 0.32 mm^{-1}, respectively. For the same phantom size, the Favg appeared to be insensitive to changes in acquisition spectra separations, but F50 increased with increasing spectra separation. Different keVs did not affect either Favg or F50, but affected the noise magnitude and contrast, and thus the detectability index. d' for the 15 mg/ml iodine insert had an average of 23% increase for all sizes and kV combinations when keV decreased from 70 to 50. At 70 keV, the larger spectra separation (80/150Sn kV) led to an increase in d' compared to less spectra separation (100/150Sn kV) at round 10% for the 20 and 30 cm phantoms, but only 3% higher d' for the 35 and 40 cm phantoms. For a fixed keV, image contrast, Favg, and F50 were relatively insensitive to changes in radiation exposure for sizes below 40cm.

CONCLUSION

The system behaved non-linearly for different phantom sizes and spectra separation. Task based metrics was able to capture the characteristics of the VMIs. Highest detectability was achieved with larger spectra separation and for smaller sizes.

CLINICAL RELEVANCE/APPLICATION

Highest iodine detectability for the VMIs was achieved with larger spectra separation and for smaller sizes.

SSK19

Science Session with Keynote: Radiation Oncology (Outcomes, Palliation, Sarcoma)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: S504AB

RO

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

FDA Discussions may include off-label uses.

Participants
Carryn Anderson, MD, Iowa City, IA (*Moderator*) Nothing to Disclose
Edward Y. Kim, MD, Seattle, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSK19-01 The Safety and Efficacy of Interstitial 125I Seeds Implantation Brachytherapy for Metastatic Epidural Spinal Cord Compression

Participants
Chaojie Li, MD, Shanghai, China (*Presenter*) Nothing to Disclose

PURPOSE

To investigate the safety and efficacy of 125I seeds interstitial implantation for metastatic epidural spinal cord compression (MESCC) and the life quality of the patients.

METHOD AND MATERIALS

From April 2009 to May 2015, 28 patients who met the inclusion criteria were retrospectively reviewed. The number of 125I seeds implanted ranged from 7 to 62 with specific activity of 0.5 to 0.8 mCi. The post-plan showed that the tumor matched peripheral dose (MPD) were 80-140 Gy. Follow-up ranged from 1 to 32 months with a median of 18 months. Visual analogue scale (VAS), karnofsky performance scale (KPS) and motor performance were measured before and after treatment.

RESULTS

All patients tolerated seed implantation well. All patients were obviously alleviated pain. VAS scores of patients decreased from 4.89±1.52 before treatment to 1.61±1.20 after treatment, and KPS scores increased from 73.93±12.27 to 86.76±10.90, both differences were statistically significant($P<0.05$). The 1-, 2-, 3- year local control rates were 77%, 34%, and 14%, respectively, with a median of 19 months (7-32 months). The 1-, 2-, 3- year survival rates were 81%, 54%, and 14%, respectively, with a median of 25 months. 7(100%) nonwalking patients regained motor ability. No myelopathies or other neurologic sequelae were encountered.

CONCLUSION

Interstitial 125I seeds implantation brachytherapy was a promising local therapy and an alternative and palliative way to treat MESCC.

CLINICAL RELEVANCE/APPLICATION

To investigate the safety and efficacy of 125I seeds interstitial implantation for metastatic epidural spinal cord compression (MESCC) and the life quality of the patients.

SSK19-02 Cancer-Related Anxiety Following Definitive Treatment of Localized Prostate Cancer: A Population-Based Cohort Study

Wednesday, Nov. 28 10:40AM - 10:50AM Room: S504AB

Awards
Student Travel Stipend Award

Participants
Dominic Moon, MD, Chapel Hill, NC (*Presenter*) Nothing to Disclose
Ram Basak, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
Deborah Usinger, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
Sarah Walden, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
Ronald Chen, MD, Chapel Hill, NC (*Abstract Co-Author*) Consultant, Accuray Incorporated

PURPOSE

Psychological distress following localized prostate cancer treatment is not well-understood. We assessed cancer-specific anxiety post-treatment and factors associated with increase in anxiety level.

METHOD AND MATERIALS

Population-based prospective cohort of newly diagnosed localized prostate cancer patients were enrolled from 1/2011 to 6/2013. A

total of 838 patients who received definitive treatment with radical prostatectomy (RP) or radiotherapy (RT) were analyzed. Patients with recurrence after treatment were excluded. Cancer-related anxiety one year post-treatment was assessed using the validated Memorial Anxiety Scale for Prostate Cancer (MAX-PC) questionnaire, which consists of 3 subscales: recurrence anxiety, PSA anxiety, and prostate cancer anxiety. Multivariable linear regression assessed factors associated with anxiety.

RESULTS

Median age was 64 and 74% were White. In this cohort, 53%, 25%, 11%, and 11% of patients received RP, conventional RT, stereotactic body RT, and brachytherapy, respectively. Multivariable analysis showed that White men had lower recurrence anxiety, PSA anxiety, and prostate cancer anxiety than non-White men (all $p<0.001$), while older men had less PSA anxiety and prostate cancer anxiety compared to younger men ($p=0.002$ and $p=0.001$, respectively). Patients with high risk prostate cancer had increased recurrence anxiety than those with low risk disease ($p=0.04$). Compared to men receiving RP, those receiving brachytherapy and conventional RT had borderline significant increase in recurrence anxiety and PSA anxiety, respectively (both $p=0.05$). Frequency of post-treatment PSA testing and last PSA value were not associated with level of anxiety.

CONCLUSION

White men and older patients overall had less cancer-related anxiety, while high risk patients had increased recurrence anxiety.

CLINICAL RELEVANCE/APPLICATION

Better understanding of factors associated with prostate cancer-related anxiety may aid in counseling patients to improve psychological well-being after definitive treatment.

SSK19-03 Evaluation of Prognostic Factors of Bone Metastasis Treated By Radiotherapy: A Single-Institution Experience

Wednesday, Nov. 28 10:50AM - 11:00AM Room: S504AB

Participants
Nana Shimoyachi, Kanazawa, Japan (*Presenter*) Nothing to Disclose
Tomoyasu Kumano, Ishikawa, Japan (*Abstract Co-Author*) Nothing to Disclose
Shigeyuki Takamatsu, MD, PhD, Kanazawa, Japan (*Abstract Co-Author*) Nothing to Disclose
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Takayuki Sakurai, Kanazawa, Japan (*Abstract Co-Author*) Nothing to Disclose
Yoko Taima, MD, Kanazawa, Japan (*Abstract Co-Author*) Nothing to Disclose
Sae Miyashita, Kanazawa, Japan (*Abstract Co-Author*) Nothing to Disclose
Toshifumi Gabata, MD, PhD, Kanazawa, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

We investigated the prognostic factors of bone metastases treated by radiotherapy and evaluated the efficacy of prognostic scoring systems in our institution.

METHOD AND MATERIALS

Between April 2011 and December 2016, 288 patients were evaluated (median age, 64 years). The median follow-up period was 11months. The common primary lesion was lung cancer (22%), liver cancer (12%) and prostate cancer (10%). We investigated the overall survival (OS) for all patients using Kaplan-Meier Method and the verification of prognostic prediction using Katagiri score and number of risk factor method (NRF). Katagiri score is scoring system using 6 factors; primary site, metastasis other than bone, poor PS, previous chemotherapy, multiple bone metastasis and abnormality of laboratory data. On the other hand, NRF uses only 3 factors; non-breast cancer, metastases other than bone, and KPS =2). Also, we analyzed factors (gender, age, primary lesion, PS, multiple bone metastases, previous chemotherapy, metastasis other than bone) by a multivariate analysis using the Cox proportional hazards model.

RESULTS

The OS rate for all patients was 42% at 1 year and median survival time was 9 months. In Katagiri score, 190 patients could be scored. The OS rate after 1 year was 79% for low risk (score0-3) and 51% for intermediate risk (score4-6). The OS rates for high risk (score7-10) after 6 months and 1 year were 43% and 19%, respectively. In NRF, all patients could be scored. Patients with a prognostic score of =3, the survival rate was 37% at 6 months, and only 18% at 1 year. Both Katagiri score and NRF, the significant differences are recognized between each all three groups. A multivariate analysis showed the significant prognostic factors for PS, primary lesion, previous chemotherapy, metastasis other than bone. Our results don't contradict the factors of previous studies.

CONCLUSION

We could investigate significant prognostic factors in our institution and show the validity of the prognostic scoring system previously reported.

CLINICAL RELEVANCE/APPLICATION

We could investigate the significant prognostic factors for radiotherapy of bone metastases and show the validity of the prognostic scoring systems (Katagiri score and number of risk factor method).

SSK19-05 Radiation Oncology Keynote Speaker: Sarcoma Keynote

Wednesday, Nov. 28 11:10AM - 11:20AM Room: S504AB

Participants
Matthew B. Spraker, MD, PhD, Saint Louis, MO (*Presenter*) Nothing to Disclose

SSK19-06 Planar and SPECT/CT Imaging in Human Immunodeficiency Virus (HIV) Subjects Diagnosed with Kaposi Sarcoma Using Intravenous 99mTc-tilmanocept

Wednesday, Nov. 28 11:20AM - 11:30AM Room: S504AB

Participants
Frederick O. Cope, PhD, Dublin, OH (*Abstract Co-Author*) Employee, Navidea Biopharmaceuticals, Inc; Stockholder, Navidea Biopharmaceuticals, Inc
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Rachael Hershey, Dublin, OH (*Abstract Co-Author*) Nothing to Disclose
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David Ralph, PhD, Dublin, OH (*Presenter*) Nothing to Disclose
Ahmad Ismail, Dublin, OH (*Abstract Co-Author*) Nothing to Disclose
Izabela Gierach, Dublin, OH (*Abstract Co-Author*) Nothing to Disclose
Michael Blue, MD, Dublin, OK (*Abstract Co-Author*) Nothing to Disclose
Matthew Haynam, Dublin, OH (*Abstract Co-Author*) Nothing to Disclose
Hannah Bailey, Dublin, OH (*Abstract Co-Author*) Nothing to Disclose
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Kieron Leslie, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
Spencer C. Behr, MD, Burlingame, CA (*Abstract Co-Author*) Research Grant, General Electric Company Consultant, General Electric Company Consultant, Navidea Biopharmaceuticals, Inc Grant, Navidea Biopharmaceuticals, Inc
Toby Maurer, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To demonstrate Kaposi Sarcoma (KS) lesion imaging by planar and SPECT/CT of cutaneous and subcutaneous KS-associated lesions using 99mTc-tilmanocept (TCT). Such imaging may augment current clinical and biopsies evaluation of KS patients.

METHOD AND MATERIALS

In previous work, we confirmed that Tumor-associated Macrophages (TAMs) and KS cells express the macrophage mannose receptor (CD206), which is the receptor target for TCT. Here we present the first results from a Phase I open-label, dose escalation clinical study of TCT imaging in KS patients. Four subjects with biopsy confirmed cutaneous KS lesions (3 HIV+) were administrated 100 µg of tilmanocept radiolabeled with 5 mCi of 99mTc by intravenous injection (IV) followed by planar and SPECT/CT imaging of areas of interest. Images were acquired at 60 to 75 and 150 to 210 minutes post-injection and were visually cross-examined for uptake in cutaneous and presumably subcutaneous lesions.

RESULTS

IV injection of TCT was well-tolerated. No drug-related adverse events were observed. Uptake on SPECT/CT images was observed in cutaneous lesions of the feet and lower legs as well as suspected subcutaneous lesions of the same regions. All SPECT/CT images were compared to the photographs of KS lesions and other targeted areas of the body taken prior TCT administration. Overall, SPECT/CT imaging revealed highly specific TCT localization in the KS-affected area. Some of the results showed presumptive TCT localization in lymphatic vessels along legs.

CONCLUSION

Results suggest that TCT is a valuable immunodiagnostic agent for imaging of cutaneous and presumably subcutaneous KS lesions. The results shows that this method would improve the accuracy of disease staging in KS patients. TCT imaging may also contribute to monitoring the efficacy of KS therapies.

CLINICAL RELEVANCE/APPLICATION

This is a first attempt of merging TCT imaging data of cutaneous and presumably subcutaneous sites of KS-associated lesions in HIV subjects diagnosed with KS-lesions tissues biopsy results obtained from pathology labs and external medical evaluation of the lesions. Currently, TCT is a first highly specific immunodiagnostic agent, which was proven to support KS evaluation without drug-related adverse events.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Spencer C. Behr, MD - 2017 Honored Educator

SSK19-07 Impact of Lymph Node Dissection and Surgical Margins on Survival Outcomes for Definitive Local Surgery in the Setting of Stage IV Soft Tissue Sarcoma of the Extremity at Presentation: An NCDB Analysis

Wednesday, Nov. 28 11:30AM - 11:40AM Room: S504AB

Awards
Student Travel Stipend Award

Participants
Mustafa Abugideiri, MD, Atlanta, GA (*Presenter*) Nothing to Disclose
Jeffrey Switchenko, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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Robert Press, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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Madhusmita Behera, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
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Pretesh Patel, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

For select patients with stage IV soft tissue sarcoma of the extremity (STSE), definitive surgery to the primary site (SP) is a treatment option as per NCCN and other modalities, such as radiotherapy (R), chemotherapy (C), and metastasectomy (M) can be added to the treatment regimen. We sought to compare the oncologic outcomes of such patients treated with SP in the National Cancer Data Base (NCDB).

METHOD AND MATERIALS

In the NCDB, patients with stage IV STSE who received SP from 2004-2014 with complete treatment records were identified. Survival distributions were estimated using the Kaplan-Meier method and compared using log-rank tests. Covariates were compared using chi-squared tests or ANOVA.

RESULTS

1,291 patients met entry criteria. 5-yr overall survival (OS5) was best for patients treated with metastasectomy (SP+M+/-C+/-R) at 31.4% compared to 20.7% for those treated with other non-surgical adjuvant therapies (SP+C, SP+R, SP+C+R) and 16.2% following SP alone (p<0.0001). Patients with adipocytic tumors had the best OS5 at 29.4% with a median OS of 2.4 years (p=0.0003). On multivariable analysis (MVA), higher Charlson-Deyo score trended with inferior OS (HR 1.20 [95% CI: 0.99-1.45], p=0.07). Patients with well-differentiated tumors had better OS (HR 0.40 [95% CI: 0.17-0.93], p=0.033). 17% of patients had lymph node sampling and this was associated with improved OS (HR 0.75 [95% CI: 0.59-0.94], p=0.014) on MVA. In addition, 27.4% of patients had positive surgical margins, and this was associated with worse OS (HR 1.56 [95% CI: 1.29-1.88], p<0.001). Tumors greater than 10-15cm (HR 1.69 [95% CI: (1.26-2.27) p<0.001) and tumors >15cm (HR 2.04 [95% CI: (1.53-2.73) p<0.001) were predictive for worse OS compared to tumors less than 5cm.

CONCLUSION

In this analysis of a national cancer database, negative surgical margins and lymph node dissection were both associated with prolonged overall survival in patients with stage IV STSE undergoing resection of the primary sarcoma. Metastasectomy was also associated with longer survival is this group. These hypothesis generating data warrant further study.

CLINICAL RELEVANCE/APPLICATION

Surgeons should consider lymph node dissections and re-resections for positive margins in patients with stage IV STSE undergoing resection of the primary sarcoma as both associated with prolonged overall survival. Metastasectomy was also associated with longer survival is this group.

SSK19-08 Radiomic Models of Pathological Markers of Sarcoma, Including Grade and Translocation Status

Wednesday, Nov. 28 11:40AM - 11:50AM Room: S504AB

Awards
Student Travel Stipend Award

Participants
Kevin C. Ball, DO, Milwaukee, WI (*Presenter*) Nothing to Disclose
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Daniel S. Hippe, MS, Seattle, WA (*Abstract Co-Author*) Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company; Research Grant, Canon Medical Systems Corporation; Research Grant, Siemens AG
Landon Wootton, PHD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Robert Ricciotti, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Jose G. Mantilla, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Jan C. Peeken, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Stephanie E. Combs, MD, Heidelberg, Germany (*Abstract Co-Author*) Research Grant, Schering-Plough Corporation Advisory Board, Schering-Plough Corporation Speaker, Schering-Plough Corporation
Edward Y. Kim, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Matthew J. Nyflot, PhD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Soft tissue sarcomas (STS) are traditionally classified by tumor grade, and recently more complex pathologic markers such as translocation status have become of interest. Radiographic correlates may help determine tumor grade and detect targetable mutations, and radiomic features have been correlated to pathologic markers in other tumor types. We examined associations between radiomic features extracted from magnetic resonance images (MRI) of sarcoma with tumor grade and translocation status.

METHOD AND MATERIALS

A retrospective analysis of 199 patients (age>14 years) with histology-confirmed STS was performed. 30 radiomic features (histogram, Haralick, neighborhood difference, and zone size features) were extracted from T1-weighted contrast-enhanced MRI in the tumor volume. FNCLCC grade and translocation status were determined by expert pathologist review. Associations between patients who were grade 1+2 vs 3 and patients with translocation vs no translocation with radiomic features were investigated using univariate logistic regression. P-values were adjusted for multiple comparisons via permutation-based stepdown (A=0.05 for each feature).

RESULTS

101 patients (51%) had grade three STS, and 52 patients (26%) had known translocation. Patients with translocated tumors were younger (42 vs 56 years, p<0.001) with lower grade tumors (p<0.001). Before adjustment, 4 variables were associated with translocation status and 14 radiomic variables were associated with tumor grade. After adjustment, no features were significantly associated with translocation status but 3 features retained significant association with tumor grade (variance, odds ratio [OR]: 0.6, p=0.045; dissimilarity, OR: 0.6, p=0.002; and contrast OR: 0.6, p=0.035).

CONCLUSION

These results suggest translocation-driven STS occur more frequently in younger individuals and are associated with lower grade tumors. Radiomic features examined were not associated with translocation status but were significantly associated with FNCLCC tumor grading of STS. The results suggest radiomic-pathologic models might provide value for patient management in sarcoma in the future.

CLINICAL RELEVANCE/APPLICATION

Radiomic analysis of conventional imaging modalities may elucidate noninvasive sarcoma biomarkers that complement current classification systems.

SSK19-09 A Radiomics Model for Preoperative Metastasis Prediction for Soft-Tissue Sarcomas

Wednesday, Nov. 28 11:50AM - 12:00PM Room: S504AB

Participants
Wenzhe Zhao, Xian, China (*Presenter*) Nothing to Disclose
Xin Huang, Xian, China (*Abstract Co-Author*) Nothing to Disclose
Yiming Wang, Xi an, China (*Abstract Co-Author*) Nothing to Disclose
Wang Yuan, Shaanxi, China (*Abstract Co-Author*) Nothing to Disclose
Jianxin Guo, Xian, China (*Abstract Co-Author*) Nothing to Disclose
Jian Yang, Xian, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To develop and validate a radiomics model based on multimodality images (PET, CT, T1-weighted and T2-weighted MRI) for the early evaluation of the metastasis risk in patients with soft-tissue sarcomas (STSs).

METHOD AND MATERIALS

In this retrospective study, a total of 51 patients with histologically confirmed STSs and clinically followed up for the metastasis were enrolled. Among the 51 patients, 35 were selected randomly as the primary cohort to build the prediction model, while the remaining 16 patients were used to test the prediction power of model. A total of 474 radiomics features were extracted from the single modality image for each patient. Feature selection was performed in 3 steps using Mann-Whitney U test, intra-class Spearman Rank Correlation test and Least absolute shrinkage and selection operator (LASSO) regression. Radiomics signature was developed based on each single modality images or their combinations. Delong test was used to detect the difference levels between the different radiomics signatures. The performance was assessed in discrimination of area under the curve (AUC) and clinical utility using 4-fold cross-validation.

RESULTS

The AUC for radiomics signatures in the primary cohort based on CT, T1-weighted MRI, T2-weighted MRI and PET individually was 0.71, 0.70, 0.80 and 0.73, respectively. In contrast, the AUC for the validation cohort based on CT, T1-weighted MRI, T2-weighted MRI and PET individually was 0.75, 0.82, 0.83 and 0.73, respectively. The combination of the radiomics signatures from CT, T2-weighted MRI and PET images improved AUC, with the optimal performance reached AUC of 0.87 for the training cohort, as well as 0.88 for the validation cohort. Besides, P<0.05 from Delong test showed significant differences between the combination of CT, MRI and PET and others. In addition, decision curve analysis confirmed the clinical usefulness of the multimodality model.

CONCLUSION

A radiomics model, based on CT, T2-weighted MRI and PET images improves the accuracy for the early evaluation of the metastasis risk in patients with STSs.

CLINICAL RELEVANCE/APPLICATION

The non-invasive radiomics model combining CT, T2-weighted MRI and PET images could be used to predict metastasis risk in patients with STSs.

SSK20

Vascular Interventional (Ablation)

Wednesday, Nov. 28 10:30AM - 12:00PM Room: E353A

IR VA

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

FDA Discussions may include off-label uses.

Participants
D. T. Johnson, MD,PhD, South San Francisco, CA (*Moderator*) Speaker, Surefire Medical, Inc; Consultant, Surefire Medical, Inc; Advisory Board, Bristol-Myers Squibb Company; Speaker, BTG International Ltd; Advisory Board, Boston Scientific Corporation; Advisory Board, Merck & Co, Inc; Advisory Board, Dova Pharmaceuticals

Sub-Events

SSK20-01 MIRA Study: Microwave versus Radiofrequency Ablation of Hepatocellular Carcinoma - A Randomized Trial

Participants
Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Presenter*) Nothing to Disclose
Lena-Maria Klohmann, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose
Tatjana Gruber-Rouh, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
Renate M. Hammerstingl, MD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
Yousef Jaraysa, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose
Nour-Eldin A. Nour-Eldin, MD,PhD, Frankfurt Am Main, Germany (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To prospectively determine and compare therapy response and safety of microwave (MWA) ablation and radiofrequency ablation (RFA) of hepatocellular carcinoma (HCC) in a randomized trial.

METHOD AND MATERIALS

In this prospective study 50 patients (39 males/11 females; mean 64 years; range 42-82; SD 9.98) underwent CT-guided thermal ablation: 25 received RFA and 25 MWA. Using MRI the location of the HCC and changes in size, volume, necrotic area, diffusion and ADC value in the malignant tissue were evaluated. First MRI control took place before treatment with thermal ablation. The follow-up contained MRI controls 24 hours after ablation and then within 12 months in 3-month intervals.

RESULTS

50 HCC lesions with a mean diameter of 2.05 cm (range 0.62-5 cm: MWA 2.22 cm, RFA 1.84 cm) were treated with thermal ablation. The mean volume 24 hours after ablation was 49.2 cm3: 69.9 cm3 for MWA and 28.3 cm3 for RFA. Complete ablation was recorded in 94.0% (47/50): 100% (18/18) in the MWA group and 88.0% (22/25) in the RFA group. Local recurrence rate wihtin one year for both groups was 6.0% (3/50) and local recurrences were only documented in the RFA group. The recurrence rate for new malignant formations occurred at the control MRI 6 months after the ablation. 12.0% (6/50) of the patients underwent thermal ablation before taking part in this trial, 14% (7/50) again recieved a treatment with thermal ablation in other segments of the liver while being part of this trial. The mortality rate for this trial amounted to 8% (4/50): 4% (1/25) for the MWA group and 12% (3/25) for the RFA group. The survival rate after one year for both groups ws 92%: 96% for the MWA group and 88% for the RFA group. Major complications were not noticed.

CONCLUSION

The first data of the MIRA trial document no significant differences in mortality or complication rates between RFA and MWA. The study shows that thermal treatment with MWA generates greater ablation volumes. 1-year follow-up of the MWA group shows a lower rate of local recurrences and the 1-year survival rate is a little higher.

CLINICAL RELEVANCE/APPLICATION

MWA provdes greater ablation volume versus RFA with a lower rate of local recurrences.

SSK20-02 MR-Guided High Intensity Focused Ultrasound (MRgFUS) For the Treatment of Oligometastatic Prostate Cancer Bone Metastasis: Can Sound Waves Downstage Cancer Spread?

Wednesday, Nov. 28 10:40AM - 10:50AM Room: E353A

Awards
Student Travel Stipend Award

Participants

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PURPOSE

With improvements in diagnostic modalities such as functional imaging, oligometastatic prostate cancer is being diagnosed with greater frequency than ever before. Our aim was to determine MRgFUS ability to downstage patients with oligometastatic bone disease with single session of non-invasive metastasis-directed therapy.

METHOD AND MATERIALS

The study was designed with intention-to-treat metastatic bone lesions. Patients were enrolled if they had accessible bone metastasis and could safely undergo MRgFUS (InSightec, Israel). Baseline measurable characteristics included dynamic contrast enhanced MRI study (Gd-BOPTA, Bracco; GE 750 3T magnet) with semiquantitative perfusion analysis, PSA level (ng/ml) and choline PET (SUV). Measurable variables were obtained at treatment time, 3 months, 12 months, 24 and 36 months follow-up.

RESULTS

23 patients fulfilled the inclusion criteria and safely underwent MRgFUS procedure of metastatic bone ablations. Lesions were located in the pelvis (13), scapula (4) and long bones (6). At baseline all lesions showed a significant DCE perfusion (highly vascular) with mean perfusion reduction of 88% at 3 months follow-up (CI: 100-50; $p<0.001$) stable at subsequent follow-up scans. Similarly PSA levels decreased from a mean baseline of 19 (ng/ml) to 7.1, 2.9, 2.1 and 1.9, at 3-12-24 and 36 months respectively. SUV values showed similar trend with reduction from baseline (mean 8.9 to 3.0, 2.3, 1.7 and 1.3: $p<0.001$). In all patients single MRgFUS session was appropriate without any major or minor adverse events reported.

CONCLUSION

MRgFUS is a totally non-invasive procedure that can obtain nearly complete bone ablation in patients with oligometastatic prostate disease. The technique features a radiation-free approach that can be of incremental value in long-survivor subset on oncological patients, significantly reducing risk of toxic effects.

CLINICAL RELEVANCE/APPLICATION

MRgFUS could be routinely introduced as a treatment option for oligometastatic bone disease non responding to conventional treatment.

SSK20-03 Modified ABLATE-Score (mABLATE): A Specific Nephrometric Score to Predict Complications and Relapses in Percutaneous Cryoablation of Renal Lesions

Wednesday, Nov. 28 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

RENAL ed mRENAL scores have been validated on predicting adverse events and relapses in percutaneous treatments of renal lesions. However these scores remain of surgical origin. The aim of this work is to obtain a specific score (mABLATE) to quantify the risk of complications and relapses in percutaneous kidney ablation procedures

METHOD AND MATERIALS

Taking inspiration from the paper 'AJR 2014;202:894-903' with some changes based on our practical experience, a score was built trying to take into account the real difficulties faced in percutaneous treatment of renal lesions(Fig.1) .The mABLATE was retrospectively assessed on 60 cryoablations to evaluate its predictive value for complications (all procedures) and relapses (malign histology). Logistic regression was used to predict complication incidence;Cox regression was used for relapses;ROC analysis was used to evaluate the accuracy of the three different scores

RESULTS

Among 60 renal lesions treated with cryoablation technique we experienced 3 bleedings with anemia(5%), 2 of them treated with angiographic embolization(3%). Among 51 lesions with malignant histology (MH) we experienced 7 relapeses(13.7%) between 2 and 17 months from treatment,with a mean FU of 19,3 months. Mean MH RENAL score: 7.2pts. Mean relapsed RENAL score: 7.71pts. Mean MH mRENAL score: 7.26. Mean relapsed mRENAL score: 8pts. Mean MH mABLATE score: 4.98. Mean relapsed mABLATE score: 8.07pts. The Cox regression analysis for Renal ($p=0.35$) and mRENAL ($p=0.29$) showed a lack of predictive value for relapses.On the contrary the mABLATE score was found to be an independent predictor of relapses(HR 1,56; $p=0,001$).The predictive accuracy based on the ROC analysis of the mABLATE showed an AUC of 89.1%(vs 61,5% for mRENAL and 58,8% for RENAL).In the logistic regression analysis none of the three scores showed statistic significance in predicting complications($p>0.05$),likely due to the small number of adverse events

CONCLUSION

The mABLATE score showed to be a better predictor of relapses than RENAL and mRENAL. All three scores showed a lack of statistic significance in predicting complications likely conditioned by the small number of complications occurred in our population.

CLINICAL RELEVANCE/APPLICATION

At the moment surgical (RENAL) or surgical modified (mRENAL) scores are used to quantify risks in percutaneous kidney ablations; a specific score (mABLATE) better performs in this task.

SSK20-04 Image-Guided Radiofrequency Hyperthermia-Enhanced Local Chemotherapy of Hepatic Tumors: The Underlying Molecular Mechanisms

Wednesday, Nov. 28 11:00AM - 11:10AM Room: E353A

Participants
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PURPOSE

To investigate the treatment effects and mechanisms of image-guided radiofrequency hyperthermia (RHF)-enhanced interventional chemotherapy of hepatic tumors.

METHOD AND MATERIALS

This study included two portions: (1) in-vitro experiments with VX2 tumor cell lines for establishing 'proof-of-principle' of the innovative concept; and (2) in-vivo experiment using rabbit models with orthotopic hepatic VX2 tumors to validate the feasibility of the new interventional technique. VX2 cell lines and animals were randomly assigned to four treatment groups (n=6/group): (i) combination therapy with 5-μM Doxorubicin plus RFH; (ii) Doxorubicin-only; (iii) RFH-only; and (iv) saline. Viability and doxorubicin uptake and distribution, as well as proliferation rate of VX2 cells, were evaluated using flow cytometer, fluorescence microscopy, and MTS assay, while potential molecular mechanism via the heat shock protein (HSP70) pathway was investigated using western blot and immunohistochemistry.

RESULTS

Of in-vitro experiments, microscopy showed an increased doxorubicin concentration in tumor cells, which correlated to significantly higher HSP70 expression in combination therapy (1.28±0.13), compared to other control treatments (0.15± 0.03, 0.64± 0.13, 0.83± 0.10, $p<0.05$). Of in-vivo experiments, immunohistochemistry staining demonstrated a significant increase of HSP 70-positive signaling (1.47±0.13) in combination therapy, compared to the control treatments, as verified in western blot analysis as well (0.16±0.04, 0.51±0.13, 0.74± 0.11, $p<0.01$). In addition, a significant increase of tumor apoptosis and necrosis was found in combination therapy in comparison to other controls with Ki-67 and TUNEL staining ($p < .001$).

CONCLUSION

Image-guided interventional RFH-enhanced local chemotherapy can effectively eradicate hepatic tumors, via the molecular mechanisms of activating HSP70 pathway, as well as enhancing the doxorubicin penetration and tumor apoptosis, which thus inhibits tumor growth and prevents tumor metastasis efficiently. This technical development may open the new avenues for effective treatment of malignancies, not only in the liver but also in other solid organs through the integration of image-guided interventional oncology, RF technology, and direct intratumoral therapies.

CLINICAL RELEVANCE/APPLICATION

An underlying way and its mechanisms to enhanced doxorubicin effects in tumor margin after RFA.

SSK20-05 Early Assessment of Post-Radiofrequency Ablation with CT Perfusion Imaging in Rabbit VX2 Liver Tumor

Wednesday, Nov. 28 11:10AM - 11:20AM Room: E353A

Participants
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PURPOSE

To evaluate the diagnostic potential of CT perfusion, and assess the characteristics of the quantitative parameters for discriminating the residual/recurrent tumors from the benign periablational enhancement (BPE) after radiofrequency ablation (RFA) in the rabbits liver VX2 tumor models, with pathological results as the standard.

METHOD AND MATERIALS

This protocol was approved by the Institutional Animal Care and Use Committee at our institution. Twenty-eight VX2 tumor were

This protocol was approved by the Institutional Animal Care and Use Committee at our institution. Twenty-eight VX2 tumor were implanted into the livers of 28 rabbits by the laparotomy method, then were treated with RFA while confirmed the existence of tumors by enhanced CT. On days 1, 3, 7, 14 after RFA, seven animals were randomly chosen for CT perfusion. Pathology exam was performed immediately after the completion of post-RFA CT perfusion. The perfusion parameters were observed both in BPE and residual/recurrent tumors, including blood flow (BF), blood volume (BV), time to peak (TTP), permeability (P), hepatic arterial perfusion (ALP), portal vein perfusion (PVP) and hepatic perfusion index (HPI), along with the profile of time-density curves (TDCs) and pseudo-color images of parameters, and compared with the pathology results.

RESULTS

26/28 rabbits successfully underwent CT perfusion while 6/26 lesions were confirmed to be residual/recurrent tumors. The TDCs of BPE were mainly speed-up curves(15/26), whereas were speed-up-speed-down (3/6) and speed-up-platforms (2/6) types in residual/recurrent tumors. The PVP values of BPE were significantly higher than residual/recurrent tumors in all the different time groups, and the HPI values were significantly lower in BPE than in residual/recurrent tumors ($P < 0.01$). These characteristics of CT perfusion parameters were consistent with the pathological changes.

CONCLUSION

The TDCs and PVP and HPI parameters have the potential to indicate BPE and residual/recurrent tumors effectively in the early postoperative RFA treatment. Thus it can be seen that CT perfusion has more advantages, with greater efficacy in monitoring therapeutic effect response early after RFA treatment.

CLINICAL RELEVANCE/APPLICATION

To evaluate the diagnostic potential of CTP as an appropriate and timely postoperative radiographic evaluation in monitoring RFA efficacy

SSK20-06 TACE plus RFA versus Surgical Resection for Single 3 to 5 Cm HCC: Propensity Score Matching Analysis

Wednesday, Nov. 28 11:20AM - 11:30AM Room: E353A

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PURPOSE

To compare long-term therapeutic outcome for single nodular 3-5 cm HCC between transcatheter arterial chemoembolization with radiofrequency ablation (TACE+RFA) and surgical resection (SR).

METHOD AND MATERIALS

139 patients treated with SR and 60 patients treated with TACE+RFA were enrolled. Long term therapeutic outcomes including local tumor progression (LTP), intrahepatic distant recurrence (IDR), disease-free survival (DFS), and overall survival (OS) rates were evaluated between two groups before and after propensity-score matching. Major complications and length of hospital stay were also investigated.

RESULTS

1-, 3-, and 5-year LTP rates were 1.8%, 3.9%, and 8.1% in TACE+RFA and 4.3%, 8.1%, and 9.3% in SR, respectively ($P = .444$). 1-, 3-, and 5-year IDR rates were 6.7%, 31.7%, and 41.6% in TACE+RFA and 14.4%, 38.0%, and 51.3% in SR, respectively ($P = .188$). 1-, 3-, and 5-year DFS rates were 88.1%, 65.3%, and 49.0% in TACE+RFA and 84.2%, 58.2%, and 46.5% in SR, respectively ($P = .446$). 1-, 3-, and 5-year OS rates were 95.0%, 73.5%, and 54.0% in TACE+RFA and 97.1%, 87.4%, and 75.0% in SR, respectively ($P = .055$). After matching ($n = 52$), there was no difference in therapeutic outcomes between groups ($P = .349$, $P = .127$, $P = .253$, $P = .878$, respectively). SR showed higher complication rates and significant longer hospital stay than TACE+RFA ($P = .015$ and $P < .001$).

CONCLUSION

TACE+RFA may be a feasible treatment for single 3-5 cm HCC with comparable therapeutic outcomes with SR and more efficiency in terms of hospital stay.

CLINICAL RELEVANCE/APPLICATION

Before and after matching, there were no significant differences in long-term therapeutic outcomes between TACE plus RFA and SR groups. Therefore, TACE plus RFA may be an alternative treatment for single 3-5 cm HCCs with an expectation of similar outcomes.

SSK20-07 Outcomes of Thermal Ablation versus Surgery for Hepatocellular Carcinoma

Wednesday, Nov. 28 11:30AM - 11:40AM Room: E353A

Participants
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PURPOSE

To compare outcomes of radiofrequency ablation (RFA) and cryoablation (CRA) versus surgical resection for hepatocellular cancer (HCC).

METHOD AND MATERIALS

The National Cancer Database was analyzed for HCC diagnosed from 2004-2015. Patients treated with thermal ablation, comprising RFA and CRA, or surgical wedge/segmental resection were included. Exclusion criteria were radiotherapy, age <18, and unknown survival status. Patients were 1:1 propensity score matched to account for confounders. In the matched cohort, duration of hospital stay, 30d unplanned hospital readmission, 30d/90d survival and 3-month postoperative overall survival were compared.

RESULTS

The study included 17,091 patients; 10,092 received RFA (59%), 243 CRA (1.4%) and 6,756 surgery (39.6%). Caucasian race, Medicare insurance, higher income, higher comorbidity indices, lower tumor stage, and treatment at academic centers were associated with an increased likelihood of thermal ablation. The matched cohort comprised 6,212 patients, 3,106 treated with thermal ablation and 3,106 with surgery, and demonstrated a balanced distribution of confounders. In the matched cohort, postoperative outcomes were superior for thermal ablation: hospital stay was short (mean 2.5d vs. 67d, p<0.001) and unplanned readmission low (2.9% vs. 4.9%, p=0.006). Mortality (30d/ 90d) was lower for thermal ablation (0% vs. 3.8%; 0% vs. 7.5%; each p<0.001). Three-month postoperative survival was superior for thermal ablation versus surgery (HR=0.75, 95% CI: 0.61-0.91, p=0.003). No significant difference was evident comparing postoperative outcomes of RFA to CRA (mean hospital stay 2.5d vs. 2.3d, p=0.96; unplanned hospital readmission rate 2.6% vs. 2.7%, p=1; 3 month postoperative survival HR= 1.41, 95% CI: 0.58 - 3.5, p=0.466).

CONCLUSION

Thermal ablation provides superior short-term outcomes to surgical resection of HCC with shorter hospital stay, lower unplanned readmission rates, and superior 3-month postoperative survival. Prospective randomized trials contrasting both modalities are warranted to assess whether this advantage translates into comparable long-term survival.

CLINICAL RELEVANCE/APPLICATION

For treatment of HCC, thermal ablation provides superior short-term outcomes compared to surgical resection, including shorter hospital stay, fewer readmissions and improved 3-month overall survival.

SSK20-08 Combined Local Thermal Ablation and Chemoembolization in Irresectable or Recurrent Intrahepatic Cholangiocarcinoma, Impact on Local Tumor Control and Overall Survival

Wednesday, Nov. 28 11:40AM - 11:50AM Room: E353A

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PURPOSE

To retrospectively evaluate the combined role of local thermal ablation and transarterial-chemoembolization in cases of irresectable or recurrent intrahepatic choloangiocarcinoma.

METHOD AND MATERIALS

Retrospective analysis for 30 patients with CCC from Januar 2007 till December 2017, in which 11 males (36.7 %) and 19 (63.3 %) females with mean age 59.2 years (25-86) with either irresectable (20/30, 66.66%) or recurrent lesions (10/30, 33.33%) managed by at least three sessions of TACE (3-26, mean 9) with local thermal ablation for overall 65 lesions with mean size 21 mm (10-74) with either laser (4/65, 6.2%), radiofrequency (8/65, 12.3%) or microwave (53/65, 81.5%) devices, with mean ablation time (8 minutes /1-27 min.) and mean Watt 640 (45-2095) at mean treatment duration 17.5 months (2-88 months). Follow up using CEMRI to evaluate local tumor control based on modified Response Evaluation Criteria for Solid Tumors (mRECIST) and the survival was evaluated using Kaplan-Meier method.

RESULTS

The mean survival was 33.4 months (CI: 22.7-44.2). The initial local tumor response following 3 TACE was 10% stable (SD), 80% partial response (PR), 10 % progressive (LR) and 0% complete remission (CR). The final effect was 13.3% SD, 16.7% PR, 63.3% LR and 6.7% CR. Local lesion response following thermal ablation was either complete resolution of the targeted lesion in 39/65 lesions (60%) or incomplete response at 26/65 (40%). Two patients (2/30 = 6.6%) developed local non-life threating complications following thermal ablation.Significant correlation has been found between the size of the targeted lesion and the response with better results at diameter ranging from 10-50 mm. However no significant correlation was found between the device type or the amount of watt used and the ablation outcome.

CONCLUSION

Combined targeted local liver therapy has a potentiality to provide a therapeutic option for irresectable or recurrent cholangiocarcinoma and may affect the overall patients' survival as well with better local results for smaller ablated lesions.

CLINICAL RELEVANCE/APPLICATION

Combined TACE and local Ablation therapy of irresectable or recurrent CCC provide the potentiality for local tumor control and improvement of survival rates.

SSK20-09 MRI-Guided High Intensity Focused Ultrasound in the Treatment of Osteoid Osteoma: Long-Term Outcomes

Wednesday, Nov. 28 11:50AM - 12:00PM Room: E353A

Awards
Student Travel Stipend Award

Participants
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Andrea Leonardi, MD , Roma, Italy (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate clinical and radiological long-term outcomes after non-invasive radiation-free ablation of osteoid osteoma with MRI-guided high intensity focused ultrasound (MRgFUS).

METHOD AND MATERIALS

50 patients with clinical and radiological diagnosis of osteoid osteoma eligible for MRgFUS and anaesthesia, were enrolled in this dual-centre prospective observational study. Osteoid osteomas with vertebral location were excluded as considered inaccessible. MrgFUS was performed using InSightec ExAblate 2100 system. Safety, clinical effectiveness and durability of treatment were evaluated in terms of rate of complications, Visual Analogue Scale (VAS) pain score reduction and stability of results over time, respectively. Tumour control (nidus ablation) at dynamic contrast enhanced MR imaging (Discovery 750, GE; Gd-BOPTA, Bracco) was considered as secondary outcome. All patients underwent a minimum follow-up period of 5 years.

RESULTS

Out of 55 subjects screened for recruitment, 50 were eligible to treatment and underwent to MRgFUS. A complete and durable response was achieved in 80% of cases at 5-years follow-up. Median VAS pain score dropped from 8 (IQR 7-9) to 0 at 1-week, and at all subsequent follow-up check points (1 month, 1 and 5 years). Also scores evaluating interference of pain with sleep, physical and daily activities showed similar improvement after treatment. Among subjects with partial response (20%), 5 received a second treatment (3 with CT-guided Radiofrequency Ablation, 2 with MRgFUS), and 5 did not need any other treatment. All re-treated patients achieved 0 VAS score. Overall, 87% of patients after MRgFUS treatment reached and maintained a stable 0 VAS score during follow-up. At 5-year MRI osteoid osteoma showed no vascularization in 36/47 patients (77%) treated with MRgFUS alone.

CONCLUSION

MRgFUS is a safe, effective and durable option in the treatment of non-spinal osteoid osteoma.

CLINICAL RELEVANCE/APPLICATION

This technique provides relevant advantages in the treatment of this impairing disease affecting mostly young population: no ionizing radiation, no incisions or needles, and, so far, no complications. Our results demonstrate the clinical and radiological long-term resolution of MRgFUS which should be the first-line treatment option for accessible osteoid osteoma.

SSM01

Breast Imaging (Interventional Techniques and Path Correlation)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E351

BR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
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Sub-Events

SSM01-01 Cryoablation as a Primary Treatment of Low-Risk Breast Cancers: An Interim Update of the Ice 3 Trial

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E351

Participants
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PURPOSE

The Ice 3 Trial is the first of its kind large scale multi center trial in the world to assess image guided cryoablation as a primary treatment for breast cancer without surgical lumpectomy. We report updated interim results and important imaging findings.

METHOD AND MATERIALS

This HIPPA compliant and IRB approved trial seeks enrollment of between 150 and 200 patients for cryoablation of low risk carcinoma of the breast. The study is limited to female patients ages 60 and over with biopsy proven primary, unifocal cancer. Cancers must measure 1.5cm or less with tumor prognostic panels that are ER+/PR+ or ER+/PR-and HER 2-. All patients underwent ultrasound guided cryoablation using the IceSense 3 system (IceCure Medical). Following local anesthesia, patients underwent a freeze, thaw, freeze cycle of cryoablation with the goal of a visible ice ball producing at least a 10mm margin of ice around the tumor. Patients will be followed for recurrence with mammography at 6 and 12 months and then annually for 5 years. Additional imaging with MRI or Ultrasound may be utilized as needed but is not a requirement. All patients have the option of post cryoablation chemotherapy, hormone therapy and or radiation therapy as clinically indicated. Patients will not undergo surgical lumpectomy following cryoablation.

RESULTS

A total of 157 patients have been treated with since enrollment began in October 2014 at 17 participating centers across the United States. Patients ranged from 60-90 years of age. Tumor sizes ranged from 3 to 15mm. No serious adverse events were reported. There has been 100% procedural success. All patients have had at least 6 months follow up. 78 patients have had at least 24 months follow up. 24 patients have had at least 36 months follow up. There has been no recurrence in 156/157 patients with at least 6 months follow up (99.4% success rate). Common imaging findings include fat necrosis, scarring and a mammographic "halo" effect.

CONCLUSION

Cryoablation of the breast is safe and well tolerated with a 100% initial procedural success rate. The overall clinical success rate for 157 patients with at least 6 months follow up is 99.4%. Long term results are also promising.

CLINICAL RELEVANCE/APPLICATION

Interim results suggest that cryoablation is a safe and effective primary treatment for women with small low risk breast cancers as an alternative to surgical lumpectomy.

SSM01-02 Do Eligibility Criteria for Ductal Carcinoma in Situ (DCIS) Active Surveillance Trials Identify Patients at Low Risk for Upgrade to Invasive Carcinoma?

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E351

Participants
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PURPOSE

Due to concerns regarding overtreatment of ductal carcinoma in situ (DCIS), randomized controlled trials are currently underway in the United States and Europe to determine the safety and efficacy of active surveillance versus usual care for women with DCIS. The purpose of this study is to determine upgrade rates of DCIS at core needle biopsy to invasive carcinoma at surgical excision among women who meet eligibility criteria for three active surveillance trials.

METHOD AND MATERIALS

In this IRB-approved and HIPAA-compliant study, a retrospective review was performed of consecutive female patients diagnosed with DCIS at vacuum-assisted core needle biopsy from 2007 to 2016. Medical records were reviewed for mode of presentation, imaging findings, core biopsy pathology results, and surgical outcomes. DCIS cases were classified based on eligibility criteria for the COMET, LORD, and LORIS Trials. Of note, eligibility for the LORIS Trial also requires real-time central pathology review with features not routinely reported and thus not captured in this retrospective study.

RESULTS

Over a ten-year period, 1378 patients were diagnosed with unilateral DCIS at core biopsy and 12 were diagnosed with bilateral DCIS, for a total of 1390 patients (mean age 57, range 27-89) with 1402 cases of DCIS. 79.8% (n=1119) were detected on screening mammography. 17.3% of cases (n=243) were low nuclear grade, 47.2% (n=662) were intermediate nuclear grade, 26.2% (n=368) were high nuclear grade, and 9.2% (n=129) were unreported. The overall upgrade rate to invasive disease was 19.1% (268/1402). 485 were eligible for the COMET Trial, 163 for the LORD Trial, and 489 for the LORIS Trial. The rates of upgrade to invasive carcinoma were 12.2% (59/485), 7.4% (12/163), and 12.5% (61/489) for the COMET, LORD, and LORIS Trials, respectively. Of the 69 cases that upgraded to invasive carcinoma, 31.9% (n=22) upgraded to microinvasive disease (less than or equal to 1 mm) and 91.3% (n=63) were node-negative.

CONCLUSION

The upgrade rates for women with DCIS who meet eligibility criteria for active surveillance trials range from 7.4 to 12.5%. Of the upgraded cases, nearly one-third were microinvasive disease and more than 90% were node-negative.

CLINICAL RELEVANCE/APPLICATION

The risk of missing occult invasive carcinoma in women eligible for active surveillance trials ranges from 7.4 to 12.5%, and the majority of these cancers have favorable biologic profiles.

SSM01-03 Role of Vacuum Assisted Excision (VAE) in Managing Ductal Atypia Such as Flat Epithelial Atypia (FEA) and Atypical Intraductal Epithelial Proliferation (AIDP)

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E351

Participants
Nisha Sharma, MBChB, Leeds, United Kingdom (*Presenter*) Nothing to Disclose
Isobel Haigh, Leeds, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

It is recognised that surgical excision for B3 lesions is considered over treatment and vacuum excision (VAE) is playing a role in managing these lesions.. In Europe and USA ductal atypia is still treated with surgical excision. In the UK ductal atypia is managed with vacuum excision rather than surgical excision.

METHOD AND MATERIALS

Retrospective audit performed from a prospective database of all B3 lesions identified through the Breast Screening Programme. All cases of pure ductal atypia, including AIDP and FEA were identified from April 2009 to March 2016. The mode of biopsy and upgrade rate were recorded and follow up data obtained until March 2018.

RESULTS

268990 women were screened from April 2009 to March 2016, of which 12434 were recalled to assessment (4.6%). 5582 biopsies were performed of which 688 were B3 lesions (12.3%). Ductal atypias (FEA and AIDP) (excluding papilloma and radial scars with ductal atypias) accounted for 39.8% of the biopsies. 69% (190/274) were managed with vacuum assisted excsion (VAE) and annual mammographic follow-up or routine screening surveillance. 3% (7/190) developed a cancer during surveillance period, of which 4 were in the same quadrant. 13% (35/274) were upgraded to malignancy following VAE and were treated with therapeutic surgery. 2 developed further cancer on surveillance in the same breast. 8% (21/274) had a vacuum excision and a surgical biopsy due to radiological or pathological concern and 14/21 was benign and 7/21 upgraded to malignancy. One case developed cancer in the contralateral breast on cancer follow up. 8% (22/274) had a surgical diagnostic biopsy instead of vacuum excision and 13/22 were benign and 9/22 were upgraded to malignancy. 2% (6/274) did not go on to have either vacuum excision or surgery due to co-morbidities. 2 developed cancer on surveillance. 12/274 (4%) developed malignancy during surveillance period of which 8/274 were in the same breast.

CONCLUSION

Our study shows that managing ductal atypia with vacuum assisted excision (VAE) is a safe alternative to surgical excision as a primary intervention but multidisciplinary review is important to determine if further surgery is required. Vacuum excision allowed 13% of our women to have a therapeutic surgery as preoperative diagnosis of malignancy was made and 69% avoided surgery altogether.

CLINICAL RELEVANCE/APPLICATION

Vacuum assisted excision is a safe alternative to surgical biopsy in managing ductal atypias

SSM01-04 Papillary Breast Lesions Without Atypia Diagnosed by Core Biopsy: Should They Be Surgically Excised?

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E351

Participants
Sarah Dhundass, MD, Saint Cloud, France (*Presenter*) Nothing to Disclose
Pascal Cherel, Saint Cloud, France (*Abstract Co-Author*) Nothing to Disclose
Adriana Langer, MD, Saint Cloud, France (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To evaluate the upgrade rate of benign papilloma without atypia diagnosed after core needle biopsy (CNB) or Vacuum assisted biopsy (VAB) in order to determine whether they should require surgical excision or not.

METHOD AND MATERIALS

Histological results of 15615 biopsy procedures were reviewed from January 2001 to December 2014 in our institution. Sampling methods included large gauge VAB by ultrasonographic (US) or stereotaxic guidance and US guided 14G CNB. A total of 179 papillary lesions without atypia that were diagnosed in 159 women were included: 121 had surgical excision following initial detection and 58 underwent imaging surveillance. Initial histological results were compared to the histological results after surgery or to the follow up findings. Statistical analysis was performed to evaluate the association of clinical and radiological variables with the upgrade rate to malignancy.

RESULTS

After exclusion of patients lost to follow up, 158 lesions have been analyzed. 90 were diagnosed by VAB and 68 by CNB. Surgical excision revealed 7 malignant lesions (6 DCIS and 1 carcinoma). The upgrade rate to malignancy was 4.4%. Among the 42 followed up patients, two necessitated secondary surgery, one of them corresponded to a malignant lesion (45 months after biopsy). The median follow-up period was 30 months (6-93). The upgrade rate was statistically higher in the group diagnosed with CNB 8.9% vs 1.1% in the VAB group ($p=0.042$). Age, history of cancer, size of the lesion, ultrasound and mammographic findings including BIRADS category were not associated with underestimation of malignancy ($p>0.05$).

CONCLUSION

Papilloma without atypia detected with VAB could not require surgery (upgrade rate 1.1%) if the excision is complete but should be radiologically followed up at least 5 years to screen for potential biopsy site changes. Papilloma without atypia diagnosed with CNB require surgical excision as the risk of coexisting carcinoma is significantly higher (8.9% in our study)

CLINICAL RELEVANCE/APPLICATION

Papilloma without atypia diagnosed with vacuum assisted biopsy can be radiologically followed up given the low rate of underestimation.

SSM01-05 Follow-Up Outcomes of BI-RADS Category 3 Solid Nodules Identified on Screening and Diagnostic Breast Ultrasound

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E351

Awards
Student Travel Stipend Award

Participants
Joanna Marie D. Choa, MD, Taguig, Philippines (*Presenter*) Nothing to Disclose
Anna Lyn C. Egwolf, MD, Taguig, Philippines (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Our study aims to determine significant difference in BI-RADS category from initial imaging to its subsequent follow-up and the minimum length of time that the BI-RADS category will change for solid nodules. Our study also wants to assess the characteristics and growth pattern of BI-RADS category 3 solid nodules.

METHOD AND MATERIALS

We did a retrospective cohort study reviewing patient reports across a 10-year follow-up period. All solid nodules with at least 2 follow-up ultrasound imaging within a minimum of 22 months were included. Patients were segregated into 2 groups by age: one group below 40 years old and another group age 40 years old and above. Mammogram results were not viewed. Patients with known carcinoma and those with other lesions having a higher BI-RADS assessment in either breast were excluded. Nodule size, characteristics, and BI-RADS score for each follow-up were obtained. We employed ANOVA for repeated measures for statistical analysis.

RESULTS

A total of 511 nodules (5.1% of identified solid nodules) were included and showed no significant difference in BI-RADS scores over the course of 2 follow-ups, regardless of age. Significant change was identified at the sixth and seventh follow-ups with downgrading of BI-RADS scores to 2. Significant changes in size between the second and third follow-up and comparing the first with the third follow-up were appreciated in patients 40 years old and above. Patients in this study were also found out to have an average interval between follow-up imaging of 14.39 months. The minimum length of time for a BI-RADS category 3 solid nodule to become category 4 on follow-up was approximately 1 year (354 days). Only 1 out of the total 511 nodules turned out malignant, 44 months after initial imaging.

CONCLUSION

There is no significant change between BI-RADS scores of solid nodules regardless of age within a 2-year follow-up period. The minimum time for change in BI-RADS from 3 to 4 is about 1 year. Low patient compliance to BI-RADS category 3 follow-up guidelines should be taken into consideration in formulating institutional protocols in the management of these solid nodules.

CLINICAL RELEVANCE/APPLICATION

Patient compliance to follow-up recommendations of BI-RADS category 3 solid nodules is very low, hence can be re-classified as category 2 and follow an annual schedule of follow-up imaging. Only 1 out of 511 nodules turned out malignant after 44 months (~0.2%, low turn-out rate).

SSM01-06 Comparison of Upright Digital Breast Tomosynthesis-Guided Vacuum-Assisted Biopsy with Conventional Prone Stereotactic Vacuum-Assisted Biopsy

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E351

Participants
Mary Maunglay, MD, Pontiac, MI (*Abstract Co-Author*) Nothing to Disclose
Manisha Bahl, MD,MPH, Boston, MA (*Presenter*) Nothing to Disclose
Helen Anne D'Alessandro, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Constance D. Lehman, MD,PhD, Boston, MA (*Abstract Co-Author*) Research Grant, General Electric Company; Medical Advisory Board, General Electric Company

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PURPOSE

Breast imaging practices are rapidly transitioning from digital 2D mammography (DM) to digital breast tomosynthesis (DBT), but there is limited research on the clinical performance of DBT-guided vacuum-assisted breast biopsy (VABB). The purpose of this study was to compare the performance of upright DBT VABB to that of conventional prone stereotactic (PS) VABB.

METHOD AND MATERIALS

In this IRB-approved and HIPAA-compliant study, a retrospective review was performed of consecutive patients who underwent PS VABB from August 2014 to December 2015 (PS VABB group) and DBT VABB from February 2016 to June 2017 (DBT VABB group). Tissue sampling methods and materials (9-gauge needles) were the same for PS VABB and DBT VABB. Student's *t*-tests and chi-square tests were used to compare the following variables between the PS VABB and DBT VABB groups: sampling success, procedure times, exposures, lesion types, histologic results, and complications.

RESULTS

Over a 17-month period before the introduction of DBT VABB, 444 PS VABBs in 410 patients (mean age 57, range 32-84) were performed (PS VABB group). Over a 17-month period after complete integration of DBT VABB, 709 DBT VABBs in 682 patients (mean age 58, range 23-90) were performed (DBT VABB group). Technical success was achieved for more lesions with DBT VABB than PS VABB (98.4% [698/709] vs 93.2% [414/444], $p<0.001$). Mean procedure time was shorter with DBT VABB (12 vs 28 minutes, $p<0.001$), and significantly fewer exposures were acquired with DBT VABB (3 vs 11, $p<0.001$). A higher percentage of lesions biopsied with DBT VABB were non-calcified lesions (eg, architectural distortion, asymmetry, and mass) (29.5% [206/698] with DBT VABB vs 3.1% [13/414] with PS VABB, $p<0.001$). There were no differences in the distribution of histologic results (benign, high-risk, or malignant) ($p=0.94$). No major complications were observed in either group. Two patients in the DBT VABB group (2/682, 0.3%) experienced self-limited vasovagal symptoms.

CONCLUSION

DBT VABB has higher technical success than PS VABB and can be performed in less than half the time and with less than one third of the radiation. In addition, more distortions and asymmetries are amenable to biopsy with DBT VABB.

CLINICAL RELEVANCE/APPLICATION

Clinical performance of DBT VABB is superior to PS VABB. DBT VABB can replace PS VABB for routine use in patients with suspicious findings identified on DBT alone and on conventional DM.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSM02

Science Session with Keynote: Breast Imaging (Risk-Based Screening: Should We Do It?)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E350

AI BR SQ

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Elizabeth A. Morris, MD, New York, NY (*Moderator*) Nothing to Disclose
Daniel B. Kopans, MD, Waban, MA (*Moderator*) Royalties, Cook Group Incorporated; Research Consultant, Deep Health; Scientific Advisory Board, Dart, Inc

Sub-Events

SSM02-01 Breast Keynote Speaker: Risk Based Screening

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E350

Participants
Elizabeth A. Morris, MD, New York, NY (*Presenter*) Nothing to Disclose

SSM02-02 Risk-Based Screening Mammography for Women Age <40: Outcomes from the National Mammography Database

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E350

Participants
Cindy S. Lee, MD, Garden City, NY (*Presenter*) Nothing to Disclose
Heidi Ashih, PhD, Reston, VA (*Abstract Co-Author*) Nothing to Disclose
Debapriya Sengupta, MBBS,MPH, Reston, VA (*Abstract Co-Author*) Nothing to Disclose
Edward A. Sickles, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
Margarita L. Zuley, MD, Pittsburgh, PA (*Abstract Co-Author*) Investigator, Hologic, Inc
Etta D. Pisano, MD, Charleston, SC (*Abstract Co-Author*) Researcher, Freenome Holdings Inc; Researcher, Real Imaging Ltd; Researcher, Therapixel; Researcher, DeepHealth, Inc; Researcher, ToDos

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PURPOSE

There is insufficient large-scale evidence supporting screening mammography in women <40 years with risk factors. This study compares risk-based screening of women ages 30-39 versus women age 40-49 with no known risk factors, using screening mammography performance metrics from the National Mammography Database (NMD).

METHOD AND MATERIALS

This HIPAA compliant and IRB approved study analyzed data from 150 mammography facilities in 31 states in the NMD. The NMD collects clinical practice data including self-reported patient demographics, clinical findings, screening mammography interpretation and biopsy results. Patients were stratified by 5-year age intervals and specific risk factors for breast cancer: family history of breast cancer (any first degree relative regardless of age), personal history of breast cancer and breast density of heterogeneously or extremely dense (C or D). Prior mammograms were identified by patient date of birth and facility-assigned identification number. Four performance metrics for screening mammography were calculated for each age and risk group: recall rate, cancer detection rate, and positive predictive values for biopsy recommended (PPV2) and biopsy performed (PPV3).

RESULTS

5,772,730 screening mammograms were performed between January 2008 and December 2015 in 2,647,315 women. Overall, mean cancer detection rate was 3.7 per 1000 (95% CI: 3.65-3.75), recall rate was 9.8% (9.8-9.8%), PPV2 was 20.1% (19.9-20.4%), and PPV3 was 28.2% (27.0-28.5%). Overall, women age 30-34 and 35-39 had similar cancer detection rates, recall rates and PPVs, with the presence of the three evaluated risk factors associated with significantly higher cancer detection rates. Moreover, compared to a population currently recommended for screening mammography in the USA (age 40-44 with no known risk factors), incidence screening (at least one prior screening examination) of women ages 30-39 with tthe three evauated risk factors has similar cancer detection rates and recall rates.

CONCLUSION

Women ages 30-39 with 3 specific risk factors should benefit by starting screening at age 30 instead of the age 40 start recommended for average-risk women.

CLINICAL RELEVANCE/APPLICATION

Women

SSM02-03 A Deep-Learning Breast Cancer Risk Prediction Network: Trained on the Population-based Swedish CSAW Data

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E350

Participants
Fredrik Strand, MD,PhD, Stockholm, Sweden (*Presenter*) Nothing to Disclose
Yue Liu, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose
Kevin Smith, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose
Hossein Azizpour, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose
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Peter Lindholm, MD, PhD, Stockholm, Sweden (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Almost half of breast cancer diagnoses among women attending mammographic screening are interval cancers or large screen-detected cancers. To enable more effective individualized screening, accurate risk prediction is paramount. In this study, we examine how our trained deep learning network compares with mammographic density in risk prediction based on negative screening mammograms.

METHOD AND MATERIALS

The Swedish cohort of screen-age women (CSAW) contains over 500,000 women linked to the cancer registry and to an image database. Our deep learning network was trained on negative mammograms from incident cases from one uptake area 2008 to 2011. The test set consisted of cases from 2013 and 2014. In each set, we included a random sample of concurrent non-overlapping controls. The input was each negative mammogram downscaled as well as full-resolution central crops, age at mammography and selected DICOM parameters. The prediction output is called deep learning risk score (DLR). For comparison, mammographic density was calculated using the validated LIBRA software. Logistic regression models were fitted to examine odds ratios.

RESULTS

The training set consisted of 3167 negative mammograms from women with subsequent breast cancer and 125,683 mammograms from healthy women. The test set consisted of negative mammograms from 752 screening rounds of 326 women with subsequent breast cancer and 6728 rounds of 2065 healthy women. AUC was higher for DLR (0.63; 95%CI: 0.61 to 0.66) than for density (0.57; 95%CI: 0.54 to 0.60) and for age-adjusted density (0.58; 95%CI: 0.56 to 0.61). The proportion of cases were 10.1% in the top quintile and 2.5% in the bottom quintile of DLR. The top-to-bottom quintile odds ratio was 4.37 (95%CI: 3.01 to 6.45) and 1.69 (95%CI: 1.23 to 2.32) for DLR and age-adjusted density respectively.

CONCLUSION

We have demonstrated that it is possible to train a deep learning network on negative screening mammograms from subsequent breast cancer cases, and produce risk predictions with reasonable accuracy and ability to identify women at elevated risk.

CLINICAL RELEVANCE/APPLICATION

After external validation, our network may be used in individualizing breast cancer screening.

SSM02-04 Potential Role of Convolutional Neural Network based Algorithms in Patient Selection for DCIS Observation Trials

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E350

Participants
Simukayi Mutasa, MD, New York, NY (*Presenter*) Nothing to Disclose
Peter Chang, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose
Jenika Karcich, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Minimizing over-diagnoses and treatment of Ductal Carcinoma in Situ (DCIS) has led to clinical trials of observing patients with DCIS instead of surgery. Despite careful selection for 'low risk' DCIS patients, there is evidence of occult invasive cancers in a significant number of these patients. We investigated the feasibility of utilizing convolutional neural networks (CNN) for predicting patients with pure DCIS versus DCIS with invasion using mammographic images.

METHOD AND MATERIALS

An IRB-approved retrospective study was performed. 246 unique images from 123 patients were used for our CNN algorithm. 164 images in 82 patients diagnosed with DCIS by stereotactic-guided biopsy of calcifications without any upgrade at the time of surgical excision (pure DCIS group). 82 images in 41 patients with mammographic calcifications yielding occult invasive carcinoma as the final upgraded diagnosis on surgery (occult invasive group). 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. A 15 hidden layer topology based on residual convolutions was used to implement the

neural network. A class balanced holdout set with 40 patients was used for testing. 5-fold cross validation was utilized with cases randomly separated into a training set [80%] and validation set [20%].

RESULTS

The CNN algorithm for predicting patients with pure DCIS achieved an overall validation accuracy of 74.6% (95%CI, ± 5) with area under the ROC curve of 0.71 (95% CI, ±0.04), specificity of 49.4% (95% CI, ± 6%) and sensitivity of 91.6% (95% CI, ± 5%).

CONCLUSION

It's feasible to apply a CNN to distinguish pure DCIS from DCIS with invasion using mammographic images. A larger dataset will likely improve our prediction model and could potentially be useful in appropriate patient selection for observation trials.

CLINICAL RELEVANCE/APPLICATION

Convolutional neural networks have demonstrated strong performance in various image classification tasks and may potentially be used in appropriate patient selection for DCIS observation trials.

SSM02-05 The Effect of Screening Modality and Race on BI-RADS Breast Density in a Large Urban Screening Cohort

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E350

Participants
Aimilia Gastounioti, Philadelphia, PA (*Presenter*) Nothing to Disclose
Anne Marie McCarthy, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
Lauren Pantalone, BS, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Marie Synnestvedt, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Despina Kontos, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Emily F. Conant, MD, Philadelphia, PA (*Abstract Co-Author*) Grant, Hologic, Inc; Consultant, Hologic, Inc; Grant, iCAD, Inc; Consultant, iCAD, Inc; Speaker, iiCME

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PURPOSE

Increased breast density is an independent breast cancer risk factor and also limits the sensitivity and specificity of mammography. We investigated the effect of screening mammography modality and race on BI-RADS breast density assessments, accounting for age and body-mass index (BMI).

METHOD AND MATERIALS

We retrospectively analyzed data from 24,740 individual women (45% White, 55% Black) who underwent screening from September 2010 through February 2017 at our institution. 15,147 women (55%) had repeated screening studies (N = 60,774 studies). Over this time period, three screening modalities were used: digital mammography alone (DM; N = 8,936); digital breast tomosynthesis (DBT) with DM (DM/DBT, N = 30,786); and synthetic 2D with DBT (s2D/DBT, N = 21,052). BI-RADS density classifications ranging from lower (fatty or scattered) to higher (heterogeneous or extremely dense) density were extracted from screening reports. Random-effects ordered logistic regression (panel variable: individual woman) was performed to estimate the odds of being assigned to higher BI-RADS density by each modality, adjusted for race, age, BMI and radiologist. The interaction of modality and race on density was tested in the model, and analyses were stratified by race.

RESULTS

Women screened with DBT had significantly lower odds of high density compared to those screened with DM alone (DM/DBT vs. DM: OR = 0.62, $p < .0001$; s2D/DBT vs. DM: OR = 0.48, $p < .0001$). Lower odds of high density were also observed in s2D/DBT compared to DM/DBT (OR = 0.76, $p < .0001$). There was a significant interaction of modality and race on breast density ($p = .0003$). All differences by modality maintained statistical significance in analyses stratified by race, with lower ORs for black (DM/DBT vs. DM: OR = 0.61; s2D/DBT vs DM: OR = 0.40; s2D/DBT vs. DM/DBT: OR = 0.67) than for white women (DM/DBT vs. DM: OR = 0.65; s2D/DBT vs. DM: OR = 0.58; s2D/DBT vs. DM/DBT: OR = 0.89).

CONCLUSION

Screening mammography modality has a significant effect on BI-RADS density assessment with an overall trend of assigning lower density with DBT and s2D/DBT screening versus DM alone. Furthermore, this effect seems to be more prominent in black than in white women.

CLINICAL RELEVANCE/APPLICATION

Our findings have direct implications for personalized screening since breast density assignments, which often drive recommendations for supplemental screening, may vary greatly by modality and race.

SSM02-06 Breast Keynote Speaker: Risk Based Screening

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E350

Participants
Daniel B. Kopans, MD, Waban, MA (*Presenter*) Royalties, Cook Group Incorporated; Research Consultant, Deep Health; Scientific Advisory Board, Dart, Inc

SSM03

Cardiac (Anatomy)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S102CD

AI CA MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Evan J. Zucker, MD, Stanford, CA (*Moderator*) Nothing to Disclose
Karin E. Dill, MD, Worcester, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSM03-01 The Automated Segmentation of the Left Ventricle Myocardium from Cardiac Computed Tomography using Deep Learning

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S102CD

Participants
Hyun Jung Koo, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
Joon-Won Kang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Ji-Yeon Ko, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
June-Goo Lee, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Dong Hyun Yang, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Segmentation of the left ventricle myocardium of the heart is important to obtain information regarding myocardial wall thickening and functional analysis data. In this study, we performed deep learning analysis for the automated segmentation of the left ventricle of the heart in cardiac computed tomography (CT) data.

METHOD AND MATERIALS

To develop a fully automated deep learning algorithm using sementic segmentation methods based on fully convolution network, 50 subjects with coronary artery diseases were used as training set, and the approach is evaluated using a data set of 1000 subjects with coronary artery diseases present whole 3D volume images of the LV. Reference standard manual segmentation data generated by experienced cardiac radiologists. Cross validation was performed using randomly selected 5% cases from the training set. The comparison of quantitative measurement data between the manual and automatic segmentations was performed using dice similarity coefficient.

RESULTS

Overall, automated segmentation data were comparable to manual segmentation data. We obtained mean 88.3% (min 78.1% and max 96.5%) of dice similarity coefficient in whole LV myocardium. The sensitivity and specificity of automated segmentation in each segment (1-16 segments) were high (range: 85.5 - 99.9).

CONCLUSION

Using a large data set, we presented a deep learning based automatic segmentation of the left ventricle of the heart, and the results was comparable to manual segmentation data with high dice index.

CLINICAL RELEVANCE/APPLICATION

Automated LV segmentation can reduce time to obtain information regarding myocardial wall thickening and LV function, and might improve the reproducibility of clinical assessment.

SSM03-02 Microcirculation Dysfunction in Patients with End-Stage Renal Disease Undergoing Dialysis: Associated with Heart Failure in the Follow-Up

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S102CD

Participants
Ying-Kun Guo, MD, Chengdu, China (*Presenter*) Nothing to Disclose
Rong Xu, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
Huayan Xu, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
Zhigang Yang, MD, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The dialysis treatment was used widely in the ESRD patients, but myocardial ischemia and the cardiovascular disease were the major cause of death in chronic kidney disease (CKD) patients. Our study aimed to quantitative evaluation of myocardial microcirculation dysfunction by rest CMR perfusion imaging in patients with ESRD undergoing dialysis, and to understand of the association between perfusion parameters and heart failure.

METHOD AND MATERIALS

In total, 67 ESRD patients with preserved EF (EF>=50%) and 22 healthy subjects underwent rest first-pass perfusion. The LV regional myocardial perfusion parameters were analyzed by a commercial soft included upslope, time to maximum signal intensity (TTM) and max signal intensity (Max SI). Continuous variables were compared using one-way analysis of variance (ANOVA). The association between perfusion parameters and the composite of CHF was assessed by Cox proportional hazards regression.

RESULTS

For the analysis, the Max SI of basal, mid- and apical segments were reduced in ESRD patients with preserved EF compared with normal controls (all $P < 0.05$). In contrast to the patients with preserved EF, the patients with impaired EF had lower upslope and longer TTM in the basal segment. Over a mean follow-up period of 12.5 months, 24 subjects developed heart failure. The TTM of Basal-, mid-, and apical- segments were inversely associated with risk of heart failure (per unit increment, HR:1.052, 95% CI: 1.010-1.095, HR:1.086, 95% CI: 1.033-1.143, and HR:1.084, 95% CI: 1.024-1.146, respectively) after multivariable adjustment by gender, age, BMI, dialysis time, hypertension, and diabetes.

CONCLUSION

In summary, the first-pass perfusion CMR parameters can early detect the regional myocardial microcirculation dysfunction in ESRD patients undergoing dialysis. The myocardial dysfunction can predictor the progression of heart failure.

CLINICAL RELEVANCE/APPLICATION

(dealing with first-pass perfusion CMR)CMR perfusion imaging with vasodilator can detect myocardial microcirculation dysfunction in ESRD patients undergoing dialysis.

SSM03-03 Differences in Cardiac MR-based Assessment of Myocardial 2D Strain between Subjects with Prediabetes, Diabetes, and Normal Controls in the General Population

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S102CD

Participants
Tanja Zitzelsberger, MD, Tuebingen, Germany (*Presenter*) Nothing to Disclose
Astrid Scholz, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

In the setting of diabetes mellitus, diabetic cardiomyopathy is associated with limited event-free survival but difficult to detect. However, cardiac MR based assessment of subtle alterations of left ventricular function using 2D cardiac strain analysis may represent an early marker of disease development. Thus, we determined differences in left ventricular strain between subjects with prediabetes, diabetes, and healthy controls in a sample from the general population.

METHOD AND MATERIALS

Subjects without prior history of stroke, coronary or peripheral artery disease were enrolled in a case-controlled study and underwent 3T whole body MRI. In all patients without history of hypertension, LGE and normal ejection fraction, radial, longitudinal and circumferential strain was measured on Cine SSFP imaging (TR: 29.97ms, TE: 1.46ms, ST: 8mm) using a semiautomatic segmentation algorithm (CVI42, Circle, Canada). Differences in strain rates were derived in multivariate linear regression analysis adjusting for age, gender, BMI, blood pressure, and smoking, HDL, LDL and TG.

RESULTS

Radial and circumferential strain analysis was performed in in total 347 subjects, of which 41 (11.8%) suffered from diabetes, 92 (26.5%) from pre-diabetes and 214 (61.7%) controls. Mean HbA1c of diabetic subjects was 6.5±1mmol/mol Hb. Pre-diabetic subjects showed a significantly higher systolic global and endocardial radial strain compared to controls (p=0.036 and p=0.011 respectively), whereas diabetic subjects didn't show any significant difference (p=1.00 and p=0.811). Similarly we detected significant lower systolic global and endocardial circumferential strain values in pre-diabetic subjects (p=0.044 and p=0.009), whereas diabetic subjects didn't show a significant difference (p=1.00 and p=0.580). Regarding diastolic radial and circumferential strain we didn't find any significant difference.

CONCLUSION

In our cohort of well-treated diabetic subjects we didn't find any changes in strain values whereas pre-diabetic subjects showed early changes. Therefore early and consequent treatment of diabetes seems to be cardioprotective.

CLINICAL RELEVANCE/APPLICATION

MR based Strain Imaging is able to detect early changes in cardic function in patients with prediabetes. As these changes are not seen in well treated diabetic patients consideration should be given to early antidiabetic therapy.

SSM03-04 Left Atrial Functional Impairment in Patients with Stroke: A Cardiovascular Magnetic Resonance

Study

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S102CD

Participants
Wieland Staab, MD, Goettingen, Germany (*Presenter*) Nothing to Disclose
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PURPOSE

In 25 % of patients with ischemic stroke, no etiologic factor can be identified. Asymptomatic paroxysmal atrial fibrillation (AF) is often suspected to be the cause of these cryptogenic strokes (CS). AF is frequently associated with left atrial (LA) structural and functional alterations. Accordingly, the aim of this study was to examine LA deformation in patients with CS using cardiovascular magnetic resonance myocardial feature tracking (CMR-FT).

METHOD AND MATERIALS

29 patients with the diagnosis of CS underwent CMR imaging. Based on the initial cranial computed tomography (cCT), the patient group was divided into patients with previous ischemic lesions (recurrent CS) and patients without (first-time CS). LA deformation was analyzed based on CMR-FT of standard cine 4- and 2-chamber views including LA reservoir function (peak total strain [s], peak positive SR [SRs]), LA conduit function (passive strain [e], peak early negative SR [SRe]) and LA booster pump function (active strain [a], late peak negative SR [SRa]). Moreover, the "time to s" and "time to SRs" were calculated and expressed as a percentage of the entire cardiac cycle.

RESULTS

Previous ischemic lesions were detected in 5 of 29 patients (17%). LA conduit strain was lower in patients with recurrent CS as compared to first-time CS (6.4 ± 1.1 % vs. 10.3 ± 3.3 %, respectively, p=0.005). Furthermore, "time to s" and "time to SRs" were prolonged in patients with recurrent CS (47 ± 6 % vs. 57 ± 8%, p=0.007; and 19 ± 5% vs. 30 ± 7%, p=0.001, respectively). In multivariable regression models "time to s" and "time to SR" were independently associated with the presence of previous ischemic lesions (ß=0.41, p=0.006 and ß=0.51, p=0.015, respectively) after adjustment for traditional risk factors (age, gender, arterial hypertension, vascular disease and diabetes).

CONCLUSION

Prolonged time to peak LA reservoir strain and SR is associated with the presence of previous ischemic lesions in patients with CS. These findings propose advanced LA impairment as a distinct feature of CS which may be associated with unrecognized paroxysmal AF. Future research is warranted to confirm these findings alongside their prognostic implications in larger prospective clinical trials.

CLINICAL RELEVANCE/APPLICATION

Advanced LA impairment detected by cardiac magnetic resonance imaging may improve management of patients with or prior to CS.

SSM03-05 Machine Learning for Automated Image Quality Control and Segmentation of Large-Scale CMR Population Studies

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S102CD

Participants
Wenjia Bai, DPhil, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
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Hideaki Suzuki, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
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Paul M. Matthew, MD,DPhil, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Daniel Rueckert, PhD, London, United Kingdom (*Presenter*) Nothing to Disclose

PURPOSE

UK Biobank is a large-scale prospective cohort study that follows the health of 500,000 subjects across the UK. Of all the subjects, 100,000 will undergo imaging scans including brain, heart and body scans. We propose a machine learning-based and automated pipeline for cardiac MR (CMR) image quality control and segmentation on this large-scale dataset.

METHOD AND MATERIALS

CMR images were obtained from the UK Biobank under Application Number *****. Short-axis and long-axis cine images were acquired using a Siemens 1.5T scanner with the balanced steady state free precession (bSSFP) sequence. For image quality control, hybrid random forests were trained to detect landmarks on long-axis images, specifically the apex and mitral valve, which were then compared to the space encompassed by short-axis image stacks for identifying incomplete heart coverage. For image segmentation, fully convolutional networks were trained to segment the left ventricle (LV) and right ventricle (RV) on short-axis images and the left atrium (LA) and right atrium (RA) on long-axis images. The segmentation accuracy was evaluated using the Dice metric and mean contour distance error.

RESULTS

The pipeline took ~1 second for image quality control and ~10 seconds for short-axis and long-axis image segmentation. Cases

with heart coverage deemed incomplete by visual examination were automatically identified with 88% sensitivity and 99% specificity on a random test set of 3,000 subjects. Regarding segmentation accuracy, the average Dice metric is 0.94 for LV cavity, 0.88 for LV myocardium, 0.90 for RV cavity, 0.93 for LA cavity (2-chamber view), 0.95 for LA cavity (4-chamber view) and 0.96 for RA cavity (4-chamber view), evaluated on a test set of 600 subjects. The average mean contour distance error is smaller than the in-plane pixel resolution of 1.8mm.

CONCLUSION

We have proposed a machine learning-based pipeline for CMR image quality control and segmentation, which is automated, fast and accurate.

CLINICAL RELEVANCE/APPLICATION

The pipeline will facilitate the analysis of large-scale CMR population studies such as the UK Biobank and enable automated extraction of clinically relevant phenotypes including the ventricular volumes and mass. Future work could evaluate its potential to add quantitative image-derived phenotypes as part of routine clinical practice.

SSM03-06 Cardiac Adaptation of Left Ventricular Volume and Mass during a Multistage Marathon Over 4486 Km

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S102CD

Participants
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Florian Sagmeister, MD, Ulm, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Long-term side effects of intense physical training and long-distance running has led to increasing concerns especially among athletes. However, the consequences on long-term endurance training on cardiac structure and function are not yet fully understood. The purpose of this study was to evaluate the effect of running a transcontinental, multistage ultramarathon of 4486km on 64 consecutive days on the heart.

METHOD AND MATERIALS

20 ultra-endurance athletes with a mean (standard deviation) age of 47.9 (10.4) years received a cardio MRI-scan at three time points (baseline, at ~2000km, ~3500km) during the multistage ultramarathon. Cardiovascular magnetic resonance (CMR) was performed on a portable 1.5 Tesla MRI unit (Magnetom Avanto™mobile MRI) which was installed on a specially hired truck. Left ventricular mass (LVM), end-diastolic volume (EDV), end-systolic volume (ESV) and myocardial strain was calculated from SSFP-cine gradient echo sequences using the commercially available software (Heart Deformation Analysis, HDA, Siemens, Erlangen, Germany). Cardiac MRI-parameters were indexed for body surface area (BSA). Ten runners were serially examined in follow-up scans eight months after the race.

RESULTS

Athletes ran at a mean running speed of 8.2 ± 1.2 km/h during the ultramarathon. Left ventricular mass increased significantly ($p<0.001$) over the course of the race while no significant changes were observed in end-diastolic volume, end-systolic volume as well as global radial, circumferential and longitudinal left ventricular strain. Results of follow-up scans showed a significant reduction in LVMi ($p=0.004$), left ventricular EDVi ($p=0.015$) and right ventricular EDVi ($p=0.045$). We did not observe any significant differences regarding myocardial strain during follow-up.

CONCLUSION

The observed structural cardiac alterations during a multistage ultra-endurance marathon indicates a physiological response to excessive cardiac volume load. The reduction in end-diastolic volumes during follow-up corresponds to the reduced endurance exercise volume within eight months after the multistage ultramarathon.

CLINICAL RELEVANCE/APPLICATION

Extreme long-distance running leads to physiological cardiac adaptations without any detectable adverse cardiovascular remodeling in non-contrast enhanced cardiovascular magnetic resonance imaging.

SSM04

Cardiac (Arrhythmia and Electrophysiology)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S103AB

CA CT MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Susan K. Hobbs, MD,PhD, Pittsford, NY (*Moderator*) Nothing to Disclose
Dharshan R. Vummidi, MD, FRCR, Sale, United Kingdom (*Moderator*) Consultant, Boehringer Ingelheim GmbH

Sub-Events

SSM04-01 Radiographic Features of Pulmonary Veins Morphology from Chest CT Predicts Risk of Post-Ablation Atrial Fibrillation

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S103AB

Participants
Michael LaBarbera, Cleveland, OH (*Presenter*) Nothing to Disclose
Mina K. Chung, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Anant Madabhushi, PhD, Cleveland, OH (*Abstract Co-Author*) Research funded, Koninklijke Philips NV

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PURPOSE

Atrial fibrillation (AF) is the most common sustained arrhythmia, affecting 1-2% of the population. Although endovascular pulmonary vein isolation (PVI) may temporarily reduce symptoms in patients failing medical management, recurrence rates are high and identifying patients likely to have successful outcomes remains elusive. Pulmonary vein morphology and left atrial size have been previously identified as radiographic markers for AF, but have not been assessed for PVI outcome. We explore pulmonary vein and left atrial morphometry as a means of predicting response to PVI.

METHOD AND MATERIALS

A retrospective review of PVI procedures from 2014-2016 excluding prior PVI or valve surgery revealed 314 cases. 154 had pre-PVI CT imaging and clinician-assessed PVI outcome recorded in the EMR at follow-up, with 50 cases diagnosed with recurrent AF within 3 months to 1 year. 50 non-recurrent cases were randomly selected to produce a balanced dataset for analysis (n = 100). Radiographic features were obtained characterizing left atrium size, pulmonary vein morphology, and angle of vein entry into the left atrium using Syngo.Via (©Siemens Healthcare). The 5 most distinguishing features were selected by Wilcoxon rank-sum and used to train a support vector machine classifier in a 3-fold cross-validation setting. Ability to predict recurrence was assessed by area under the receiver operating characteristic curve (AUC) among all patients and the predictive ability including clinical features was investigated similarly.

RESULTS

Distinguishing radiographic features include angle between right pulmonary veins ($p = 0.063$) and angle of left inferior pulmonary vein entry into the left atrium ($p = 0.060$). Radiographic features effectively predicted recurrence of AF within 1 year of PVI (AUC = 0.65 ± 0.03) and inclusion of clinical features further improved performance (AUC = 0.77 ± 0.02). Distinguishing clinical features include age ($p < 0.001$), BMI ($p = 0.005$), left ventricular ejection fraction ($p = 0.014$), history of hypertension ($p = 0.016$), NYHA class of I or greater ($p = 0.016$), and use of apixaban ($p = 0.016$).

CONCLUSION

Pulmonary vein morphology in CT successfully predicts recurrence of AF after endovascular treatment.

CLINICAL RELEVANCE/APPLICATION

The ability to identify patients likely to have recurrent AF based on CT morphometric features may provide a pre-treatment indicator of response and anatomic features that may be targeted.

SSM04-02 Relationship Between Chronicity of Atrial Fibrillation and Left Atrial Remodeling Determined with Cardiac Magnetic Resonance Imaging in Patients with Atrial Fibrillation: Significance of Regional Left Atrial Late Gadolinium Enhancement

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S103AB

Participants
Dong Kyu Lee, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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Yu-Whan Oh, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Left atrial (LA) remodeling is associated with progression of atrial fibrillation (AF). Cardiac magnetic resonance (CMR) imaging can assess the LA remodeling with LA volume (LAV) and LA late gadolinium enhancement (LA-LGE). The distribution of LA-LGE by LAV is largely unknown. This study aimed to determine the relationship of LA-LGE distribution with LAV and progression of AF.

METHOD AND MATERIALS

195 patients (mean age: 55.7 ± 10.7 years, 82.6% men) underwent LGE-CMR examinations before ablation of paroxysmal AF (PAF, n = 121) or persistent AF (PeAF, n = 74). The LAV and LA-LGE were assessed by three-dimension reconstruction of LGE-CMR images. In each of all 9 preselected LA regions, the presence of LA-LGE was evaluated. Additionally, the incidences (in %) of LA-LGE were calculated in every LA region.

RESULTS

Of all the preselected LA regions, the anterior wall and left inferior pulmonary vein (LIPV) region showed a significantly different incidence of LA-LGE ($p < 0.05$, respectively) depending on the LAV. In all 195 patients, the incidences of LA-LGE in the anterior wall and LIPV region were 15.4% and 15.9%. The patients with PeAF showed significantly higher LA-LGE incidence in the anterior wall (31.1% vs. 5.8%, $p < 0.001$) and LIPV region (29.7% vs. 7.4%, $p < 0.001$) than did those with PAF. After adjusting for LAV, the odd ratios for PeAF of the LA-LGE in anterior wall and LIPV region were 3.8 (95% CI = 1.40-10.41, $p = 0.009$) and 3.7 (95% CI = 1.46-9.75, $p = 0.006$), respectively.

CONCLUSION

In evaluation of LA remodeling using CMR imaging, the regional LA-LGE in anterior wall and LIPV region of LA may be associated with the presence of PeAF.

CLINICAL RELEVANCE/APPLICATION

Cardiac MRI can describe the LA remodeling related to the chronicity of AF. Furthermore, the LA remodling determined with cardiac MRI may help understanding the AF mechanism.

SSM04-03 Determination of Conducting Channels from LGE CMR in Patients with Myocardial Infarction-Direct Comparison with Electroanatomic Mapping for Ventricular Tachycardia Ablation

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S103AB

Participants
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Saman Nazarian, MD, Baltimore, MD (*Abstract Co-Author*) Scientific Advisor, Johnson & Johnson Research funded, Johnson & Johnson
Harold I. Litt, MD, PhD, Philadelphia, PA (*Presenter*) Research Grant, Siemens AG ; ; ;

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PURPOSE

LGE CMR is an excellent tool to evaluate scar in patients after myocardial infarction (MI). Electroanatomic mapping (EAM) is traditionally used to locate areas in scar tissue giving rise to ventricular tachycardia (VT) and guide ablation. However, new software using pixel signal intensity (PSI) algorithms has made it possible to locate conducting channels (CC) in scar tissue which form VT substrate using LGE CMR. We compared LGE derived CC with EAM findings in patients with VT post MI.

METHOD AND MATERIALS

We evaluated retrospectively 28 patients with previous MI and VT who underwent CMR prior to EAM and VT ablation. Short axis LGE CMR were evaluated using ADAS-VT (Galgo Medical SL, Barcelona) to identify CC within myocardial layers. A PSI-based algorithm was applied to characterize the LGE area as scar core or border zone, using 60% and 40% of the maximum LGE intensity as thresholds. CC were identified topologically by finding border zone coursing through scar core, representing corridors of viable tissue. CC on LGE-CMR were co-registered with EAM on Carto system. This data was evaluated according to AHA 17 segment model for targeted sites of VT ablation on a per patient and per channel basis

RESULTS

In 28 patients, 232 potential VT sites were identified on EAM-CMR merge, of which 129(55%) were targeted for ablation.138 sites of CC were identified. On a per patient basis, 4 CMR analyses were in total agreement with EAM, 24 had partial agreement. 87(67.4 %) CC sites matched sites of ablation, 50(21%) CC sites were detected only on CMR. 53(23%) scar sites had neither CC on CMR nor ablation on EAM. 42(32.5%) sites of ablation on EAM did not show CC on LGE CMR. CC were also correlated with sites having late(64%), fractionated(65%) potentials, critical isthmus, entry points (60%), pacing sites(60%) and induced VT(48%). LGE CMR PSI-based analysis showed sensitivity of 67.4%(95%CI 58.6%-75.4%), specificity of 52%, positive predictive value of 64%(95%CI 58 % - 69.6%) and negative predicting value of 56% and overall diagnostic accuracy of 60% in identifying sites of EAM sites of ablation.

CONCLUSION

LGE CMR PSI-based analysis has good sensitivity and positive predictive value in identifying sites of VT on EAM.

CLINICAL RELEVANCE/APPLICATION

Target sites for VT ablations can predicted by LGE-CMR to aid preprocedural planning, potentially reducing the need for extensive EAM and additional CC on CMR can also identify cause of recurrent VT

SSM04-04 Comparison of Cardiac Venous Anomalies in Complete and Congenitally Corrected Transposition of

the Great Arteries: Implications for Cardiac Resynchronization Therapy

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S103AB

Participants
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PURPOSE

Cardiac resynchronization therapy (CRT) can help improve cardiac function of progressively failing subaortic morphologic right ventricles in both complete (c-TGA) and congenitally corrected (cc-TGA) transposition of the great arteries, but requires transvenous access to the subaortic morphologic right ventricle. We aim to compare the prevalence of cardiac venous anomalies and accessibility for CRT in c-TGA and cc-TGA using cardiac gated computed tomography angiography (CTA).

METHOD AND MATERIALS

With institutional review board approval, all CTA studies performed between 2007-2018 in patients with c-TGA and cc-TGA were retrospectively reviewed. CTAs were evaluated for cardiac venous anomalies and whether both subaortic and subpulmonic ventricles could be accessed via the subpulmonic atrium and coronary sinus. Statistical analysis included independent samples t-test for continuous variables and Fisher's exact test for categorical variables.

RESULTS

121 patients were included [mean age 36 years (range 18-69 yrs), 75 males (62%)] including 70 patients with c-TGA (44 atrial switch, 13 arterial switch, 13 Rastelli) and 51 with cc-TGA (48 no surgery, 3 double switch). Cardiac venous anomalies were more frequent in cc-TGA (30% vs. 6%; $p<0.001$). Accessibility was significantly higher in cc-TGA compared to c-TGA (86% vs 60%; $p<0.002$). Accesibility was lower among c-TGA patients who had undergone atrial switch compared to those with arterial switch or Rastelli procedures (39% vs. 96%, $p<0.001$). Accesibility was also significantly lower among cc-TGA patients who had undergone double switch compared to those who had not (33% vs. 89%, $p=0.048$).

CONCLUSION

Cardiac CTA identifies cardiac venous anomalies that impact eligibility for CRT. CRT eligibility is significantly lower among both c-TGA patients who have undergone atrial switch procedure and cc-TGA patients who have undergone double switch procedure compared to patients who have not.

CLINICAL RELEVANCE/APPLICATION

Cardiac-gated CTA is essential prior to CRT due to high prevalence of cardiac venous anomalies that may render the patient ineligible due to lack of access.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Kate Hanneman, MD, FRCPC - 2017 Honored EducatorKate Hanneman, MD, FRCPC - 2018 Honored Educator

SSM04-05 Anatomical Shape Differences of Left Atrium on CT Predicts Post-Ablation Recurrence of Atrial Fibrillation

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S103AB

Participants
Thomas Atta-Fosu, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Michael LaBarbera, Cleveland, OH (*Presenter*) Nothing to Disclose
Mina K. Chung, MD, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
Anant Madabhushi, PhD, Cleveland, OH (*Abstract Co-Author*) Research funded, Koninklijke Philips NV

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PURPOSE

Approximately 30% of Atrial Fibrillation (AF) patients who undergo endovascular ablation experience recurring symptoms within the first year after ablation. Patients with long-standing AF demonstrate changes in left atrial morphology and the atrial appendage and pulmonary veins are known regions of interest in ablation, although the impact of morphology on ablation outcome remains unclear. In this study we employed image analysis and machine learning approaches to investigate whether the morphology of the left atrium (LA) was predictive of recurrence in patients undergoing ablation for AF.

METHOD AND MATERIALS

Pre-operative chest CT scans of 68 patients who underwent surgical ablation were acquired between July 2015 and November 2016, of which 31 had AF episodes between 3 and 12 months after ablation. LA masks were created for each patient using an in-house segmentation toolbox and verified by a cardiologist. All patient LA were registered to a common atlas defined by the LA with median volume. Sites of interest (SOI) was then defined for each patient as the regions on the atrial surface with significant difference between recurrent (AF+) and non-recurrent (AF-) patients using a t-test based comparison of the registered atrial. First order statistics of the Gaussian curvature of the surface within the SOI and deformation from atlas to patient LA were extracted,

and a 5-fold cross-validation scheme across 100 runs was conducted to evaluate performance of the features in distinguishing between AF+ and AF- patients using area under the receiver operating characteristic curve (AUC).

RESULTS

The identified regions of maximum shape variation consisted of sites around the atrial appendage and pulmonary veins. Employing feature maps from these regions to classify recurrence performed better (AUC=0.69±0.049) than features from the remaining atrial sites (AUC=0.58±0.58). Combining the feature maps with clinical features (Age, Height, BMI and Weight) produced an AUC of 0.77±0.09, while Using Clinical variables alone produced AUC of 0.66±0.11

CONCLUSION

We identified shape differences between AF+ and AF- patients as well as a set of features relating to local curvature within regions differing different between the two populations that was correlated with likelihood of recurrence.

CLINICAL RELEVANCE/APPLICATION

A systematic process for identifying patients at increased risk for post-ablation recurrence may lead to improved management.

SSM04-06 Detects Myocardial Dyssynchrony of Isolated Left Ventricular Noncompaction Patients with Preserved Ejection Fraction Using Cardiac Magnetic Resonance Feature Tracking

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S103AB

Participants
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PURPOSE

Left ventricular non-compaction (LVNC) is a rare congenital cardiomyopathy, with or without LV dysfunction, and it may be asymptomatic or it may lead to severe HF, sudden death. The aim of our study is to early evaluate the myocardial dyssynchrony in isolated LVNC children with preserved EF by using cardiac magnetic resonance (CMR), and to explore the correlate factors of progress of LVNC.

METHOD AND MATERIALS

we investigated 17 isolated LVNC patients with preserved LVEF (EF>=50%), and 23 age- and gender-matched controls. The feature tracking parameters including peak strain (PS), peak displacement (PD) and strain rate in radial, circumferential, and longitudinal directions were measurement in all subjects.

RESULTS

In all patients, 14 patients were left ventricular apical (73.7%), two patients were left ventricular septum (10.5%), one patient were global left ventricular noncompaction (5.3%). The PS and PD in radial, circumferential, and longitudinal directions decreased significantly in the LVNC patients with preserved EF compared with the normal controls (all $p<0.001$), Furthermore, the PS in three directions were associated with the EF ($r=0.43$; $r=-0.41$; $r=-0.54$); and PS in three directions were also significant correlates with age ($r=-0.47$; $r=0.46$; and $r=0.47$).

CONCLUSION

CMR feature tracking can be used for the detection of early myocardial deformation in the isolated LVNC children who are subclinical left ventricular dysfunctions, and early clinical intervention might be important for the decrease of LVEF function and myocardial deformation.

CLINICAL RELEVANCE/APPLICATION

(dealing with MRI feature tracking) CMR feature tracking can detect early myocardial deformation in the isolated LVNC children with subclinical dysfunctions.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSM05

Chest (Vascular/Interventional)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S404CD

CH CT IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Seth J. Kligerman, MD, Denver, CO (*Moderator*) Nothing to Disclose
Matthew D. Cham, MD, New York, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSM05-01 Image-guided Intratumoral Radiofrequency Hyperthermia-Enhanced HSV-TK Gene Therapy of Lung Cancer: The Underlying Molecular Mechanisms

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S404CD

Participants
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PURPOSE

To develop a new interventional oncologic technique, namely 'image-guided intratumoral radiofrequency hyperthermia (RFH)-enhanced local HSV-TK/GCV-mediated suicide gene therapy of lung cancers' and investigate its associated bio-molecular mechanisms.

METHOD AND MATERIALS

Human lung cancer cells (A549) transduced with Luciferase/mCherry/lentivirus for in-vitro confirmation, and 24 nude rats with the same orthotopic lung cancers for in-vivo validation were divided into four study groups with different treatments of (i) combination therapy with intratumoral HSV-TK/GCV gene therapy followed by RFH at 41-42 °C for 30 minutes; (ii) HSV-TK/GCV gene therapy alone;(iii) RFH alone; (iv) PBS as a control. In in-vitro experiments, bioluminescence assay, confocal microscopy and flow cytometry were used to determine the viability and apoptosis of cells, while in the in-vivo experiments molecular optical/x-ray imaging was used to evaluate the changes of bioluminescent signals among different groups over 2 weeks. To investigate the potential mechanisms of apoptosis, IHC staining and WB were used for detecting the expression of Bcl-2/Bax, and Caspase-3. To determine mechanisms of immune-response, IHC and WB were used to exam the expression of HSP-70, IL-2 and CD94.

RESULTS

Of in-vitro experiments, compared with gene therapy alone, RFH alone or PBS, combination therapy induced the lowest cell viability ($P<0.01$), the highest cell apoptosis ($P<0.001$), and a significant decrease of relative bioluminescence signal ($P<0.01$). Of in-vivo experiments, optical imaging detected a significantly decreased bioluminescence signal of the tumor with combination therapy ($P<0.05$). Regarding to the mechanisms, both WB analysis and IHC staining displayed the significantly decreased expression of Bcl-2, as well as increased expression of Bax, Caspase-3, HSP-70, IL-2 and CD94 in cancer tissues of combination therapy, compare to other control treatments.

CONCLUSION

This study validated the feasibility of image-guided interventional RFH-enhanced direct suicide gene therapy of orthotopic lung cancers, which is activated through the mechanisms of augmenting Bax/Bcl-2/caspase-3-depended apoptosis and the HSP-70/IL-2 depended immune regulation pathway.

CLINICAL RELEVANCE/APPLICATION

This alternative technique may open new avenues for effective treatment of lung cancers via integrating image-guided interventional oncology, RF technology, and direct gene therapy.

SSM05-02 Impact of Availability of PET-CT Imaging on Diagnostic Accuracy and Biopsy Safety of CT-Guided Percutaneous Needle Biopsy (PNB) of Suspected Lung Cancer

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S404CD

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PURPOSE

To determine whether the availability of PET-CT improves diagnostic yield and safety in lung cancer PNB.

METHOD AND MATERIALS

PNB diagnostic rates over 3yrs for 3 thoracic radiologists (6-17yr practice) were retrospectively reviewed. Radiologists review PET-CT, if available, prior to PNB, to target the maximum activity tissue (PET-CT-MA). The availability of PET-CT pre or post PNB was recorded, and whether PNB was ultimately taken from the PET-CT-MA (whether PET-CT pre- or post PNB). The number of needle passes, complications and biopsy results were recorded. The influence of lesion morphology on results was assessed.

RESULTS

353 PNBs were performed in 350 patients (median lesion size 30mm, 7-120mm). 178 PNB (50.4%) had PET-CT pre-PNB, in 102 (28.9%) cases PET-CT was post-PNB. In 73 (20.7%) PET-CT was never performed.Overall PNB success was 83.9% (95.8% malignant). 88.8% of 178 PNB with PET-CT pre-PNB were diagnostic, versus 78.9% of 175 PNB without PET-CT upfront ($p<0.01$ Fisher exact test).Correct targeting to PET-CT-MA was present in 87.1% of 278 cases with PET-CT. 88.8% of 242 PNB targeting the PET-CT-MA were successful, but only 52.8% of 36 PNB not targeting PET-CT-MA ($p<0.0001$). PET-CT pre-PNB had higher rates of PET-CT-MA targeting compared to PET-CT post PNB (91.0% v 80.0%, $p=0.01$).More patients with PET-CT pre-PNB (n=162) and correct localization had diagnostic PNB than patients with PET-CT pre-PNB (n=16) but incorrect localization (90.1% v 75%). Similarly, more patients with no PET-CT pre-PNB (n=80) but ultimately correct localization had successful PNB compared to patients with no PET-CT pre-PNB (n=20) and ultimately incorrect localization (86.3% v 35%, $p<=0.0001$).Patients with a PET-CT pre-PNB underwent fewer PNB passes (mean 2.6 v 3.1, $p<0.0001$ Mann Whitney U). Serious complications were less common in PET-CT pre-PNB group (4.5% v 10.9%, $p<0.05$). Pre-PNB PET-CT performance improvement applied to all 3 radiologists and was greatest for masses and infiltrative abnormalities.

CONCLUSION

PNB localisation to the PET-CT-MA is associated with higher diagnostic biopsy rates and appears to account for improved performance, less needle passes and complications when available pre-biopsy.

CLINICAL RELEVANCE/APPLICATION

Prospective studies are required to confirm the results that suggest PET-CT should be available prior to biopsy particularly for larger masses or infiltrative lesions.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ioannis Vlahos, MRCP,FRCR - 2015 Honored Educator

SSM05-03 Diagnostic Success and Complication Rate of Ultrasound-Guided Percutaneous Needle Biopsy of Thoracic Lesions: Study of 147 Cases

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S404CD

Participants
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PURPOSE

The goal of this study was to assess the diagnostic yield and safety profile of US-guided biopsy in the diagnosis of thoracic lesions, including lesions located in the chest wall, mediastinal and lung parenchyma.

METHOD AND MATERIALS

A total of 147 US-guided percutaneous needle biopsies of thoracic lesions performed in 146 consecutive patients (66±7y,83M,63F)

were analyzed, including lesions originating from the lung (67/147), chest wall (54/147), mediastinum (14/147) and pleura (12/147), obtained with FNA and/or CNB (FNA/CNB). Lesions varied in size from 1.5cm to 16cm. The overall diagnostic yield and complication rate of US-guided biopsy as well as the influence of lesion location and size, biopsy technique (FNA or CNB) and number of specimens on diagnostic yield and complication were calculate. Fisher's exact test, Chi-square test and logistic regression were used for statistical analysis. Results with $p<0.05$ were considered to be statistically significant and yield was summarized as proportion with 95% CI.

RESULTS

The overall diagnostic yield of US-guided needle biopsy was 88%. Biopsy of lesions located in the chest wall were diagnostic in 91% of cases, compared to 88% for lung lesions and 75% for pleural lesions and 93% for mediastinal lesions, although this was not statistically significant ($p = 0.45$). The diagnostic yield of FNA was similar to that of CNB (89% and 86% respectively) and the number of specimens obtained for either FNA or CNB did not affect yield ($p = 0.10$). Complications occurred in 4/147(3%) cases, including pneumothorax in two and mild hemoptysis in one patient. In all cases patients were treated conservatively with no cases requiring intervention. Complications were not statistically associated with any of the covariates analyzed.

CONCLUSION

US-guided biopsy has high yield for the diagnosis of thoracic lesions, including lesions located in the mediastinum and lung parenchyma. Tissue diagnosis sufficient to direct specific management is often obtained. The safety profile of US-guided thoracic biopsy is excellent with very low complication rates.

CLINICAL RELEVANCE/APPLICATION

Imaging-guided percutaneous biopsy is a safe minimally invasive technique used for the diagnosis of thoracic lesions and usually considered the initial modality to obtain tissue diagnosis.

SSM05-04 Artificial Intelligence Based Aortic Diameter Quantification on Routine Unenhanced Chest CT

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S404CD

Awards
Student Travel Stipend Award

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PURPOSE

To validate a supervised machine learning algorithm to quantify thoracic aortic diameters on non-ECG synchronized, non-contrast material enhanced chest CT.

METHOD AND MATERIALS

A novel deep learning based radiology assistant was applied to a training dataset of manually annotated chest CTs. Aortic measurements were made by a single observer off of volumetric datasets utilizing double-oblique short axis measurements at 7 levels, as defined by the American Heart Association (sinuses of Valsalva, sino-tubular junction, mid ascending aorta, proximal aortic arch, mid aortic arch, proximal descending thoracic aorta, mid descending aorta). A deep convolutional image-to-image learning model was used to learn the mapping between the input CT volume and the ground truth aorta mask. The algorithm was then applied to a test set of 72 cases, and aortic diameters between manual measurements and the machine learning algorithm were compared.

RESULTS

The overall correlation between manual and machine learning measurements was r=0.86. The best correlation between manual and machine learning measurements was in the mid descending aorta (r=0.875). The model predictions resulted in an area under the curve of 0.877 when applying a threshold of 38 mm to detect an abnormally enlarged mid ascending aorta, with peak performance of the model set at cutoff 39 mm (indicating a small bias in the model) and resulting in sensitivity and specificity of 77% and 89%, respectively.

CONCLUSION

A machine learning algorithm may be able to automatically provide reliable quantitative measures of thoracic aortic diameters and flag abnormal values.

CLINICAL RELEVANCE/APPLICATION

Automated aortic measurements could enrich radiology reports for epidemiologic studies, save time for the interpreting clinician, and ensure that abnormally dilated aortas are not missed.

SSM05-05 Volume-Helical-Shuttle Mode with Low Contrast Dose and Low Tube Voltage in CT Pulmonary Angiography for Critically Ill Patients

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S404CD

Participants
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PURPOSE

To explore the value of using volume-helical-shuttle (VHS) mode with low contrast dose and low kVp in CT pulmonary artery (CTPA) imaging for critically ill patients.

METHOD AND MATERIALS

38 critically ill patients for CTPA were in the study group (Group A), and other 38 cases of conventional CTPA served as the control group (Group B). Group A used the VHS mode: tube voltage 80kVp, smart mA, noise index (NI) 25HU, pitch 1.375:1, rotation speed 0.5s for 4 passes with scan started 6s after the contrast injection. Contrast dose of 25mL (350mgI/ml) at 4mL/s flow rate was used. Images were reconstructed using 60%ASiR and the best images were selected from the 4 passes for analysis. Group B used tube voltage 120kVp, smart mA for NI of 12HU, pitch 1.375:1, rotating speed 0.8s and contrast dose of 60ml, and images were reconstructed with 40%ASiR. The CT values and SD values of vessels and the vertical spinal muscles were measured to calculate SNR and CNR for vessels. Artifacts near superior vena cava was graded with 5 being the worst. The attenuation difference between the right inferior pulmonary artery and right inferior pulmonary vein was calculated. Two experienced physicians also evaluated image quality double blindly using a 5-point scoring system. Measurements in both groups were statistically compared.

RESULTS

The total radiation dose in VHS mode (Group A) was the same as the conventional CTPA ($P>0.05$), but the contrast dose in Group A was reduced by 58% compared with Group B. The target vessel CT and SD values in Group A were both higher than group B ($P<0.05$), resulting in similar SNR and CNR values in both groups ($P>0.05$), except that the CNR values of MPA and RPA in group B were higher ($P<0.05$); There was no difference in the subjective score of image quality between the two groups ($P>0.05$). However, Group A was better in both the attenuation difference and superior vena cava artifacts ($P<0.05$).

CONCLUSION

CTPA using VHS mode at low kVp works for critically ill patients who were unable to cooperate. Compared with the conventional CTPA, the proposed method provides more satisfactory image results with the same total radiation dose and 58% contrast dose reduction.

CLINICAL RELEVANCE/APPLICATION

For critically ill patients, this method can reduce contrast dose, make multi-phase diagnosis, overcome difficulties that patients cannot cooperate well and ensure the success rate of examination.

SSM05-06 Real-Time Patient Specific Scan Initiation for Pulmonary Embolism CTA: Impact on Image Quality

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S404CD

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PURPOSE

Real-time modulation of scan initiation based on patient specific hemodynamics may allow for optimal timing of contrast enhancement in the pulmonary arteries in evaluation of pulmonary embolism (PE), reducing the number of non-diagnostic scans. The purpose of this study is to assess image quality for PE chest CTA using a modulated scan initiation delay based on patient specific hemodynamics.

METHOD AND MATERIALS

This was a HIPAA compliant, IRB approved quality improvement project. Fluoroscopic administration of contrast was used for all PE chest CTA exams. A new modulated scan initiation delay software was evaluated in 30 patients (cohort 1) scanned on a dual-source 192 detector CT (Siemens FORCE, Forchheim, Germany) from 01/2018-04/2018. 30 patients (cohort 2, matched to cohort 1 for BMI and age) with exams performed using a fixed scan initiation delay of 5 seconds (sec) were identified from 10/2016-12/2017. Subjective image quality was graded on a 4-point Likert-scale (1=excellent, 2=good, 3=fair and 4=inadequate). Objective image quality was determined by measuring the Hounsfield (HU) values in the main pulmonary artery, the bilateral lower lobe segmental and subsegmental arteries (150 arterial segments/cohort). HU values and standard deviations were compared for both cohorts.

RESULTS

Average patient age was 54.5 vs 54.3 years for cohorts 1 and 2 respectively. Average BMI was 32.9 kg/m2 for both cohorts. There was a statistically significant difference in scan initiation delay of 11±3.6 sec (range 7.8 to 27.8 sec) for cohort 1 vs the set delay of 5 sec for cohort 2 ($P<0.01$). Subjective image quality for cohort 1 was graded as excellent or good in 22 patients, fair in 5 and inadequate in 3 patients; for cohort 2 it was graded as excellent or good in 20 patients, fair in 4 and inadequate in 6 patients. Average HU values were higher for cohort 1 vs cohort 2 in segmental (382 vs 349 HU right/387 vs 359 HU left) and subsegmental arteries (371 vs 327 HU right/382 vs 330 HU left). A total of 20/150 segments in cohort 1 and 31/150 segments in cohort 2 were non-diagnostic (HU<250; 7.4% reduction).

CONCLUSION

Real time, patient specific modulated scan initiation delay achieved higher image quality than a set delay for PE chest CTA.

CLINICAL RELEVANCE/APPLICATION

A real-time patient specific scan initiation can improve subjective image quality for PE chest CTA exams and reduce the total number of non-diagnostic pulmonary artery segments.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
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SSM06

Chest (Diffuse Lung Disease)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S402AB

CH CT

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

SSM06-01 Imaging Manifestations of IgG4-Related Disease in the Thorax: Association Between CT Findings and IgG4 Antibody Levels

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S402AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

IgG4-related disease (RD) is an immune-mediated fibro-inflammatory disease that can affect the respiratory system. The goal of this study is to investigate the association between thoracic imaging manifestations of IgG4-RD, IgG4 antibody levels and pulmonary symptoms.

METHOD AND MATERIALS

In this IRB-approved retrospective study, 62 patients with a pathology-proven diagnosis of IgG4-RD and thoracic CT imaging were identified. Images were reviewed by two thoracic radiologists. IgG4 antibody levels, pulmonary symptoms and patient demographics were collected. Wilcoxon rank-sum test was used to assess for differences of the mean IgG4 levels between patients with and without thoracic imaging manifestations of disease. Fischer's exact test was performed to assess for independent association between IgG4 levels and the presence of imaging findings. Spearman correlation analysis was used to assess the correlation between the number of imaging findings and IgG4 levels. Univariate logistic regression analysis was performed to assess for independent contribution of IgG4 levels and pulmonary symptoms in predicting the presence of imaging manifestation on CT.

RESULTS

Of the 62 patients enrolled, 36 patients (58%) had imaging findings attributable to IgG4-RD. Patients with imaging findings had significantly higher IgG4 antibody levels (897±218 mg/dL vs. 87±17 mg/dL in those without imaging findings) ($p<0.01$). Airway involvement was a common imaging finding, present in 19/36 (52.8%) patients. Patients with bronchial wall thickening ($p<0.01$), mosaic lung attenuation ($p=0.01$), and saber sheath trachea ($p=0.03$) had significantly higher serum IgG4 levels compared to those without airway involvement. IgG4 levels and pulmonary symptoms were independent predictors of presence of thoracic imaging manifestations on regression analysis ($p=0.02$ and 0.01 respectively). Overall, there was a positive correlation between the number of thoracic manifestations on CT and serum IgG4 levels ($r=0.60$, $P<0.01$).

CONCLUSION

Airway involvement is a common manifestation of IgG4-RD. High IgG4 levels and pulmonary symptoms are independently associated with presence of findings on chest CT in patients with IgG4-RD.

CLINICAL RELEVANCE/APPLICATION

Elevated IgG4 antibody levels and the presence of pulmonary symptoms should prompt thoracic imaging to identify lung involvement and direct management decisions in patients with IgG4-RD.

SSM06-02 Chest CT Analysis for Prediction of Treatment Response in Organizing Pneumonia: A 20-year Retrospective Cohort Study

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S402AB

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PURPOSE

To investigate the CT imaging features associated with poor clinical outcome after steroid treatment (Tx) in patients diagnosed with organizing pneumonia (OP).

METHOD AND MATERIALS

The study retrospectively enrolled 166 patients (M:F=55:111; mean age, 57.2; mean FVC, 65.9; mean DLco, 58.5) with the pathologically proven OP, which included 131 cases of cryptogenic OP (COP) and 35 cases of connective tissue disease-related OP (CTD). Baseline chest CTs prior to Tx were semi-quantitatively analyzed by two thoracic radiologists in consensus. Lesion extent (consolidation, GGO, reticulation, and total), dominant lesion pattern, dominant distribution, and presence of bronchiectasis (BE), lymph nodes, pleural or pericardial effusions, and reverse halo were evaluated. Uni- and multivariate logistic regression analyses were performed to identify variables associated with poor clinical outcomes including failure to achieve complete response (non-CR) and relapse after Tx.

RESULTS

CR was achieved in 40 (24%) patients and relapse was detected in 53 (31%) patients. While BE was detected in 30% of patients with CR, 65% of patients with non-CR were found to have BE on baseline chest CT. Average extent of consolidation for CR and non-CR group was 14.1% and 15.2%, respectively. Presence of BE (hazard ratio (HR), 4.38) and extent of consolidation greater than 10% of the lung (con>10%) (HR, 2.46) were significantly associated with higher non-CR rate (all, $p < 0.01$). CTD-OP was also found to have higher non-CR rate (HR, 4.19) than COP. On multivariate logistic regression analysis adjusted for age and sex, BE, con>10%, and CTD-OP all remained as significant predictors. For the prediction of relapse, significant associations were found with con>10% (HR, 2.86), total extent > 25% (HR, 2.77), and CTD-OP (HR, 6.79). After adjusted for age and sex, con>10 % and CTD-OP were found be significant predictors of relapse.

CONCLUSION

In patients diagnosed with OP, patients with BE and greater extent of consolidation on baseline chest CT were less likely to achieve CR, and the latter was also associated with higher rate of relapse after treatment. Additionally, CTD-OP was found to have worse treatment outcome than COP.

CLINICAL RELEVANCE/APPLICATION

Patients with underlying CTD, bronchiectasis, and greater extent of consolidation at the time of diagnosis were found to have worse treatment outcome in OP, and therefore should be monitored with extra vigilance.

SSM06-03 Identification of CT Patterns for Disease Progression in CTs of Patients with Idiopathic Pulmonary Fibrosis - An Unsupervised Machine-Learning Approach

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S402AB

Participants
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PURPOSE

To identify CT patterns which can be used as markers of disease progression in patients with idiopathic pulmonary fibrosis (IPF) using an unsupervised machine-learning approach.

METHOD AND MATERIALS

695 CT scans from 106 IPF patients (1-4 per patient) were investigated in the study. All CT studies were automatically segmented into into super-voxels and gray-level co-occurrence features at the centroid positions were extracted. Twenty clusters of these super-voxels proved to be stable across the population in the feature space. The volume of each cluster relative to the entire lung was used as the signature of a lung. To identify prognostic markers in these signatures, we trained a random-forest classifier to predict for any pair of scans for one patient (scans A and B) if A was acquired prior to B or vice versa (overall 230 pairs). The classifier determined which features were most informative regarding the classification. To determine whether the signature was predictive and stable, a four-fold cross-validation was performed on the data set. The classifier was trained on 3/4 of the patients, and predicted an A/B sequence on the remaining 1/4 of these patients. To study the distribution of predictive information in the lung, we split the volume into upper-, middle-, and lower third, and performed the evaluation for each of them individually.

RESULTS

The random forest identified four distinct clusters as predictive for the temporal course. In the four-fold cross-validation experiment, using all lung data, the classifier correctly determined the sequence of scans for 80.35% of the cases. Using only cluster information in one of three parts of the lung reduces the accuracy, but reveals that the middle segment results in highest accuracy (76.52%) compared to upper (73.04%) and lower (72.61%) segments. Three clusters where among the top four most predictive clusters in all folds, and one cluster was in the top four for three of four folds.

CONCLUSION

The described approach identified four patterns that were markers of disease progression in lung CT data of IPF patients. The information contributed by individual clusters differs depending on their location in the lung.

CLINICAL RELEVANCE/APPLICATION

Data-driven identification of imaging markers enables the exploitation of complex patterns for the detection and quantification of progression.

SSM06-04 Interstitial Lung Abnormalities in Stage IV Non-Small Cell Lung Cancer Patients: A Validation Study for the Association with Poor Clinical Outcome

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S402AB

Awards
Student Travel Stipend Award

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PURPOSE

The presence of interstitial lung abnormalities (ILA) at diagnosis of stage IV non-small cell lung cancer (NSCLC) patients have previously shown to be associated with shorter survival. The present study aimed to validate the association in a larger cohort of treatment-naïve stage IV NSCLC patients.

METHOD AND MATERIALS

This study included 484 patients (205 males and 279 females, median age: 62) with stage IV NSCLC. ILA was scored on the baseline chest CT scans at diagnosis prior to therapy using 3-point scale (0=no ILA, 1=equivocal for ILA, 2=ILA) using a sequential reading method by 3 readers as published previously. Clinical characteristics and overall survival (OS) were compared in patients with ILA (score 2) vs. those without ILA (score 0 or 1).

RESULTS

ILA was present (score 2) on baseline CT in 19 of the 484 patients (3.9%, 95%CI: 2.4 - 6.1 %). Patients with baseline ILA were older (median age: 69 vs. 62 years, Wilcoxon p=0.0008) and were more commonly male (68.4% (13/19) vs. 41.3% (192/465); Fisher p=0.03) compared to those without ILA. Other variables including race, smoking history, and histology were not significantly associated with baseline ILA. Patients with baseline ILA had significantly shorter overall survival compared to those without (median OS: 9.95 months [95%CI: 5.88-15.5] vs. 16.95 months [95%CI: 14.65-18.7]; Log-rank p=0.0002). In multivariable analyses, baseline ILA remained significant as a marker for shorter overall survival (HR=2.09; Cox p=0.004), after adjusting for age (>70 years using the 75th percentile; HR=1.48; Cox p=0.001), male gender (HR= 1.22; Cox p=0.055) and smoking (never vs. current/former smoker; HR=0.79; Cox p=0.051).

CONCLUSION

The presence of ILA at diagnosis of stage IV NSCLC was significantly associated with shorter survival, validating ILA as an independent marker for poor outcome.

CLINICAL RELEVANCE/APPLICATION

Recognition of ILA on chest CT at diagnosis of stage IV NSCLC is important, because ILA can serve as a marker for shorter survival and may contribute to patient monitoring and management.

SSM06-05 Juxta-Pleural and Acutely-Folded Bronchi: Differential CT Findings of IPF without Evidence Honeycombing From NSIP

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S402AB

Participants
Heekyung Kim, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
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Hyun-Ju Lee, MD, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Gong Yong Jin, MD, PhD, Jeonju, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate juxta-pleural and acutely-folded bronchi for the differentiation of IPF patients without honeycombing from idiopathic NSIP.

METHOD AND MATERIALS

The derivation cohort consisted of 80 consecutive patients (41 IPF and 39 NSIP; 17 probable, 10 indeterminate, 53 non-IPF CT patterns) who met following criteria in a single hospital: (a) multidisciplinary diagnosis of IPF or idiopathic NSIP with surgical biopsy from 2005 to 2017, (b) diagnostic thin-section chest CT, and (c) lack of honeycombing in case of IPF. For validation, 22 patients (14 IPF and 8 NSIP; 4 probable, 11 indeterminate, 7 non-IPF CT patterns) with the same condition were included from another institution. Two radiologists for derivation cohort independently assessed the presence of juxta-pleural and acutely-folded bronchi on axial, coronal, sagittal minimum intensity projection (MinIP) images (20mm overlap, 5mm increment; MEDIP software, MEDICALIP Co., Ltd. Seoul, South Korea). Juxta-pleural bronchus was defined as bronchiectasis attached perpendicular to the pleura 1.5cm or longer in length. Acutely-folded bronchus was defined if a single bronchus folded abruptly over 90 degrees and if bronchus branched at an angle of 135 degrees or larger. Logistic regression analysis was used to identify the association of the MinIP findings with IPF. For validation, we assessed the diagnostic accuracy and interobserver agreement of 4 radiologists blinded to any clinical information using a proportion of correct diagnosis of IPF and NSIP and ROC curve before and after reviewing MinIP images.

RESULTS

Non-juxta-pleural and juxta-pleural acutely-folded bronchi (OR, 3.5 95%CI, 1.37-8.66; p=.008 and OR, 6.22, 95%CI, 1.62-23.84; p=.008, respectively), and co-existence of non-juxta-pleural acutely-folded bronchus and juxta-pleural bronchus in same patient (OR, 5.67, 95%CI, 2.03-15.85; p=.001) were significant imaging features for IPF. After reviewing MinIP images, the readers' area under the curve mildly improved from 0.496-0.808 to 0.554-0.808 with increased proportion of correct diagnosis from 40.9-54.5% to 50.0-77.3%. Mean interobserver kappa values for juxta-pleural and acutely-folded bronchi were 0.373 and 0.475.

CONCLUSION

Juxta-pleural and acutely-folded bronchi were differential CT findings for IPF without honeycombing.

CLINICAL RELEVANCE/APPLICATION

Analysis of bronchial trajectory using MinIP images could increase an imaging confidence of IPF without honeycombing.

SSM06-06 Fibrotic Lung Disease on CT Predicts Adverse Outcomes in Patients Undergoing Transcatheter Aortic Valve Replacement

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S402AB

Participants
Cheng Ting Lin, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
Matthew Czarny, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Amira F. Hussien, MBBCh, Rochester, NY (*Abstract Co-Author*) Nothing to Disclose
Rani K. Hasan, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Elliot K. Fishman, MD, Baltimore, MD (*Abstract Co-Author*) Institutional Grant support, Siemens AG; Institutional Grant support, General Electric Company; Co-founder, HipGraphics, Inc
Jon Resar, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Stefan L. Zimmerman, MD, Ellicott City, MD (*Abstract Co-Author*) Project consultant, Siemens Healthcare; Research grant, American Heart Association;

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PURPOSE

To evaluate the relationship between CT findings of diffuse lung disease (fibrosis and emphysema) and outcomes in patients who underwent transcatheter aortic valve replacement (TAVR).

METHOD AND MATERIALS

Retrospective review of pre-operative CT scans obtained from 507 patients who underwent TAVR during 2012-2017. Lung images were divided into ten contiguous axial sections spaced equally apart. The extent of fibrotic lung disease - characterized by reticular abnormality and/or honeycombing - was graded by a thoracic radiologist using a five-point scale based on the percent of lung parenchyma involved. A similar approach was used to grade the extent of emphysema. Scores from all the axial slices for each patient were summed to determine fibrosis and emphysema scores. Demographic and clinical data, including pulmonary function tests, were extracted from institutional data submitted to the national Transcatheter Valve Therapy (TVT) Registry. Outcome analyses were performed according to the Kaplan-Meier method using a combined endpoint of death and readmission as the primary outcome.

RESULTS

Complete clinical parameters and outcome data were available in 335 patients. Fibrosis was present in 91 out of 507 (18%) patients with fibrosis scores ranging from 1-34. Emphysema was seen in 33 out of 507 (6.5%) patients. Fibrosis scores between patients with and without chronic lung disease - defined according to TVT registry as FEV1 below 60% - were not statistically different (p=0.59). The presence of fibrotic lung disease on CT was significantly associated with the primary outcome (HR 1.62; 95% CI

1.09-2.40; p=0.016) after adjustment for pre-specified covariates (including FEV1, smoking status, age, and LVEF). Emphysema scores were not associated with the primary outcome. FEV1 was also an independent predictor of worse outcome (HR 0.99; 95% CI 0.984-0.998; p<0.01).

CONCLUSION

The presence of fibrotic lung disease on pre-TAVR CT scans was a significant predictor of adverse events, independent of known risk factors for mortality. Radiologists should be aware that these pulmonary findings could help identify patients who are at higher risk among those referred for TAVR.

CLINICAL RELEVANCE/APPLICATION

Visual assessment of reticular abnormality and honeycombing on pre-operative CT scans can predict adverse events in patients undergoing transcatheter aortic valve replacement.

Honored Educators

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SSM07

Emergency Radiology (Abdomen and Pelvis Trauma)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S404AB

CT ER GI GU

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Michael N. Patlas, MD,FRCPC, Hamilton, ON (*Moderator*) Nothing to Disclose
Karen S. Lee, MD, Boston, MA (*Moderator*) Nothing to Disclose

Sub-Events

SSM07-01 Can Contrast Enhanced Ultrasound Be an Alternative to CECT for Grading and Triaging Management of Blunt Traumatic Solid Abdominal Organ Injuries?

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S404AB

Awards
Trainee Research Prize - Resident

Participants
Deepak Ravichandran, MD, New Delhi, India (*Presenter*) Nothing to Disclose
Atin Kumar, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Raju Sharma, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Ashu S. Bhalla, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

CECT is the gold standard for the detection and grading of hepatic and splenic injuries in BAT. Due to the high incidence of low energy trauma with negative CECT findings and the high doses of iodinated contrast used, contrast enhanced ultrasound(CEUS) is an alternative tool in the detection of solid organ injuries in the emergency setting. This study was done to assess the agreement between the grades of hepatic and splenic injuries assigned on CEUS and CECT

METHOD AND MATERIALS

In this ethically approved study consecutive hemodynamically stable patients with BAT with CECT showing solid abdominal organ injuries were recruited. These patients underwent CEUS by a radiologist who was blinded to the findings of CECT. The injuries were graded on both modalities using the American Association for the Surgery of Trauma (AAST) scales. The agreement between the grading of injuries on CECT and CEUS was analysed through kappa statistics. The injuries were further classified as high grade (AAST grades IV & above) and low grade (AAST grades I to III) and agreement between the grading on CECT and CEUS was compared

RESULTS

Among the 105 patients included as a part of a larger study, there were 66 hepatic and 43 splenic injuries detected on CECT. CEUS identified 63 out of the 66 liver injuries and these 63 injuries were graded and compared with CECT. There was significant agreement between their grading on CECT and CEUS with a kappa value of 0.95 (>0.75 is significant). On combining the grades as low grade and high grade injuries, there was significant agreement on both modalities with a kappa value of 1.00. Similarly, 40 splenic injuries were detected on CEUS out of the 43 detected on CECT and these were graded on both the modalities and compared. There was significant agreement between the grading with a kappa value of 0.87. On combining the grades as low grade and high grade injuries there was significant agreement between the grading of splenic injuries on both modalities with a kappa value of 0.91

CONCLUSION

CEUS is accurate in grading of hepatic and splenic injuries in case of blunt traumatic solid abdominal organ injuries

CLINICAL RELEVANCE/APPLICATION

CEUS can provide a radiation free alternative for accurately grading hepatic and splenic injuries and can suggest further management.

SSM07-02 Accuracy of Preoperative MDCT in Patients with Penetrating Abdominal and Pelvic Trauma

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S404AB

Awards
Trainee Research Prize - Resident

Participants
Zonia Ghumman, MD, Hamilton, ON (*Presenter*) Nothing to Disclose
Vincent M. Mellnick, MD, Saint Louis, MO (*Abstract Co-Author*) Nothing to Disclose
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Sandra Monteiro, PhD, Hamilton, ON (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The role of imaging has become more important for preoperative assessment of traumatic penetrating injuries (PIs). This study aims to evaluate the overall diagnostic accuracy of preoperative MCDT in abdominal and pelvic PIs.

METHOD AND MATERIALS

We used our hospital's trauma registry to retrospectively identify patients with penetrating abdominal and pelvic injuries from 1/1/2006 to12/31/2016. Only patients who had a 64-MDCT scan at presentation and subsequently underwent laparotomy or laparoscopy were included in our study cohort. Each finding noted on MDCT was rated using a 5-point scale to indicate certainty of injury, with a score of 0 being definitive. Using surgical findings as the gold standard, the accuracy of radiology reports was analyzed in 2 ways. A kappa statistic was calculated to evaluate each pair of values for absolute agreement, and ratings for all organ systems were analyzed using a repeated measures ANOVA to determine if radiology and OR findings were similar enough to be clinically meaningful.

RESULTS

Of the 194 trauma patients identified from the trauma registry, 42 met our inclusion criteria - 14 of which sustained GSW, 25 sustained stab wounds, and 3 were miscellaneous penetrating injuries. Our cohort consisted of 38 males and 4 females with a median age of 29 years and a median injury severity score (ISS) of 15.6. For this study, 15 different organ groups were categorized and analysed. Of those organ groups, absolute agreement between MDCT and surgical findings was found only for liver, spleen, peritoneal space and retroperitoneum (kappa values ranging from 0.2 to 0.5). Additionally, the ANOVA revealed an interaction between finding type and organ system ($F(1, 33) = 7.4$, $p < 0.001$). The most clinically significant discrepancies between MDCT and OR findings were for gallbladder (GB), bowel and mesenteric, and diaphragmatic injuries (DI). In particular, MDCT imaging showed a slight tendency towards false negatives for GB, mesenteric and DI.

CONCLUSION

The detection of clinically significant injuries to solid organs in trauma patients with penetrating abdominal and pelvic injuries on 64-MDCT is adequate. However, detection of injury to the remaining organ groups on MDCT - especially the GI tract, mesentery, and diaphragm - remains a challenge.

CLINICAL RELEVANCE/APPLICATION

The accurate preoperative detection of bowel, mesenteric and diaphragmatic injuries on preoperative MDCT remains a challenge.

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SSM07-03 Evaluation of CT and Clinical Features of Bowel and Mesenteric Injuries in Blunt Abdominal Trauma: A Case-Control Study

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S404AB

Participants
Alexandre Lansier, Paris, France (*Presenter*) Nothing to Disclose
Camille Bourillon, Paris, France (*Abstract Co-Author*) Nothing to Disclose
Olivier G. Clement, MD, PhD, Paris, France (*Abstract Co-Author*) Consultant, Bracco Group Research Consultant, Bayer AG Research collaboration, Guerbet SA
Charles-Andre Cuenod, Paris, France (*Abstract Co-Author*) Research collaboration, Guerbet SA Speaker, Guerbet SA

PURPOSE

To evaluate accuracy of individual or associations of CT and clinical signs To determine signs that are implied in missed diagnosis on first CT

METHOD AND MATERIALS

This retrospective case-control study included 30 cases with surgically confirmed bowel and/or mesentery requiering surgical repair and 52 consecutive controls with blunt abdominal or chest trauma and no surgically important bowel and/or mesenteric injury. CT findings were screened by two radiologists: a 10-year-experimented in abdominal imaging radiologistand a second-year resident blinded to the patients' outcome. Clinical outcomes were analysed by consulting the medical file. Sensitivity and specificity were calculated for each sign and a kappa coefficient were used to establish the interobserver variability.

RESULTS

The CT signs with best positive likelihood ratio were extra luminal air, bowel wall defect and thickening, decreased bowel wall enhancement and mesenteric vessels abnormalities. The specificity of clinical seat belt sign associated with anterior abdominal wall injury on CT was 98%. The sensitivity of free intraperitoneal fluid was 100% and its density was higher in cases. More than 50% of patients with missed diagnosis on first CT had a visceral injury associated. Diagnosis of mesenteric and/or bowel injury depends on

the experience of the radiologist (kappa = 0,6).

CONCLUSION

CT scan is accurate for the diagnosis of bowel and/or mesenteric injuries in blunt abdominal trauma depending on the experience of the radiologist. The association of clinical seat belt sign and anterior abdominal wall injury on CT is highly specific.

CLINICAL RELEVANCE/APPLICATION

The radiologist should know the relevant signs and have a stratified strategy for the diagnosis. Therefore we propose an algorithm for the diagnosis.

SSM07-04 Radiation Dose versus Injury Yield: A Study of CT Imaging Findings in Stabbing Related Injuries at an Urban Level 1 Trauma Center

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S404AB

Participants
Oliver Duxbury, MBBCh,FRCR, London, United Kingdom (*Presenter*) Nothing to Disclose
Gurinder Nandra, FRCR,MBChB, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Ioannis Vlahos, MRCP,FRCR, London, United Kingdom (*Abstract Co-Author*) Research Consultant, Siemens AG Research Consultant, General Electric Company

PURPOSE

Clinical uncertainty over stab injury severity results in extensive CT use based solely on anatomic location often without consideration of injury depth or other clinical parameters. The study aim was to determine whether the diagnostic yield of emergency department (ED) requests justifies the CT radiation dose exposure.

METHOD AND MATERIALS

All ED CT examinations performed for stabbing in 2017 at an Urban Level 1 Trauma Center were retrospectively assessed. CT coverage/protocol phases were determined by ED referral based on injury anatomic location. CT evaluation (Definition,Siemens Medical Solutions,Forchheim,DE) was performed with autoKVp selection (80-140kVp, filtered back projection). Parameters recorded included: age, body parts imaged, phases per scan, identifiable site injuries and depth, organ injuries, presence of active bleeding and patient management. Effective radiation dose was calculated.

RESULTS

A total of 175 patients were scanned for 179 stabbing related injuries (median age 25, 87% male). A mean 1.6 phases of CT were performed per patient (range 1-3), imaging a mean 3.9 body part-phases/patient. Mean dose was 11.8mSv (1.5-43.9). A total of 79 organ injuries were identified in 61/179 patient episodes, imaged at a cost of 26.7mSv/organ injury. The injury site was identifiable in 95% of cases, but was limited to the subcutaneous layer in 38% and the muscular layer in 66% of patients. No injuries were fatal. 106/179 (59%) of studies had more than one phase, but only 17% of all patients demonstrated active bleeding, and only one third of these required surgery or interventional radiology. Excluding 15 patients with clinically overt injuries (knife in situ, evisceration, needing chest drain prior to CT), only 22% of 164 patients had CT detected injuries necessitating treatment. The dose in patients without injuries was only slightly lower than patients with treatable injuries(11.3mSv v. 13.1mSv, $p<0.05$, Mann-Whitney U).

CONCLUSION

Most stab injuries are superficial, or not necessitating treatment. A high radiation dose burden in young patients without significant injury dictates better CT use criteria are required to limit imaging to the minority with significant injuries.

CLINICAL RELEVANCE/APPLICATION

The high radiation dose in young patients dictates better clinical criteria are needed to limit CT in stabbing injuries to the patient minority likelier to have injuries requiring further management.

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SSM07-05 Diagnostic Value of IV Contrast Extravasation (CE) at CT for Major Arterial Injury After Blunt Pelvic Ring Disruption: A Meta-Analysis of 3855 Patients

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S404AB

Participants
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Thomas M. Scalea, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

The diagnostic performance of intravenous contrast extravasation on computed tomography for prediction of angiopositivity after pelvic ring disruption has not been previously assessed using meta-analysis, despite ongoing controversy and widely variable results

in the literature. We performed a meta-analysis to determine pooled accuracy of CE, and to assess the influence of CT scanner generation and multiphasic protocols.

METHOD AND MATERIALS

We conducted a systematic literature search to answer the following: 'What is the diagnostic accuracy of intravenous contrast extravasation (CE) at admission trauma CT for predicting angiopositivity and need for angioembolization in patients who have sustained blunt pelvic ring disruptions?'. MEDLINE, Embase, and Cochrane databases were queried using a combination of text words and MeSH terms. Of 206 potentially eligible studies, 23 studies that met criteria were assessed for methodologic quality using the QUADAS-2 tool. Sensitivity and specificity were synthesized using bivariate mixed-effects logistic regression. Heterogeneity was assessed using the I2 statistic. Publication bias was examined using Deeks' test. Subgroup analyses were conducted to explore the heterogeneity based on the use of 64-section CT, multiphasic versus single phase protocols, study sample size, and prevalence of arterial bleeding on angiography.

RESULTS

23 included studies provided 3855 patients for meta-analysis. There was no evidence of publication bias (p=0.62) Pooled sensitivity and specificity were 80% (95% CI: 66-90%, I2 = 92.65%) and 93% (CI: 90-96, I2 = 89.34%), respectively, with substantial heterogeneity. Subgroup analysis showed pooled sens and spec of 94% and 89% for 64-section CT compared to 69% and 95% with older generation scanners. With multiphasic protocols, CE had pooled sensitivity and specificity of 95% and 92%, compared to 74% and 94% with single phase protocols. Studies with lower disease prevalence and larger sample size also had better diagnostic performance.

CONCLUSION

Multiphasic protocols and improved scanner quality result in substantial gains in sensitivity of CE, potentially at the expense of specificity.

CLINICAL RELEVANCE/APPLICATION

Little further improvement in sensitivity can be expected beyond 64MDCT. Increased conspicuity of small foci of self-limiting CE could potentially reduce specificity for angioembolization need.

SSM07-06 Whole Body CT Using Biphasic Injection Protocol with Adaptive Statistical Iterative Reconstruction-V (Asir-V) in Multi-Trauma Patients: Impact on Dose Reduction and Image Quality

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S404AB

Awards
Student Travel Stipend Award

Participants
Ali H. Elmokadem, MD,PhD, Mansoura, Egypt (*Presenter*) Nothing to Disclose
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Walaa A. Gouda, MD, Shebeen El-Kom, Egypt (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate potential dose savings and image quality after implementing adaptive statistical iterative reconstruction-V (ASiR-V) algorism on a revised protocol for whole-body computed tomography (WBCT) for multi-trauma patients and compare it to conventional protocols.

METHOD AND MATERIALS

One hundred multi-trauma patients were scanned using a 256-multidetector CT system (GE Healthcare Revolution system). They were randomized into two groups using two different scanning protocols. Group (A) (n=50, age 32.48±8.09) underwent conventional protocol including unenhanced WBCT scan, then contrast-enhanced arterial-phase of the thorax and abdomen followed by a portal and delayed scan of the abdomen and pelvis. Group (B) (n=50, age 35.94±13.57) underwent biphasic injection protocol including unenhanced WBCT scan, followed by a one-step acquisition of the thorax, abdomen, and pelvis following a biphasic injection, the examination was ended by delayed phase for the abdomen and pelvis. All examination were done under 50 % ASiR-V. Image count, radiation dose, total acquisition time, mediastinal artifacts were compared. Two radiologists independently graded image quality from 1 to 5. In addition, contrast enhancement was measured in the pulmonary artery, aorta, inferior vena cava, portal vein, liver, spleen, and kidneys.

RESULTS

The mean (±SD) dose length product value for group (A) was 2202.3 ± 271.8 mGy*cm and higher when compared to group (B) ($p < 0.001$) which was 1485.8 ± 489.2 mGy*cm. Protocol B gave a dose reduction of 32.5% and 7.7 % acquisition time reduction. The Houndsfield unit values of the aorta, liver and spleen were significantly higher in group (A) while both kidneys values were higher in group (B). There was no statistically significant difference between the image quality scores for both groups however, group (A) scored higher grades (4.62±0.56 & 4.56±0.67).

CONCLUSION

Implementing ASiR-V algorism on biphasic injection WBCT protocol reduced radiation dose significantly with maintenance of diagnostic accuracy and image quality.

CLINICAL RELEVANCE/APPLICATION

Whole body computed tomography (WBCT) is an important diagnostic tool for initial clinical trauma management. Dose reduction with maintenance of image quality is still a concerning subject for emergency radiologists.

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104th Scientific Assembly and Annual Meeting
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SSM08

Gastrointestinal (Liver, Quantitative Imaging)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S502AB

BQ GI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Mustafa R. Bashir, MD, Cary, NC (*Moderator*) Research Grant, Siemens AG; Research Grant, General Electric Company; Research Grant, NGM Biopharmaceuticals, Inc; Research Grant, TaiwanJ Pharmaceuticals Co, Ltd; Research Grant, Madrigal Pharmaceuticals, Inc; Research Consultant, RadMD
Utaroh Motosugi, MD, Chuo, Japan (*Moderator*) Nothing to Disclose

Sub-Events

SSM08-01 Prediction of Overall Survival and Treatment Response in HCC Patients Using Baseline Imaging and Biochemical Biomarkers

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S502AB

Participants
Mounes Aliyari Ghasabeh, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
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PURPOSE

To identify baseline imaging and biochemical factors that would determine prognosis, tumor response to treatment and overall survival in patients with HCC.

METHOD AND MATERIALS

This retrospective, IRB approve HIPAA compliant study included 220 HCC patients between March 2005 and November 2016. Diagnosis was confirmed either pathologically (n=105) or by typical imaging criteria (n = 115). All patients had baseline liver MRI before treatment. Baseline tumor variables were measured including tumor volume, volumetric ADC, and viable tumor volume. Baseline Child score, BCLC criteria, laboratory data, comorbidities and etiology of the liver disease were recorded. Patients were followed until death, or until December 2017. Cox regression models were utilized to identify the impact of clinical and imaging variables on patient survival. Additive value of imaging variables to the BCLC criteria and clinical variables was quantified. Classification and Regression Trees (CART) analysis was performed to predict patient overall survival based on the final model with independent predictive variables.

RESULTS

Among baseline variables BCLC criteria, tumor type (infiltrative vs well vs ill-defined tumors on MRI), tumor volume and viable tumor volume had significant impact on overall patient survival. Adding imaging variables to BCLC significantly increased the accuracy of overall patient survival prediction by 6% (p<=0.001); the number of treatments did not alter the predictive ability of the imaging variables. However, including liver transplantation status in the model with BCLC and imaging criteria significantly improved the accuracy of overall survival prediction by 7% (p<= 0.001), Figure 1. CART analysis showed that patients who received liver transplant had the highest survival. In patients who did not receive liver transplant, those with viable tumor volume <=800 ml3 had higher survival compared to those who had viable tumor volume >800 ml3, Figure 2.

CONCLUSION

In a relatively large sample size of HCC patients we were able to show that in patients who do not receive transplant, viable tumor volume and tumor type were the most important criteria in predicting survival.

CLINICAL RELEVANCE/APPLICATION

Baseline features in HCC patients stratified patients into those who would benefit from management with improved overall survival and those who would not.

Honored Educators

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SSM08-02 Categorization of Indeterminate Nodules in Patients at High Risk of HCC by Quantitative CT-Scan Features

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S502AB

Participants
Fatima-Zohra Mokrane, MD, Toulouse, France (*Presenter*) Nothing to Disclose
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Lawrence H. Schwartz, MD, New York, NY (*Abstract Co-Author*) Committee member, Celgene Corporation Committee member, Novartis AG Committee member, ICON plc Committee member, BioClinica, Inc
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Philippe Otal, MD, Toulouse, France (*Abstract Co-Author*) Nothing to Disclose
Herve P. Rousseau, MD, Toulouse, France (*Abstract Co-Author*) Nothing to Disclose
Binsheng Zhao, DSc, New York, NY (*Abstract Co-Author*) License agreement, Varian Medical Systems, Inc; Royalties, Varian Medical Systems, Inc; License agreement, Keosys SAS; License agreement, Hinacom Software and Technology, Ltd;
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PURPOSE

Radiological categorization of liver nodules is standardized by the AASLD and LIRADS criteria. However, a significant proportion of nodules in cirrhotic livers remains classified as indeterminate. We aimed to improve categorization of indeterminate nodules recognized at CT, in patients at high risk of hepatocellular carcinoma (HCC) through machine-learning.

METHOD AND MATERIALS

We analyzed retrospectively and consecutively 106 pts with indeterminate liver nodules reaching predefined quality criteria: (i) biopsy-proven, (ii) follow-up at our institution, (iii) triphasic CT-scan (non contrast-enhanced 'NCP', arterial 'AP' and portal 'PVP' phases). The volume of HCC was contoured on CT-scans gathered from 2010 and 2015. Model building used Random Forest algorithm and 1.160 quantitative imaging features extracted from NCP, AP, PVP, deltaNCP-AP, deltaAP-PVP, and delta NCP-PVP, respectively. The performance of prediction model was evaluated by the area under the receiver operating characteristic curve (AUC) and ten-fold cross-validation. The Synthetic Minority Over-sampling Technique (SMOTE) was employed to alleviate the sample imbalance problem.

RESULTS

The proportion of HCC in indeterminate liver nodules biopsied was 81%: 86 pts in HCC group and 20 pts in non-HCC group. The model based on DeltaAP-PVP features achieved the highest AUC=0.85. As a comparison, model built on NCP, AP, PVP, DeltaAP-PVP, Delta DeltaNCP-PVP imaging features reached AUCs of 0.73, 0.73, 0.78, 0.71, and 0.72. The 5 most important features were features characterizing lesion contours and homogeneity (DWT1, Gabor, GLCM homogeneity, Laws and RSRE). Non-HCC nodules were composed of dysplastic (n=8), regenerative nodules (n=5), steatohepatitis (n=4), and others (n=3).

CONCLUSION

This study is a proof of concept that quantitative CT interpretation can categorize indeterminate nodules of cirrhotic patients as HCC or non-HCC, with a great precision. We demonstrated that the optimal imaging features characterized the change in lesion contours and homogeneity and allow to differenciate HCC from non HCC.

CLINICAL RELEVANCE/APPLICATION

Noninvasive categorization of indeterminate nodules in cirrhotic patients is feasible. Virtual biopsies using artificial intelligence will improve patients' management for earlier diagnosis of HCC.

SSM08-03 Exploring the Uncharted Realm of Laboratory Radiology: Quantification and Landmark-Based Normalization of Liver Volume

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S502AB

Participants
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PURPOSE

To become meaningful in a clinical context, quantitative imaging-based values, in this case liver volumes, may need to be normalized to reveal their relevance. Here, we evaluate variability of liver volumes and assess methods for normalization using automatically detected osseous and soft tissue body landmarks.

METHOD AND MATERIALS

4578 CT-datasets of 1812 woman and 2766 men were consecutively included. Liver volumes and body landmarks were fully automatically detected using Multi-scale Deep-Reinforcement Learning for 3D body markers detection and Adversarial Deep

Image2Image for 3D liver segmentation. The landmark detection library includes 17 landmarks e.g. th6, liver top and right lung top. Distances between landmark pairs were extracted and Pearson correlation was calculated for landmark-distances/liver volumes. As a measure of normalization effect, the quartile coefficient of dispersion before and after normalization was calculated.

RESULTS

A large spread of liver volumes was found (mean f:1496.4±486.1ml, m:1746.0±571.2ml, total 1647.2±552.7ml). Of all extracted landmark pairs, a high correlation was found between the distance vertebral body th6-l5 and l1-l5 (m/f: r=0.83/0.87) and liver volume. The high correlation between liver volume normalized by the th6-l5 distance and liver volume itself confirms that the normalization step preserves the information (r=0.97/0.95). In parallel, a 68% drop of the quartile coefficient of dispersion using this landmark pair illustrates the highest reduction of the variability within the normalized volume among all available landmarks

CONCLUSION

The large variance of non-normalized liver volumes illustrates the limited potential of liver volume as a measure of disease. The distance between th6 and l5 is a valid candidate for normalization since the thus normalized volume shows little loss of information while reducing substantially the variability

CLINICAL RELEVANCE/APPLICATION

Automatically derived imaging-based reference values, very much comparable to current laboratory medicine, may be helpful to classify an organ as normal or pathological. In future research, the pathological value of thus extracted normalized volumes will be further elucidated.

SSM08-04 Comparison of Magnetic Resonance Elastography and Ultrasound Shear Wave Elastography for Long-Term Monitoring of Direct Antiviral HCV-Treatment

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S502AB

Awards
Student Travel Stipend Award

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PURPOSE

Direct antiviral treatment of chronic hepatitis C virus (HCV) induced liver fibrosis is associated with viscoelastic tissue changes. The purpose of this prospective study is to non-invasively monitor treatment-related liver elasticity changes in HCV-patients over a period of 15 months using magnetic resonance elastography (MRE) and shear wave elastography (SWE).

METHOD AND MATERIALS

In this prospective study a total of 54 MRE/SWE examinations of the liver was performed in 15 patients with chronic HCV infection and biopsy proven liver fibrosis. Patients were treated daily over 3 months with direct-acting antivirals (Daclatasvir/Sofosbuvir). MRE/SWE and laboratory results were obtained at baseline and during a follow-up period after therapy at 3, 6 and 15 months. The results were compared to a healthy control group (CTR, n=7). Multifrequency MRE (1.5 T scanner, Siemens) with tomoelastography postprocessing was performed at 4 frequencies from 30 to 60 Hz. SWE (Aplio500, Canon Medical Systems) based on an ultrasonic burst captured by a 5 MHz convex broadband transducer was employed. Shear wave speed (SWS), reflecting tissue stiffness, was obtained from both MRE and SWE and compared to each other.

RESULTS

Mean time point to reach undetectable viral RNA was 22±13 days. Analysis of repeated measurements of MRE and SWE showed a significant decrease in liver SWS at 6 months (1.56±0.27 m/s; 1.62±0.36 m/s; $p<0.01$) compared to baseline (1.67±0.33 m/s; 2.09±0.68 m/s), being stable at 15 months (1.55±0.26 m/s; 1.63±0.34 m/s; $p<0.05$). Compared to CTR (MRE, 1.36 m/s; SWE, 1.48±0.23 m/s), the patient group showed higher values at baseline and after 3 months (patients vs. CTR: baseline, $p<0.01$; 3 months, $p<0.05$). SWS values from MRE and SWE were highly correlated ($r=0.8$; $p<0.000.1$).

CONCLUSION

Changes in liver stiffness after viral clearance were related to reduction in the inflammatory response. Both, MRE and SWE are sensitive in detecting early changes in hepatic stiffness after direct antiviral treatment.

CLINICAL RELEVANCE/APPLICATION

Mechanical properties obtained from both techniques could be used as non-invasive biomarker for novel antiviral HCV-treatment.

SSM08-05 Individuals with NAFLD Show Stronger Improvements in Liver Function and Insulin Sensitivity Than Individuals without NAFLD upon Dietary Weight Loss

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S502AB

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PURPOSE

Non-alcoholic fatty liver disease (NAFLD) is a driver of insulin resistance and metabolic diseases. The presence or absence of NAFLD in obesity may in part explain the phenomena of metabolically healthy vs. unhealthy obesity. Here, we tested whether individuals with NAFLD at baseline show stronger metabolic improvements upon dietary weight loss with regard to liver function and insulin sensitivity than individuals without NAFLD.

METHOD AND MATERIALS

We used data of the HELENA-Trial, an RCT among 143 non-smokers with BMIs between 25 and 40 kg/m2 at baseline (50 % female). The participants underwent a three-month dietary intervention that induced moderate weight loss (5.0±4.3% on average). MRI-derived liver fat content before and after the intervention was evaluated on a post-processing software (OsiriX, Pixmeo SARL, Bernex, Switzerland) manually using the proton density fat fraction map, based on mean counts from three identical regions of interest. Liver fat values >5.56 % were classified as NAFLD.

RESULTS

Overall, 52.4% of the study participants had NAFLD at baseline; 73.3% of those with NAFLD and 47.1 % of those without NAFLD were obese (BMI values >30 kg/m2). Mean age was 50.0±8.1 years among participants with NAFLD, and 50.1±8.1 years among participants without NAFLD. The prevalence of NAFLD was higher among men (61.1%) then women (43.6%). Diet-induced weight loss was similar in both groups (NAFLD: -5.0±0.6%, No NAFLD: -5.3±0.5%), while the relative decrease in liver fat was significantly greater in the NAFLD group (-50.1±5.7% vs. -11.9±4.2%). Relative decreases in liver function tests (GGT, ALT, AST) and HOMA-IR were also significantly stronger in the NAFLD group. Other metabolic parameters (blood lipids, adipokines, CRP) showed no significant differences between the groups.

CONCLUSION

Our data suggest that individuals with NAFLD show stronger improvements of liver function and insulin sensitivity with moderate diet-induced weight loss than individuals without NAFLD.

CLINICAL RELEVANCE/APPLICATION

With increasing incidence of obesity also NAFLD is increasing. NAFLD is an important entity as it can progress in NASH and advanced liver disease and therefore intervention to stop development of NAFLD and NASH is crucial.

SSM08-06 Association Between 3D Radiomic Features and Size of Hepatic Metastasis in Breast Cancer

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S502AB

Participants
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PURPOSE

To evaluate the effect of the size of the hepatic metastasis in patients with breast cancer on 3D radiomic imaging features.

METHOD AND MATERIALS

This HIPAA compliant retrospective study was IRB approved. CT scans of 81 liver metastases from 54 patients with breast cancer were evaluated. To exclude imaging variability, the same CT scanner and imaging protocol were used. 3D radiomic features from the histogram and gray level co-occurrence matrix (GLCM) categories were calculated for the normal liver and hepatic metastasis. The effect of size (tumor volume) was evaluated by using linear mixed-effects regression models with variable slopes and intercepts. The tumor size and the treatment period were considered as independent variables. If the slope of the regression was significantly ($P < 0.05$) different between the normal liver and hepatic metastasis, then the effect of the size was considered to be significant.

RESULTS

3D radiomic features from GLCM demonstrate tumor-size dependence. In particular, Homogeneity (log model, $P < 0.001$), Energy

(power model, P < 0.03), Contrast (power model, P < 0.001), Correlation (log model, P < 0.001), Entropy (log model, P < 0.024) and Dissimilarity (power model, P < 0.001) show statistically significant size dependence.

CONCLUSION

Radiomic imaging features from the major texture feature category demonstrate statistically significant size dependence in breast cancer hepatic metastasis. This finding demonstrates the complex behavior of imaging features and the need to include feature specific properties into radiomic models.

CLINICAL RELEVANCE/APPLICATION

Radiomic features of breast cancer hepatic metastasis may be affected by tumor size. Caution should be exercised when directly comparing radiomic features of different size tumors.

Honored Educators

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RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSM09

Gastrointestinal (Gallbladder and Bile Ducts)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S503AB

CT GI MR US OI AI

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Alice W. Fung, MD, Portland, OR (*Moderator*) Nothing to Disclose
Benjamin Wildman-Tobriner, MD, Durham, NC (*Moderator*) Nothing to Disclose

Sub-Events

SSM09-01 Apparent Diffusion Coefficient as a Potential Marker for Tumor Differentiation, Staging, and Long-Term Clinical Outcomes in Gallbladder Cancer

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S503AB

Participants
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PURPOSE

To evaluate the correlation between tumor differentiation or stage of gallbladder cancer (GBC) and the apparent diffusion coefficient (ADC), as well as to assess whether ADC value can predict long-term disease-free survival (DFS) after surgery.

METHOD AND MATERIALS

This retrospective study was approved by the Institutional Review Board and the requirement for informed consent was waived. Between March 2008 and June 2016, 79 patients who underwent magnetic resonance (MR) imaging with diffusion-weighted image and subsequent surgery for GBC were included in this study. Correlations between quantitative ADC values, and tumor differentiation or stage based on the American Joint Committee on Cancer (AJCC) were assessed using Spearman's correlation analysis. Prognostic factors for DFS were identified with multivariate Cox regression analysis using imaging and clinical characteristics.

RESULTS

All patients were classified as having well- (n = 18), moderately- (n = 35), or poorly-differentiated GBCs (n = 26). The ADC value of GBCs was significantly correlated with tumor differentiation and AJCC stage ($p < 0.001$ and $p < 0.001$, respectively). Sixty nine patients were followed up for 2.0-92.4 months (median, 23.5 months). On multivariate analysis, the significant prognostic factor for DFS was not tumor differentiation or AJCC stage, but a binary tumor ADC value (hazard ratio, 4.29, $p = 0.009$).

CONCLUSION

The ADC value of GBCs was significantly correlated with tumor differentiation as well as AJCC stage. In addition, it predicted long-term outcomes after surgery in patients with GBC.

CLINICAL RELEVANCE/APPLICATION

Tumor recurrence after curative surgical resection in patients with GBC could be predicted by using ADC values on diffusion-weighted images preoperatively.

SSM09-02 Is the MR Contrast Agent Gadoxetate Disodium Suitable for CT Cholangiography?

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S503AB

Participants
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PURPOSE

Gadoxetate disodium (Eovist®), a Gadolinium-based contrast agent, is primarily used in MR, with an FDA approved dose limit of 0.1 mL/kg. The purpose of this work is to determine whether low doses of gadoxetate disodium can be visualized for CT cholangiography using a phantom setup.

METHOD AND MATERIALS

Vials containing four concentrations of gadoxetate disodium (9.6, 4.8, 3.4, and 1.9mgGd/ml) were placed in a 35x26cm2 water phantom and imaged on two CT scanners: Siemens Somatom Flash and Force (Siemens Healthcare, Erlangen, Germany). These concentrations correspond to the dose limit for a 200, 100, 70, 40kg patient, respectively. Single-energy (SE) scans were acquired at 70, 80, 90, 100, 120, and 140kVp. Dual-energy (DE) scans were acquired at 90/150Sn (Force) and 100/150 (Flash) for two dose levels (13 and 23 mGy). Virtual monoenergetic images at 50keV were created (Mono+, Siemens). The mean intensity and standard deviation for each concentration of gadoxetate disodium and the water background were extracted from each image set. To determine whether the signal provided by gadoxetate disodium was sufficient for clinical imaging, the contrast, noise, and contrast-to-noise ratio (CNR) were compared to measurements acquired from 12 clinical CT cholangiography exams performed with iodine-containing iodipamide meglumine.

RESULTS

From the retrospective clinical cohort, mean contrast (± standard deviation) of 239±107HU and CNR of 12.8±4.2 were found in the bile duct relative to the liver. Comparing these metrics to the gadoxetate disodium samples, the highest concentration (9.6mgGd/ml) surpassed these thresholds at all energy levels. The 4.8mgGd/ml had sufficient CNR in the Force, but not in the Flash. The 3.4mgGd/ml had clinically relevant CNR at low kV of SE (<100kVp) and 50 keV of DE in the Force but was insufficient in the Flash. Images acquired by the Force had a lower noise level and greater CNR compared to the Flash. Similar trends were seen at both dose levels.

CONCLUSION

Gadoxetate disodium shows promise as a viable contrast agent for CT cholangiography, with CNR similar to those seen clinically with an iodine-based contrast agent. DE CT or low kV SE CT is helpful to enhance the signal.

CLINICAL RELEVANCE/APPLICATION

Gadoxetate disodium, a Gadolinium-based hepatobiliary contrast agent, shows promise as a CT cholangiography contrast agent with contrast-to-noise ratios similar to iodine contrast-enhanced CT.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Sudhakar K. Venkatesh, MD, FRCR - 2017 Honored Educator

SSM09-03 CT and Ultrasound for the Diagnosis of Cholecystitis in the Adult Emergency Department: A Comparison of Accuracy and Incremental Value Offered By Each Modality Over the Other

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S503AB

Awards
Student Travel Stipend Award

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PURPOSE

To compare the diagnostic accuracy and relative value of CT and ultrasound (US) in the workup of cholecystitis in adult emergency department (ED) patients.

METHOD AND MATERIALS

A retrospective chart review conducted over a 5 year period identified adult ED encounters for right upper quadrant pain where patients were evaluated with CT and/or US. Those with prior cholecystectomy, current pregnancy, and acute trauma were excluded. Imaging studies were assessed for the reported presence of gallstones, gallbladder distension, wall thickening, and pericholecystic fluid/inflammation. A positive suspicion for cholecystitis required at least two findings, or a positive sonographic Murphy's sign with at least one additional finding. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for each modality based on linked clinical, surgical, and pathology data. When both US and CT were performed, the second modality was determined to add value if it correctly identified cholecystitis when the first study was incorrect or provided a non-gallbladder alternative diagnosis for acute abdominal pain. The second study was determined to detract value if it was incorrectly positive or negative for cholecystitis when the first study was correct.

RESULTS

3495 ED encounters were reviewed, with 2859 meeting inclusion criteria. 91% of patients had one or more imaging studies performed, with US performed in 81%, CT performed in 30%, and both US and CT performed in 20%. 559 patients went on to cholecystectomy with pathology results available for 540. For US and CT, respectively: sensitivity 48% and 53%, specificity 93% and 93%, PPV 65% and 58%, and NPV 88% and 92%. Only NPV represented a statistically significant difference. When performed after CT, US added value in 8% and detracted value in 6% of cases. When performed after US, CT added value in 35% and detracted value in 2% of cases.

CONCLUSION

In this patient cohort, imaging diagnosis of cholecystitis by CT was non-inferior to the more commonly utilized gold standard of US. There was also little added value for use of US after already obtaining a CT.

CLINICAL RELEVANCE/APPLICATION

CT performance in the diagnosis of cholecystitis is essentially equivalent to ultrasound and has an advantage in supplying additional information for adult ED patients presenting with right upper quadrant pain.

SSM09-04 Development and Validation of Deep Learning Based Clinical Decision Supporting System for the Diagnosis of Neoplastic Gallbladder Polyps Using High Resolution Ultrasonography: Preliminary Results

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S503AB

Awards
Student Travel Stipend Award

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PURPOSE

To investigate the added value of the deep learning based clinical decision supporting system for the differential diagnosis of neoplastic gallbladder (GB) polyps using high resolution ultrasonography (HRUS)

METHOD AND MATERIALS

We retrospectively collected 337 patients with GB polyps (>4 mm) proved by cholecystectomy. They were divided into training set (239 patients) and test set (98 patients) according to the time period. Based on pathology, all images of polyps (neoplastic: 1822 images in 137 patients, non-neoplastic: 2058 images in 200 patients) were manually cropped into a square box containing the polyp and labeled as either neoplastic or non-neoplastic. The binary classification convolutional neural network model was constructed by transfer learning based on Inception-v3 architecture. Using test set, two radiologists with different experience level, retrospectively graded the possibility of neoplastic polyp using a 5-point confident scale. After providing model's probability value on the test set for each patient, reviewers requested to re-evaluate the grade. Diagnostic performances were measured by ROC analysis and sensitivity, specificity, and accuracy were calculated.

RESULTS

For the diagnosis of neoplastic polyp, model itself provided AUC 0.920, sensitivity 82.1%, specificity 88.1%, accuracy 85.4% with optimal cut off >0.503 in training set and AUC 0.903, sensitivity 80.5%, specificity 85.3%, accuracy 82.8% with optimal cut off >0.726 in test set. On the first review, highly and less experienced reviewers showed AUC 0.944 and 0.775; sensitivity 88.6% and 71.4%; specificity 85.7% and 68.2%; accuracy 86.7% and 69.4%, respectively. On the second review with the supporting system, less experienced reviewer's AUC was improved from 0.775 to 0.859 (p=0.0513), whereas, highly experienced reviewer's AUC showed no significant change (0.944 to 0.940).

CONCLUSION

Our preliminary results suggest that deep learning based clinical decision supporting system for differential diagnosis of neoplastic GB polyp is helpful for improving diagnostic performance, especially in less experienced readers.

CLINICAL RELEVANCE/APPLICATION

Differential diagnosis of neoplastic GB polyp is important as it has a malignant potential. Our decision supporting system can improve the diagnostic performance of radiologists using HRUS.

SSM09-05 Differentiation Between Gallbladder Premalignant or Malignant Polyps and Cholesterol Polyps Using Contrast-Enhanced Ultrasound: Preliminary Study

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S503AB

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PURPOSE

To differentiate between gallbladder (GB) premalignant or malignant polyps and cholesterol polyps using contrast-enhanced

ultrasound (CEUS).

METHOD AND MATERIALS

From September 2017 to March 2018, 20 patients with large GB polyps (>= 1 cm) who were scheduled to undergo cholecystectomy were prospectively enrolled. All patients underwent conventional US including color Doppler and CEUS prior to surgery. CEUS was performed using a LOGIQ E9 US scanner (GE Healthcare) after an injection of 2.5 ml of SonoVue® for 1 minute. After CEUS, perfusion US parameters including peak enhancement, mean transit time, fall time (FT), wash-in rate (WiR), and wash-out rate (WoR) were obtained using VueBox® software. Patients were separately classified into the cholesterol polyp group (n = 6) and premalignant or malignant polyp group (n = 14) according to the final histopathology. All US features and quantitative CEUS parameters between the two groups were compared using the Mann-Whitney U test. Diagnostic performances of the parameters were assessed using receiver operating characteristic (ROC) analysis.

RESULTS

Among US imaging features, there were significant differences in lesion size (2.20 cm for adenomatous polyps and 1.18 cm for cholesterol polyps) and internal homogeneity between the two groups (P<0.05); internal homogeneity was more commonly found in cholesterol polyps (5/6, 83%) than in malignant polyps (4/14, 28%). On quantitative analysis of CEUS parameters, FT and WoR demonstrated significant differences between the two groups (P<0.05), i.e., premalignant or malignant polyps showed significantly longer FT (12.74 sec) and smaller WoR (183.3 arbitrary units [a.u]) than cholesterol polyps (5.37 sec and 1068.3 a.u). On ROC analysis, an area under the curve (AUC) of 1.00, 100% (14/14) sensitivity, and 100% (4/4) specificity were demonstrated when the cut-off value was set at 9.62 sec for FT; and WoR yielded an AUC of 0.89, sensitivity of 100% (14/14), and a specificity of 75% (3/4) using a cut-off value of 784.4 a.u.

CONCLUSION

CEUS can be useful for the differentiation of premalignant or malignant GB polyps from cholesterol polyps >= 1 cm.

CLINICAL RELEVANCE/APPLICATION

CEUS can help distinguish premalignant or malignant GB polyps from cholesterol polyps >= 1 cm, thereby aiding in the selection of an optimal management option for large GB polyps.

SSM09-06 Fully Automated Detection of Primary Sclerosing Cholangitis (PSC) in 3D-MRCP Images Using Deep Learning

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S503AB

Participants
Hinrich B. Winther, MD, Hannover, Germany (*Presenter*) Nothing to Disclose
Van Dai Vo Chieu, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose
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Jens Vogel-Claussen, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose
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Kristina I. Ringe, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To automatically detect PSC-typical cholangiographic changes in 3D-MRCP images.

METHOD AND MATERIALS

428 patients (m = 274 / w = 154, age 42.5 ± 18.5 years) who underwent liver MRI including 3D MRCP were included in this retrospective study. The study population consisted of 206 patients with confirmed PSC (based on clinical, typical cholangiographic and confirmatory histologic findings) and 222 patients in whom this diagnosis was excluded. The patients were randomized into a training (n = 386) and validation group (n = 42). For each individual case, 20 uniformly distributed axial MRCP rotations, covering a total of 180°, were calculated, followed by a maximum intensity projection (MIP). This resulted in a training record of 7720 and a validation record of 840 2D images. An Inception ResNet (Inception-v4 arXiv: 1602.07261) was trained, which was initialized with weights previously learned from ImageNet. Finally, we fine-tuned the entire network with a small learning rate of 10-5.

RESULTS

The mean absolute error (MAE) on the validation record was 30% and therefore insufficient. This value could be improved to 7.1% (3/42) by applying an ensemble strategy. For this purpose, the 20 related MRCP projections of each patient were binned and a majority vote was conducted. With this approach, sensitivity, specificity, positive predictive and negative predictive value for the detection of PSC-typical cholangiographic changes were 95.0%, 90.9%, 90.5%, and 95.2% respectively.

CONCLUSION

The results of this study demonstrate the feasibility of transfer learning to detect PSC-typical cholangiographic changes in 3D MRCP images with an MAE of ~7%. Further validation with more and multicentric data should be made, as experience shows that neural networks tend to overfit the characteristics of the dataset.

CLINICAL RELEVANCE/APPLICATION

Automatic detection of PSC typical changes at MRCP may improve early detection and aid in follow-up imaging, especially of subtle changes.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSM10

Genitourinary (Pelvic Ultrasound: Male and Female)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E353A

GU US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Mary C. Frates, MD, Sharon, MA (*Moderator*) Nothing to Disclose
Harris L. Cohen, MD, Memphis, TN (*Moderator*) Nothing to Disclose

Sub-Events

SSM10-01 Contrast Enhanced Ultrasound (CEUS) of Intra-Testicular Lesions: Inter-Observer Variation in the Assessment of Non-Neoplastic versus Neoplastic Abnormalities

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E353A

Participants
Phillip Lung, Middlesex, United Kingdom (*Abstract Co-Author*) Advisory Board, Takeda Pharmaceutical Company Limited; Speaker, Siemens AG
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PURPOSE

To assess the additional benefit of microbubble ultrasound contrast agents (UCA) over conventional ultrasonography (US) to differentiate between neoplastic and non-neoplastic intra-testicular abnormalities among observers with various levels of experience in contrast enhanced ultrasound (CEUS).

METHOD AND MATERIALS

Seven blinded observers divided into experienced (n=3, 7-9 years experience) and inexperienced groups (n=4, 2-3 years experience) retrospectively reviewed testicular B-mode/color Doppler images and repeated this one month later with the addition of CEUS images. Observers rated each testicular lesion on a 5-point scale: 1-definitely non-neoplastic; 2-likely non-neoplastic; 3-don't know; 4-likely neoplastic; 5-definitely neoplastic. Electronic medical records were reviewed for histological results (n=59) and follow up US (n=32). Inter-observer agreement was calculated using kappa statistics and AUROC/Sensitivity/Specificity compared using McNemar test.

RESULTS

Ninety patients with 91 lesions, neoplastic (n=46) and non-neoplastic (n=45), were accessed from a database from 2008-2013. Overall, specificity (73.7% vs 54.9%, p<0.001), PPV (77.6% vs 67.8%, p=0.001), accuracy (81.6% vs 74.1%, p<0.001) were better with the addition of UCA, at the expense of slightly reduced sensitivity (89.4% vs 92.3%, p=0.04). Subgroup analysis showed that the addition of CEUS images significantly improved diagnostic specificity and accuracy for both experienced (Specificity: 71.1% vs 59.3%, P=0.005; Accuracy: 83.5% vs 76.9%, P=0.003) and inexperienced reader groups (Specificity: 75.6% vs 51.7%, p=0.005; Accuracy: 80.2% vs 72.0%, P<0.001). Significant inter-observer variability between experienced and inexperienced observer groups were observed for conventional US (Kappa 0.51 vs 0.68 respectively; p=0.03), but this was not detected with the additional of CEUS (Kappa 0.60 vs 0.69 respectively; p=0.24).

CONCLUSION

The addition of CEUS not only significantly improves the accuracy of subjective interpretation for both experienced and inexperienced blinded observers, but also eliminates variability between the two observer groups with different experiences.

CLINICAL RELEVANCE/APPLICATION

The use of CEUS in addition to conventional US improves diagnostic accuracy of differentiating neoplastic and non-neoplastic

intratesticular lesion, potentially reducing unnecessary orchidectomies.

SSM10-02 Cause of Avascular Hypoechoic Testicular Lesions Detected at Scrotal Color Doppler Ultrasound: Can They Be Considered Benign? Correlation with Histological, Clinical and Contrast-Enhanced Ultrasound (CEUS) Imaging Findings

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E353A

Participants
Dean Y. Huang, FRCR, London, United Kingdom (*Presenter*) Nothing to Disclose
Majed R. Alsadiq, MD,FRCR, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purposes of this study were to determine the cause of avascular lesions detected at scrotal color Doppler ultrasound (CDUS) with histological and clinical correlations and to assess the added value of contrast-enhanced ultrasound (CEUS) in identifying benign testicular lesions.

METHOD AND MATERIALS

This retrospective study included 113 focal testicular lesions detected with CDUS and further assessed with CEUS. The sonographic features recorded were lesion size, the presence of focal calcification, and presence or absence of vascularity on CEUS. Also recorded were patient age, symptoms, and levels of serum tumor markers. The reference standard was histopathologic results or at least at least 6 months documented stability with serial follow-ups. Sonographic and clinical features associated with malignant, including 'burnt-out' tumors, and benign lesions were examined.

RESULTS

Of the 113 avascular lesions on CDUS, 6 (5.3%) were malignant and 107 (94.6%) were benign. 2 of the 6 patients (33.3%) with malignant lesions had elevated serum tumor marker levels. Histologically, malignant lesions include mixed germ cell tumors and 'burnt-out' tumors with metastatic lymphadenopathy. The size of a lesion or presence of calcification were not significantly associated with either the benign or the malignant nature of a lesion. 18 lesions (17.6%) showed enhancement on CEUS despite lack of signal on CDUS. Enhancement was demonstrated on CEUS in all 6 of the 6 malignant lesions (100%). The remaining lesions which demonstrated enhancement on CEUS include pathologies such as sarcoidosis, post-biopsy change, intra-testicular adenomatoid tumour, focal scarring with history of previous orchiopexy, and focal atrophy in a patient with Klinefelter syndrome. All 95 of 95 lesions with no enhancement on CEUS were of benign nature.

CONCLUSION

Although most avascular testicular lesions on CDUS are benign, our experience suggests that caution should be made in assuming benignity when a testicular lesion demonstrates no vascularity on CDUS. A proportion of these lesions are malignant and demonstrate vascularity with CEUS, which could improve diagnostic confidence for the benign nature of testicular pathologies.

CLINICAL RELEVANCE/APPLICATION

Caution should be made in assuming benignity lesions demonstrate no vascularity on CDUS. CEUS improves detection of vascularity and adds value to conventional CDUS in assessing testicular lesions.

SSM10-03 The Audiovisual Sexual Stimulation during Penile Duplex-Doppler Ultrasound: Is it a Tool to Avoid False-Positive Diagnostic of Venous Leak?

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E353A

Participants
Felipe Carneiro, MD, Sao Paulo, Brazil (*Presenter*) Nothing to Disclose
Jose Cury, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose
Maria Cristina Chammas, MD,PhD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Erection is a neurovascular phenomenon under hormonal control. It involves arterial dilatation, trabecular smooth muscle relaxation and activation of the corporeal veno-occlusive mechanism. Penile Duplex-Doppler ultrasound (PDDU) with intracavernous injection (ICI) is the first-line diagnostic modality used to determine the subtype of vasculogenic erectile dysfunction (ED). Unfortunately, anxiety and other psychological inhibitions may hinder the optimal response of cavernous arteries relaxation imparing the veno-occlusive mechanism leading to possible false venous leak diagnostic. Several methods to assist PDDU in order to avoid false-positive results have been suggested, including audiovisual sexual stimulation (AVSS). The purpose of the present study is to assess the use of AVSS in combination with PDDU in vasculogenic ED.

METHOD AND MATERIALS

Prospective study on adult patients with ED that were referred to PDDU by Urology Department. Twenty seven men (mean age =

62.7 years, range 26 to 80 years) were enrolled in the study. Each patient underwent 2 PDDU sessions. During session 1, patients were injected with ICI (20 µg of alprostadil) and after 5 minutes submitted to PDDU. During session 2, after the ICI injection, patients watched a 4 minute erotic movie before PDDU. The interval between the 2 sessions was 7 days. Cavernous artery flow was considered normal when peak systolic velocity (PSV) was >30 cm/s, while the corporeal veno-occlusive function was considered normal when ending diastolic velocity (EDV) was <5 cm/s) and resistant index (IR) >0.9. Penile vascular parameters were monitored and recorded before ICI administration, and 5, 10, 15 and 20 min after ICI.

RESULTS

The mean cavernous artery diameter was higher in session 2 (p = 0.003). The mean cavernous artery systolic velocity was higher in session 2 in the moment 15 and 20 minute (p= 0.022 and p= 0.026). The mean artery resistant index was higher in session 2 in the moment 15 minute (p = 0.043).

CONCLUSION

The AVSS improves smooth muscle relaxation of cavernous arteries and penile blood flow. Therefore, it is a good tool to avoid false-positive diagnostic of venous leak.

CLINICAL RELEVANCE/APPLICATION

AVSS during PDDU with ICI can improve penile blood flow and is recommended in all cases manly on anxious patients. The real venous leak has bad prognosis but the psicogenic ED (false venous leak) can be treated clinically. Diferenciate both is mandatory.

SSM10-04 Can Shear Wave Elastography of Endometrial and Subendometrial Lesions Provide Additive Information: Initial Experience

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E353A

Participants
Zainab A. Vora, MBBS, New Delhi, India (*Presenter*) Nothing to Disclose
Smita Manchanda, MD, Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Raju Sharma, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

-Evaluate the normal sono-elastographic characteristics of endometrium and its variability with menstrual phase-Investigate the role of Shear Wave Elastography (SWE) in distinguishing benign and malignant endometrial and subendometrial masses.

METHOD AND MATERIALS

A total of 110 women were enrolled in this ethically approved prospective study, and they were divided into two groups:Group I-55 women with pathologically proven endometrial masses, including 27 cases of endometrial carcinoma, and 28 cases of benign lesions (9-endometrial hyperplasia, 5-endometrial polyp and 5-focal adenomyoma, 9-submucosal fibroid)Group II- 56 women with normal endometrium (14 women each in menstrual, proliferative, secretory and post-menopausal phase)All patients underwent transvaginal ultrasound including B-mode and real time SWE (SuperSonic Aixplorer ultrasound system). The variability of mean elasticity value (in kPa) of endometrium in different menstrual phases and the difference in elasticity value of normal endometrium and various pathological sub-groups in Group I was analysed.

RESULTS

Normal endometrium (n=56) showed a mean elasticity value of 25.54 ± 8.56 kPa. There was no significant difference (p-0.227) in the mean elasticity value in women in different menstrual phases. In the evaluation of endometrial and subendometrial pathologies, the mean elasticity values of submucosal fibroid, focal adenomyoma and polyp were significantly (p<0.01) different from normal endometrium. However, there was no significant difference in the elasticity value of normal endometrium versus carcinoma (p-0.276), and carcinoma versus hyperplasia (p-0.191).

CONCLUSION

SWE is not useful to distinguish normal endometrium from hyperplasia or carcinoma. However, significantly different elasticity values obtained in case of submucosal fibroid, endometrial polyp and focal adenomyoma can be useful in confidently diagnosing these pathologies.

CLINICAL RELEVANCE/APPLICATION

This study shows that SWE, as an adjunct to ultrasound may play a role to increase the specificity of diagnosis of certain endometrial pathologies like submucosal fibroid and endometrial polyp and help to appropriately triage patients for more invasive testing. However, it is not a reliable tool to distinguish normal endometrium from carcinoma or hyperplasia.

SSM10-05 Diagnostic Pitfall for Early Complete Hydatidiform Mole by Transvaginal Ultrasound: A Large Cohort Study

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E353A

Participants
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PURPOSE

With the availability of hCG and transvaginal ultrasound, CHM diagnosis is typically made in the first trimester, rather than in the second trimester over the past two decades, which makes the difficulty of correct diagnose due to the lack of understanding about early features. In our study, we revealed sonographic features of early CHM in large cohort study, to improve the diagnose accuracy.

METHOD AND MATERIALS

This study included 337 retrospective and 182 prospective cases of histologically proven CHM in the first trimester in our institute 2003 to 2017. In additional, 519 missed abortion patients were matched with CHM cases on ultrasound scan date. The data were recorded: age, gestational age, the serum hCG level before evacuation, the sonographic features (the length, width and anteroposterior diameter of uterus and cavity mass, the extent of vesicular area, lutein ovarian cyst). The volume was calculated using the prolate ellipsoid formula. The software used for statistical analysis was SPSS 19.0 for Mac.

RESULTS

Among all CHM cases (mean gestational age 64.2±7.2 days), 335 cases (64.5%) were correctly diagnosed on the basis of the initial sonographic examination, but almost (94.6%, 105/112) cases of gestational age <42 days could not be made a definitive diagnose. Compared with missed abortion, the higher serum hCG level, the larger volume of uterus and cavity mass, the more severe extent of vesicular area were the significant index for CHM (all $p<0.05$). However, on the time scale of gestational age, the 95% confidence interval of four index in CHM overlapped with missed abortion group at the certain time points (such as before 42 days). Thus, it was hard to distinguish two entities in very early pregnancy by initial ultrasound exam. Among the 184 suspicious cases, 104 cases made a second scan 7 days later, the volume of cavity mass in CHM (42 cases) increased 2.3±0.9 fold, significantly higher than 1.6±1.0 fold in the missed abortion group (62 cases) ($p<0.05$)

CONCLUSION

The ultrasound diagnostic pitfall exists in early CHM, especially in the gestational age <42 days. For the case with suspicious findings in the initial ultrasound, the second scan after 7 days could help to improve the diagnose power for early CHM.

CLINICAL RELEVANCE/APPLICATION

The second ultrasound scan after 7 days is an easy method to improve the diagnose power for early CHM on the cases with suspicious findings in the initial exam.

SSM10-06 Sonographic Detection of Ovarian Cancer in Adnexal Cysts: Comparing IOTA Simple Rules, SRU Guidelines, and Original Radiologists' Interpretation

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E353A

Participants
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PURPOSE

To evaluate the performance of the IOTA group simple rules, the SRU consensus statement guideline criteria and the original radiologist's report for detecting ovarian malignancy in women with adnexal cystic lesions presenting to academic radiology departments.

METHOD AND MATERIALS

An IRB-approved retrospective multicenter cohort study of ultrasound-detected adnexal cystic lesions with appropriate follow up was conducted. Lesions were classified into benign, indeterminate, or malignant categories according to criteria based on the IOTA simple rules, SRU guidelines and the original radiologist's report. The prevalence of non-neoplastic cysts, neoplasms, and malignant tumors was calculated. Sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV), accuracy and ROC analysis for the diagnosis of malignancy were performed.

RESULTS

697 women with 764 cystic lesions were included: 85.2% (651/764) were non-neoplastic, 12.2% (93/764) were benign neoplasms and 2.6% (20/764) were malignant. Nearly all malignancies were classified by imaging into indeterminate (7-10/20) or malignant (10-13/20) categories. The sensitivity/specificity/PPV/NPV/accuracy for malignancy were: IOTA = 90%/96.5%/29%/99.8%/96.4%, SRU = 100%/89.6%/14.9%/100%/89.8% and radiologist's report = 100%/82%/7.6%/100%/82.3%. From the ROC analysis, the performance of both the IOTA simple rules and SRU guidelines was superior to the original radiologist's report ($p<0.0001$).

CONCLUSION

All imaging classification methods evaluated were sensitive for identifying potential ovarian malignancies on ultrasound. Nearly all malignancies were classified into the malignant or indeterminate imaging categories. The PPV was low in a general population of women presenting to academic radiology departments and the appropriate management of indeterminate cystic lesions remains an open question warranting further investigation.

CLINICAL RELEVANCE/APPLICATION

Image-based classification systems are sensitive in detecting ovarian cancer; the PPV is low in our patient cohort and considering other clinical/imaging data may improve the PPV.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Katherine E. Maturen, MD - 2014 Honored Educator

SSM11

Science Session with Keynote: Health Service, Policy and Research (Patient and Family-Centered Care)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S403B

HP

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 0

Participants
Martha G. Menchaca, MD, PhD, Brookfield, IL (*Moderator*) Nothing to Disclose
Keith D. Herr, MD, Atlanta, GA (*Moderator*) Nothing to Disclose

Sub-Events

SSM11-01 Health Service, Policy and Practice Keynote Speaker: Patient and Family Centered Care

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S403B

Participants
Jason N. Itri, MD, PhD, Winston-Salem, NC (*Presenter*) Nothing to Disclose

SSM11-02 The Value of Real Time Thoracic Radiology Consulting in an Integrated Lung Center Clinic: Bringing the Radiologist to the Center of Multidisciplinary Health Care

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S403B

Participants
Eduardo J. Mortani Barbosa JR, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
Sean Novak, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

We have established an integrated thoracic radiology reading room within a multidisciplinary Lung Center clinic (LC). While our subjective experience has been positive, we sought to quantify how this model affects radiology workflow and whether the referring practitioners perceive value in having real time access to a radiologist consultant

METHOD AND MATERIALS

One attending thoracic radiologist and one trainee continuously staffed the LC on regular work hours on a daily schedule. We assessed the impact on workflow by recording over six months the number, duration and type of face-to-face radiology consultations to LC practitioners. We also conducted an anonymous survey to assess how LC practitioners felt regarding the utility and value of our service.

RESULTS

Face-to-face consultations account for an average of 10% of total time spent by radiologists in the LC, though on busy clinical days this can reach 25-30%. Our survey response rate was very high (86.4%, n=51), with overwhelming positive response by referring practitioners, who unanimously rate the usefulness of this service as high (9.8%) or extremely high (90.2%). Not a single respondent had a negative or even neutral view of this service. Moreover, 90.2% thought that radiology consultations directly add clinical value in greater than 60% of episodes, whereas 86.2% responded that these alter management in greater than 40% of episodes.

CONCLUSION

Face-to-face radiology consultations in an integrated LC are numerous and comprise a sizable share of radiologist workload, but are not compensated under the current fee for service payment model. More importantly, the radiologist is highly praised as a consultant and this service is considered valuable and impactful for patient care.

CLINICAL RELEVANCE/APPLICATION

The integrated radiology practice setup we proposed can be implemented in most facilities across the country, however it will be crucial to steer the payment model away from emphasizing volume to emphasizing quality, effectiveness and clinical impact. The radiologist as a consultant is at the same time the future of our specialty and also a return to a past in which the interaction of radiologists and referring practitioners was the foundation of diagnosis and medical decision-making.

SSM11-03 Online-Results in Mammography: Do Patients Really Want to Wait?

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S403B

Participants
Kerri Vincenti, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
Dayna Levin, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Junjian Huang, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

According to the American College of Radiology, all women, beginning at the age of 40 years old, should undergo yearly screening mammograms to aid in the detection of clinically occult breast cancers. Most women are contacted with the results of their examinations by postal service or by viewing their electronic medical record. Timing of results varies by institution from same day to several days following exam. Additionally, if an abnormality is detected, patients typically have to schedule additional workup for a later date. At our institution, all patients who undergo a screening mammogram receive online-results (patients wait for a radiologist to provide in-person results prior to leaving the breast center). Additionally, for women who need to undergo additional workup, our practice contacts referring physicians for additional imaging authorizations (if not conditionally ordered) for follow up imaging (diagnostic mammography with or without ultrasound). We aimed to query screening patients in the breast center to determine if the use of same-day and in-person results reduces their reported anxiety level. Additionally, we wanted to increase our understanding of patient preferences with regards to timing of results and who provides the results accounting for various demographic factors such as age, income level and ethnicity.

RESULTS

There were a total of 919 respondents to the survey during the study period. 680 patients completed the survey in its entirety (74%). Of the 680 patients with complete responses, most patients reported that they preferred to wait for results 64% (n = 437). 25% reported that it depended on wait time (n = 168)and only 8% preferred not to wait (n = 51). Most (65%) respondents did not have a preference with who provided results (n =441). For the remaining 239 patients who indicated a preference, the majority (90%) preferred to receive results from an attending or resident physician (n = 214) as opposed to a technologist or nurse. When queried about the prospect of a same-day biopsy, slightly more than half of patients stated that they would prefer a same day procedure (n = 364). Approximately one third of patients indicated that they would not want a biopsy performed on the same day (n = 197). The remaining patients indicated no preference. Most (68%) respondents indicated that their level of anxiety was decreased as a result of receiving same day results (n = 461). Responses did not vary significantly by age, income level, or ethnicity. The majority of patients indicated they preferred yearly mammographic screening (n = 542). Patients ranged in age from 31 to 86, with a median age of 56. The majority of patients were white 70% (n = 475), followed by African American 23% (n = 158), Asian 4% (n = 24), Hispanic 3% (n = 19) and other 1% (n = 4).

CONCLUSION

There are approximately 325,000 new cases of breast cancer diagnosed each year. The use of screening mammography aids in the detection of cancers before they become clinically evident and has been proven to decrease breast cancer mortality by over 30%. The United States Preventative Taskforce (USPTF) has criticized the use of yearly mammograms based on the 'harms of screening' including excess anxiety from false positive results, which includes the need for additional diagnostic imaging to further assess suspected abnormalities. As radiologists, we should aim to improve our practice patterns and workflow to reduce this anxiety when possible. Offering online-results and the opportunity to perform additional tests/interventions has the potential to decrease the degree of anxiety for patients. While this may require additional time on the part of the radiologist to provide results to waiting patients, this model allows patients to engage in face-to-face interactions with radiologists and offers opportunities for patients ask questions and gain a better understanding of their results. For our practice, the use of online-results has allowed radiologists in our breast center provide a service that we believe adds value to the patient care experience.

METHODS

The study was conducted following IRB Waiver for Human Subjects research. Questionnaires were given to all screening patients entering the breast center over a 2 week time period. Closed-ended questions were given related to preferences of wait time and regading who delivered test results. Patients were also asked about whether they preferred a same day biopsy option. Patients were also asked if received same day results reduced their level of anxiety. One question focused on patient preferences regarding how often to be screened with mammography. For demographic information, patients were given a closed-ended question regarding income and open-ended questions for age and ethnicity (sample survey included in PDF). Results were organized in an Excel spreadsheet and responses were coded into ordinal data. Any patients who did not answer all questions on the survey were excluded from analysis.

PDF UPLOAD

http://abstract.rsna.org/uploads/2018/18011727/18011727_bzb2.pdf

SSM11-04 A Contemporary Survey of Patient and Referring Physician Preferences for Direct Radiologic Reporting of Results

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S403B

Participants
Janice Thai, MD, Staten Island, NY (*Presenter*) Nothing to Disclose
Raina Josemon, BS, Staten Island, NY (*Abstract Co-Author*) Nothing to Disclose
Shrita Smith, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose
Jose Morey, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Arnold Brenner, DO, Staten Island, NY (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To identify contemporary preferences of patients and referring physicians for direct patient communication and notification of results by the radiologist.

RESULTS

368 patients completed the survey (39.9% male and 60.1% female). 168 referring physician surveys were completed [surgery (16.7%), pediatrics (18.6%), internal medicine (38.5%), emergency medicine (4.3%), obstetrics and gynecology (7.4%), and other (14.3%)]. Patient preference: 81.5% of patient responders preferred all results communicated from the radiologist within the same day. 65.9% of patients preferred same day results - if normal vs 65.8% if abnormal. 34.5% preferred to wait and review normal results with the referring physician. 41.5% preferred to wait and review abnormal results with the referring physician. It was found

that patients were more likely to strongly agree with waiting to review results with the referring physician if the results were abnormal, as opposed to normal (18.5% vs 11.9%, respectively; P < 0.0141). Physician preference: 36% of referring physicians preferred same day communication by the radiologist to the patient along with a report sent to their office. 12.4% preferred radiology reports to be sent to their office with a summary report sent to the patient. 59% preferred traditional communication with reports sent to their office. Conversely, 64% of physicians did not want results reviewed with their patients; 87.6% did not want a report sent to the patient by the radiologist, even after report was sent to their office.

CONCLUSION

58-82% of patients preferred same day radiologist communication of their results while 55-87.6% of physicians did not prefer same day radiologist communication of results directly with their patients. Our study examined and identified contemporary preferences of patients and their referring physicians regarding direct radiologic reporting of results. This could potentially impact the current movement in radiology towards a patient-centered care model by providing direct access to radiologic reports and direct communication of results by the radiologist.

METHODS

An anonymous survey was conducted between July 2017 and February 2018 of all patients undergoing radiologic imaging studies and their referring physicians. Two survey questionnaires were designed to examine patient and physician preferences for reporting of radiologic results. The surveys consisted of questions related to real time communication of results by the radiologist to the patient. The surveys elicited responses regarding preferences on a 5-point likert scale (Strongly disagree, disagree, neutral, agree and strongly agree), as well as indicated by responding yes or no to specific questions. All categorical variables were summarized using frequency counts and percentages. Comparisons between groups (Gender, age, medical specialty) with respect to responses to questions were analyzed using either the chi-square test or Fisher's exact test. Kappa statistics and Bowker's test of symmetry were used to determine if there was agreement in response within a patient, when examination results were assumed to be 'normal' or 'abnormal'. All statistical tests were two-sided at the alpha=0.05 level of significance.

PDF UPLOAD

http://abstract.rsna.org/uploads/2018/18018812/18018812_ywd7.pdf

SSM11-05 A Pilot Trial of a Decentralized General Ultrasound Imaging Consultation Service

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S403B

Participants
Jason C. Birnholz, MD, Delray Beach, FL (*Presenter*) Consultant, Sonoscanner SARL

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PURPOSE

This study concerns the feasibility and utilization of an interactive consultation service provided by a Radiologist equipped with high performance portable ultrasound equipment at selected medical care facilities.

METHOD AND MATERIALS

Facilities selected for 'field testing of a portable ultrasound device with reporting in one or two visits' were a suburban family practice clinic (FPC) providing care for the indigent, a suburban OB/GYN practice (GYN) adjacent to a community hospital, a private Urology clinic (UROL) with associated facilities. A limited number of ultrasound exams performed at patient designated locations (HOME). Limited exams were performed as part of feasibility assessment at a free standing Mammography center and at 3, level III NICU's. Facilities were not informed that full services would be continued on request. Patients were selected by the attending physician; the Radiologist confirmed that ultrasound was appropriate and performed an interactive examination, deciding the extent and content of each session, reporting findingswhile the patient was in the facility. All examinations were performed with a high performance, adjustable, touch screen tablet sized, dynamic beam former instrument with 6 interchangeable, broadband, array transducers. Variable aperture settings enabled 180 degree field of view with the endocavitary probe and transfontanelle imaging with a linear array.

RESULTS

There were 150 patients with 4206 archived static images in the utilization group, characterized by frequency of 12 exam components for each venue. Every requested was able to be performed for all indications. Findings were reported in a context of individual patient management. One or more secondary findings occurred in 52% for GYN, 48% for FPC, 38% for HOME, and 74% for UROL. Each location requested that the service be continued. As the trial progressed, GYN broadened their study indications; UROL did not.

CONCLUSION

Feasibility of high level remote operation was noted in limited but clinically typical, prospective exam conditions. This on-site consultative model had wide diagnostic yield., but utilization of secondary findings varied.

CLINICAL RELEVANCE/APPLICATION

A consultative model warrants further evaluation for planning expanded diagnostic ultrasound coverage for selected patient and practice cohorts.

SSM11-06 Care Integration in Radiology: Screening Mammography Encounters as Opportunities to Improve Lung Cancer Screening Engagement

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S403B

Participants
Gary X. Wang, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose
Anand K. Narayan, MD,PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Diego Lopez, Boston, MA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

A main barrier to uptake of lung cancer screening (LCS) for primary care providers (PCPs) is difficulty in identifying eligible patients, in part due to incomplete electronic medical record (EMR) data. Screening mammography (SM) is a common point of contact with the healthcare system for women within LCS age criteria. At our institution, detailed smoking history data is collected as a routine part of SM, but is not communicated to PCPs or integrated with the EMR in a way that facilitates its clinical use. We studied whether SM encounters at a community health center can be used to assist PCPs in identifying eligible patients for LCS.

METHOD AND MATERIALS

This IRB approved, HIPAA-compliant, retrospective study was performed at a community health center affiliated with a quaternary care academic medical center. Medical record review was performed of all consecutive SM patent encounters from 1/2018-3/2018 to extract patient demographic data, date of most recent LCS chest CT, and smoking history available prior to SM encounter and history obtained at SM. Determination of LCS eligibility was based on institutional criteria: age 55-77, smoked at least 30 pack-years, and either currently smoking or quit within 15 years.

RESULTS

There were 733 unique patient encounters during the study period. Smoking history was obtained at SM for 611 (83%): there were 75 (12%) current and 169 (28%) former smokers. Among current smokers, 14/75 (19%) met LCS eligibility criteria: 7 (50%) were not enrolled in LCS and 3 (21%) were overdue. 12/169 (7%) former smokers met LCS eligibility criteria: 8 (67%) were not enrolled, none overdue. Smoking status from SM was concordant with EMR data for 353/362 (98%) never smokers, 69/75 (92%) current smokers, and 132/169 (78%) former smokers. Among smokers with concordant smoking status, sufficient data to determine LCS eligibility was only available from SM data and not from EMR for 37/69 (54%) current and 87/132 (66%) former smokers.

CONCLUSION

Smoking history data in the EMR is often insufficient to allow determination of LCS eligibility, and can be supplemented with data obtained at SM. Furthermore, at the time of SM, most eligible patients are either not enrolled or are overdue for LCS.

CLINICAL RELEVANCE/APPLICATION

SM encounters can serve as opportunities to integrate radiology care, provide added value to PCPs, and decrease barriers to LCS participation by identifying eligible smokers for screening engagement.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSM12

Informatics (Quantitative Imaging)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E353B

BQ IN MR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants

Gary J. Wendt, MD, Middleton, WI (*Moderator*) Medical Advisory Board, McKesson Corporation; Medical Advisory Board, HealthMyne, Inc; Stockholder, HealthMyne, Inc; Co-founder, ImageMoverMD;
Christopher R. Deible, MD, PhD, Allison Park, PA (*Moderator*) Nothing to Disclose
Pamela T. Johnson, MD, Baltimore, MD (*Moderator*) Consultant, Oliver Wyman

Sub-Events

SSM12-01 Quantitative DCE-MRI Features Can Complement Molecular Markers for Predicting Tumor Infiltrating Lymphocytes in Breast Cancer: Model Discovery and Independent Validation

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E353B

Participants
Jia Wu, PhD, Stanford, CA (*Presenter*) Nothing to Disclose
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Daniel L. Rubin, MD, MS, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
Sandy Napel, PhD, Stanford, CA (*Abstract Co-Author*) Medical Advisory Board, Fovia, Inc; Consultant, Carestream Health, Inc; Scientific Advisor, EchoPixel, Inc; Scientific Advisor, RADLogics, Inc
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PURPOSE

To investigate the association between DCE MRI features and tumor infiltrating lymphocytes (TILs) in breast cancer.

METHOD AND MATERIALS

We retrospectively analyzed two breast cancer cohorts, with 126 patients from the cancer genome atlas (TCGA) as discovery cohort and 106 patients from ACRIN 6657/I-SPY 1 TRIAL as validation cohort. 17 computational features were extracted from DCE MRI to characterize functional tumor volume, tumor morphology and texture as well as parenchymal enhancement patterns. The percentage of stromal TILs was evaluated on hematoxylin and eosin stained histologic whole-tumor sections by two experienced pathologists. From tumor molecular data, we computed two markers as surrogates for TILs, including the non-synonymous somatic mutational burden and cytolytic activity score. First, we evaluated the associations between individual DCE-MRI features and TILs read by pathologists. Multiple hypotheses testing was corrected by the Benjamini-Hochberg method using false discovery rate (FDR). Next, we built a composite prediction model for TILs by combining DCE-MRI features with molecular surrogates. Finally, we independently validated the prognostic significance of the built TILs model in the I-SPY cohort.

RESULTS

Four image features were significantly associated with TILs ($P<0.05$ and $FDR<0.2$). Among molecular and clinicopathologic factors, only cytolytic score showed significant correlation with TILs ($\rho=0.51$, 95% confidence interval [CI]: 0.36-0.63). A composite model combining an imaging signature and cytolytic score improved correlation with TILs ($\rho=0.62$, 95% CI: 0.50-0.72). Compared with molecular surrogates as baseline, the composite model showed significant improvement in distinguishing intermediate vs high and low vs high TILs groups, with area under the curve or AUC=0.76 and 0.94, as shown in Fig. 1A and B. In the validation cohort, the predicted TILs separated patients into two groups with distinct recurrence-free survival (log-rank $P=0.0008$) among triple negative breast cancer (Fig. 1C and D).

CONCLUSION

Specific DCE-MRI features of tumor and parenchyma are associated with TILs in breast cancer, and integrating imaging and molecular features may allow better prediction for TILs.

CLINICAL RELEVANCE/APPLICATION

Imaging may play an important role in the evaluation of TILs, by providing key complementary information in equivocal cases or situations that are prone to sampling bias (e.g., in core biopsy).

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel L. Rubin, MD, MS - 2012 Honored EducatorDaniel L. Rubin, MD, MS - 2013 Honored Educator

SSM12-02 Development and Validation of a Radiomics Nomogram for Identifying Invasiveness of Pulmonary Adenocarcinomas Appearing as Subcentimeter Ground-Glass Opacity Nodules

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E353B

Participants
Wei Zhao, MD, Shanghai, China (*Presenter*) Nothing to Disclose
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PURPOSE

This study aimed to develop and validate a radiomics-based nomogram for differentiation of pre-invasive lesions from invasive lesions that manifest as ground-glass nodules (GGNs) <=10 mm (sub-centimeter) in diameter at CT.

METHOD AND MATERIALS

542 consecutive patients with 626 pathologically confirmed pulmonary subcentimeter GGNs were retrospectively studied from October 2011 to September 2017, which were divided into a training-set (n=334) and a validation-set (n=292). Researchers extracted 475 radiomics features from the plain CT images and a radiomics signature was constructed with the least absolute shrinkage and selection operator (LASSO) based on multivariable regression in the training-set. Based on the multivariable logistic regression model, a radiomics nomogram was developed in the training-set. The performance of the nomogram was evaluated with respect to its calibration, discrimination, and clinical-utility and this was assessed in the validation-set.

RESULTS

The constructed radiomics signature, which consisted of 15 radiomics features, was significantly associated with the invasiveness of subcentimeter GGNs (P <0.0001 for both training-set and validation-set). To build the nomogram model Radiomics signature and mean CT value were used. The nomogram model demonstrated good discrimination and calibration in both training-set (C-index, 0.716 [95% CI, 0.632 to 0.801]) and validation-set (C-index, 0.707 [95% CI, 0.625 to 0.788]). Decision curve analysis indicated that radiomics-based nomogram was clinically useful.

CONCLUSION

A radiomics-based nomogram that incorporates both radiomics signature and mean CT value is constructed in the study, which can be conveniently used to facilitate the preoperative individualized prediction of the invasiveness in patients with subcentimeter GGNs.

CLINICAL RELEVANCE/APPLICATION

Using the radiomics nomogram in the current study to predict the invasiveness of subcentimeter GGNs adds more benefit especially with respect to the treat-all scenario or the treat-none scenario, which in meanwhile indicated that this tool could aid in clinical decision making and facilitate the individualized precision medical treatment.

SSM12-03 18F FDG Positron Emission Tomography (PET) Tumor Penumbra Texture Predicts Recurrence in Non-Small Cell Lung Cancer

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E353B

Participants
Sarah Mattonen, PhD, Stanford, CA (*Presenter*) Nothing to Disclose
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PURPOSE

To identify computational imaging features (radiomics) in the tumor and surrounding area on Fluorodeoxyglucose (FDG) Positron Emission Tomography (PET) that predict time to recurrence in non-small cell lung cancer (NSCLC). We hypothesize that radiomic features can augment traditional metrics of stage and maximum standardized uptake value (SUVmax) to predict recurrence.

METHOD AND MATERIALS

We identified 300 patients with NSCLC from two cohorts acquired between 2008-2016 (training, n=145; validation, n=155). Two

We identified 300 patients with NSCLC from two cohorts acquired between 2008-2010 (training, n=145; validation, n=155). Two observers used commercial software to contour the Metabolic Tumor Volume (MTV) on pre-treatment PET images and added a 3-dimensional penumbra region that extended outward 1cm from the tumor surface. We generated 512 radiomics features from these volumes of interest. We selected features based on robustness to contour variations, and then applied randomized sparse regression (LASSO) to identify features that predicted recurrence in the training cohort. We built a Cox proportional hazards model in the training cohort and independently evaluated the model in the validation cohort.

RESULTS

SUVmax was a significant predictor of recurrence in the training (concordance=0.67, log-rank p<0.001) and validation cohorts (concordance=0.67, Noether's p<0.001). Stage was also a significant predictor in both cohorts (training: concordance=0.68, log-rank p<0.001; validation: concordance=0.70, Noether's p<0.001). The top radiomic feature selected by LASSO was the grey-level co-occurrence matrix maximum probability feature in the union of the MTV and penumbra regions. This texture feature was a significant predictor in the training (concordance=0.66, log-rank p=0.002) and validation cohorts (concordance=0.66, Noether's p<0.001). The radiomic feature integrated with stage and SUVmax significantly improved performance in both cohorts (training: concordance=0.73, log-rank p<0.001; validation: concordance=0.76, Noether's p<0.001), with both stage and texture being significant predictors in the multivariate model. Adding additional radiomic features to the model did not significantly improve performance.

CONCLUSION

A radiomics texture feature in the MTV plus surrounding penumbra improved upon staging and SUVmax for NSCLC recurrence prediction.

CLINICAL RELEVANCE/APPLICATION

PET radiomics may assist clinicians in stratifying patients at a higher risk of recurrence and could be used to recommend more aggressive personalized treatments options.

SSM12-04 Direct Validation of Quantitative MRI Cerebral Perfusion at Rest, Stress and Ischemia

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E353B

Participants
Niloufar S. Saadat, MD, Chicago, IL (*Presenter*) Nothing to Disclose
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Timothy J. Carroll, PhD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose
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Keigo Kawaji, PhD, Chicago, IL (*Abstract Co-Author*) Consultant, Myocardial Solutions, Inc
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PURPOSE

This study sought to assess the accuracy of a quantitative MRI-based (qMRI) measure of cerebral blood flow (qCBF) against reference stable isotope neutron capture microsphere-based cerebral blood flow quantification in an experimental model during normocapnia, hypercapnia and middle cerebral artery (MCAO)

METHOD AND MATERIALS

Five female, mongrel dogs (20-30 kg) each studied over two days. On day 1, qCBF images acquired during normocapnia (target PaCO2 30-40 mmHg) and hypercapnia (target PaCO2 > 60 mmHg) induced by CO2 gas inhalation (5% CO2/95% O2). On day 2 animals underwent angiographically verified permanent endovascular occlusion of the M1 segment while in a normocapnic state. Anesthesia selected to minimize the influence on cerebrovascular reactivity. Physiologic parameters kept within normal range except for PCO2 for hypercapnia. Microspheres injected at the time of qMRI acquisition to obtain reference-standard CBF values. qMRI acquired on a 3 Tesla unit using a 15-channel receive-only head coil a 'bookend dynamic susceptibility (DSC)' approach, which uses pre- and post-contrast T1 maps bookended to a DSC MRI sequence to calculate parenchymal T1 changes and calibrate the DSC scan for quantitative perfusion in ml/100 g/min. Quantitative T1 maps created using a standard inversion recovery Look-Locker imaging, co-localized to the DSC perfusion scan using a previously reported approach

RESULTS

MRI correlated strongly with microsphere perfusion (qCBFMRI = 0.93*qCBFSPHERES + 3.85 ml/100g/min; r2 = 0.96; p < 0.001), for individual CVR (CVRMRI = 1.17*CVRSPHERES - 0.95 %;CBF/mmHg CO2; r2 = 0.84; p < 0.001), and for post-occlusion CBF (qCBFMRI = 0.80*qCBFSPHERES + 12.9 ml/100g/min; r2 = 0.82; p = 0.002). Correction for delay and dispersion resulted in a significant improvement in the correlation between MRI and microsphere deposition in the ischemic state (qCBFMRI = 0.97*qCBFSPHERES + 2.58 ml/100g/min; r2 = 0.96; p < 0.001).

CONCLUSION

MRI derived values of CBF are strongly correlated with reference value microsphere deposition in normocapnia, hypercapnia, and MCAO ischemic stroke. Correction for delay and dispersion significantly improved the accuracy of this quantification during MCAO, underscoring the importance of this correction under focal ischemic condition

CLINICAL RELEVANCE/APPLICATION

Quantitative CBF by MRI perfusion accurately measures CBF, improving our ability to triage patients with acute ischemic stroke for treatment

SSM12-05 Utility of Radiomics Features to Detect Pancreatic Adenocarinoma

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E353B

Participants

Linda C. Chu, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Seyoun Park, Baltimore, MD (*Presenter*) Nothing to Disclose
Satomi Kawamoto, MD, Laurel, MD (*Abstract Co-Author*) Nothing to Disclose
Daniel Fadaei Fouladi, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Shahab Shayesteh, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Karen M. Horton, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose
Elliot K. Fishman, MD, Baltimore, MD (*Abstract Co-Author*) Institutional Grant support, Siemens AG; Institutional Grant support, General Electric Company; Co-founder, HipGraphics, Inc
Alan Yuille, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Pancreatic adenocarcinoma is one of the leading causes of cancer related death. Recent advances in computer analytics offer the potential of computer aided detection of pancreatic adenocarcinoma. The purpose of this study is to determine if quantitative radiomics features can be used to differentiate pancreatic adenocarcinoma from normal controls.

METHOD AND MATERIALS

As an IRB-approved matched case-control study, 190 cases of pathologically proven pancreatic adenocarcinoma (PDAC) and 190 normal controls were retrospectively selected from the radiology and pathology databases. The whole pancreas boundary (including tumor region) were manually segmented from preoperative pancreatic protocol CT using dedicated software, VelocityAI (Varian Medical Systems, USA). The phenotype of pancreas on CT images was expressed with 478 radiomics features, which include the first order statistics, shape, texture, and texture features from wavelet and Laplacian of Gaussian filtering. The studies were randomly split into a training set (251 cases) and a testing set (129 cases). Feature reduction was performed by the minimum-redundancy maximum-relevance selection approach and random forest was applied for the PDAC classification.

RESULTS

The mean and standard deviation of PDAC masses were 4.4±2.0cm. The overall classification accuracy of the testing set was 0.992 (128 among 129 cases were correctly classified) with 0.999 of the area under the curve. The sensitivity was 0.98, only 1 among 62 PDAC cases were incorrectly classified, and specificity and PPV showed all 1.00. Most relevant features to differentiate PDAC include intensity uniformity, shape compactness, and texture features of gray level non-uniformity, skewness, fractal dimension from the original images and filtered images.

CONCLUSION

Radiomics features can differentiate pancreatic adenocarcinoma from normal pancreas with 3D segmented pancreas.

CLINICAL RELEVANCE/APPLICATION

Radiomics features can be used to differentiate pancreatic adenocarcinoma from normal pancreas, which can serve as one of the tools towards automatic detection of pancreatic adenocarcinoma.

Honored Educators

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SSM12-06 Chaos-Based Fractal Radiomic Features of Nodule Vasculature Distinguish Granulomas from Adenocarcinomas on Non-Contrast Lung CT

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E353B

Participants
Mehdi Alilou, PhD, Cleveland, OH (*Presenter*) Nothing to Disclose
Marjan Firouznia, Cleveland, OH (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

A wide variety of fungal processes can cause a chronic granulomatous reaction in the lungs manifesting as benign pulmonary nodules on CT. Visually to a radiologist, granulomas can appear similar to a malignant adenocarcinoma making them difficult to distinguish. However, these nodules differ in terms of the morphology of the nodule vasculature. The purpose is to model the distinct vessel tortuosity patterns and find associated deterministic dynamics. We sought to evaluate if fractal features of nodule vasculature on non-contrast CT are significantly different between granulomas and adenocarcinomas. We present a set of chaos-based fractal radiomic features of the vasculature (VFR) which transform the nodule vasculature to a low-dimensional discriminative feature space.

METHOD AND MATERIALS

Our study comprised non-contrast CT scans of 100 patients, including 50 adenocarcinomas and 50 granulomas, with pixel size

ranging from 0.42 x 0.42mm to 0.97 x 0.97mm. All patients had previously undergone resection for suspicious nodules. From nodule annotations provided by a trained radiologist, a region-growing algorithm was used to segment the surrounding vasculature (Fig 1a-d). A set of 6 chaotic features pertaining to the fractal analysis and the state space reconstruction of tumor vasculature were extracted from each nodule vasculature. The extracted features include fractal dimensions 1-dimension (D), 2D, and 3D, the mutual information, and the optimal delay of the state space reconstruction from each nodule vasculature. A linear discriminant analysis classifier was then used, in a 3-fold cross-validation setting, to identify adenocarcinomas.

RESULTS

VFR features (Fig 1 e-f, i-j) were capable identifying malignant nodules with AUC=0.70. Statistically significant difference was observed for one of the VFR features between adenocarcinomas and granulomas (p=0.009).

CONCLUSION

Adenocarcinomas can be distinguished from granulomas using VFR radiomics extracted from nodule vasculature.

CLINICAL RELEVANCE/APPLICATION

VFR radiomic markers could allow for improved discrimination of benign from malignant nodules, and could help reduce unnecessary surgical interventions for pathologic confirmation of nodule diagnosis.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Prabhakar Rajiah, MD, FRCR - 2014 Honored Educator

SSM13

Informatics (3D Printing and Alt Realities - AR/VR)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E353C

IN

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

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Participants
Ciprian N. Ionita, PhD, Buffalo, NY (*Moderator*) Grant, Canon Medical Systems Corporation; Grant, Stratasys, Ltd; Grant, Medtronic plc;
Kenneth C. Wang, MD, PhD, Ellicott City, MD (*Moderator*) Co-founder, DexNote, LLC; Software support, 3D Systems, Inc

Sub-Events

SSM13-01 Evaluation of the Accuracy of 3D Printed Patient-Specific Coronary Tree Phantoms Using 320-Detector Row Aquilion ONE

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E353C

Participants
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PURPOSE

3D printing of cardiovascular anatomy can be used for radiology applications such as diagnostic software validation and image guided surgical training. We developed coronary tree phantoms from materials that are capable of sustaining physiological flow and pressure conditions while maintaining the stress and strain characteristics of human coronary arteries. The purpose of this research is to assess the accuracy of 3D printed patient-specific phantoms with coronary artery disease.

METHOD AND MATERIALS

Five patients underwent 320-detector row coronary CT angiography (CCTA) (Aquilion ONE, Canon Medical Systems). Reconstructed voxel size was 0.63 mm. The aortic root and three main coronary arteries were segmented (Vitrea, Vital Images) and 3D printed (Eden 260V, Stratasys). The patient-specific phantoms were connected into a pulsatile flow loop which replicated physiological flow and pressure gradients. Contrast was introduced and the phantoms were scanned using the same CT scanner model and same CCTA protocol as used for the patients. Patient and phantom CCTA images were segmented using Mimics Research (Materialise). The minimum vessel diameter and tortuosity (defined as shortest distance / vessel length) were measured for all three vessels at 20, 40, 60, 80, and 100 mm distances from the ostium for both patients and phantoms. Results were compared to assess the accuracy of the 3D printed patient-specific phantoms.

RESULTS

The average absolute difference between all minimum diameter measurements of the coronaries for the patient and phantom images was 0.73 ± 0.58 mm (~ 1±1 voxels), and in vessels with known stenosis (n = 5), the average absolute difference was 0.58 ± 0.20 mm (~ 1 voxel), range of 0.04 - 2.48 mm. The average absolute difference in tortuosity for the patients and phantoms was 0.06 ± 0.05, and in stenosed vessels was 0.05 ± 0.008, range of 0 - 0.17.

CONCLUSION

The phantoms showed high accuracy in maintaining the inner vessel lumen geometry and on average were within the scanner resolution, 1-2 voxels (630 µm each) of the patient images. Overall, the 3D printed patient-specific phantom accuracy has been evaluated and shown to replicate the patient images.

CLINICAL RELEVANCE/APPLICATION

Accurate 3D printing of patient-specific coronary phantoms allows for the replication of physiological blood flow conditions to allow precise evaluation of image-based diagnostic software.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Frank J. Rybicki III, MD, PhD - 2016 Honored Educator

SSM13-02 Reducing Operating Room Time by Using In-House 3D-Printed Models of Inferior Orbital Wall Fractures for Pre-contouring Osteosynthesis Implants

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E353C

Participants
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PURPOSE

To investigate if the use of CT data based 3D printed models for pre-contouring implants in inferior orbital wall fracture surgery is able to shorten operating room time.

METHOD AND MATERIALS

22 patients (11 m, 11 f, age: 52,38 ± 21,59 years) received an inferior orbital wall reconstruction with a titanium implant due to trauma (14 pts) or physical altercation (8 pts). For 12 patients a 3D mesh-model was created by segmenting the bone on the initial CT scan. The model was printed in 1:1 scale using either fused filament fabrication, stereolithography or polyjetting techniques. The 3D printed model was preoperatively used as a scaffold for pre-contouring a dedicated titanium mesh, which was implanted after sterilization using a mid-eyelid approach. Operating room times (incision to suture time points) were analyzed for both groups.

RESULTS

Overall the use of a 3D model to precontour the orbital floor implant shortened the mean operating room time significantly ($p<0.05$) from 96 min to 64 min (- 32 min). The model creation time including DICOM-export, segmentation and post-processing with pre-contouring of the implant took approx. 30 min. Printing time took between 2 to 4 hours, depending on the printer used.

CONCLUSION

A preoperative 3D printed model of orbital wall fractures significantly reduces operating room time while also supposedly improving patient care through shorter operating times. Since model creation and printing is less cost- and staff-intensive this workload shift from operating room to the 3D print lab represents a considerable cost reduction while at the same time offering an opportunity to expand the radiologic service through 3D printing.

CLINICAL RELEVANCE/APPLICATION

3D models in orbital wall surgery reduce costs and improve patient care by significantly reducing operating time.

SSM13-03 Utilizing Semantic Segmentation Method with Convolutional Neural Net to Model a Partial Nephrectomy Simulator for 3D Printing

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E353C

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CONCLUSION

We have developed a semantic segmentation method with CNN for modeling a partial nephrectomy simulator for 3DP. The parenchyma showed robust performance, but segmenting the relatively complex vessels was still challenging. However, this segmentation application could dramatically reduce the time for 3DP.

Background

The image segmentation is necessary for modeling a simulator for 3D printing (3DP). However, segmenting process is very tedious and labor intensive. Therefore, we proposed and evaluated a deep-learning-based segmentation method to model kidney surgical simulators and fabricate them by using 3DP.

Evaluation

Thirty-six patients with renal cell carcinoma (RCC) and normal kidney were enrolled. For 50 kidneys in this dataset, the artery, ureter, vein, and RCC connected to the kidney parenchyma were manually delineated for ground truth. Because the kidneys are symmetrically located on the left and right sides, a right kidney was flipped as left kidney to augment data. A certain margin was set based on the segmented kidney coordinates to extract the region of interest including the vessels connected to the kidney. The segmentation was performed using a 3D U-Net architecture of deep convolutional neural networks (CNN), with 80% and 20% for training and test, respectively. The segmentation performance on each class was evaluated using the Dice similarity coefficient (DSC). The mean and SD of DSC were 51.7 ± 21.0, 48.9 ± 12.7, 67.5 ± 15.8, 32.6 ± 34.8, 95.0 ± 3.6 % for artery, ureter, vein, RCC and parenchyma, respectively.

Discussion

The performance for parenchyma segmentation was the highest, while that of RCC was the lowest with large SD. Among the artery, ureter, and vein, vein accuracy was the highest. Using this method the time on modeling procedure for 3DP has been drastically reduced. The less complex parenchyma and ureter have been useful, but the blood vessels inside the parenchyma seem to be still challenging. The boundaries between parenchyma and RCC were not distinguished clearly, so more data is required.

SSM13-04 3D Printed and Augmented Reality Urologic Oncology Models: Impact in Patient Education

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E353C

Participants
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Hersh Chandarana, MD, New York, NY (*Abstract Co-Author*) Equipment support, Siemens AG; Software support, Siemens AG; Advisory Board, Siemens AG; Speaker, Bayer AG;

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PURPOSE

To investigate the impact of using 3D printed and augmented reality (AR) urologic cancer models for patient education.

METHOD AND MATERIALS

Patients with renal cancer (nephrometry score >= 7, diameter >= 4cm, or polar lesions) or MRI visible prostate cancer (PI-RADS v2 score >= 3) scheduled to undergo partial nephrectomy, radical prostatectomy, or focal therapy for prostate cancer were enrolled in our ongoing prospective study. Upon enrollment, patients were randomized to receive a pre-operative, patient-specific 3D printed or AR cancer model. A Likert-scale questionnaire was administered to assess patient understanding of disease, cancer size, cancer location, and treatment plan before and after reviewing the patient-specific 3D printed or AR model. Survey responses were compared using a paired t-test. For a subset of patients, additional questions were included asking patients to rate from 1-10 to what extent the 3D model helped them learn about their anatomy, disease, procedure, and potential complications; and results for the 3D printed and AR models were compared with an unpaired t-test.

RESULTS

73 patients completed the questionnaire twice, once before and once after reviewing the 3D printed model (n=31) or AR model (n=42). Both the 3D printed and AR kidney and prostate cancer models outperformed conventional imaging. Patient understanding of disease, cancer size, cancer location, and treatment plan improved with the 3D printed models compared to imaging alone (range = 4.56-4.84/5 for 3D printed model vs. 4.20-4.36/5 for imaging; all $p<0.03$). For the AR models, only understanding of cancer size improved (4.31 ± 0.87 for AR model vs. 3.90 ± 0.91 for imaging, $p = 0.03$). Seventeen patients with 3D printed models and 25 patients with AR models completed the additional questions. For the question regarding how much the model helped improve understanding of disease, ratings were 9.6 ± 0.8 for 3D printed model and 8.5 ± 2.4 for the AR models, $p = 0.05$.

CONCLUSION

Overall, the 3D printed models performed better than both conventional imaging and AR models at helping patients to understand their disease and treatment plan.

CLINICAL RELEVANCE/APPLICATION

Patients frequently do not fully understand their disease or surgical plan using conventional imaging methods. By providing enhanced visualization and tactile feedback, 3D printed models may help to overcome this limitation.

SSM13-05 Implementation of Multiparametric Magnetic Resonance Imaging into Robotic - Assisted Radical Prostatectomy Using Virtual Reality

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E353C

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CONCLUSION

Realtime use of in-vivo mpMRI derived 3D prostate and periprostatic anatomy information during laparoscopic RARP procedure via the da Vinci® surgical system can be advantageous to better tailor the surgery procedure and can improve spatial awareness. Future goals include use of the robot's stereo image viewer instead of HMD and advancement of the MRI-stereo image alignment for direct intraoperative use of mpMRI.

Background

Robotic-assisted radical prostatectomy (RARP) has become a more popular approach for prostate cancer (PCa) recently. Its 3D stereo-laparoscopic view allows for optimal spatial awareness. Recently, multiparametric magnetic resonance imaging (mpMRI) is more commonly used pre- and intraoperatively. Currently, surgeons can only utilize mpMRI data cognitively to guide surgery. In this study, we present use of mpMRI data and intraoperative stereo captures of RARP to create 3D virtual reality (VR) models which can guide surgeons during RARP to optimize spatial awareness.

Evaluation

Axial T2W MRI was utilized to create 3D models of the prostate, bladder, rectum, NVBs, seminal vesicles, urethra and PCa lesions by a manual contouring process. These contours were then used to create 3D mesh models for a commercially available VR platform with head mounted display (HMD) and touch controls (Oculus Rift®). During RARP, stereo images of the laparoscopic views were extracted using the da Vinci´s DVI outputs. Both models were then aligned to each other using an in-house algorithm and provided to urologists during RARP. When needed surgeons withdrew from the console and interacted with the 3D models using the HMD.

Discussion

VR system was used during 9 RARPs. All models were successfully generated and integrated into the VR system. The time between the stereo image capture to full applicability of the model was approximately 3 minutes. The VR system was utilized at 4 steps: General check before the surgery, prior to bladder neck separation, apical dissection and during separation of nerves from the prostate capsule in lesions with proximity to the NVB. The system was used for one minute during each step and did not interfere with routine workflow.

SSM13-06 Head Mounted Display Augmented Reality for Image Guided Procedures of the Spine

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E353C

Participants
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CONCLUSION

We demonstrated feasibility of using HMD-AR in facet and sacroiliac joint injections, and percutaneous discectomy. To the authors' knowledge, this is the first reported use of HMD-AR guidance in live surgery.

Background

Head Mounted Display Augmented Reality (HMD-AR) is a recent technological advancement that can be used to superimpose CT or MRI images on a patient in real space to visualize inner anatomical structures in three dimensions, as well as axial, sagittal, and coronal views. We used HMD-AR to perform three common image-guided spine procedures, facet and sacroiliac (SI) joint injections as well as percutaneous discectomy, with no real time fluoroscopic guidance on a 3D printed lumbar model. Finally, we successfully demonstrated the utility of HMD-AR by performing these procedures on live patients using HMD-AR guidance.

Evaluation

CT images were performed of a 3D printed lumbar phantom made of radiodense gypsum-based material encased in silicone. Suggested trajectories for instrumentation were embedded in the images, which were uploaded to the Microsoft Hololens using Novarad Open Sight system. Images were superimposed on the phantom, and localization of the facet joint, sacroiliac joint, and nucleus pulposus was performed by placing 18-gauge cannulated needles along holographic trajectories. Repeat CT images

confirmed accurate placement of the needles. Registration accuracy was determined by measuring deviation of model to hologram and was found to be roughly spherical with radius of 2.5 mm (STD 0.44 mm). Finally, a certified neuro-radiologist used the same method to localize the facet joint, sacroiliac joint and nucleus pulposus during three separate live procedures, all of which were confirmed with fluoroscopy.

Discussion

HMD-AR can be used to project holographic guidance trajectories within vital anatomic structures, allowing accurate interventional and surgical instrumentation, potentially decreasing operating and fluoroscopy time and reducing error for select procedures. HMD-AR can also utilize existing images, potentially reducing radiation exposure by minimizing need of fluoroscopy use intraoperatively.

SSM14

Molecular Imaging (Oncology Therapy)

Wednesday, Nov. 28 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.

Participants
Pedram Heidari, MD, Boston, MA (*Moderator*) Nothing to Disclose
Gabriel C. Fine, MD, Salt Lake City, UT (*Moderator*) Stockholder, Apple Inc

Sub-Events

SSM14-02 Furin-Targeted Nanotheranostics for CEST MR Imaging and Cancer Therapy

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S505AB

Participants
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PURPOSE

Furin is a membrane-bound proprotein convertase that is overexpressed in many types of tumors. It activates certain specific proteins associated with tumor progression, with the degree of expression correlating to 5-year survival rates. We have adapted the compound olsalazine, an anti-cancer agent that also exhibits chemical exchange saturation transfer (CEST) MRI contrast, with a synthetic peptide (RVRR) that is cleaved by furin. Our aim was to assess the imaging and therapeutic effects of the furin-catalyzed condensation reaction and subsequent formation of intracellular OLSA nanoparticles.

METHOD AND MATERIALS

NU/J immunodeficient mice (n=20) were subcutaneously injected with 1×106 HCT116 (furin-overexpressing) human tumor cells in the left flank and 1×106 LoVo (low furin-expressing) human tumor cells in the right flank. Animals received 0.14 mmol/kg furin-targeted RVRR-OLSA or 0.14 mmol/kg OLSA as non-targeted control injected i.v. In vivo CEST MRI was performed at different time points using a 11.7 T horizontal scanner. In three separate cohorts (n=4 each), animals received 0.07 mmol/kg RVRR-OLSA, 0.07 mmol/kg OLSA, or PBS only (as control) injected i.v. 8 times with 3-day intervals.

RESULTS

After i.v. injection of RVRR-OLSA, furin-overexpressing HCT116 tumors and low furin-expressing LoVo tumors could be clearly distinguished from each other in vivo on CEST MRI (Fig. 1a, shown at 2h post injection). No such differences were observed for OLSA without RVRR. Mice injected with RVRR-OLSA showed significantly reduced tumor sizes compared to those injected with OLSA alone for the HCT 116 tumor ($p<0.05$) but not the LoVo tumor (Fig. 1b). At day 33, average tumor volumes of HCT116 tumors and LoVo tumors for the RVRR-OLSA treated group were reduced to 38% and 61%, respectively, as compared to the control group.

CONCLUSION

Furin-induced intracellular formation of OLSA-NPs following administration of RVRR-OLSA enhances CEST contrast and reduces tumor size in vivo.

CLINICAL RELEVANCE/APPLICATION

The new nanotheranostic probe RVVR-OLSA may be further developed for imaging tumor aggressiveness and tumor response to furin-targeted therapy.

SSM14-03 Orthotopic Pancreatic Cancers: Molecular Imaging-Guided Radiofrequency Hyperthermia-Enhanced Immuno/Oncolytic Therapy

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S505AB

Awards
Trainee Research Prize - Fellow

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PURPOSE

To validate the feasibility of using interventional molecular imaging to guide radiofrequency hyperthermia (RFH)-enhanced local immune/oncolytic therapy of rat orthotopic pancreatic cancers.

METHOD AND MATERIALS

Luciferase-labeled rat pancreatic cancer cells and 24 Lewis rats with orthotopic pancreatic cancers in four groups (n = 6/group) were treated by (i) combination therapy of oncolytic virus (T-VEC, 10×106 pfu) plus RFH at 42? for 30 mins; (ii) oncolytic virotherapy-only; (iii) RFH-only; and (iv) saline. MTS and flow cytometry were used to analyze cell proliferation and apoptosis. Optical/x-ray imaging and ultrasound imaging were used to follow up and compare the therapeutic effects among various groups, correlated with subsequent pathologic examinations.

RESULTS

Both confocal microscopy and MTS assay demonstrated diminished number of viable cells with combination therapy (RHF+T-VEC) compared with other three treatments (Fig. A&B), as well as significant increase of cell apoptosis in flow cytometry (Fig. C). Optical/x-ray imaging demonstrated decreased tumor bioluminescent signal (Fig. D) and ultrasound imaging showed the smallest tumor volume of combination therapy, in comparison to other treatments (Fig. E). Imaging findings were well correlated with pathologic examinations, shown as (1) the smallest tumor size (Fig. F&G); (2) increased apoptosis with TUNEL staining (Fig. F&H); and (3) significantly decreased cell proliferation with Ki-67 stain (Figs. F&I) in the combination therapy group, compared to other treatment groups.

CONCLUSION

We validated the feasibility of using molecular imaging-guided interventional RFH to enhance immune/oncolytic therapy of pancreatic cancer, which may open the new avenues for effective management of pancreatic cancer, one of the deadliest malignancies worldwide.

CLINICAL RELEVANCE/APPLICATION

Molecular imaging-guided interventional RFH can enhance immune/oncolytic therapy of pancreatic cancer.

SSM14-04 Molecular Imaging-Monitored Radiofrequency Hyperthermia-Enhanced Intratumoral Herpes Simplex Virus-Thymidine Kinase/Ganciclovir Gene Therapy for Rat Hepatic Cancers

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S505AB

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PURPOSE

To explore a new method using optical/ultrasound imaging to monitor RF hyperthermia(RFH)-enhanced herpes simplex virus-thymidine kinase/Ganciclovir(HSV-TK/GCV)suicide gene therapy of rat hepatocellular carcinoma(HCC).

METHOD AND MATERIALS

Rat liver cancer cells(MCA-RH-7777)were transduced with lentivirus/luciferase gene. Serial in-vitro experiments with luciferase-cells and in-vivo experiments of rat orthotopic HCC were divided into four groups :(i) HSV-TK/GCV combined with RFH; (ii) HSV-TK/GCV; (iii) RFH; and (iv) PBS. HSV-tk gene expression was qualified by western blotting, while cell viability was evaluated by confocal microscopy and MTS. Bioluminescence optical imaging and ultrasound imaging were used to monitor the photon signal and size changes of tumors in each groups at different time points. The imaging findings were correlated with histologic analysis.

RESULTS

Of in-vitro experiments, MTS assay demonstrated the lowest cell proliferation in the group of combination therapy, compared with other three groups (26.1±3.2% vs 50.4±4.6% vs 82.9±6.3% vs 100%,$p<0.01$), which was corresponding to the lowest number of survived cells with confocal microscopy and the lowest bioluminescence signal with the optical imaging. Of in-vivo experiments, ultrasound imaging showed the smallest tumor volumes in the combination therapy group, compared to other control groups (0.28±0.11, 1.28±0.23 vs 4.64±0.35 vs 6.37±0.36, $p<0.05$). Bioluminescent optical imaging further demonstrated a significantly decreased bioluminescence signal intensities in the combination group, compared with three control groups (0.57±0.09, 1.06±0.10

vs 3.43±0.27 vs 3.85±0.12, p<0.05). These imaging findings were further confirmed by significantly increased apoptotic cells in the combination therapy group.

CONCLUSION

It is feasibility using optical imaging and ultrasound imaging to monitor intratumoral RFH-enhanced HSV-TK/GCV gene therapy of rat HCC, which may provide a new image-guided interventional oncology technique for efficient management of liver malignancies by simultaneous integration of radiofrequency technology, interventional oncology, and direct intratumoral gene therapy.

CLINICAL RELEVANCE/APPLICATION

Optical imaging is a useful tool for monitoring intratumoral RFH-enhanced HSV-TK/GCV gene therapy of rat hepatic cancers, which may provide a new opportunity for effectively managing liver cancers

SSM14-05 2D Magnetic Titanium Carbide (Ti3C2 MXene) for Cancer Theranostics

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S505AB

Participants
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PURPOSE

The aim of this part was to construct superparamagnetic 2D Ti3C2 MXenes for enhance MR molecular imaging and photothermal therapy (PTT).

METHOD AND MATERIALS

The fabrication of ultrathin Ti3C2 MXene nanosheets was based on an exfoliation strategy and the construction of superparamagnetic 2D Ti3C2 MXenes is based on the specific MXenes' surface chemistry for the in-situ growth of superparamagnetic Fe3O4 nanocrystals onto the surface of Ti3C2 MXenes. The magnetic Ti3C2-IONPs composite MXenes were modified with soybean phospholipid (SP) to guarantee high stability in physiological conditions. These MXenes were characterized via transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), electron energy loss spectroscopy (EELS), dynamic light scattering (DLS), zeta-potential, X-ray photoelectron spectroscopy (XPS) and UV-Vis-NIR spectra. The photothermal therapy, T2-weighted magnetic resonance imaging and the high biocompatibility of these composite nanosheets have also been evaluated in vitro and in vivo.

RESULTS

These magnetic Ti3C2-IONPs composite MXenes exhibit high T2 relaxivity of 394.2 mM-1s-1 and efficient contrast-enhanced magnetic resonance imaging of tumor, providing the potential for the therapeutic guidance. Importantly, these superparamagnetic MXenes have shown high photothermal-conversion efficiency (48.6%) to guarantee their efficient photothermal killing of cancer cells and ablation of tumor tissues, which has been systematically demonstrated both in vitro and in vivo.

CONCLUSION

For the first time, we have successfully illustrated that the superparamagnetic MXenes nanosheets feature the high intrinsic photothermal-conversion capability for PTT against tumor, which are also the first paradigm of integrated superparamagnetic IONPs acted as the contrast agents for T2-weighted MR imaging. The high biocompatibility of these elaborately designed magnetic Ti3C2-based composite MXenes guarantees their further potential clinical translation. This report paves a new way for the functionalization of MXene-based 2D nanosheets for broadening their novel applications based on the unique surface chemistry of MXenes, especially in theranostic nanomedicine.

CLINICAL RELEVANCE/APPLICATION

These superparamagnetic MXenes nanosheets feature the high intrinsic photothermal-conversion capability to against tumor and acted as the contrast agents for T2-weighted MR imaging.

SSM14-06 Gene Therapy Targeting of GDPD5/6 in Choline Metabolism of Breast Cancer

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S505AB

Awards
Student Travel Stipend Award

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PURPOSE

Glycerophosphocholine (GPC) is an important 1H MRS-detected metabolite in choline metabolism1. The GDPD52,4/GDPD63 enzymes, which convert GPC to free choline, are overexpressed in breast cancer. Previously we have shown that GDPD5/GDPD6 silencing

increased cellular GPC5 levels and reduced migration and proliferation of breast cancer cells4. We are continuing our studies *in-vivo* to evaluate if lentiviral vector based silencing of GDPD5/GDPD6 will reduce tumor growth in breast cancer xenograft models. The metabolic effects of silencing were studied for identifying novel biomarkers and therapeutic targets for anti-cancer therapy.

METHOD AND MATERIALS

GDPD5 and GDPD6 were silenced in nude mice growing human breast cancer xenografts. In these mice, we injected lentiviral vectors expressing GDPD5-shRNA, or GDPD6-shRNA along with control vector expressing luc-shRNA. Once tumor sizes reached 150mm3, mice were treated with viral suspension. Upon necropsy, tumors were harvested and subjected to 1H MRS analysis.

RESULTS

Initially, tumors showed a gradual increase in size. Upon treatment, tumor growth was significantly reduced in the GDPD6-shRNA treated group compared to other groups. 1H MR spectra of tumor extracts showed significant differences in various metabolites (Fig 1A-B). A heatmap demonstrated % changes among the three treated groups (Fig 1C).Significant changes were observed in metabolites from metabolic pathways including amino acid and protein synthetic pathways and glycolysis, which are in accordance with the literature. Choline was decreased while GPC was increased in the GDPD6-shRNA treated group (Fig 1D). The PC/GPC ratio was lower in the GDPD6-shRNA treated group (Fig 1E), which was consistent with our previous findings4.

CONCLUSION

These data in breast tumor xenografts suggest that GDPD5 and GDPD6 silencing could be an effective molecular treatment strategy. Additional studies are continuing in our lab to corroborate these initial findings. Ref.: Glunde et al, Nat Rev Cancer 2011 Cao, et al, NMR Biomed 2012 Cao, et al, NMR Biomed 2016 4. Wijnen et al, NMR Biomed 2014 5. Krishnamachary et al, Can Res 2009

CLINICAL RELEVANCE/APPLICATION

Lentiviral gene silencing is emerging as efficient technique for suppressing genes of interest for cancer treatment. We are assessing effects of gene silencing by means of 1H MRS based metabolomics following silencing of two glycerophosphodiesterases GDPD5 and GDPD6.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSM15

Musculoskeletal (Novel Signs and Patterns)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E450B

MR MK

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Ogonna K. Nwawka, MD, New York, NY (*Moderator*) Research Grant, General Electric Company
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Sub-Events

SSM15-01 **Expert Consensus on Determination of Acuity/Chronicity of Neuropathic Arthropathy on MRI: Results of a Delphi Survey**

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E450B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

As diabetes becomes more commonplace, neuropathic arthropathy (NA) is a mushrooming problem in clinical interpretation. Although radiographic classification schema was well established, many of these patients come to MR for potential superimposed infections. Thus, it behooves us to develop MR imaging staging criteria for various temporal points of NA.

METHOD AND MATERIALS

An international expert panel of 6 musculoskeletal radiologists was formed and participated in a two-round Delphi survey. A total of 30 qualitative radiologic features associated with various NA stages were compiled after a comprehensive literature search of 9 papers. For round 1, experts were asked to rate the relevance of selected criteria for identifying NA at acute, intermediate, and chronic stages on a scale of 1-10, with 1 as not relevant at all and 10 as extremely important. For round 2, panelists resubmitted answers to the same questionnaire after distributing the group median, interquartile range, and range results from round 1. A Cronbach's a score was calculated to determine consistency of signs.

RESULTS

The median scores for each sign ranged from 2-9. The highest medians for diagnostic relevance of acute presentations were marrow edema with visible fracture, inhomogeneous marrow edema, and diffuse bone marrow edema with medians of 9, 9, and 8.5 respectively. The lowest medians were irregular bone shape on T2, ligament damage, and cartilage damage with medians of 4, 3, and 2 respectively. For chronic presentations of NA, the highest medians were subchondral sclerosis, new bone formation, and fibrosis with medians of 8.5, 8, and 6.5 respectively. The lowest medians were the ghost sign, T1 tapering of distal second and third metatarsals, and sinus tracts with medians of 4, 4, and 2.5 respectively. For intermediate presentations of NA, subchondral cysts scored a higher median of 6 than the 4.5 median for intra-articular bodies. Cronbach's a score of the first and second round of questionnaires were 0.69 and 0.79 respectively.

CONCLUSION

Results of the delphi survey suggest consensus of several qualitative MRI features of neuropathic arthropathy that are indicative of disease acuity/chronicity and show good consistency.

CLINICAL RELEVANCE/APPLICATION

Staging criteria for the acuity/chronicity of neuropathic arthropathy was established such that radiologists may interpret MR images at a similar level to current standards for radiographic images.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Jenny T. Bencardino, MD - 2014 Honored Educator

SSM15-02 The Metaphyseal Flare Sign: A Secondary Sign on MRI of Subchondral Insufficiency Fracture of the Knee

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E450B

Participants
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PURPOSE

To describe a novel secondary sign of subchondral insufficiency fracture of the knee, the metaphyseal flare sign.

METHOD AND MATERIALS

A retrospective research of 7926 knee MRI examinations was performed. 48 scans were included in the study. The diagnosis of subchondral insufficiency fracture (SIF) was confirmed in a consensus review by one fellowship trained MSK radiologist and one radiology registrar. The presence of metaphyseal flare sign (soft tissue oedema in the meta-epiphyseal region of the affected condyle) was evaluated in the cohort.

RESULTS

41 patients were included in the study (21 male, 20 female). The mean age was 61.5 years (range 41 to 80 years). The anatomical location of the SIF were the medial femoral condyle (n=28), the lateral femoral condyle in (n=5) and medial tibial condyle (n=8). The metaphyseal flare sign was present in 45 of the 48 scans reviewed. The average craniocaudal length of the soft tissue oedema defined as metaphyseal flare sign was 7 cm (range 10.5 to 4.5).

CONCLUSION

The metaphyseal flare sign is an early, indirect sign of subchondral insufficiency fracture (SIF).

CLINICAL RELEVANCE/APPLICATION

The metaphyseal flare sign is an early, indirect sign of subchondral insufficiency fracture (SIF) particularly useful if the diagnosis is unclear to promptly begin the treatment and prevent the progression of the pathology.

SSM15-03 Uncovered Medial Meniscus Sign on Knee Magnetic Resonance Imaging: Evidence of Lost Brake Stop Mechanism of Posterior Horn Medial Meniscus

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E450B

Participants
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PURPOSE

To evaluate the association between anterior tibial translation and injuries on the posterior horn medial meniscus (PHMM) and the integrity of brake stop mechanism of the PHMM in anterior cruciate ligament (ACL) deficient knee.

METHOD AND MATERIALS

This retrospective study included 85 consecutive patients with arthroscopically confirmed complete ACL tear. Anterior tibial translation was quantitatively measured using sagittal MRI at the midpoint of the lateral femoral condyle. Uncovered medial meniscus sign was considered positive if a vertical line tangent to the posterior most margin of the medial tibial plateau intersected the PHMM at the midpoint of the medial femoral condyle on sagittal MRI. Concomitant injury on the structures of the posteromedial and posterolateral corners of the knee, including PHMM tear and meniscal ramp lesion, was recorded. Stratified subgroup analysis and multivariable regression analysis were performed to identify factors associated with anterior tibial translation.

RESULTS

The uncovered medial meniscus sign was positive in 21.2% (18/85) of patients and was significantly associated with anterior tibial translation. In the stratified subgroup analysis and multivariable regression analysis, positive uncovered medial meniscus sign consistently demonstrated a significant association with anterior tibial translation and generated an additional 3.5 mm of anterior tibial translation. Other injuries, including PHMM tear and meniscal ramp lesion, were not associated with anterior tibial translation.

CONCLUSION

The uncovered medial meniscus sign demonstrated a statistically significant correlation with anterior tibial translation and could be

The uncovered medial meniscus sign demonstrated a statistically significant correlation with anterior tibial translation and could be a useful marker for the lost brake stop mechanism of PHMM in the ACL deficient knee.

CLINICAL RELEVANCE/APPLICATION

1. An uncovered medial meniscus sign proved to have a statistically significant correlation with anterior translation of the tibia in patients with complete tear of the anterior cruciate ligament. 2. The uncovered medial meniscus sign could be a useful magnetic resonance imaging marker for a lost brake stop mechanism of the posterior horn medial meniscus in the knee. 3. A tear at the PHMM or meniscal ramp lesion itself should not be interpreted as an evidence of lost brake stop function of the PHMM.

SSM15-04 T2 Relaxation Times of the Anterolateral Femoral Cartilage in Patients After ACL-Repair with and Without a Deep Lateral Femoral Notch Sign

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E450B

Participants
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PURPOSE

To assess T2 relaxation times of the anterolateral femoral cartilage following anterior cruciate ligament (ACL)-repair with and without a positive deep lateral femoral notch sign (DLNS) at post-traumatic MRI.

METHOD AND MATERIALS

In 52 patients post-traumatic MRI as well as 12 months after ACL-rupture (ACLR) and surgical treatment were analysed. In 28 patients a positive DLNS was present at post-traumatic MRI. For quantitative analysis, T2 relaxation time measurements (7 TE: 10-70 ms) were performed at time of re-evaluation. Polygonal ROIs encompassing the full cartilage layer were placed in the anterolateral as well as adjacent femoral cartilage. Clinical assessment included Lysholm-Tegner-Activity-Score, Rasmussen's clinical score and modified Cincinnati-Rating-System-Questionnaire. Description and differences were calculations as means and confidence intervals of means, controlled for the cluster effect of person, if appropriate.

RESULTS

In patients with a positive DLNS after ACLR, relaxation times in the notch region were significantly prolonged compared to patients without a positive DLNS (Δ 7.4 ms, CI: 5.6 - 9.2; p-value <0.001) as well as to the adjacent anterior (Δ 5.7 ms, CI: 4.7 - 6.7; p-value <0.001) and central femoral cartilage (Δ 6.6 ms, CI: 5.7 - 7.6; p-value <0.001). No significant differences in the performed clinical scores between the two groups were noticed (p>0.05).

CONCLUSION

Significantly prolonged T2 relaxation times of the anterolateral femoral cartilage were found in patients with a positive DLNS following ACL-repair compared to patients without a DLNS. Based on these results, it has to be assumed that a positive DLNS is associated with higher cartilage degradation.

CLINICAL RELEVANCE/APPLICATION

The presented results implicate an impact on relaxation times in patients with a femoral notch sign after ACL-rupture. T2 analysis might help identifying patients at risk for earlier onset of Osteoarthritis, which might benefit from precocious surgical treatment.

SSM15-05 Decreased Vertebral Enhancement in Patients with Infectious Spondylitis, Presenting 'Black Vertebrae' as an Atypical Enhancement Pattern

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E450B

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To investigate the characteristics of patients with infectious spondylitis who show decreased vertebral enhancement.

METHOD AND MATERIALS

From January 2010 to November 2017, 767 patients with reports containing terms about infectious spondylitis was collected for this retrospective study. After reviewing images and medical record, we included 456 patients suspicious for infectious spondylitis with 706 post-contrast MR exams. When affected vertebra showed markedly lower degree of enhancement than that of normal bone

marrow(BM) and when the area showing decreased enhancement was greater than 50% of the area of the vertebral body, the vertebra was recognized as 'black vertebra'. Finally 10 patients(M:F=5:5, mean age=66.4 years) with 10 MRI were identified as showing 'black vertebra'. In those patients, imaging findings of MRI and CT within 2 weeks interval from MRI were evaluated. Clinical characteristics including comorbidities, causative organism and treatment course were reviewed.

RESULTS

10 patients with black vertebra showed atypical findings as for infectious spondylitis. There was little BM signal alteration on T1-weighted image(n=9), or absence of fluid-equivalent discal signal intensity(SI) on T2-weighted image(n=5). However, 6 patients showed T2 signal voids in or around the vertebral body and 8 patients showed air burbles on CT images(average interval : -1.1days from MR), suggesting emphysematous infection. On follow-up MRI(average interval: 7.2weeks from initial MR), available in 5 patients, those atypical findings almost disappeared but marked progression of infection was evident: increased range of affected segments (n = 3); low T1 SI of affected vertebra(n = 5); and increased contrast enhancement(n = 3). 9 patients had underlying disease such as Diabetes mellitus(n =5) or connective tissue disease(n=2) or etc. Causative organisms were identified as Klebsiella pneumonia(n=3), Staphylococcus aureus(n=3), Escherichia coli(n=2) and etc. Finally, 5 patients underwent surgery due to uncontrolled infection despite antibiotic treatment.

CONCLUSION

'Black vertebra' on contrast enhanced image seems to be associated with early finding of emphysematous infection.

CLINICAL RELEVANCE/APPLICATION

Recognition of decreased enhancement of affected spine, 'black vertebra', would be important to diagnose early emphysematous infection, known to have worse course than typical infectious spondylitis.

SSM15-06 Leopard Spot Edema: An Osseous Stress, Healing and Reinjury Phenomenon in Professional Ballet Dancers Seen on MR

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E450B

Participants
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PURPOSE

Professional ballet dancers are subject to numerous overuse syndromes about the ankle and foot. Anecdotally, we observed a patchy bone marrow pattern on MR in the hindfeet of skeletally mature dancers, similar to the "starry night" pattern described as normal in children. We sought to describe this pattern of "leopard spot marrow edema" (LSME) at MR and explore its potential etiology and significance using clinical correlation and follow-up imaging.

METHOD AND MATERIALS

28 MR exams of the ankle/hindfoot in 19 professional ballet dancers were reviewed by 2 MSK radiologists. The presence of LSME was recorded along with age, gender, clinical indication and primary MR findings potentially related to symptoms. Follow-up MRs were reviewed and edema was graded as improved or progressive. Correlation with clinical findings was made.

RESULTS

LSME was observed in 14/18 subjects (78%) and 22/28 MRs (78.5%). 8/22 with LSME had repeat MR (interval 3-71, mean 33 months). 5/8 showed improvement of LSME including 2 with complete resolution, both of whom were not dancing at follow-up. 1 subject showed improvement at 5 months but progression at 24 months. 3/8 had progressive LSME, and all 3 were dancing in an active production at follow-up. For subjects with LSME, the age range was 22-35, mean 25 years. There was little gender difference as 9/11 females and 5/7 males had LSME. As for other MR findings, 9/18(50%) had focal osseous stress response or stress fracture, 7/18(39%) had findings of posterior impingement, 2 had lateral ligament injury, 2 had posterior tibial tendon injury, and 1 each had Achilles tendinopathy, Lisfranc sprain and peroneal tendinopathy. 2 subjects with LSME at 1st MR had stress fractures at follow-up.

CONCLUSION

"Leopard spot marrow edema" is a common but previously unreported finding at MR of the hindfoot in ballet dancers, and our series suggests progression with active dancing such that it may reflect a syndrome of microtrabecular injury, healing response, and re-injury distinct from the pediatric marrow pattern reported as normal.

CLINICAL RELEVANCE/APPLICATION

The observation of this bone marrow pattern in an active ballet dancer should raise concern for evolving osseous stress response and a period of limited activity should be considered. Worsening bone marrow edema suggests that a process of microtrabecular injury with a healing response and re-injury is present explaining the observed MR findings.

SSM16

Nuclear Medicine (Thyroid/Parathyroid Imaging and Therapy)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S504CD

CT HN NR NM

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Don C. Yoo, MD, E Greenwich, RI (*Moderator*) Consultant, Endocyte, Inc
Brian M. Rodgers, MD, New Orleans, LA (*Moderator*) Nothing to Disclose

Sub-Events

SSM16-01 Complementary Gadoxetic Acid-Enhanced MRI in Addition to 18F-DOPA-PET/CT Improves Liver Staging in Patients with Medullary Thyroid Carcinoma

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S504CD

Participants
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PURPOSE

To investigate the additional diagnostic value of gadoxetic acid-enhanced MRI to 18F-DOPA-PET/CT for liver staging in patients with medullary thyroid carcinoma (MTC).

METHOD AND MATERIALS

41 consecutive patients with histologically confirmed MTC who underwent gadoxetic acid-enhanced MRI and 18F-DOPA-PET/CT within one month between 2010 and 2015 were selected for this retrospective study. The 18F-DOPA-PET/CT and multiparametric gadoxetic acid-enhanced MRI data sets were analyzed by two blinded radiologists. A 5-point Likert scale (based on the LI-RADS criteria: 1-definitely benign, 2-probably benign, 3-intermediate risk for metastasis, 4-probably metastasis, 5-definitely metastasis) was used for lesion categorization in both modalities. The additional value of MRI was defined as detection of 18F-DOPA-PET/CT-occult category 5 lesions or a definitive categorization (category 1 or 5) of lesions remaining inconclusive on the 18F-DOPA-PET/CT scan.

RESULTS

We categorized a total of 212 liver lesions (166 lesions on 18F-DOPA-PET/CT, 212 lesions on MRI; 165 metastases, 37 cysts, 18 hemangiomas). Out of 165 category 5 lesions on MRI, only 94 were classified as category 5 lesions on 18F-DOPA-PET/CT. In 65 % (30/46) of inconclusively categorized lesions on 18F-DOPA-PET/CT (category 2-4), a definitive lesion classification was possible with MRI (change in categorization to categories 1 or 5, respectively). A change in lesion classification by MRI was made in 12 patients (lesions with a change in category from 2 to 1: n=10; from 3 to 1: n=3; from 4 to 5: n=12; from 3 to 5: n=5).

CONCLUSION

Complementary liver-specific MRI allows for the detection of 18F-DOPA-PET/CT-occult metastases and optimizes liver lesion classification in MTC patients.

CLINICAL RELEVANCE/APPLICATION

The definitive categorization of detected liver lesions and timely identification of liver metastases in MTC patients is essential in guiding treatment decisions on early surgical or interventional management.

SSM16-02 Radiotheranostics for Regionally Advanced and Metastatic Differentiated Thyroid Cancer: Outcomes Following Initial Treatment Strategy Informed By Diagnostic 131-I Scintigraphy with SPECT/CT

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S504CD

Participants
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PURPOSE

Diagnostic staging 131-I scans with SPECT/CT (Dx scan) guide patient-individualized 131-I therapy for differentiated thyroid cancer (DTC). The objective of this study was to determine dynamic risk stratification outcomes after surgery and activity-adjusted 131-I therapy informed by diagnostic 131-I scintigraphy with SPECT/CT.

METHOD AND MATERIALS

Single-institution retrospective cohort study analysis of clinical outcomes in 350 patients with DTC associated with histopathologic risk factors, nodal metastases, and/or distant metastases treated at University of Michigan. Post-operatively all patients underwent Dx 131-I SPECT/CT scans for completion of staging and risk stratification. 131-I therapy was based on integration of information from histopathology, stimulated thyroglobulin (Tg) and scintigraphy. The patients were followed for 1-5 years (mean 39.6 ±23.4 months)

RESULTS

23 patients (6.6%) underwent re-operative neck dissection for removal of unsuspected residual nodal metastases identified on Dx scans. Dynamic risk stratification outcomes were: 84.3% complete response; 1.4% biochemical incomplete response; 2.3% indeterminate response and 12% structural incomplete response. Of the entire cohort only 8 patients (2.3%) had persistent iodine-avid metastatic disease which required repeated 131-I therapy. Of 31 patients with iodine-avid distant metastases identified on Dx scans, 13 patients (42%) achieved complete response with a single 131-I treatment.

CONCLUSION

Detection of regional and distant metastases on postoperative Dx scans permits adjustment of prescribed 131-I activity for targeted treatment, as compared to fixed-activity ablation. This approach resulted in complete response after a single 131-I treatment in 88% patients with histopathologic risk factors and regional metastases, and 42% patients with distant metastases. Most patients (81%) with structural incomplete response had negative follow-up 131-I scans and positive PET/CT and/or CT scans consistent with altered tumor biology (non-iodine avid disease).

CLINICAL RELEVANCE/APPLICATION

Postoperative Diagnostic 131-I scans with SPECT/CT are useful for identification of regional and distant metastases in thyroid cancer, informing 131-I therapy decisions. Elimination of iodine-avid regional and distant metastases with complete therapeutic response is achieved in the majority of patients after a single 131-I treatment based on radiotheranostics principles.

SSM16-03 I-131 Thyroid Dosimetry in Patients with Lung Metastases

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S504CD

Participants
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PURPOSE

To protect bone marrow from excessive radiation, maximum permissible activity (MPA) of I-131 to treat thyroid cancer is the value that limits absorbed dose to blood (as a surrogate of marrow) to < 200 cGy. Pts with thyroid carcinoma pulmonary metastases potentially are a unique subgroup because I-131 uptake in the lungs could result in apparently accelerated blood clearance, which in turn could lead to an overestimation of MPA. The objective of this investigation was to test the hypothesis that in pts with diffuse lung metastases from thyroid carcinoma, MPA based on blood measurements alone is not affected by the presence of diffuse lung metastases.

METHOD AND MATERIALS

Data were analyzed retrospectively for 87 thyroid cancer pts (60±15 yrs; 45 female; 42 male) referred for determination of MPA prior to I-131 treatment. Method1 for determining MPA computed total absorbed dose to blood (DTotal) as the sum of mean whole-body γ ray dose component (Dγ) from un-collimated gamma-camera measurements, along with dose due to ß emissions (Dß) from blood samples. Method2 estimated DTotal from Dß alone, using linear regression to associate in-vitro blood sample measurements

alone to conventional Method1 DTotal. MPA was computed as 200 cGy/DTotal for each DTotal estimate for Method1 & Method2. All pts also underwent whole body imaging 48 hrs after I-131 administration.

RESULTS

Six pts had iodine avid diffuse lung metastases. MPA values were similar for Method1 & Method2 for all pts (14.3±8.9 versus 14.1±8.7 GBq, p = 0.34), pts with lung metastases (12.4±6.9 versus 11.7±6.4 GBq, p = 0.06) & for pts without lung metastases (14.4±9.0 versus 14.3±8.8 GBq, p = 0.52). MPA values were similar for pts with lung metastases & pts without lung metastases (12.4±6.9 versus 14.4±9.0 GBq, p = 0.59). Correlations between Method1 & Method2 MPA values were similar for all pts (r = 0.990, p < 0.0001), those with lung metastases (r = 0.999, p < 0.0001), & those without lung metastases (0.989, p < 0.0001).

CONCLUSION

Our data suggest that in pts with iodine avid diffuse lung metastases from thyroid carcinoma, MPA can be accurately estimated by measuring I-131 blood clearance alone without the need to perform un-collimated gamma camera whole body counting.

CLINICAL RELEVANCE/APPLICATION

MPA can be estimated by I-131 blood clearance alone in pts with lung metastases from thyroid carcinoma.

SSM16-04 Influence of Age on Multivariate Analysis of Disease Specific Survival in Differentiated Thyroid Cancer

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S504CD

Participants
Jasna Mihailovic, MD, 21204 Sremska Kamenica, Serbia (*Presenter*) Nothing to Disclose
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Jelena Roganovic, MD, Sremska Kamenica, Serbia (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The aim of the study was to analyze the influence of age (<45 years versus >=45 years) on disease-specific survival (DSS) and its prognostic factors in patients with differentiated thyroid cancer (DTC).

METHOD AND MATERIALS

569 DTC patients were treated with I-131 (RAI) in our institution from 2001 to 2010. We analyzed DSS and its predicting factors in all 569 patients as well as in different age groups (Group I<45 years, 237 patients and Group II: >=45 years, 332 patients) by Kaplan-Meier's method. Statistical significance of differences was tested by Log rank test.

RESULTS

There were 185 (32.51%) high risk and 378 (66.43%) low-risk patients, while T was not defined in 5 (0.88%) patients; 132 (23.2%) males, 437 (76.8%) females; 57 (10%) follicular and 465 (81.7%) papillary carcinomas, while histology was not defined in 3 (0.53%) patients. Initial regional metastases were present in 202 (35.5%) patients. DSS was 96.5%; 93.5%; 87%, and 69.6% after 5,10,15 and 17 years, respectively. Prognostic factors that significantly influenced DSS were: gender (p=0.003), age (p=0.0001), T stage (p=0.02), initial metastases (p=0.0001), histology (p=0.039), type of initial treatment (p=0.01), while number of RAI course did not inlfuence the survival (p=0.087). In Group I, DSS after 5, 10 and 15 years was 99.1%. Prognostic factors that significantly influenced DSS in this group were: initial metastases (p=0.015) and histology (p=0.007), while gender, type of initial therapy, T stage, and number of RAI courses had no significant influence (p=0.89; p=0.143; p=0.969; p=0.504, respectively). In Group II, DSS after 5 years was 94%, after 10 years = 89.3% and after 15 years = 78%. Strong predicting factors were: gender (p=0.0001), initial metastases (p=0.0001), type of initial therapy (p=0.028), and number of RAI courses (p=0.031), while histology and T stage had no influence to DSS (p=0.275; p=0.101, respectively).

CONCLUSION

DSS prognostic factors differ among age groups. Young patients show longer DSS significantly influenced by the presence of initial metastases and histology. In contrast, elderly patients have shorter DSS with significant influence of gender, type of initial therapy, presence of initial metastases and number of RAI courses.

CLINICAL RELEVANCE/APPLICATION

In comparison to elderly, young DTC patients have longer DSS that is influenced by different prognostic factors.

SSM16-05 Feasibility of Parathyroid Adenoma Localization with Fluciclovine (18F) PET-CT

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S504CD

Awards
Student Travel Stipend Award

Participants
Akinyemi A. Akintayo, MD, Atlanta, GA (*Presenter*) Nothing to Disclose
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Collin Weber, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Joe Sharma, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Cynthia Cohen, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose
Raghuveer K. Halkar, MD, Atlanta, GA (*Abstract Co-Author*) Research Grant, General Electric Company Research Grant, Gilead Sciences, Inc Royalties, General Electric Company
Mark M. Goodman, PhD, Atlanta, GA (*Abstract Co-Author*) Royalties, Nihon Medi-Physics Co, Ltd
David M. Schuster, MD, Decatur, GA (*Abstract Co-Author*) Institutional Research Grant, Nihon Medi-Physics Co, Ltd; Institutional Research Grant, Blue Earth Diagnostics Ltd; Institutional Research Grant, Advanced Accelerator Applications SA; Consultant,

Syncona Ltd; ; ;

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PURPOSE

Localization of parathyroid adenomas is essential for surgical planning. Uptake of fluciclovine (18F) by parathyroid cells has been reported in-vitro. We conducted a feasibility pilot study to evaluate the ability of fluciclovine PET-CT in comparison to 99m Tc sestamibi SPECT-CT for localization of parathyroid adenomas in patients with hyperparathyroidism.

METHOD AND MATERIALS

Four patients with hyperparathyroidism underwent PET-CT of the neck and upper mediastinum for 60 mins after IV injection of fluciclovine (351.5±28MBq). SUVmax of the adenomas, and target-to-background ratios (TBR) (SUVmax/SUVmean) utilizing blood pool (aortic arch), muscle (pectoralis) or thyroid gland as the background were compared with TBRs of the 45-minute sestamibi (798.3±26.8MBq)SPECT-CT in the same patient. Surgical confirmation was reference standard for truth.

RESULTS

Both modalities had 100% concordance in the localization of the adenomas at surgery (n=4). Mean SUVmax (±SD) of the adenomas were 3.5±1.67, 2.6±1.17, 2.1±0.81, 2.1±0.95, and 2.2±1.03 at 5, 10, 20, 35 and 50 minutes, respectively. The highest fluciclovine SUVs and TBRs were at the 5 min time-point with rapid washout. Sestamibi had significantly higher TBRs compared with fluciclovine (5 min) for blood pool (10.9±4.70 vs 1.3±0.57; p<0.01) and pectoralis muscle (5.8±3.01 vs 1.7±0.55; p<0.01) with a non-significant trend for thyroid gland (1.3±0.48 vs 1.1±0.45; p=0.73), respectively. After surgical resection of the adenomas, the post-operative parathyroid hormone levels decreased to normal. A 2x2 mm adenoma at surgery was not detected by either modality.

CONCLUSION

In this small series we found that parathyroid adenomas can be detected on fluciclovine PET-CT at early imaging but with rapid washout. In addition, adenoma conspicuity (TBR) was better with sestamibi compared with fluciclovine. Fluciclovine PET-CT does not seem promising in the detection and localization of parathyroid adenomas compared with sestamibi SPECT-CT. Studies in patients with negative sestamibi scans are encouraged.

CLINICAL RELEVANCE/APPLICATION

Parathyroid adenomas can be detected on fluciclovine PET-CT at early imaging; however, adenoma conspicuity (TBR) seems better with sestamibi compared with fluciclovine.

SSM16-06 Evaluating the Role of Tc99m Sestamibi Scan in Parathyroid Surgery: A 10-Year Institutional Experience

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S504CD

Participants
Parul Mohan, MBBS, MD, New Delhi, India (*Abstract Co-Author*) Nothing to Disclose
Harsh Mahajan, MD, MBBS, New Delhi, India (*Presenter*) Nothing to Disclose
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PURPOSE

In this study we aim to evaluate the (99mTc) sestamibi parathyroid scan as a single localizing modality, and we also assess its relation to the weight of the gland and to the preoperative parathyroid hormone (PTH) levels.

METHOD AND MATERIALS

We reviewed 744 patients from our hospital from 2007 to 2017, with a mean age of 56.6 years and a female to male ratio of 3.3:1. With primary hyperparathyroidism, all of them had (99mTc) sestamibi parathyroid scan for the localization of the parathyroid adenoma. Preoperative and postoperative PTH levels were recorded. The histopathology reports confirmed the diagnosis and weight of the diseased gland, which were recorded every time. The results were analyzed and correlated with the sestamibi results, to evaluate its accuracy.

RESULTS

506 patients (68%) of the 744 had an exact match (EM) sestamibi results, 227 (30.5%) had a partial match, and only 11 patients were reported as mismatch. Analyzing the mean weight of the gland in each group between matching (EM, PM) versus mismatch resulted in a mean difference of 0.823 g (1.05 and 0.247 g, respectively) P = 0.045. Hyperplasia to adenoma ratio was more in the partial matching group (18.5%) versus the exact matching group (7.6%). Finally the mean PTH level was higher in the EM group (36.8 pmol/L) compared to the mismatch group (10.1 pmol/L) P = 0.02. Overall sensitivity and specificity for the (99 mTc) sestamibi in our data was 98.1 and 97%, respectively.

CONCLUSION

(99mTc) sestamibi is a highly accurate test that can be employed as a single localizing modality for identifying a hypersecreting parathyroid, a parathyroid adenoma, or a parathyroidectomy. The weight of the gland plays an important role in the accuracy of the test, as also the preoperative PTH levels.

CLINICAL RELEVANCE/APPLICATION

(99mTc) sestamibi is a highly accurate test that can be employed as a single localizing modality for identifying a parathyroid adenoma.

SSM17

Neuroradiology/Head and Neck (Dual-Energy CT in Head and Neck Imaging)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: N228

CT HN NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Reza Forghani, MD,PhD, Cote-saint-Luc, QC (*Moderator*) Stockholder, Real-Time Medical, Inc; Founder, 4 Intel Inc; Stockholder, 4 Intel Inc; Consultant, General Electric Company; Speaker, General Electric Company
Salman Qureshi, MBChB, BSc, Sale, United Kingdom (*Moderator*) Nothing to Disclose

Sub-Events

SSM17-01 Differentiation of Benign and Malignant Neck Lymph Nodes on Dual-Energy CT

Wednesday, Nov. 28 3:00PM - 3:10PM Room: N228

Awards
Student Travel Stipend Award

Participants
Jeanne Kochkodan, BS, Ann Arbor, MI (*Presenter*) Nothing to Disclose
Remy R. Lobo, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Differentiation of benign versus malignant metastatic lymph nodes in the head and neck currently relies on size, morphology and functional status, such as abnormal FDG metabolism. Dual energy CT (DECT) has shown potential in differentiating benign and malignant head and neck lesions in prior studies. Our aim was to evaluate the utility of DECT derived parameters in differentiating benign and metastatic lymph nodes in head and neck squamous cell carcinoma (HNSCC).

METHOD AND MATERIALS

This retrospective IRB approved study included 14 patients with HNSCC who underwent head/neck DECT and PET/CT within 60 days of each other. One reader placed regions of interest within multiple lymph nodes deemed metastatic (on PET/CT, histopathology or both), normal nodes and skeletal muscle in the same patients (32 metastatic, 49 normal nodes). Independent sample t-tests were used to compare differences in DECT parameters between the two groups, including node HU at 40keV, 50keV, 70keV, 140keV, HU40keV-HU140 keV, effective Z and iodine concentration after normalizing the values by creating node to muscle ratios. When gross necrosis was present in the nodes, ROIs including entire node and those that excluded the necrotic portion were separately studied.

RESULTS

Significant differences in node HU40keV and RATIO-HU40keV were seen between normal and metastatic nodes (207 vs 177 HU, p=0.048; 2.29 vs 1.91, p=0.027) when necrosis was excluded. Similarly, significant differences were seen in node HU140keV and RATIO-HU140keV between normal and metastatic nodes (30.4 vs 38.2 HU, p=0.003; 0.75 vs 0.62, p=0.012), as well as RATIO-HU40-140keV (p=0.047). The other DECT parameters studied did not reveal any differences between the two groups.

CONCLUSION

DECT derived lymph node HU at monochromatic 40keV and 140 keV and ratio of node to muscle HU at monochromatic 40keV and 140 keV are significantly different between normal and metastatic nodes in patients with HNSCC, implying that DECT could have utility, in addition to size and morphology of nodes, in distinguishing these groups. We plan to further study the thresholds that can be used for employing this in clinical practice.

CLINICAL RELEVANCE/APPLICATION

Since most patients with HNSCC undergo CT examination for disease workup, utilizing DECT based metrics for improving the differentiation of normal from metastatic nodes in patients with HNSCC without any additional radiation can help better stage disease.

SSM17-02 Diagnostic Value of Dual-energy Spectral Computed Tomography in Differentiating Parotid Gland Tumors

Wednesday, Nov. 28 3:10PM - 3:20PM Room: N228

Participants
Lin Li, MD, Beijing, China (*Presenter*) Nothing to Disclose

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PURPOSE

To quantitatively evaluate the value of single-source dual-energy spectral computed tomography in differentiating parotid gland tumors.

METHOD AND MATERIALS

43 patients underwent enhanced neck dual-energy spectral CT scan before operation. The spectral CT scan protocol included tube current of 260mA, helical pitch of 0.984 and rotation speed of 0.7s/r. The material decomposition images and monochromatic images were reconstructed and transferred to a GEAW4.6 workstation for spectral analysis using the Gemstone Spectral Imaging (GSI) Viewer software. Tumors were divided into pleomorphic adenomas (PAs), Warthin tumors (WTs) and malignant tumors (MTs) types. The CT number as function of photon energy, iodine concentration (IC) and water concentration (WC) of tumors were measured. The slope value (λHU) of the spectral HU curve and normalized iodine concentration (to common carotid artery, NICA) were calculated and compared among the three types of tumors. The statistical analysis was performed with SPSS 13.0 software. ROC analysis was performed to evaluate the efficiency of these multiple parameters for the differential diagnosis.

RESULTS

52 tumors were confirmed by pathology and were included in our study, including 12 pleomorphic adenomas, 24 Warthin tumors (15 patients), and 16 malignant tumors. The IC, NICA and λHU values of WTs (2.45±0.82mg/ml, 0.33±0.08 and 2.76±0.08, respectively) were significantly higher than those of MTs (1.48±0.90mg/ml) which were in turn higher than those of PAs (0.59±0.28mg/ml) (all $P<0.05$). The optimal IC, NICA and λHU threshold was 0.91mg/ml, 0.15 and 1.09, respectively for differentiating PAs from MTs, achieving sensitivity of 91.7%, 91.7% and 91.7%, specificity of 95.0%, 85.0% and 95.0%, and accuracy of 94.2%, 86.5%and 94.2%, respectively for distinguishing PAs from MTs. The optimal IC, NICA and λHU threshold was1.46mg/ml, 0.20 and 1.72,achieving 91.7%, 95.8% and 91.7% sensitivity, 89.3%, 85.7% and 89.3% specificity, respectively. The accuracy was 90.4%, 90.4%and90.4%, respectively for distinguishing WTs from MTs.

CONCLUSION

The single-source dual-energy spectral CT-related measurements such as iodine concentration in parotid tumors in the enhanced CT scans are useful in the differential diagnosis of parotid tumors.

CLINICAL RELEVANCE/APPLICATION

The single-source dual-energy spectral CT imaging is helpful to differentiate various pathological types of parotid gland tumors.

SSM17-03 Comparison of Dual and Single Source Dual Energy CT in Head and Neck Imaging

Wednesday, Nov. 28 3:20PM - 3:30PM Room: N228

Participants
Matthias S. May, MD, Erlangen, Germany (*Presenter*) Speakers Bureau, Siemens AG
Rafael Heiss, Erlangen, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG
Michael Uder, MD, Erlangen, Germany (*Abstract Co-Author*) Speakers Bureau, Bracco Group Speakers Bureau, Siemens AG Speakers Bureau, Bayer AG Research Grant, Siemens AG
Wolfgang Wust, MD, Erlangen, Germany (*Abstract Co-Author*) Speakers Bureau, Siemens AG

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PURPOSE

Aim of this study was to compare image quality of Single-Source Dual-Energy CT (SS-DECT) with third-generation Dual-Source dual energy CT (DS-DECT) in head and neck cancer.

METHOD AND MATERIALS

102 patients with histologically proven head and neck cancer were prospectively randomized to undergo radiation dose matched SS-DECT (n=51, 120 kV, split filter technique, 384 ref. mAs) or DS-DECT (n=51, 80/Sn150 kV, tube A 100/ tube B 67 ref. mAs). Inline default images (DI) and virtual monoenergetic images (VMI) for two different low energies (40 and 60 keV) were reconstructed. Objective image quality was evaluated as dose normalized contrast to noise ratio (CNRD) and subjective image quality was rated on a 5-point Likert-scale.

RESULTS

In both groups highest CNRD values for vessel and tumor attenuation were obtained at 40 keV. DS-DECT was significantly better than SS-DECT regarding vessel and tumor attenuation. Overall subjective image quality in the SS-DECT group was highest on the DI followed by 40 keV and 60 keV. In the DS-DECT group subjective image quality was highest at 40 keV followed by 60 keV and the DI. 40 keV and 60 keV were significantly better in the DS-DECT compared to the SS-DECT group (both $p<0.01$).

CONCLUSION

In split filter SS-DECT as well as DS-DECT highest overall image quality in head and neck imaging can be obtained with a combination of DI and low keV reconstructions. DS-DECT is superior to split filter SS-DECT in terms of subjective image quality, vessel and tumor attenuation.

CLINICAL RELEVANCE/APPLICATION

This is the first study comparing image quality of two different dual energy techniques of the same vendor in a radiation dose-matched setting for head and neck imaging.

SSM17-05 Iodine Quantification in Patients with Initially Diagnosed Head and Neck Cancer Using Dual-Layer

Detector Spectral CT: Which Factor Could Significantly Affect the Tumoral Iodine Concentration?

Wednesday, Nov. 28 3:40PM - 3:50PM Room: N228

Participants
Younghen Lee, MD, Ansan, Korea, Republic Of (*Presenter*) Nothing to Disclose
Hyung Suk Seo, Ansan-si, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
Soon Young Kwon, Ansan, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

We aimed to investigate of impacts of patient- & tumor-related factors on the dual-layer detector spectral CT-derived iodine concentration(IC) in the patients initially diagnosed with head and neck squamous cell carcinoma(HNSCC).

METHOD AND MATERIALS

From July 2016 to March 2018, a total of 46 patients (M:F=41:5, mean age: 62.8years) initially diagnosed with HNSCC which were identified by contrast-enhanced neck CT examination using a double-layer detector spectral CT (IQon CT, Philips healthcare) were retrospectively enrolled. To obtain the IC of the primary tumors, an experienced neuroradiologist draw the region of interest (ROI) on the representative axial images after reviewing the corresponding MRI images, and then copied the same ROI on the additional iodine density map. In addition, other ROIs were drawn on the aortic arch and ipsilateral neck muscle for normalization. We statistically determined the variables which significantly influenced the IC and normalized IC (nIC) of primary HNSCC using a multivariate linear regression: age, gender, iodine concentration, body surface area, T stage, histologic grading and location of tumor.

RESULTS

According to our quantitative analysis obtained from contrast-enhanced neck CT examination with fixed scan delay (50-sec), only histologic grading significantly influenced the mean IC of primary HNSCC ($p<0.05$). The mean IC (mg/ml) was significantly highest in well differentiated (n=11;2.2±0.84), followed by those of moderately-(n=27;2.0±0.65), poorly differentiated (n=4;1.8±0.49) and that of non-keratizing type were lowest (n=4; 1.40±0.18).

CONCLUSION

Dual-layer detector spectral CT-derived mean IC could be used as useful predictor of histologic grading in patients initially diagnosed HNSCC.

CLINICAL RELEVANCE/APPLICATION

Dual-layer detector spectral CT-derived mean IC could be used as useful predictor of histologic grading in patients initially diagnosed HNSCC. Iodine quantification using dual-layer detector spectral CT might potentially improve the role of contrast-enhanced CT examination in the HNSCC.

SSM17-06 Preliminary Study on Spectral CT in the Diagnostic Value of Papillary Thyroid Microcarcinoma

Wednesday, Nov. 28 3:50PM - 4:00PM Room: N228

Participants
Lin Li, MD, Beijing, China (*Presenter*) Nothing to Disclose

PURPOSE

The aim of the current study was to retrospectively analyze spectral CT images of papillary thyroid microcarcinoma (PTMC) and evaluate the detection and diagnostic value for PTMC.

METHOD AND MATERIALS

33 cases (35 lesions) of PTMC which were confirmed by surgical pathology from January 2015 to January 2016 were included in this retrospective study. All the patients underwent Spectral CT scan using Discovery CT750 HD scanner. All the spectral CT images were divided into 3 groups: polychromatic image (group A), optimal monochromatic image (group B), and the fused image which blended optimal monochromatic image with iodine-based material decomposition image together (group C). The image qualities of group A and B were evaluated objectively, and the detection abilities of the 3 groups were evaluated subjectively.

RESULTS

The optimal CNR level is (65.96±4.01)keV (range from 62 to 75keV). The CNR of optimal monochromatic image of spectral CT was higher than that of polychromatic image(t=-5.626,P=0.000), and the noise of optimal monochromatic image was lower than that of polychromatic image(t=12.00,P=0.000), and the differences were significant($P<0.05$). The detection rate of the 3 groups of images for microcarcinoma lesions were 91.4%(32/35),97.1%(34/35), and 100%(35/35) respectively, while the subjective scores of the 3 groups of images were 2.54±1.15,3.31±0.93, and 3.46±0.74 respectively. The detection ability of fused image was better than that of polychromatic image and similar to that of optimal monochromatic image. The characteristics of microcarcinoma were irregular shape (19 cases, 54.3%), indistinct margin (24 cases, 68.6%), heterogeneous density (24 cases, 68.6%), detection of microcalcification (16 cases, 45.7%), and lymph node metastasis (20 cases, 57.1%). The lesions' average iodine concentration, normalized iodine concentration, and the average spectral HU curve slope values were (25.0±10.3)×100μg/ml (range from (9~43)×100μg/ml), 0.33±0.14(0.14~0.61), and 2.99±1.59(-0.83~5.38), respectively.

CONCLUSION

Spectral CT could provide more detailed information for PTMC diagnosis, and the fused image which blended optimal monochromatic image with iodine-based material decomposition image may be useful for PTMC detection and diagnosis in the clinics.

CLINICAL RELEVANCE/APPLICATION

Spectral CT imaging is helpful to detect and diagnosis papillary thyroid microcarcinomas.

SSM18

Neuroradiology (Advances in Neuro MRI)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: N226

MR NR

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Sugoto Mukherjee, MD, Charlottesville, VA (*Moderator*) Nothing to Disclose
David M. Wilson, MD, PhD, San Francisco, CA (*Moderator*) Nothing to Disclose

Sub-Events

SSM18-01 Quantitative Assessment of the Effect of Endovascular Treatment for Cerebral Venous Sinus Thrombosis by Using Magnetic Resonance Black-Blood Thrombus Imaging (MRBTI)

Wednesday, Nov. 28 3:00PM - 3:10PM Room: N226

Participants
Xiaoxu Yang, Beijing, China (*Presenter*) Nothing to Disclose
Qi Yang, MD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
Fang Wu, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
Xunming Ji, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Our study aims to quantitatively evaluate the treatment effect of endovascular treatment for patients with acute cerebral venous sinus thrombosis(CVST) by Magnetic Resonance Black-Blood Thrombus Imaging(MRBTI) for the first time.

METHOD AND MATERIALS

From 2014 to 2018, 34 patients diagnosed with acute CVST were included in this study, of whom 19 patients received endovascular treatment(experimental group) while 15 patients received anticoagulant therapy(control group). Initial MRBTI and MRV, follow-up MRBTI and MRV were performed on all these enrolled patients. Thrombus Volume (TV) of each person was measured between endovascular group and anticoagulant group on BTI images. Thrombosed segments, venous colleterals, degree of recanalization and modified Rankin Scale(mRS) were noted between these two groups.

RESULTS

In endovascular and anticoagulant groups, the volume of thrombus(VT) was 9538±5343 mm^3 and 6424±3633 mm^3($P>0.05$, $P=0.77$) before treatment, the volume of thrombus was 2028±3836 mm^3 and 2642±2234 mm^3($P>0.05$, $P=0.604$) respectively. The decreased volume after treatment were 7509±4660 mm^3 and 3782±2269 mm^3 ($P<0.01$, $P=0.009$). Before treatment, the thrombosed segments in experimental group and control group were 6.3±2.8 and 5.9±2.5($P>0.05$, $P=0.692$) and were 2.9 ±2.5 and 4.5 ±2.7($P> 0.05$, $P=0.109$) after treatment, and the decreased segments were 3.3 ±1.8 and 1.4 ±1.3($P< 0.01$, $P=0.002$), respectively. And the degree of recanalization in endovascular group is better than anticoagulant group ($P < 0.01$, $P=0.000$), which predict a satisfied prognosis. While as for venous collaterals, the venous collateral in anticoagulant group(control group) is more than endovascular group(experimental group).

CONCLUSION

MRBTI can quantitatively assess the effect of endovascular treatment for patients with CVST. Furthermore this technique should be the best imaging technique to follow up patients with CVST after treatment, which may help to judge prognosis of patients with CVST.

CLINICAL RELEVANCE/APPLICATION

The novel imaging technique-MRBTI to quantitatively assess the effect of endovascular therapy for the first time. It may help to predict the prognosis of patients with CVST.

SSM18-02 Amine Protons Were Increased in the Demented Patients: Evaluation of the Chemical Exchange Dependent Saturation Transfer MRI

Wednesday, Nov. 28 3:10PM - 3:20PM Room: N226

Participants
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Yeji Shin, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose
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Geon-Ho Jahng, PhD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Chemical exchange dependent saturation transfer (CEST) MRI is sensitive to solid-like proteins and may detect mobile proteins and peptides in tissues. There is no study for investigating various substances such as amine, hydroxyl protons with a full Z spectrum. Therefore, the purpose of our study is to evaluate the characteristics of chemical exchange proton pools using a CEST MRI technique in dementia patients.

METHOD AND MATERIALS

Nineteen demented (mean=77.9 years, range=55-92 years) and 22 non-demented (mean=66.7 years, range=51-83 years) subjects were included in this study. Using two 3.0 Tesla MRI systems, the full Z spectrum data by total 38 dynamics from -5.00 ppm to 5.00 ppm frequency offset ranges were acquired with using a 3D turbo-spin-echo (TSE) sequence in the brain using alternative increased frequency interval of 0.25 ppm. To map the voxel-based exchangeable signals with the special frequency offsets of protons and the magnetization transfer ratio (MTR) asymmetry (MTRasym), we quantified exchangeable protons with the Lorentzian fitting method using the six-pool model consisted of amide, amine, hydroxyl, direct water saturation (DWS), nuclear overhauser effect (NOE) and magnetization transfer (MT). The voxel-based MTRasym maps were calculated at the frequency offsets of 1.00 ppm, 3.00 ppm, 3.50 ppm. The two sample t-test was used for comparison between two groups.

RESULTS

Based on the Lorentzian fitting, the amide was not significantly different between the two groups and the amine was significantly different between the two groups at the anterior cingulate, hippocampus, parahippocampal gyrus, and pons. MTRasym values were significantly different between the two groups at the anterior cingulate, hippocampus, and putamen for both 3 ppm and 3.5 ppm.

CONCLUSION

In the demented subjects, the amine and the MTR asymmetry values were increased, probably related with increased proteins, neurotransmitters, or metabolites. CEST MRI has several advantages compared with amyloid PET. Therefore, CEST MRI may be useful to investigate brain changes in demented patients without radiation exposure and with high resolution.

CLINICAL RELEVANCE/APPLICATION

CEST MRI technique in dementia patients can be effective for the evaluation of brain changes in demented patients without radiation exposure and with high resolution.

SSM18-03 Assessing Histologic and Genetic Subtypes in Glioma Patients Using CEST MRI at 7T

Wednesday, Nov. 28 3:20PM - 3:30PM Room: N226

Participants
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Constantin Dreher, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The study purpose was to investigate the non-invasive predictability of IDH-mutation status, MGMT promotor methylation, and differentiation of lower versus higher grade glioma (LGG vs. HGG) in newly-diagnosed WHO grade I-IV glioma patients employing Chemical Exchange Saturation Transfer (CEST) magnetic resonance imaging (MRI) at 7.0 Tesla (7T).

METHOD AND MATERIALS

Thirty-four newly-diagnosed glioma patients were included in this prospective study (WHO grade I-II: 7/34=20.6%=LGG; WHO grade III-IV: 27/34=79.4%=HGG; IDH1-R132H status: 9/33=27.3% IDH-mutant; 24/33=72.7% IDH-wildtype, 1 patient not assessed; MGMT promotor methylation status 13/28=46.4% methylated, 11/28=39.3% unmethylated, 4/28=14.3% indeterminate, 2 patients not assessed). CEST MRI was performed at a 7T whole-body scanner followed by a multi-Lorentzian fit analysis. Nuclear Overhauser Effect (NOE) and amide proton transfer (APT) CEST signals were quantitatively investigated in the whole tumor area with regard to predictability of IDH-mutation, MGMT status, and differentiation of LGG vs. HGG. Statistics were performed using

receiver operating characteristic (ROC) and area under the curve (AUC) analysis.

RESULTS

The APT CEST contrasts yielded highest AUCs in IDH-mutation status prediction (dns-APT=0.92, p<0.01; sensitivity=81%, specificity=100%). NOE mediated CEST imaging yielded inferior performance in IDH status prediction (AUC=0.78, p=0.02; sensitivity=61%, specificity=83%). Furthermore, dns-APT metrics enabled significant differentiation of LGG vs. HGG (AUC: dns-APT=0.78, p<0.05; sensitivity=71%, specificity=100%). There was no significant difference regarding MGMT status at any CEST contrast (p>0.05).

CONCLUSION

CEST MRI at 7T, particularly APT imaging, enabled prediction of IDH-mutation status and differentiation of LGG vs. HGG and should therefore be considered as non-invasive MR biomarker to assess histologic and genetic subtypes in glioma patients in the diagnostic workup.

CLINICAL RELEVANCE/APPLICATION

Early identification of prognostic superior characteristics in glioma patients such as IDH-mutation and MGMT status is of great clinical importance. Our study demonstrates that CEST MRI at 7.0T enables non-invasive prediction of IDH mutation status and differentiation of LGG vs. HGG tumors. Consequently, CEST MRI may add valuable information as a non-invasive imaging biomarker in the preoperative diagnostic work-up of glioma patients.

SSM18-04 NODDI: A Promising Method for Assessing Glioma Grade and Cellular Proliferation

Wednesday, Nov. 28 3:30PM - 3:40PM Room: N226

Participants
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PURPOSE

To explore the diagnostic performance of neurite orientation dispersion and density imaging (NODDI) in grading gliomas and to evaluate the cellular proliferation.

METHOD AND MATERIALS

NODDI and diffusion-weighed imaging were performed on 80 patients with histopathologically proven glioma. Parameter maps of intra-cellular volume fraction (ficvf), isotropic volume fraction (fiso) and orientation dispersion index (odi) were calculated. Regions of interest were placed in the most solid parts of the tumor. These metrics were normalized to the contralateral normal-appearing white matter and correlated with Ki-67 expression.

RESULTS

Significant differences in normalized ficvf, odi and fiso were observed between low-grade gliomas and high-grade gliomas (ficvf: 0.213 ± 0.107 vs. 0.718 ± 0.234; odi: 0.962 ± 0.426 vs. 1.767 ± 0.636; fiso: 2.482 ± 2.040 vs. 0.109 ± 0.140; $p < 0.001$ for all) and between grade II and grade III (ficvf: 0.208 ± 0.104 vs. 0.603 ± 0.253; odi: 0.952 ± 0.428 vs. 1.762 ± 0.542; fiso: 2.550 ± 2.031 vs. 0.115 ± 0.133, $p < 0.001$ for all). Only normalized ficvf was significant different between grade III and grade IV (0.603 ± 0.253 vs. 0.803 ± 0.182, $p = 0.004$). Ki-67 labeling index was positively correlated with ficvf and odi ($r = 0.758$ and 0.616), and negatively correlated with fiso and ADC ($r = -0.523$ and -0.703).

CONCLUSION

NODDI can effectively grade gliomas, and also showed great potential in predicting Ki-67 expression.

CLINICAL RELEVANCE/APPLICATION

NODDI offers a novel and non-invasive method in grading gliomas and to evaluate the cellular proliferation in gliomas.

SSM18-05 T2 Nerve Imaging of the Brachial Plexus Using Compressed-SENSE Effect on Image Quality and Acquisition Time

Wednesday, Nov. 28 3:40PM - 3:50PM Room: N226

Participants
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PURPOSE

In this study, compressed sensing is combined with the parallel-imaging or SENSE infrastructure, i.e., Compressed-SENSE (CSENSE),

for accelerating anatomical MR data acquisition by exploiting the multi-element receiver coil sensitivity variation and sparsity constraining. We quantitatively evaluate the dual role of CSENSE imaging in reducing scan time without loss in resolution and in improving resolution with minimal increase in scan time.

METHOD AND MATERIALS

Ten healthy volunteers were scanned on a 3.0T MRI (Ingenia, Philips) using a proprietary "3D NerveView Sequence" (NVS), a T2W TSE isotropic sequence (TR 2200, TE 170, 2 mm slice thickness). Three versions of NVS were developed, SEQ1 (no CSENSE), SEQ2 (CSENSE factor = 9) and SEQ3 (CSENSE factor = 9) with acquisition times 6:16, 3:22 and 8:19 minutes respectively. SEQ1 and SEQ2 had the same acquisition and recon matrix of 252X325 and 640X640 while SEQ3 had a higher resolution having acquisition and recon matrix of 316X414 and 720X720 respectively. Contrast-to-Noise Ratio (CNR) was measured in all at the levels of the nerve roots (C5 to T1 levels), trunks and cords using Shinkei's formula of CNR = (SI-Nerve - SI-Muscle)/ (SI-Nerve + SI-Muscle) where SI is average Signal Intensity in the region.

RESULTS

There was no significant difference in CNR for roots in all three sequences, i.e. SEQ1 - 0.7102±0.102, SEQ2 - 0.7040±0.044 and SEQ3 - 0.7253±0.035. In the trunks, SEQ3 performed as well as SEQ1 with a CNR of 0.567±0.10 against 0.5497±0.09. SEQ2 had a lower CNR of 0.4843±0.11. At the level of cords, SEQ1 outperformed both SEQ2 and SEQ3 with a CNR of 0.4248±0.17 against 0.3079±0.11 and 0.3505±0.19 respectively. We note that CSENSE performs better in areas where average CNR is on the higher side.

CONCLUSION

While CSENSE gives radiologists flexibility of reducing time or increasing resolution, the decision of when and how to use CSENSE depends on the clinical context. It can be used to reduce scan time when root lesions are suspected and improve resolution when lesions of the trunks and cords are suspected.

CLINICAL RELEVANCE/APPLICATION

Compressed Sensing for nerve imaging should be part of every radiologist and technologists' arsenal to conduct patient-specific personalised scanning. Lower scan time leads to improved patient comfort and hence less motion artefacts, and higher resolution improves diagnostic accuracy of the scan.

SSM18-06 Visualization of the Peripheral Branches of the Mandibular Nerve Using a Micro Surface Coil and Three-Dimensional Double-Echo Steady-State with Water Excitation Sequence

Wednesday, Nov. 28 3:50PM - 4:00PM Room: N226

Participants
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PURPOSE

To investigated the detectability of the branches of the mandibular nerve on a three-dimensional double-echo steady-state with water excitation sequence using a small surface coil.

METHOD AND MATERIALS

The maxillofacial regions of 52 volunteers were scanned unilaterally by a small surface coil combined with 3D-DESS-WE sequence. According to the Gray's anatomy atlas, MPR and CPR was done according to the anatomic position of mandibular nerve and the branches, the signal characteristics of the nerves and neighboring structures were analyzed, the displaying rate of the mandibular nerves and their branches were evaluated, the image quality and display of the nerve were subjectively scored, the signal intensity(SI) of the nerve and adjacent lateral pterygoid muscle were measured,the signal intensity ratio(SIR) of mandibular nerve/lateral pterygoid muscle (SIRN/M) was calculated.

RESULTS

Compared with the muscles, the nerve showed iso signal intensity. The subjective scores for all small coil 3D-DESS-WE images were 3.02±0.82. The displaying rates of the mandibular nerve trunk, anterior trunk, buccal nerve, posterior trunk, inferior alveolar nerve and lingual nerve were all 100%. The posterior trunk, inferior alveolar nerve and lingual nerve showed the best quality scores, which were all about 3 points, and the SIRN/M were about 1. The displaying rates of the auricular temporal nerve and masseter muscle nerve were also satisfied. The displaying rate of mylohyoid muscle nerve, medial pterygoid nerve and lateral pterygoid nerve was low.

CONCLUSION

The small surface coil combine with 3D-DESS-WE sequence demonstrated excellent visualization of the extracranial branches of the mandibular nerves in most volunteers, which has the potential for diagnosing mandibular nerve pathologies and preoperatively identifying peripheral cranial nerves to prevent surgical complications.

CLINICAL RELEVANCE/APPLICATION

Small surface coil combine with 3D-DESS-WE sequence performed high-quality in mandibular nerves imaging using MPR, CPR post-processing technology, which are suitable for clinical application.

SSM19

Neuroradiology (Contrast Issues in Neuroimaging)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: N227B

NR SQ

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

SSM19-01 The Gadolinium Deposition Debate Revisited Using a Fully Automated Big Data Approach

Wednesday, Nov. 28 3:00PM - 3:10PM Room: N227B

Participants
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PURPOSE

Numerous independent studies reported increasing T1w signal intensity (SI) of the dentate nucleus (DN) and the globus pallidus (GP) after repetitive administrations of linear Gadolinium-based contrast agents (LGBCA). Also, a recent study indicates that a high number of macrocyclic GBCA (MGBCA) administrations may also lead to an increase of SI. However, most previous studies were performed at small scale and predominantly by using manual ROI-based methods. In this study, we present results from a large-scale study that uses a completely automated high performance computing pipeline.

METHOD AND MATERIALS

In-house developed PACS/RIS mining software was used to locate and retrieve all native T1W MPRAGE datasets performed on patients that received at least 2 exams with GBCA. Datasets were histogram-normalized and segmented utilizing FSL and a cerebellum atlas. Calculations were performed overnight on a high performance computing cluster. SI increase was analyzed in a mixed effects model.

RESULTS

3021 consecutive patients receiving 11,922 MRI brain scans were included. Repeated administration of GBCA was associated with increased overall SI for both LGBCA (Estimate 0.23, 95% CI 0.07-0.39, p=.006) and MGBCA (Estimate 0.06, 95% CI 0.02-0.09, p<.001). Stratified among brain nuclei, significant SI increase was found only after LGBCA application in the DN (Estimate 0.6, 95% CI 0.077-1.12, p=.027) and the GP (Estimate 0.38, 95% CI 0.03-0.72, p=.033) but not for MGBCA. On the other hand, significant SI increase was found only after MGBCA in the thalamus, putamen, amygdala, caudate, hippocampus, and accumbens (Estimates up to 0.29, p<.001) but not for LGBCA.

CONCLUSION

Our findings confirm previous reports on increased SI after LGBCA application in the DN and GP, but not after MGBCA. However, we found increase in SI for other brain nuclei only for MGBCA. Based on our findings, Gadolinium accumulation in the brain may be more widespread than assumed and could occur with the use of both L- and MGBCA.

CLINICAL RELEVANCE/APPLICATION

Gadolinium accumulation in the brain may be more widespread than assumed and could occur with the use of both L- and MGBCA.

SSM19-02 The Correlation of GD Deposition with Administration of GBCAs and the Elimination Rates in Human Brain, Bone, and Skin

Wednesday, Nov. 28 3:10PM - 3:20PM Room: N227B

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PURPOSE

The purpose of this study was to determine the correlation of Gadolinium (Gd) deposition between Brain tissue ,white matter (WM),Globus Paliidus (GP),Dentate nuclueus (DN) ,and Bone,Skin in human with administration of gadolinium-based contrast agents (GBCAs) and to determine the elimination rates.

METHOD AND MATERIALS

Under the IRB approved study , medical records of decedents coming to autopsy were reviewed, 35 cases were identified that received GBCAs including 13 who received only macrocyclic agents(gadoteridol, gadobutrol) and 8 decedents only linear type of agents (gadodiamide,gadobenate, gadoxetic acid, gadoversetamide and gadopentate) and 3 with mix type of agents.(gadoteridol and gadoversetamide, gadoteridol with gadopentate and gadobenate, gadoteridol and gadobenate). All cases are with normal renal function (eGFR>60) and have more than a week from last injection to death.11 cases not exposed to a GBCA during life are included as control. Tissue from WM, GP, DN along with bone and skin were collected. Inductively coupled plasma mass spectrometry (ICP-MS) analysis was used to quantify levels of Gd in tissue. The time from last injection of GBCA to death was determined for each case. Gd levels for each subject were plotted versus time interval from last contrast administration for each agent to compare elimination rates.

RESULTS

Median Gd concentrations significantly higher in GBCA cases than controls in WM, GP and bone. (<0.001).Macrocyclic agents group showed significantly lower deposition than Linear agent groups in WM ,GP, DN, Bone.(P<0.001).Gd deposition in all tissues ,WM, GP, DN, Bone, Skin were correlated with each other (rho ranging from 0.71to.86). And Bone had significantly higher deposition than all other tissues(P<0.001),whereas WM had significantly lower deposition(P<0.001).Graphical results of tissue concentration versus time from last administration showed the Macrocyclic subjects had more rapid decline and plateaued at a lower level than the linear subjects.

CONCLUSION

Gd deposition in each human tissues were correlated significantly and deposition in bone was much higher than other organs. Gd deposition with Macrocyclis agents showed more rapid elimination that appeared to plateau at a lower level of retained Gd concentration than linear agents.

CLINICAL RELEVANCE/APPLICATION

This study shows correlation of Gd deposition in human tissues with the administration of GBCAs and elimination rates.

SSM19-03 Gd Deposition in Rat and Human Cerebral Cortex After Systemic Administration of Gd-Containing Contrast Agents

Wednesday, Nov. 28 3:20PM - 3:30PM Room: N227B

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PURPOSE

While Gd accumulation in the deep cerebellar nuclei (DCN) amd globus pallidus (GP), has received considerable attention, Gd accumulation in the cerebral cortex remains poorly characterized and of potential clinical concern given the central role of the

cortex in cognition, affect, and behavior. The purpose of this study was to analyze the degree and distribution of Gd deposition in the cortex. The study utilized high-resolution metallomic imaging mass spectrometry (MIMS) to anatomically localize and analytically quantify Gd in postmortem brains from rats and humans.

METHOD AND MATERIALS

IACUC/IRB protocols approved at our institute. Sprague-Dawley rats received Magnevist (dose: 2.4mmol/Kg x 3 times, IV) or volume-matched saline(control). Harvested brains fixed with 4% PFA. Human brain specimens (n=3) were analyzed, two specimens from subjects with antemortem Gd exposure and a third from a control subject without Gd exposure. MIMS was performed using a quadrupole ICP-MS (Thermo Scientific) custom hyphenated to a Nd-YAG laser ablation system. Calibration was performed with matrix-matched standards and NIST reference standard (SRM 612).

RESULTS

We detected non-homogeneous Gd retention in rat brain after Gd exposure. Cortical Gd accumulation was far greater in gray matter than adjacent white matter. We detected variation in Gd accumulation by cortical subregion (cingulate=medial prefrontal>piriform>insular>motor) and cortical layer (layers II-III>>layerI>layers V,VIa,sVib) and subcortical structures (caudate-putamen, GP, DCN>olfactory tubercle>nucleus accumbens). Gd accumulation also varied by cortex type: agranular>dysgranular>granular. We confirmed Gd accumulation with long post-exposure retention in human cortex.

CONCLUSION

Gd is retained in cerebral cortex after systemic Gd administration. Cortical Gd deposition is non-uniform and demonstrates regional, laminar, type variation. Gd accumulation in human cerebral cortex and persists long after Gdexposure and washout. These results raise concern about possible long-term functional effects of Gd accumulation in the brain.

CLINICAL RELEVANCE/APPLICATION

Our results suggest that Gd deposits not only in deep gray matter, but also in specific regions in cerebral cortex. As the cerebral cortex exerts a large influence on brain function and behavior, our study suggests that additional clinical/pre-clinical studies should be conducted and focused on the cortex.

Honored Educators

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SSM19-04 Evaluation of Chelating Agent Administration Following Exposure to Gadolinium-Based Contrast Agents in Rats

Wednesday, Nov. 28 3:30PM - 3:40PM Room: N227B

Participants
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PURPOSE

This study investigates the efficacy of the chelating agent calcium trisodium pentetate (Ca-DTPA) on the urinary excretion and presence of gadolinium (Gd) in the brain after single administration of gadodiamide and gadobutrol in rats.

METHOD AND MATERIALS

Rats received either a single injection of gadodiamide, gadobutrol (1.8 mmol/kg, n=18 per group) or saline. 7 weeks after GBCA injection, 6 animals of each group were sacrificed prior to chelation treatment. The remaining 12 animals received either 3 infusions of Ca-DTPA (180 µmol/kg, once weekly) or saline. Urine was collected daily for 3 days following each infusion. Gd measurements by ICP-MS were performed in urine and tissue samples obtained prior and post treatment.

RESULTS

After a Gd-free period of 7 weeks, urinary excretion of Gd under physiological conditions (saline infusion) was still observed for gadobutrol (sum of Gd in all urine samples: 33±12 nmol Gd, $p <= 0.0005$) but not gadodiamide (10±4 nmol Gd, $p=0.68$) when compared to animals which initially received a saline injection instead of GBCA (5±5 nmol Gd). Ca-DTPA increased the urinary excretion of Gd originating from gadodiamide (114±21 nmol Gd), but not from gadobutrol (30±11 nmol Gd). The highest Gd brain concentration in nmol/g tissue was present in the cerebellum after injection of gadodiamide (0.55±0.07), which was partially reduced by Ca-DTPA (0.47±0.08, $p=0.015$). The cerebellar Gd concentration from gadobutrol was 20-fold lower (0.024±0.006) and unaffected by Ca-DTPA (0.027±0.017).

CONCLUSION

Administration of a chelating agent increased the urinary excretion and partial elimination of the residual Gd in brain tissue originating from gadodiamide but not from gadobutrol. This indicates a pool among the chemical Gd forms present in the rat brain and other organs that can be mobilized and excreted by Ca-DTPA after the use of linear gadodiamide. The lower Gd tissue concentrations found for macrocyclic gadobutrol were associated with a continuous physiological urinary excretion which was not influenced by Ca-DTPA, indicating that this Gd represents the intact gadobutrol.

CLINICAL RELEVANCE/APPLICATION

Chelation treatment efficacy is dependent on the administered GBCA class.

SSM19-05 Experimental Sepsis Increases Brain Deposition of Gadolinium in the Rat

Wednesday, Nov. 28 3:40PM - 3:50PM Room: N227B

Participants
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John M. Hoffman, MD, Salt Lake City, UT (*Abstract Co-Author*) Research Grant, General Electric Company; Research Grant, Blue Earth Diagnostics Ltd
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PURPOSE

There is emerging concern that gadolinium based contrast agents (GBCA) may undergo dechelation, leading to deposition of potentially neurotoxic Gd3+ in the brain. Because GBCA do not cross an intact BBB, disruption of the BBB may result in enhanced deposition of Gd in the brain. We have previously reported that a lipopolysaccharide (LPS) endotoxemia sepsis model in rats results in secondary neuroinflammation, increased cerebral blood flow and blood brain barrier permeability. Septic patients often have neurocognitive compromise and frequently undergo CEMR. The purpose of this study was to determine whether experimental sepsis results in increased Gd deposition in the brain.

METHOD AND MATERIALS

Male Sprague Dawley rats (250 g) were injected intraperioneally with 10 mg/kg LPS. Control animals received no injection. 24h later, 100 ul of gadobenate dimeglumine (MultiHance®) MRI contrast was injected intravenously. The brains were harvested at 1 h, 24 h, 1 week, 3 weeks and 6 weeks post GBCA administration. Gd content in the brain was measured by inductively coupled plasma mass spectroscopy.

RESULTS

At 1 h post injection of GBCA, there was 56% greater content of Gd in the brain of LPS animals than controls. At 1 week, 3 weeks and 6 weeks post GBCA administration, further decreases in Gd content in the brains of both LPS-treated and control rats occurred, but at a much slower rate than between 1 h and 24 h. The percent of initial (1 h) Gd in the brain of LPS treated rats was 3.2% at 24 h, 2.7% at 1 week, 2.3% at 3 weeks and 2.3% at 6 weeks. At all time points beyond 1 h, there were statistically significant increases in the content of Gd in the brains of LPS-treated animals when compared to controls. LPS:control ratios of brain Gd were 3.2 at 24 h, 1.9 at 1 week, 2.4 at 3 weeks and 2.4 at 6 weeks.

CONCLUSION

When GBCA is administered to septic rats, there is a significantly higher deposition of Gd in the brain compared to control rats. In both LPS and control rats, the brain retains substantial Gd even at 6 weeks post GBCA injection.

CLINICAL RELEVANCE/APPLICATION

Consideration should be given to avoidance of GBCA in vulnerable patients who may have an increase in blood brain barrier permeability.

SSM19-06 Screening for Gadolinium Brain Retention in Patients Receiving Multiple Doses of Gadobutrol in a University Medical Center Over 10 Years

Wednesday, Nov. 28 3:50PM - 4:00PM Room: N227B

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PURPOSE

Purpose was to screen a large MRI population for the frequency of applied doses of gadobutrol in patients with normal and impaired kidney function and to recall selected individuals for assessment of gadolinium brain retention.

METHOD AND MATERIALS

The database of the University Hospital Erlangen, Germany was searched for patients receiving gadobutrol between 2007 and 2017 and not any other intravenous MRI contrast agent in the patients' history. Patients with at least 5 (range 5-20) contrast-enhanced MRI scans and normal kidney function (group 1) and at least 1 (range 1-9) contrast-enhanced MRI scans and impaired kidney function (group 2) were matched with control patients receiving no MRI contrast agent before (groups 3 and 4). The aim was to recall all individuals from groups 1-4 performing the following brain MRI protocol: T1w morphology, T1/T2 mapping and quantitative susceptibility mapping (QSM).

RESULTS

Between 2007 and 2017, more than 35.000 patients at our institution received up to 26 single doses of gadobutrol only. Of these, 701, 1239, 94 and 409 patients matched the criteria of groups 1-4, respectively. After recalling 2.444 individuals, we were able to perform brain MRI in 220 individuals (groups 1-4: 76, 84, 25, 35, respectively). In the study population, no significant differences in T1w signal intensity ratios, T1/T2 mapping and QSM were found in the dentate nucleus and globus pallidus between patients of groups 1 and 2 and the matched controls.

CONCLUSION

In this recall study, we found no statistical evidence for gadolinium brain retention after administration of multiple doses of gadobutrol in patients with normal and impaired kidney function.

CLINICAL RELEVANCE/APPLICATION

To the best of our knowledge, here we present the first recall study on gadolinium brain retention in a large cohort of patients receiving multiple doses of gadobutrol and no other MRI contrast agent.

SSM20

Pediatrics (Interventional Radiology)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E260

IR PD US

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Kamlesh U. Kukreja, MD, Bellaire, TX (*Moderator*) Nothing to Disclose
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Sub-Events

SSM20-01 A Single Center Experience of Gastrojejunosomy Tube Interventions: Comparison of Manufacturers and Complications

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E260

Participants
Daniel J. Ashton, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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Kristin Lingle, The Woodlands, TX (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Report single insititution experience of interventions related to gastrojejunostomy tubes, their complications, and comparison of complication rates between gastrojejunostomy tube types and manufacturers.

METHOD AND MATERIALS

379 patients with a gastrojejunostomy tube (GJ tube) were retrospecitively reviewed from January 2016 through February 2018. PACS and electronic medical records were reviewed for GJ tube exchanges or conversions. Date of procedure, indication for procedure, complications associated with the GJ tube, GJ tube specifics, and patient demographics were entered into a HIPAA compliant database. Complications were defined as GJ tube condition that necessitated urgent exchange or conversion. Comparisons of complications were made using chi-square test between GJ tube length and manufacturer.

RESULTS

There were 1,792 interventions during the study period, with 641 conversions (35.8%) and 1151 (64.2%) exchanges performed in 379 patients. There were 810 GJ tubes from Applied Medical Technology, Inc (Brecksville, Oh), and 834 from Halyard (Alpharetta, Ga). Patients presented as outpatients (65.3%) through the emergency center (9.2%) or as inpatients (25.5%). There were 595 (53.5%) GJ tubes exchanged as routine, and there were 176 (27.9%) initial conversions, comprising 43% of interventions. 57% exchanges and conversions were performed due to complication. There was no difference between manufacturers and overall complications (p=0.243 for exchanges; p=0.821 for conversions). There was a signficant difference between complication and tube length (p=0.000054), with 15 cm length tubes having a complication rate of 52%, 22 cm of 40%, 30 cm of 44%, and 45 cm of 63%.

CONCLUSION

Gastrojejunostomy tubes are frequently replaced urgently do to tube malfunction or malposition, with increased rates seen in 15 cm and 45 cm length tubes. There is no difference between manufacturers for overall complications.

CLINICAL RELEVANCE/APPLICATION

GJ tubes have a high frequncey of complication, highlighting an area for significant quality improvement.

SSM20-02 Early Experience on the Impact of Contrast-Enhanced Ultrasound in Drainage Catheter Placement and Management

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E260

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To describe use of contrast-enhanced ultrasound (CEUS) in aiding drainage catheter management in children.

METHOD AND MATERIALS

An IRB-approved retrospective review identified13 drainage catheter procedures in which contrast-enhanced ultrasound (CEUS) prompted changes in management by illuminating the need for additional treatment or cessation thereof.

RESULTS

13 patients underwent drainage catheter placement with concurrent intracavitary contrast-enhanced ultrasound (CEUS). 6 abscess catheters were injected, revealing: noncommunicating locules in 2 of 6 cases (one inaccessible and one requiring an additional drain), safe accessibility in 3 of 6 cases with communicating locules without need for additional catheter, and confirmation of fistula to small bowel in a Crohn's patient in 1 of 6 cases. Simultaneous CEUS cholangiogram though a cholecystostomy tube and percutaneous biliary drain in a presumed case of Mirizzi syndrome showed patency of both the common bile and cystic ducts leading to catheter removal. CEUS injection in 1 chest tube showed multiseptated pleural effusion requiring t-PA via the drain, later shown at bedside with CEUS to have achieved complete lysis of septations. Injection of a catheter in a large renal cyst showed no connection to the collecting system where there was concern for urinoma and calyceal rupture, leading to drain removal. Injection of a sinus tract and cecostomy tube in a patient with peristomal leak showed an enterocutaneous fistula, requiring catheter placement through the fistula to promote diversion and healing. CEUS in 3 sclerotherapy cases showed adequate distribution of sclerosant in one lymphatic malformation and an inaccessible small, noncommunicating moiety of a second lymphatic malformation left untreated. In a third case, no connection was seen between a renal cyst and the renal collecting system, allowing for safe sclerotherapy. No adverse reaction to the agent occured.

CONCLUSION

CEUS is an adjunctive imaging modality allowing real-time catheter-directed provision of additional or cessation of medical treatment while reducing radiation dose to the patient.

CLINICAL RELEVANCE/APPLICATION

Intracavitary CEUS administration via drainage catheters can help in identifying clinical situations in the IR suite and at bedside where addition or cessation of treatment will improve patient outcome and shorten the time to drainage catheter removal while reducing radiation dose to the patient.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Kassa Darge, MD,PhD - 2016 Honored Educator

SSM20-03 Early Experience: Periprocedural Contrast-Enhanced Ultrasound Guidance in Targeted Soft Tissue and Organ Biopsy

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E260

Participants
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PURPOSE

To show that contrast-enhanced ultrasound (CEUS) may be leveraged during targeted soft tissue and organ biopsy to improve pathologic yield and differentiate benign from malignant lesions.

METHOD AND MATERIALS

An IRB-approved retrospective review identified 19 lesions biopsied with CEUS guidance in patients aged 2 mo to 19 years with median weight 30 kg (range 3.6-107 kg). Outcomes included concordance of CEUS enhancement with pathology and ability to differentiate benign from malignant lesions equal to or better than MRI. Concordance was defined as agreement between enhancement pattern and pathology diagnosis.

RESULTS

19 soft tissue and organ based lesions biopsied with CEUS guidance were reviewed. Biopsy or CEUS evaluation was recommended

19 soft tissue and organ-based lesions biopsied with CEUS guidance were reviewed. Biopsy or CEUS evaluation was recommended on pre-biopsy MRI in 18 cases. One patient with known lymphoma had a new hypermetabolic lesion on PET/CT requiring biopsy. Hyperenhancing areas of biopsy targets on CEUS correlated with hypermetabolic areas on PET, aiding accurate needle placement in high yield parts of lesions. There was concordance of CEUS enhancement pattern with pathologic diagnosis in 18 lesions (11 malignant and 7 benign). In the only discordant CEUS case, enhancement on both MRI and CEUS was concerning for malignancy showing brisk arterial enhancement with early washout, however pathology showed benign hepatic fibrosis. MRI enhancement patterns were discordant with pathology results in 3 of 18 lesions. Of those, 2 showed enhancement on CEUS which was concordant with pathology. Diagnostic specimens were obtained in all 19 cases. No adverse reactions to the contrast agent occurred.

CONCLUSION

Peri-procedural CEUS can further differentiate benign from malignant soft tissue and organ-based lesions and aids in their biopsy. In the future, this modality could reduce cost in the work-up of focal lesions requiring tissue diagnosis. Additional studies need to be performed to validate use of CEUS in pediatric biopsies.

CLINICAL RELEVANCE/APPLICATION

CEUS has equal or better lesion characterization compared to MRI and early experience shows it can be a powerful tool in biopsy guidance.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Kassa Darge, MD,PhD - 2016 Honored Educator

SSM20-04 Image Guided Sacroiliac Steroid Joint Injections in Children

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E260

Participants
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Ronald Laxer, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose
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Dimitri A. Parra, MD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Image guided sacroiliac (SI) joint injections are frequently requested in pediatric patients with sacroilitis, which is characterized by the inflammation of SI joints (+/- adjacent tissues) and it is commonly seen in enthesitis-related arthritis (ERA), a subtype of juvenile idiopathic arthritis (JIA). The treatment involves systemic therapy with or without corticosteroid joint injections. The aim of this study is to evaluate our experience performing SI joint injections in children in terms of indications, technique and efficacy.

METHOD AND MATERIALS

This is a retrospective study of all patients that were referred to the department of Image Guided Therapy for SI joint steroid injections (Jan 2004 -Jan 2018). Patient demographis and clinical histories were collected from Electronic Patient Charts (EPC) and procedural details from our Picture Archiving and Communication System (PACS).

RESULTS

51 patients underwent SI joint injections during the time of the study, 35 were boys (68.6%). Mean age was 13.8 y/o (8-18 y/o). The most common etiology was JIA (82.4%) followed by inflammatory bowel disease (13.7%). 78% had bilateral injections and 22% unilateral (45.5% Left; 54.5% Right). All procedures were technically successful. 78% of patients received general anesthetics and 22% sedation, The steroid of choice was triamcinolone hexacetonide (20 mg most common dose). Needle guidance and confirmation was done with CT fluroscopy in 55% and Cone Beam CT in 45%. Ultrasound was used in the initial needle guidance in 33.3%. 40 patients had long term follow up. 21 (52.5%) documented clinical improvement. 26 patients had a pre and post-procedure MRI, with 81% showing improvement based on imaging findings. No complications were encountered.

CONCLUSION

Image guided SI joint injections is a safe and technically feasible procedure in children. In our cohort, the majority of patients showed clincal and imaging improvement post procedure. Cone beam CT is our current imaging modality of choice for this intervention.

CLINICAL RELEVANCE/APPLICATION

This study will provide evidence and guidance to (pediatric) interventional radiologist performing SI joint injections in children.

SSM20-05 Recurrent Pediatric Thyroid Cancer: Diagnosis and Treatment Dilemma

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E260

Awards
Student Travel Stipend Award

Participants
Zachary S. Jeng, MD, Houston, TX (*Presenter*) Nothing to Disclose
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PURPOSE

Analyze the experience of a tertiary pediatric referral center with biopsy for recurrent thyroid cancer in children for a planned, future prospective trial using other minimally invasive techniques for treatment.

METHOD AND MATERIALS

278 thyroid biopsies were performed from 2004 to 2018. 25 biopsies were performed specifically for recurrent thyroid cancer in 18 patients (5 males, 13 females) with a total of 38 lesions sampled. 3 patients underwent 2 biopsies with 1 patient undergoing 5 biopsies. Age and weight at time of biopsy ranged from 13 y, 3 mo to 19 y 11, mo (median 17 yr) and from 33 kg to 124 kg (median 69.2 kg). 17 patients had a prior diagnosis of papillary thyroid cancer while 1 patient had a diagnosis of medullary thyroid cancer.

RESULTS

The technical success rate and diagnostic yield were both 100%. There were no complications. 25/38 (66%) of sampled lesions were malignant while 13/38 (34%) were benign. 20/25 (80%) of biopsies were malignant while 5/25 (20%) were benign. Benign and malignant lesions were evaluated based on size and TIRADS imaging criteria (composition, echogenicity, borders, calcifications, vascularity, shape, and punctate echogenic foci). Size was assessed using the Wilcoxon rank test and imaging characteristics were assessed using the Fisher's exact test with no significant difference between malignant and benign lesions. 7 patients have since undergone repeat surgery with the rest remaining on surveillance with suppressive thyroid hormone therapy.

CONCLUSION

Children who have had thyroidectomy and lateral neck dissection represent a surgical dilemma with early recurrence due to the difficulty of reoperation in an already treated field. No specific imaging criteria (including TIRADS) can easily distinguish between benign and malignant nodules in the surgical bed. FNA reliably provides accurate diagnosis of early recurrent thyroid carcinoma. When small lesions are confidently confirmed as recurrent disease, percutaneous treatments such as High Intensity Focused Ultrasound (HIFU) and Radiofrequency Ablation (RFA) may be a feasible alternative to a more complicated surgical approach.

CLINICAL RELEVANCE/APPLICATION

Recurrent pediatric thyroid cancer presents a surgical dilemma. FNA provides an accurate diagnosis of recurrence. Alternative minimally invasive methods for treatment (HIFU, RFA) should be considered

SSM20-06 Minimally Invasive CT- and US-Guided Biopsies of Mediastinal Masses in Pediatric Patients in a Large Pediatric Hospital

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E260

Awards
Student Travel Stipend Award

Participants
Thomas Shum, PhD, Houston, TX (*Presenter*) Patent holder, Immunotherapy
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PURPOSE

Tissue diagnosis of mediastinal masses remains essential for directing subsequent medical or surgical management of patients. Minimally invasive procedures utilizing CT and ultrasound guidance are an alternative method to obtain biopsies, in comparison to open surgical approaches. However, analysis of procedural correlates associated with minimally invasive mediastinal biopsies such as sampling adequacy, patient risk level, and complications remain largely anecdotal.

METHOD AND MATERIALS

We therefore reviewed 25 mediastinal biopsy cases performed at the Texas Children's Hospital in which the procedure was performed before surgical intervention.

RESULTS

Risk characterization in patients: A number of patients demonstrated pre-existing compression of mediastinal structures that are known to increase risk for surgery and anesthesia, including airway (10/25), superior vena cava (8/25), pulmonary vessel (4/25), heart (2/5), and aorta (1/25). Pericardial effusions were found in 2/25 patients and pleural effusions were found in 5/25 patients. Atelectasis was detected in 7/25 patients. Results: The majority of the cases were located in the anterior mediastinum (80%), whereas 4% were in the middle mediastinum, and 16% in the posterior mediastinum. In 22/25 patients, biopsy samples had adequate tissue content for pathological diagnosis using histology and/or flow cytometry. In the three patients with inadequate biopsies, 2/3 patients required subsequent surgeries to gain additional tissue for definitive diagnosis, of which only 1/2 generated a different pathological diagnosis. Four patients had pre-existing airway compression. Minor complications were found in 3 patients post-procedure, which consisted of trace pneumothorax detected in 2 patients and minimal hemorrhage at the biopsy site in 1 patient, all of which resolved without need for further intervention.

CONCLUSION

Our data with CT- and US-guided mediastinal biopsies in a large quaternary pediatric treatment center show that it is a feasible method as a first-line for obtaining biopsies for definitive pathological diagnosis with minimal complications, even in patients with pre-existing risk factors for surgical intervention

CLINICAL RELEVANCE/APPLICATION

This will increase feasbility and speed of clinical diagnosis.

SSM21

Physics (Photon-Counting CT)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: S104B

CT PH

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Guang-Hong Chen, PhD, Madison, WI (*Moderator*) Research funded, General Electric Company Research funded, Siemens AG
Katsuyuki Taguchi, PhD, Baltimore, MD (*Moderator*) Research Grant, Siemens AG; Consultant, JOB Corporation

Sub-Events

SSM21-01 Improving Iodine Contrast to Noise Ratio on a Whole-Body Photon-Counting-Detector CT System using Virtual Mono-Energetic Imaging and Spectral Prior Image Constrained Compressed Sensing

Wednesday, Nov. 28 3:00PM - 3:10PM Room: S104B

Participants
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Shuai Leng, PHD, Rochester, MN (*Abstract Co-Author*) License agreement, Bayer AG

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PURPOSE

Virtual mono-energetic images (VMIs) at lower keV can improve iodine contrast but have increased noise. For photon-counting-detector (PCD)-CT, spatio-spectral data redundancy exists between VMIs and the low-energy threshold (TL) images, which are reconstructed using all available photons and have the lowest noise. Here, we develop a denoising technique named spectral image constrained compressed sensing (SPICCS) that exploits this data redundancy to denoise VMIs and improve iodine contrast-to-noise ratio (CNR).

METHOD AND MATERIALS

A multi-energy CT phantom (Sun Nuclear) and iodine inserts of different concentrations (2, 5, 10, 15 mg/mL) were scanned on a whole-body PCD-CT using a routine abdomen protocol (140 kV, 100 mAs, energy thresholds = 25/75keV). VMIs at 40-70keV were generated using vendor-supplied software (Mono+, Siemens). The images were then denoised using the SPICCS algorithm which is applied in the image domain by minimizing an objective function consisting of a data fidelity term and a regularization term. The regularization term penalizes total variation (TV) of the VMIs and TV of the difference between VMIs and TL images. A uniform water phantom and a thin wire phantom were scanned to assess noise texture and spatial resolution, respectively. With IRB approval, patient images were acquired on the same PCD-CT (140 kV, 100 mAs, energy thresholds = 25/75keV). The iodine CNR was calculated from VMIs before/after SPICCS.

RESULTS

VMIs processed with SPICCS preserved iodine contrast and reduced noise compared to the original VMIs (129±51 vs. 128±27 HU before/after SPICCS, measured from 5mg/mL iodine insert at 50keV), which improved iodine CNR especially at lower keV (5.65 vs 10.3 at 50keV). Compared with TL images, SPICCS-processed VMIs had improved CNR at lower keV (e.g., 50keV). MTF and NPS data showed that SPICCS preserved resolution and noise texture compared to TL images and original VMIs. The 50 keV VMI from patient data demonstrated similar improvement in iodine CNR (1.8 fold increase in iodine CNR at 50 keV).

CONCLUSION

We developed a denoising framework to improve iodine CNR in VMIs acquired on PCD-CT using SPICCS, while preserving spatial resolution and noise texture.

CLINICAL RELEVANCE/APPLICATION

The proposed denoising scheme improved iodine CNR for VMIs acquired on a whole-body PCD-CT system while preserving spatial resolution and noise texture, which may improve clinical diagnosis.

SSM21-02 Multi-Energy (ME) CT Imaging for Large Patients Using Photon-Counting-Detector (PCD) Technology

Wednesday, Nov. 28 3:10PM - 3:20PM Room: S104B

Participants
Shengzhen Tao, Rochester, MN (*Presenter*) Nothing to Disclose

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PURPOSE

Imaging large patients with conventional dual-source dual-energy (DSDE) CT using energy-integrating-detectors (EIDs) is challenging due to artifacts in lower kV (80-100) images caused by photon starvation and electronic noise. Although the use of higher kV (e.g. 120) can reduce this effect, the energy separation is insufficient for multi-energy CT (MECT) imaging, even with the addition of a tin filter in the high kV beam. Photon-counting-detector (PCD) CT is more resistant to electronic noise and can provide spectral information with a single tube potential, which may be more suitable for MECT imaging on large patients. This work aims to evaluate the feasibility of MECT imaging on large patients assuming a dual-PCD acquisition system.

METHOD AND MATERIALS

An anthropomorphic CT phantom was padded with an additional 5 cm tissue-mimicking layer to simulate a large patient, and scanned on a conventional DSDE EID-CT system with 100 kV and Sn140 kV (i.e., 140 kV with additional tin filter) tube potentials. In addition, iodine inserts of known concentrations (2, 5, 10, 15 mg/mL) were attached to the phantom. The same phantom was then scanned on a whole-body PCD-CT system. This system was built based on a conventional DSDE CT platform, with the second EID replaced with a PCD. A dual-source, dual-PCD acquisition was emulated by scanning the object separately with tube potentials of 100 kV and Sn140 kV. Tube current for PCD scans was matched to that of EID scans. Material decomposition was then performed to generate iodine and water maps.

RESULTS

The low-energy image (100 kV) acquired on the conventional DSDE EID-CT system showed noticeable shading, which limited its use for clinical diagnosis. These artifacts were largely eliminated in images acquired on the PCD system. The iodine quantification root-mean-square-errors (RMSE) measured from iodine inserts was 2.3 mg/mL for EID and 2.1 mg/mL for PCD.

CONCLUSION

This work demonstrated the feasibility of MECT imaging for large patient assuming a dual-source PCD acquisition. The DS-PCD system out-performs conventional DS-EID CT system by reducing image artifacts and yet providing reasonable energy separation.

CLINICAL RELEVANCE/APPLICATION

Imaging large patients using DECT is known to be challenging. This work demonstrated the feasibility of MECT imaging for large patients using PCD, which allows all patients to benefit from MECT.

SSM21-03 Photon-Counting CT: Dependence of Noise Power Spectra, Task-Transfer Function, and Detectability Index (d') on Patient Size, Imaging Mode, and Reconstruction Kernel

Wednesday, Nov. 28 3:20PM - 3:30PM Room: S104B

Participants
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PURPOSE

To evaluate image quality in photon-counting CT due to change in patient size, imaging mode, and reconstruction kernel as measured by a tiered phantom

METHOD AND MATERIALS

The study utilized a five-tiered size variant phantom (Mercury Phantom, Gammex/Duke University). Images were acquired on a prototype photon-counting CT system (Siemens, Germany) using two imaging modes: Macro and Ultra High-Resolution (UHR) with effective voxel sizes of 0.5 and 0.25 mm, respectively, at a clinically-relevant dose (CTDIvol = 16 mGy). UHR scans were also done at maximum allowable mAs. Images were reconstructed with three kernels of increasing sharpness with 5 mm slice thickness. A task-based assessment was performed including calculation of noise power spectra, task-transfer function, and detectability index (d') of an iodine insert using the standard methodology of AAPM TG 233.

RESULTS

UHR had a higher d' of 8-88% across all reconstruction kernels and phantom sizes when compared to Macro mode. For softer kernels, TTFs were comparable between the two modes. The magnitude and shape of the noise power spectrum was different influencing d'. Sharp kernel showed edge enhancement with increased noise magnitude for UHR mode and different TTFs for different imaging modes. For ultra-sharp kernels, UHR mode showed a significant reduction of noise magnitude while preserving the shape of the spectra and the TTF. As expected, increasing dose led to a reduction in noise magnitude without affecting the task

transfer function.

CONCLUSION

UHR mode showed reduced noise and superior detectability for an iodinated task when controlling for patient size and reconstruction kernel. Task performance was dependent on selected reconstruction kernel and imaging mode.

CLINICAL RELEVANCE/APPLICATION

Ultra high-resolution mode in photon-counting CT offers improved spatial resolution and superior detectability compared to macro mode, and superior to conventional energy-integrating CT.

SSM21-04 Deep Inpainting for Photon-Counting Cone-Beam CT

Wednesday, Nov. 28 3:30PM - 3:40PM Room: S104B

Participants
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Joscha Maier, Heidelberg, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To provide an efficient method to close the gaps of large area photon counting detectors in x-ray imaging and cone-beam CT (CBCT).

METHOD AND MATERIALS

Photon counting detector technology promises improved CT image quality at reduced patient dose. Moreover, the new detectors have the potential to provide diagnostic image quality in cone-beam CT systems that, today, still suffer from inferior image quality. However, the limited size of the ASICs (typically about 3x3 cm) requires tiling of many detector modules in order to assemble detectors large enough for almost any medical application. Inevitably, one or more pixel wide gaps between the modules may occur. Prior to reading the x-ray images or to reconstructing the CBCT data, the gaps or dead pixels need to be closed by inpainting. Therefore, we developed a deep adversarial architecture based on a generator and discriminator network that trains itself to fill the dead pixels. Training was performed using uncorrupted CBCT thoracic and abdominal patient data with artificially induced pixel gaps. Since the adversarial approach is unsupervised the same architecture can be applied to photon-counting flat dectector data in the same way. The performance was compared to a linear inpainting, to a diffusion-based inpainting and to an exemplar-based inpainting algorithm. Our novel approach was implemented using the PyTorch Deep Learning framework and trained on 6400 samples for 20 epochs on a GeForce GTX 1080 Ti GPU.

RESULTS

The visual impression of the correction was best with the deep inpainting approach and the exemplar-based algorithm, second best with the linear interpolation and worst with the diffusion-based algorithm where the location of the gaps was clearly visible after inpainting. The computation time per 1024×768 projection was 83 ms, 52 s, 29 ms and 2 s, respectively. The network was running on the GPU while all the other algorithms were running on the CPU.

CONCLUSION

Deep inpainting has the potential to remove pixel defects or gaps between detector modules at least as good as exemplar-based inpainting while reducing computation times drastically.

CLINICAL RELEVANCE/APPLICATION

Photon counting detector technology has the potential to improve CT and CBCT imaging in the near future. An efficient inpainting approach, such as the deep inpainting algorithm presented here, brings the new detector technology one step closer to clinical routine.

SSM21-05 Can a Universal Protocol for Photon-Counting-Detector CT Provide Equivalent Iodine Detectability as Optimal kV Energy-Integrating-Detector CT: A Feasibility Study

Wednesday, Nov. 28 3:40PM - 3:50PM Room: S104B

Participants
Wei Zhou, PhD, Rochester, MN (*Presenter*) Nothing to Disclose
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Hao Gong, PhD, Rochester,, MN (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine iodine detectability using a single-kV universal protocol on a photon-counting-detector (PCD) CT for different phantom sizes, and to compare with optimized-kV single-energy (SE) and dual-source, dual-energy (DSDE) CT using an energy-integrating-detector (EID).

METHOD AND MATERIALS

A 4-mm diameter hole in a water-equivalent cylinder was filled with iodine solutions at one of 4 concentrations (0.2, 0.5, 1.0 and 2.0 mgI/cc) and the cylinder was inserted into one of 3 abdomen phantoms (QRM, lateral widths of 30, 35 and 40 cm). The whole phantom was scanned on a 2nd generation DSDE CT with SE and DE protocols using a kV or kV pair adjusted for phantom size. The phantom was also scanned on a whole body PCD CT using a single-kV universal protocol for all phantom sizes: 140 kV, 25 and 75 keV energy thresholds. EID-SE tube current was automatically adjusted (CareDose4D, 120 kV, 200 QRM), resulting in CTDIvol of 6.9 to 17.7 mGy for different size phantoms. EID-DE and PCD tube current was adjusted to match the CTDIvol of the EID-SE scans. Scans were repeated 200 times for each of 24 conditions: 4 concentrations, 3 phantom sizes and 3 protocols. All images were reconstructed with a quantitative kernel (D30) and 5 mm thickness. Virtual monoenergetic images (VMI) at 50 keV were generated from PCD and EID-DE images. CNR and AUC of the ROC from a calibrated channelized hoteling observer (CHO) model were calculated as figures of merit for quantifying iodine detection for PCD VMI@50 keV, EID-SE, and EID-DE VMI@50keV.

RESULTS

VMI@50 keV from PCD and EID-DE showed higher iodine CNR than the EID-SE images for all phantom sizes. For 0.5 mg/cc iodine, VMI@50 keV from PCD (0.93) and EID-DE (0.94) showed comparable AUC for iodine detection on a 30cm phantom and superior AUC for 35 cm (PCD: 0.93; EID-DE: 0.90) and 40 cm (PCD: 0.81; EID-DE: 0.88) phantoms compared to that of EID-SE (30 cm: 0.95; 35cm: 0.83; 40 cm: 0.77). A similar trend showing preference for VMI from PCD and EID-DE was observed for other iodine concentrations.

CONCLUSION

VMI images from a single kV PCD acquisition demonstrated comparable or improved iodine detectability and CNR compared to SE images where kV was selected based on patient size.

CLINICAL RELEVANCE/APPLICATION

A universal PCD CT protocol can maintain iodine sensitivity, simplify protocol selection and avoid sub-optimal images from inappropriate kV (or kV pair) selection with EID CT.

SSM21-06 A Method of Calculating Lesion Detectability in Photon-Counting Spectral CT

Wednesday, Nov. 28 3:50PM - 4:00PM Room: S104B

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; Scientific Advisory Board, Theranos, Inc; Stockholder, Theranos, Inc; Medical Advisory Board, OurCrowd, LP; Scientific Advisory Board, Izotropic, Inc; Stockholder, Izotropic, Inc

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PURPOSE

To develop a method of calculating the lesion detectability attainable in photon-counting spectral CT and demonstrate it for a cadmium telluride detector in a simulation study.

METHOD AND MATERIALS

Using a Monte Carlo simulation of an X-ray beam incident on a 3 mm thick cadmium telluride detector with 0.5x0.5 mm2 pixels and five energy bins, the energy-dependent point-spread function and autocorrelation function were calculated. Correlation between pixels due to fluorescence and charge diffusion was included in the simulation model. A recently developed linear-systems methodology was used to calculate the optimal-linear-observer detectability, i. e. the maximal detectability that can be obtained through optimal weighting of the data from the five energy bins. This detectability was computed for nonenhancing (soft tissue) and enhancing (10 mg/ml iodine) spherical lesions of different sizes in a 250 mm soft tissue cylinder, for a system with detector-limited resolution and a 120 kVp spectrum with 2.5 mm Al filtration. The results were compared to an ideal detector with perfect spatial and energy resolution and to an energy-integrating detector with 1x1 mm2 pixels but otherwise ideal.

RESULTS

The ideal-linear-observer detectability, relative to the ideal detector, was 67%, 83% and 91% for nonenhancing lesions with 1 mm, 2 mm and 10 mm diameter. For enhancing lesions the corresponding values were 48%, 58% and 62%, respectively. This is an improvement of 6-98 % (nonenhancing) and 58-203% (enhancing) compared to the energy-integrating detector.

CONCLUSION

Whereas large-area image quality metrics such as CNR have been used to characterize photon-counting CT scanners in previous work, so far there has not been a method of calculating the attainable detectability for smaller objects with energy-resolving photon-counting detectors. This simulation study demonstrates for the first time how the detectability of lesions in a photon-counting CT scanner can be simulated, taking energy resolution, pixel size and cross-talk between pixels into account. The results show that the detector performance is closer to ideal for nonenhancing lesions than for enhancing lesions.

CLINICAL RELEVANCE/APPLICATION

With photon-counting CT scanners expected to become clinically available in a few years, the proposed method will enable comprehensive comparison of systems and optimization of imaging protocols.

SSM22

Radiation Oncology (Genitourinary)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E261

AI GU MR OI RO

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Martin Colman, MD, Houston, TX (*Moderator*) Stockholder, Steward Health Care
Edward Y. Kim, MD, Seattle, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSM22-01 Deep Decision Forests of Radiomic Features for Automatic Contouring of Pelvic Anatomy for Prostate Radiotherapy

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E261

Participants
Meghan W. Macomber, MD, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Machine learning for image segmentation is a potentially innovative approach to improve efficiency and promote standardization for radiotherapy treatment planning. We evaluated a new model that uses deep decision forests of image features to contour pelvic anatomy on treatment planning CTs.

METHOD AND MATERIALS

We anonymized 193 prostate treatment planning CTs (acquired 2012-2016 at 1 UK and 2 US sites, GE and Toshiba scanners, 512x512 pixels inplane, 1.25 or 2.5 mm between slices). A deep decision forest (DF) was trained to contour prostate, bladder, rectum, femurs, and seminal vesicles on 94 images from Site 1. Testing was done on 99 separate scans (n=35, 34, and 25 from Site 1, 2, and 3). Similarity between DF contours and clinical (ground truth) contours was measured with Dice score (DSC) in the validation datasets. DF performance was compared to four commercial tools on a random subset of images (n=20). Additionally, interobserver variability (IOV) between three physicians' contours and ground truth was evaluated on 10 random images and compared to DF performance with Student's t-test.

RESULTS

Across all sites, DF agreement with ground truth was: bladder, DSC 0.94-0.97 [interquartile range (IQR) 0.92-0.98], prostate, DSC 0.75-0.76 [IQR 0.67-0.82], rectum: DSC 0.71-0.82 [IQR 0.63-0.87], femurs: DSC 0.96-0.97 [IQR 0.94-0.97], seminal vesicles: DSC 0.49-0.70 [IQR, 0.31-0.79]. The results were similar across the three sites (e.g. median prostate DSC for each site was 0.76, 0.76, 0.75). In the commercial model comparison, DF had highest DSC for all organs, followed by the two model-based systems, with atlas-based systems having worst performance. For IOV data, variability between DF and ground truth was smaller than variability between raters for prostate (median DSC 0.87 vs 0.77, p=0.006) and femurs (median DSC 0.973 vs 0.968, p=0.002), and not significantly different for other contours (p>0.3).

CONCLUSION

Deep decision forests are effective at contouring pelvic anatomy for radiotherapy planning, with good performance relative to commercial programs, and agreement with ground truth was as similar as can be expected between human experts.

CLINICAL RELEVANCE/APPLICATION

Machine learning methods for automated treatment planning would be useful to improve clinical efficiency and increase standardization in radiation oncology.

SSM22-02 Nationwide Prostate Cancer Outcome Prediction Study of Permanent Iodine-125 Seed Implantation: Outcome Prediction Using Machine Learning Techniques with Cohort 1

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E261

Participants
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PURPOSE

The nationwide Japanese Prostate Cancer Outcome Study of Permanent Iodine-125 Seed Implantation (J-POPS) is a big novel data with the fundamental aim of collecting clinical data as a prospective cohort study. The purpose of this study is to predict prostate cancer outcome after brachytherapy based on machine learning techniques using J-POPS big data.

METHOD AND MATERIALS

Among 72 hospitals performing brachytherapy in Japan, 46 (64 %) hospitals provided 2,339 cases of the J-POPS cohort 1. Patient/family background, TNM classification, serum PSA level, Gleason score, brachytherapy and external radiotherapy parameters, adverse event and outcome information, etc. were included in the survey items. Two types of dataset were used for the prediction; i.e., the large dataset including the majority of survey items, and limited dataset including only the survey items which are considered as relevant items with the outcome by radiation oncologists. In this study, four machine learning algorithms, i.e., logistic regression (LR), support vector machine (SVM), random forest (RF), and deep neural network (DNN) were tested. Outcome information including biochemical failure and rectal/urinary toxicity were predicted by the machine learning techniques. The prediction accuracy, defined as (true positive + true negative cases) / all cases, was evaluated by 10-fold cross-validation test.

RESULTS

The prediction accuracy with the large dataset was higher than that with the limited dataset in each machine learning algorithm. Although 5.2 percent of cases showed the biochemical failure, the highest accuracy of biochemical failure prediction with a large dataset and limited dataset was 0.938 and 0.892, respectively, for test data. The prediction model using RF had the highest accuracy.

CONCLUSION

Our results showed a potential to predict the outcome of prostate cancer patients with the big nationwide data including many survey items.

CLINICAL RELEVANCE/APPLICATION

Prostate cancer outcome after brachytherapy could be accurately predicted with big nationwide data.

SSM22-03 Dose to the Bladder Neck in MRI-guided High Dose-Rate Prostate Brachytherapy

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E261

Participants
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Joelle Helou, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

We aim to assess the impact of the dose to the bladder neck (BN) on physician and patient-reported GU toxicity after MRI-guided high dose-rate brachytherapy (HDR-BT) boost.

METHOD AND MATERIALS

Sixty-three patients were treated with a single 15-Gy MRI-guided HDR-BT implant followed by external beam radiotherapy. MRI-based treatment planning was used. The clinical target volume (CTV) was defined as the prostate and planning target volume was CTV + 2mm craniocaudal margin. BN was delineated in retrospect on T2-weighted images by a radiation oncologist (RO) and reviewed by an independent RO and a radiologist. Dosimetric parameters, acute (<=3 months) toxicity using CTCAE v.4 and health-related quality of life (HRQoL)using the expanded prostate index composite (EPIC) were collected prospectively. A minimally important difference (MID) was defined as a deterioration of HRQoL scores at 3 months compared to baseline >= 0.5 standard deviation of baseline score. Linear and logistic regression models were used to assess the impact of BN dose on GU toxicity and HRQoL. A p-value <=0.05 was considered statistically significant.

RESULTS

The median BN volume was 0.6 cc [interquartile range (IQR): 0.4-0.7]. Median maximum dose to the BN (BNDmax) and urethra (UDmax) was 24.9 Gy (IQR 18.8- 26.4) and 17 Gy (IQR 16.7- 17.7) respectively. Median dose to 2cc of the urethra was 52 Gy (IQR: 36-62). BNDmax was significantly associated with UDmax (p=0.027) and 7.7% of the total amount of variation in BNDmax was explained by the UDmax (R2=0.059, p=0.028). Grade 2+ GU toxicity was observed in 31% of patients. Among those, 4 patients had an acute urinary retention. No grade 4+ toxicity was reported. Furthermore 46% of patients reported a MID in EPIC urinary domain score at 3 months. None of the dosimetric parameters including BNDmax was associated with acute grade 2+ urinary toxicity or MID. However, 3 out of 4 patients with acute urinary retention had a BND max in the highest quartile; 26.4, 28.3 and 52.7 Gy (>175% of prescription dose).

CONCLUSION

MRI-based planning offers a unique opportunity to delineate and assess the dose to the BN. Although the predictive value of this parameter is yet to be determined in a larger population, it is worthwhile including BN contours and constraints into HDR-BT

treatment planning if an MRI-planning is available.

CLINICAL RELEVANCE/APPLICATION

Uncertainties exist regarding bladder neck definition.

SSM22-04 Machine Leaning Based Prediction of Prostate Cancer Recurrence After Radiotherapy with Radiosensitivity Related Proteins

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E261

Participants
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PURPOSE

There are several reports that the expression of proteins in tumors related to radiosensitivity could be used as biomarkers for the outcome prediction after radiotherapy. The purpose of this study was to predict local relapse of prostate cancer after radiotherapy using a machine learning methodology with the combination of conventional factors and the protein information related to radiosensitivity.

METHOD AND MATERIALS

A total of 100 patients with localized adenocarcinoma of the prostate who were treated from 2001 to 2010 were included in this study. Support vector machine (SVM) was used as a machine learning methodology to predict local relapse of prostate cancer. Candidate input features for the prediction included 16 clinical features (age, Gleason score, PSA level, etc.), 16 radiation dose features (mean dose, dose per fraction, etc.) and 3 protein information related to radiosensitivity (Ku70, Ku86, XRCC4). Effective features for prediction were determined by a sequential forward selection using Akaike's information criterion. The prediction performance of the models with or without protein information were compared by a leave-one-out cross-validation test. Accuracy, sensitivity, specificity and Matthew's correlation coefficient (MCC) were used as prediction performance metrics.

RESULTS

The prediction performance was improved by considering the radiosensitivity related protein information, e.g., accuracy of the models with and without the protein information was 0.78 and 0.69, respectively. Ku70 was the most selected feature in the proteins related to radiosensitivity.

CONCLUSION

Our result showed the potential to predict local relapse of prostate cancer with the combination of conventional factors and the protein information related to radiosensitivity. Accurate outcome prediction after radiotherapy could be useful for personalized optimal selection of treatment modalities of cancer.

CLINICAL RELEVANCE/APPLICATION

Accuracy of the machine learning model for outcome prediction after radiotherapy could be improved with the radiosensitivity related protein information.

SSM22-05 Prostate Cancer: Assessment of Toxicity of Focal Dose Escalation of Radiotherapy Guided by Multiparametric Magnetic Resonance Imaging

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E261

Participants
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Volker Brandes, Hamburg, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To evaluate acute and late toxicity after moderately hypofractionated radiotherapy of prostate cancer with focal dose escalation guided by multiparametric magnetic resonance imaging (mpMRI) using intensity-modulated treatment planning and image-guided treatment (IGRT) delivery.

METHOD AND MATERIALS

58 patients (age 55-82y, cT2/cT3, initial PSA 3.3-16.4ng/ml, Gleason Score >3+4) were included into the study. Before implantation of three gold markers, each patient underwent mpMRI (T2-TSE, DCE, DWI) that detected a suspicious focal lesion (PIRADS 4+5) followed by image fusion with the radiation treatment planning CT. In total, a dose of 79.2Gy in 33 fractions (single dose 2.4Gy) were prescribed to PIRADS 4 and 5 intraprostatic lesions with a margin of 3mm (gross target volume + 3mm = planning target volume) delivered with a simultaneous integrated boost (SIB) by static field intensity-modulated radiotherapy (IMRT) or volumetric modulated arc therapy (VMAT). Further dose levels were 76.23Gy and 60.06Gy prescribed to the prostate and the

seminal vesicles, respectively. Patients with high risk prostate cancer received 46Gy to the pelvic lymphatics, lymph node metastases 60Gy in 25 fractions with SIB. Daily IGRT by cone-beam computed tomography (CBCT) in addition to gold markers. Acute and late gastrointestinal (GI) and genitourinary (GU) toxicity was evaluated using CTCAE v4.03.

RESULTS

Treatment was completed according to the treatment plan in all included patients. Acute GI and GU toxicity grade >=2 was observed in 13.8% and 39.6% of the patients, respectively, with 6.8% suffering from GU toxicity grade 3. Six weeks after treatment, the incidence of acute toxicity grade >=2 had decreased to 15.5%. With a median follow-up of 28 months, late GI and GU toxicity grade >=2 was seen in 1.7% and 8.6% of the patients, respectively. Three patients developed late toxicity grade 3 (GI n=2; GU n=1).

CONCLUSION

Moderately hypofractionated high-dose radiotherapy with further dose-escalation to mpMRI PIRADS 4 and 5 lesions resulted in acceptable rates of acute and late toxicity according to the current literature. Conformal IMRT / VMAT planning and accurate daily IGRT treatment delivery using goldmarker and CBCT may have contributed to these results.

CLINICAL RELEVANCE/APPLICATION

The use of mpMRI for focal dose escalation in patients with prostate cancer may enhance post-radiotherapeutic local control.

SSM22-06 Weekly Magnetic Resonance Imaging Using a Linear Accelerator Equipped with a 1.5 Tesla MRI (MR-Linac) Reveals Intra-Treatment Signal Variance in Regional Organs at Risk (OAR), An Exploratory Analysis

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E261

Participants
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PURPOSE

To investigate changes in quantitative signal variables of organs at risk (OAR) in serially obtained T2-weighted MR images, acquired on an MR-Linac, in patients being treated for prostate cancer.

METHOD AND MATERIALS

Four patients with prostate cancer undergoing treatment with radiation therapy (RT) were compiled from an ongoing prospective observational imaging trial using MR-Linac. All patients provided informed consent for weekly imaging; images were obtained between November 2017 and March 2018. Contiguous sections of rectal and bladder wall adjacent to the prostate were contoured and normalized to temporally corresponding regions of rectum and bladder removed from the planning target volume. Similarly, contiguous axial slices of Sartorius muscle outside of the regions of high dose RT exposure were also contoured as a normal control. The quantitative features considered included: max-to-mean ratio, kurtosis, mean, median, skewness, and standard deviation. A student's t-test was used to evaluate for statistically significant variance week-to-week.

RESULTS

Between weeks 1 and 2, significant variance in the mean and median signal values were seen in sections of rectal wall adjacent to the prostate (p=0.05, p=0.04). Bladder wall near the prostate also exhibited significant variance in the mean and median signal values between weeks 1 and 4 (p=0.05, p=0.04). No significant variance in signal values for the variables considered was observed in the Sartorius muscle control.

CONCLUSION

This is one of the earliest analyses examining quantitative signal value changes in regional organs (bladder and rectum), using an MR-Linac in patients being actively treated with RT for prostate cancer. Significant changes occurred after only 1 week of therapy in regional organs at risk during treatment with RT. Expanded data sets are needed to evaluate if these early changes correlate with clinical outcomes such as acute or late toxicity.

CLINICAL RELEVANCE/APPLICATION

Radiotherapy (RT) response assessment with a 1.5 Tesla MRI may allow for intra-treatment modification of RT plans to increase oncologic control and reduce toxicity. Increased understand of radiomic changes in OAR's will improve RT response assessment.

SSM23

Vascular Interventional (Neurovascular Interventions)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E263

IR NR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

Participants
Gordon McLennan, MD, Chagrin Falls, OH (*Moderator*) Grant, Siemens AG; Grant, Surefire Medical, Inc; Speakers Bureau, Medtronic plc; Speakers Bureau, General Electric Company; Speakers Bureau, Stryker Corporation; Advisory Board, Siemens AG; Advisory Board, Surefire Medical, Inc; Advisory Board, Stealth Medical; Advisory Board, Rene Medical, Inc; Advisory Board, F. Hoffmann-La Roche Ltd; Advisory Board, Bristol-Myers Squibb Company; Advisory Board, B. Braun Melsungen AG; Advisory Board, General Electric Company;
Dimitrios Filippiadis, MD, PhD, Athens, Greece (*Moderator*) Nothing to Disclose

Sub-Events

SSM23-01 Experimental Study of the Self-Expandable Partial-Covered Stent Insertion for the Treatment of Side-Wall Aneurysms in a Canine Model

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E263

Participants
Yueqi Zhu, MD, Shanghai, China (*Presenter*) Nothing to Disclose
Yingsheng Cheng, MD, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

to test the safety and efficacy of a newly designed self-expandable partial-covered stents insertion for the treatment of side-wall aneurysms with a comparation to bared stents in a canine model

METHOD AND MATERIALS

Thirty-six saccular side-wall aneurysms were created in 18 dogs and were randomly divided into a partial-covered stent group (PSG; receive partial-covered stent insertion, n=9) to and a bared stent group (BSG; receive bared stent insertion, n=9) as control. Angiography was performed post implantation and at 1, 3 and 6 months follow-up to investigate aneurysm isolation, endoleak, stent angulation, parent-artery (PA) patency, and restenosis. Light and scanning electron (SEM) microscopy was used at each follow-up to identify aneurysmal sac thrombi, intima hyperplasia, and endothelial progress

RESULTS

Immediate angiography demonstrated complete isolation of 6 (33.3%) aneurysms, mild endoleak in 9 (50%) and obvious endoleak in 3 (16.7%) in the PSG, with a comparison to that were 0 (0%), 5 (27.8%) and 13 (72.2%) in the BSG. Follow-up angiography at 6 months revealed 17 (94.4%) aneurysms were completely occluded and mild endoleak in 1 (5.6%) aneurysm in the PSG and complete occlusion in 3 (16.7%), mild endoleak in 6 (33.3%) and obvious endoleak in 9 (50%) in the BSG. Mild stenosis (<30%) and occlusion was revealed in 2 and 1 PAs in the PSG. Light microscopy revealed that all aneurysm sacs were filled with thrombi and small residual sac was found in the aneurysm with endoleak filling in the PSG. Endothelial progress was almost complete at 6 months after partial-covered stent insertion and endothelial cell coverage was closely correlated with the occurrence of endoleak

CONCLUSION

this new kind of partial-covered stent was technically feasible and effective to occlude aneurysm sac in canine models

CLINICAL RELEVANCE/APPLICATION

The self-expandable partial-covered stent insertion is safe and leads to satisfied occlusion to aneurysm sac in canine models, thus this device may further be applied for the treatment of brain aneurysms in clinical.

SSM23-02 Placement Of Laser-Cut Stents Within Flow Diverters Enhances Anatomic Results Of Flow Diverters

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E263

Participants
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PURPOSE

To evaluate the effect of better wall apposition of flow diverters by placement of laser-cut stents with higher radial force within the flow diverters during the same treatment session.

METHOD AND MATERIALS

Patients treated using a Surpass flow diverter (SFD) in a single institution with and without placement of a laser-cut stent were retrospectively evaluated. Patients with flow diverter placement inside a scaffolding stent, adjunctive use of another flow diverter, intrasaccular treatment and previously placed stents were excluded from study. Patient and aneurysm characteristics and clinical and imaging follow-up results were compared.

RESULTS

Of the 68 patients (mean age 50.4±14), 35 patients (41 aneurysms) were treated with SFD only ("SFD-only group") and in 33 patients (35 aneurysms) a stent was placed within SFD for better apposition ("apposed group"). No statistical difference was noted between two groups in age, body weight, gender, history of thromboembolic events, smoking, hypertension, hyperlipidemia, diabetes mellitus and malignancy or rate of procedure-related complications. Aneurysms of apposed group were significantly larger than SFD-only group (14.8 vs 9.1 mm, P<0.001). There was no difference between two groups with respect to aneurysm location in anterior versus posterior circulation (P=0.326) or proximal versus distal location with regard to the circle of Willis (P=0.281). In spite of a trend for earlier aneurysm occlusion in the apposed group, complete aneurysm occlusion rates were similar at 0-3 and 3-6 months imaging follow-up (73.3% vs. 61.3%, P=0.466 and 83.9% vs. 72.9%, P=0.432). On 9-12 months follow-up, a significantly higher proportion of aneurysms in the apposed group achieved complete occlusion compared to SFD-only group (93.8% vs. 73.2%, P=0.049). There was no significant difference in complete aneurysm obliteration rates after one year (93.3% vs. 78.0%, P=0.154).

CONCLUSION

Enhancement of flow diverter wall apposition increases rate of aneurysm occlusion. We propose that placement of laser-cut stents with higher radial force within flow diverters is a safe method for improved wall apposition.

CLINICAL RELEVANCE/APPLICATION

Enhanced wall apposition of FD with higher radial force laser-cut stents increases flow diverter efficiency with safety profile.

SSM23-03 Perioperative Result of Carotid Artery Stenting in Patients with Atherosclerotic Extracranial Internal Carotid Artery near Occlusion

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E263

Participants
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PURPOSE

'Near occlusion' of the carotid artery (NOCA) is not a well-defined entity. Recently, NOCA has been subclassified into two forms: 1) NOCA with collapse of the carotid artery, 2) NOCA without collapse. We aimed to compare the technical success and perioperative complication rates of these two sub-types to see whether there is a clinical correlate of this classification.

METHOD AND MATERIALS

We retrospectively evaluated all patients with atherosclerotic extracranial carotid stenosis treated by carotid artery stenting (CAS) in a single medical institution between January 2014 and January 2018. Patients with NOCA were identified based on cerebral DSA findings. Patient demographics, presence of vessel collapse distal to the stenosis, technical success rate and perioperative (<=30 day) complication rate were analyzed.

RESULTS

We identified 59 NOCAs in 58 (46 male, 12 women) patients; one patient had bilateral NOCA. The mean age of patients was 67.4 (range 46 to 86) years. Twelve cases (20.3%) had NOCA with collapse and 47 cases (79.6%) had NOCA without collapse. The NOCAs were symptomatic in 42 cases (71.1%) and asymptomatic in 17 cases (28.8%). Fifty-eight of the 59 CAS procedures were successful. In one case of NOCA, we were not able to pass through the stenosis because of significant patient motion; the patient was advised to undergo stenting under general anesthesia but refused this procedure. The overall perioperative complications included hyperperfusion (HP; 8.6%) and minor stroke (1.7%). Compared to patients with NOCA but no collapse (4.2% of 47 cases), those with NOCA resulting in vascular collapse (27.2% of 11 cases stented) had significantly higher rates of post-intervention HP (Fisher's exact test, p=0.042). Permanent morbidity and mortality rate was 1.7% and 1.7%, respectively.

CONCLUSION

CAS is feasible in the setting of NOCAs with and without collapse. Care should be taken for HP risk, especially in the subgroup of patients with collapse.

CLINICAL RELEVANCE/APPLICATION

Special care should be taken for HP in the treatment of NOCA by CAS

SSM23-04 Intraaneurysmal Air After Flow Diverter Treatment of Intracranial Aneurysms: Incidence, Characteristics, and Clinical Significance

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E263

Participants
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PURPOSE

To describe the rate and characteristics of air bubble retention within cerebral aneurysms treated by flow diverters.

METHOD AND MATERIALS

Patients with cerebral aneurysms treated by flow diversion in a single institution over 30 months were identified. Patients were excluded if selective intrasaccular treatment was also attempted or performed in the same session. Among the remaining patients, those with immediate postprocedure flat detector CT (FDCT) images were identified. FDCT studies were included unless there were surgical or endovascular materials previously used to treat the target aneurysm or other aneurysms interfering with image interpretation. 66 FDCT studies in 66 patients were identified and were scrutinized for presence of air in the aneurysm. Clinical outcome, aneurysm characteristics and imaging features of air within the aneurysm were evaluated.

RESULTS

Intraaneurysmal air bubbles were noted in eleven aneurysms (16.9%). Six aneurysms were saccular and remaining five were fusiform/dissecting. Seven were located in the anterior circulation. All of these aneurysms except one were large or giant and were significantly larger than aneurysms without air bubbles (mean diameter 16 mm versus 9.7 mm in 55 aneurysms, P=0.0277). Air bubbles were more frequently encountered when multiple devices/stents were used for flow diversion as compared to a single flow diverter (P=0.0275). There was a single air bubble in 6 patients, two bubbles in three patients and three bubbles in one patient. All of the bubbles were in the rostral portion of the aneurysm sac, were smaller than 5 mm in maximum diameter (mean diameter 2.6 mm). None of the patients had postprocedural change in neurological status. Air had spontaneously disappeared on all postprocedure follow-up CT images (available in 9 patients) at a mean CT follow-up duration of 2 days.

CONCLUSION

Intravascular microbubble formation probably occurs in all endovascular procedures despite rigorous attention to technique. Flow diverters probably result in the intraaneurysmal entrapment of these microbubbles. In this study this finding was common, incidental, self-limited and without clinical consequences.

CLINICAL RELEVANCE/APPLICATION

The finding of intraaneurysmal microbubble within cerebral aneurysms treated by flow diverters is clinical inconsequential and self-limited.

SSM23-06 Initial Experience and One Year Follow-Up with Neuroform Atlas™ Stent System for the Treatment of Brain Aneurysms

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E263

Participants
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Eduardo Murias, Oviedo, Spain (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The Neuroform Atlas Stent System is a recently introduced modification of the classical Neuroform stent consisting of a hybrid design with open and closed cells. Initial experience, technical considerations, treatment outcomes and one year follow up using the Atlas stent in combination with coil embolization are reported.

METHOD AND MATERIALS

Thirty unruptured aneurysms (from 30 patients) were treated with stent reconstruction. Control angiography and clinical assessment were performed inmediately, at four-month and at twelve-month after treatment.

RESULTS

The stents were delivered and positioned without difficulty in 29 cases. There were technical complications in one case, related to the displacement of the stent during its delivery. Only in one case occurred procedure-related clinical complications, with no permanent neurological deficit. We aimed for intial complete aneurysm occlusion with coils whenever technically feasible.The control angiography shortly after procedure showed class 1 or 2 occlusion (Raymond Roy classification) in 29 of 30 aneurysms. At one year angiographic follow-up, all 30 patients were clinically stable, 18 of 30 aneurysms were total occluded and two presented recanalizations. The objective ATLAS implantation was treatment stability. The treatment stability remained in 93% of our patients at four mounts and one year follow-up. In aneurysms with initial complete occlusion, this was maintained by the ATLAS system, while aneurysms with neck remnants showed no progression of the degree of closure. Our series of patients treated with ATLAS stents showed a very low rate of technical incidents (during the implantation and release of the stent) with permanent clinical complications (0%), compared with a review of series treated with other devices (1.4% to 4.3%).

CONCLUSION

The ATLAS stent is technically simple to implant and has a low thrombogenic potential. There are fewer problems associated with implantation, thromboembolic complications and hemorrhagic events compared with other types of stent, including braided stents. On the other hand, because of its low thrombogenic potential, partially occluded aneurysms or those with aneurysm remnants do not progress to complete occlusion.

CLINICAL RELEVANCE/APPLICATION

ATLAS stent implantation is useful to remaind the treatment stability of wide-neck auneurysms with complete initial occlusion with out or minimal procedure-related complications.

SSM24

Vascular Interventional (Portal Interventions)

Wednesday, Nov. 28 3:00PM - 4:00PM Room: E264

CT GI IR VA

AMA PRA Category 1 Credit ™: 1.00
ARRT Category A+ Credit: 1.00

Participants
Naganathan B. Mani, MD, Chesterfield, MO (*Moderator*) Nothing to Disclose
Nael E. Saad, MBBCh, ROCHESTER, NY (*Moderator*) Nothing to Disclose

Sub-Events

SSM24-01 Effect of Portal Decompression on Pulmonary Gas Exchange in Patients with Budd-Chiari Syndrome and Hepatopulmonary Syndrome

Wednesday, Nov. 28 3:00PM - 3:10PM Room: E264

Participants
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PURPOSE

To evaluate the effect of portal decompression on pulmonary gas exchange in patients with Budd-Chiari syndrome (BCS) and hepatopulmonary syndrome (HPS).

METHOD AND MATERIALS

From June 2014 to June 2015, all patients with BCS undergoing balloon angioplasty and transjugular intrahepatic portosystemic shunt creation at our institution were eligible for inclusion in this study. The primary endpoint was the changes in alveolar-arterial oxygen gradient (A-aO2) before and over 3 months after portal decompression.

RESULTS

Eleven patients with HPS (mean age, 51.7 years; six males) and 14 patients without HPS (mean age, 47.2 years; nine males) were included. Of the 11 patients with HPS, dyspnea was found in three (27.3%), all of which (100%) reported improvement in dyspnea after portal decompression. However, this improvement was not maintained at 3-month follow-up in two (33.7%) patients. For patients with HPS, the mean change in A-aO2 was statistically significant before and at 1 month (-11.7 ± 6.4 mmHg; P < .001) but not at 2-3 days (-3.2 ± 11.9 mmHg; P = .412) and 3 months (-1.3 ± 12.5 mmHg; P = .757) after portal decompression. For patients without HPS, the mean change in A-aO2 was not statistically significant before and at 2-3 days (+1.4 ± 8.3; P = .543) and 1 (+3.5 ± 8.1 mmHg; P = .137) and 3 months (+1.3 ± 8.2 mmHg; P = .565) after portal decompression. The overall mean changes in A-aO2 before and over 3 months after portal decompression was statistically significant for patients with HPS (-5.4 ± 6.9 mmHg; P = .035) but not for patients without HPS (+2.0 ± 7.6 mmHg; P = .333).

CONCLUSION

Portal decompression can improve pulmonary gas exchange in patients with BCS and HPS, but this effect is not sustainable at 3 months.

CLINICAL RELEVANCE/APPLICATION

1. Hepatopulmonary syndrome are common in patients with Budd-Chiari syndrome. 2. Portal decompression via balloon angioplasty and transjugular intrahepatic portosystemic shunt creation is effective and safe for the treatment of hepatopulmonary syndrome in patients with Budd-Chiari syndrome. 3. The treatment effect of balloon angioplasty and transjugular intrahepatic portosystemic shunt creation on hepatopulmonary syndrome is not sustainable at 3 months in patients with Budd-Chiari syndrome

SSM24-02 Outcomes in Cirrhotic Patients with Recurrent Ascites Who Received TIPS (Transjugular Intrahepatic Portosystemic Shunt) and/or Paracentesis

Wednesday, Nov. 28 3:10PM - 3:20PM Room: E264

Participants
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PURPOSE

Many cirrhotic patients who cannot undergo liver transplantation are symptomatically treated for recurrent ascites with paracenteses and/or transjugular intrahepatic portosystemic shunts (TIPS). Placing TIPS earlier in the cirrhotic disease process can potentially decrease the cost and inconvenience of repeated paracenteses. This study aimed to determine if there were differences in paracenteses and hospital admissions from bacterial peritonitis, variceal bleeds, and hepatic encephalopathy between cirrhotic patients who did and did not receive TIPS.

METHOD AND MATERIALS

A retrospective analysis was performed on all cirrhotic patients, age 18 and older, with refractory ascites between January 1, 2008 and December 31, 2016 at our institution. Demographics, cirrhosis etiology, lab values, paracentesis, TIPS, and hospitalization information were documented. A shared frailty model with TIPS placement as a time-varying covariate was used to calculate the association of time between paracentesis with TIPS placement, while chi-square tests examined the association between hospitalization rates for each outcome with TIPS placement.

RESULTS

A total of 344 patients with refractory ascites and a median age of 57 (IQR=50-62) were included. Of these, 92 (26.8%) received TIPS. Median MELD score at refractory date was higher among patients without TIPS compared to patients with TIPS (18 and 13, respectively; $p<0.01$). TIPS and the risk of paracentesis for ascites were highly associated ($p<0.01$). A 60% reduction in the risk of a paracentesis post-TIPS was observed regardless of MELD score, age, or gender (HR=0.40, 95%CI=0.33, 0.49). There was no significant difference in hospitalizations for bacterial peritonitis ($p=0.13$), variceal bleeding ($p=0.23$), or hepatic encephalopathy ($p=0.46$) between patients with and without TIPS.

CONCLUSION

This study found that cirrhotic patients with refractory ascites have a 60% reduction in the risk of receiving a paracentesis for symptomatic ascites after TIPS is placed with no change in hospitalizations for TIPS-associated outcomes. This suggests that TIPS placement should be considered earlier in the cirrhosis disease process to improve symptomatic control and decrease the need and associated costs of frequent paracenteses.

CLINICAL RELEVANCE/APPLICATION

Early placement of TIPS in cirrhotic patients reduces risk of repeat paracenteses without effecting hospitalization rates for common complications of ESLD.

SSM24-03 Optimal Energy Level in Assessment of TIPS Stent Luman in Dual-Energy CT Portal Venography in Liver Cirrhosis: A Prospective Study

Wednesday, Nov. 28 3:20PM - 3:30PM Room: E264

Participants
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PURPOSE

To investigate the optimal energy level in monochromatic imaging of portal vein for the assessment of transjugular intrahepatic portosystemic shunt stent (TIPSS) lumen using 16-cm wide-detector spectral CT.

METHOD AND MATERIALS

Thirty-seven patients with TIPSS for portal hypertension performed spectral CT (Revolution, GE Healthcare) portal venography (CTPV) in our study. 120 kVp-like images as well as 4 groups of monochromatic images from 55 to 85 keV with an interval of 10 keV were collected. CTPV images at main portal vein, proximal, middle and distant level of stent were evaluated. Objective image quality indexes for portal vein and stent lumen included CT attenuations, noise, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were measured. Two experienced radiologists subjectively evaluated image quality independently with a 5-point scale on image quality and diagnostic confidence was obtained.

RESULTS

Within 37 patients with TIPS, 3 were classified into grade A, 24 were classified as grade B while 10 were graded C according to Child - Pugh staging. In portal vein and stent lumen, CT attenuations, SNR and CNR decreased with the increase of keV (all $P<0.01$). CT attenuations were higher than 200 HU in 55 keV (287.6 ± 36.9 HU) and 65 keV (223.1 ± 42.7 HU) in portal vein and stent lumen. Images at 55 keV demonstrated the highest objective indexes (CT attenuations, SNR and CNR). However, the subject score was the lowest (2.1± 0.7), with 9 (24.3%) of undiagnosed rate. Images at 65 keV exhibited highest subjective image quality score (3.6 ± 0.8) and diagnostic confidence (3.3 ± 0.6) while the second best CT attenuations, noise, SNR and CNR (all $P<0.01$). Subjective as well as objective indexes at 75 keV showed no statistical difference from 120 kVp-like group (all $P>0.05$), and these 75 keV indexes were inferior to 65 keV group, and superior to 85 keV group.

CONCLUSION

In monochromatic imaging of portal vein for the assessment of transjugular intrahepatic portosystemic shunt stent (TIPSS) lumen

In monochromatic imaging of portal vein for the assessment of transjugular intrahepatic portosystemic shunt stent (TIPSS) lumen using 16-cm wide-detector spectral CT, images at 55 keV manifested best objective image quality (CT attenuation, SNR and CNR), while 65 keV images demonstrated best subjective image quality and diagnostic confidence.

CLINICAL RELEVANCE/APPLICATION

It is recommended to conduct CT portal venography using 16-cm wide-detector spectral CT for the visualization of TIPS stent lumen in liver cirrhosis patients at 65 keV.

SSM24-04 Metal Artifact Reductions with Monochromatic Imaging in Spectral CT Portal Venography after Gastric Coronary Vein Embolization (GCVE) in Portal Hypertension: A Comparative Study

Wednesday, Nov. 28 3:30PM - 3:40PM Room: E264

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PURPOSE

To investigate the clinical value of metal artifact reductions (MARs) combined with monochromatic imaging in spectral CT portal venography (CTPV) after gastric coronary vein embolization (GCVE) by comparison with 120 kVp-like imaging.

METHOD AND MATERIALS

Thirty-one patients with GCVE artifacts were performed CTPV with spectral CT in our study. All raw data were reconstructed as 120 kVp-like imaging without MARs (group A), and monochromatic imaging with MARs at 65 keV (group B) and 74 keV (group C), respectively. Three slices of CTPV images were evaluated, including main portal vein, heaviest artifacts and no artifacts level from all groups. Objective indexes for portal vein included signal intensity (SI), standard deviation (SD), signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR) and artifact index (AI). Subjective indexes were assessed by two radiologists separately with 5-point scale. Statistical analyses were analyzed.

RESULTS

With the use of MARs, AI in group B (29.1 ± 3.6)and C (35.6 ± 4.4) are much lower than group A (87.2 ± 11.3)($P<0.01$). As for the quantitative indices of main portal vein, group B demonstrates the highest SI (243 ± 20.6), SNR (22.1 ± 3.7) and CNR (11.5 ± 2.6) than the other two groups (all $P<0.01$), while there is no statistical differences in SI (184 ± 19.7 Versus 179 ± 21.6), SNR (20.4 ± 3.1 Versus 21.6 ± 3.7) and CNR (9.2 ± 2.4 Versus 9.6 ± 2.9) between group A and C (all $P>0.05$). For subjective assessment, group B (3.8 ± 1.6) is superior to group A (2.1 ± 1.4)and (3.1 ± 1.1) ($P<0.01$).

CONCLUSION

Combination of MARs with monochromatic imaging decreased metal artifacts, and improved image quality in spectral CT portal venography with GCVE, with 65 keV as the optimal energy level.

CLINICAL RELEVANCE/APPLICATION

It is recommended that 65 keV with MARs as the optimal CTPV protocol for liver cirrhosis patients with GCVE.

SSM24-05 Role of Preoperative MSCT and MRI for Endovascular Procedures in Budd-Chiari Syndrome with Inferior Vena Cava (IVC) Obstruction: A Retrospective Study of 112 Cases

Wednesday, Nov. 28 3:40PM - 3:50PM Room: E264

Participants
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PURPOSE

This article focuses specifically on the obstructive characteristics, collateral vessels and floating thrombus demonstrated on preoperative imaging, to determine the role of preoperative MSCT and/or MRI for endovascular procedures.

METHOD AND MATERIALS

This retrospective analysis included 112 patients who underwent endovascular procedures for BCS between October 2009 and Jun 2017 in our institution. All patients had preoperative MSCT and/or MRI imaging. Two radiologists independently assessed (on a 5-point scale) the imaging data to evaluate diagnostic accuracy, inter-reader agreement, and association between imaging presentation and interventional procedures.

RESULTS

Eighty-two patients had preoperative MSCT data and corresponding sensitivities were 83.33%, 86.96%, 88%, and 81.25% for reader 1, and 83.33%, 91.30%, 92.00%, and 81.25% for reader 2. Thirty two patients had preoperative MRI data and corresponding sensitivities were 88.89%, 100%, 100%, and 83.33% for reader 1, and 100%, 100%, 100% and 100% for reader 2. Areas under the receiver operating characteristic curves (AUCs) for judging IVC secondary thrombus were 0.88 for reader 1, 0.87 for reader 2 in group MSCT, and 0.975 for reader 1, 0.933 for reader 2 in group MRI. Inter-reader agreement was substantial or excellent for diagnostic accuracy (κ=0.745-0.927).

CONCLUSION

In patients with BCS, it is important to focus preoperatively on the degree and extent of the obstruction, collateral vessels and floating thrombus, to optimize interventional procedures and minimize complications.

CLINICAL RELEVANCE/APPLICATION

Interventional therapy is the preferred microinvasive therapeutic for patients with BCS, however, varying degree of procedure-related complications still exist. If we properly estimate obstructive characteristics preoperatively and detect risk factors, such as dangerous collateral vessels and IVC secondary thrombosis, we can design a reasonable interventional program and minimize complications.

SSM24-06 The Feasibility and Utility of the Overlay Technique Under Cone-Beam Computed Tomography Guidance for Portal Vein Puncture During Transjugular Intrahepatic Portosystemic Shunt

Wednesday, Nov. 28 3:50PM - 4:00PM Room: E264

Participants
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PURPOSE

The purpose of this study was to investigate the feasibility and utility of the overlay technique under cone-beam computed tomography (CBCT) which was used as a navigation method for portal vein puncture during transjugular intrahepatic portosystemic shunt (TIPS).

METHOD AND MATERIALS

From February 2016 to April 2017, 15 consecutive cirrhotic patients (12 males and 3 females; mean age 58 years, range from 44 to 68 years) received TIPS treatment and prospectively enrolled in this study. An initial CBCT image acquisition was performed before TIPS and we applied the overlay technique by register the preoperative contrast enhanced CT or MRI portal venous phase images with the newly acquired CBCT images. According to the overlaid images, a planned needle path was made and displayed simultaneously on the axial, sagittal and coronal plane. The angle from hepatic vein to portal vein was calculated manually on three planes and intended for the interventional radiologists' reference. The contrast material consumption, number of needle puncture attempts, radiation dose and fluoroscopic time were recorded from hepatic vein catheterization to portal vein entry.

RESULTS

The overlay technique was technically feasible in 14 of 15 patients (93%). The only failure was due to the overlay misregistration caused by progress of ascites. No complications were observed postoperative monitoring. The mean (± SD) contrast material consumption was 38 ± 9.2ml, number of needle attempts was 1.9 ± 1.1 punctures(range 1 to 4), dose area product (DAP) was 138 ± 55.8 Gy·cm3 ,fluoroscopic time was 19 ± 5.5min.

CONCLUSION

The overlay technique under CBCT guidance is a feasible and safe method for TIPS portal vein puncture. It contributes to the creation of TIPS and facilitate the portal vein pressure reduction.

CLINICAL RELEVANCE/APPLICATION

The overlay techique under cone-beam computed tomography for portal vein puncture during TIPS is feasible, safe and helps portal puncture vein pressure reduction.

SSQ01

Breast Imaging (Abbreviated MRI, Ultrafast Imaging and Artificial Intelligence)

Thursday, Nov. 29 10:30AM - 12:00PM Room: E450A

AI BR MR

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

Participants
Christiane K. Kuhl, MD, Aachen, Germany (*Moderator*) Nothing to Disclose
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

Sub-Events

SSQ01-01 Assessing the Accuracy of an Abbreviated Breast MRI Protocol Compared to a Full MRI Protocol in Women with a Personal History of Breast Cancer

Thursday, Nov. 29 10:30AM - 10:40AM Room: E450A

Participants
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Susan Weinstein, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Women with a personal history of breast cancer have an elevated lifetime risk for a second breast cancer. However, the current American Cancer Society guidelines do not recommend MRI screening in this population. Multiple studies have demonstrated that the sensitivity of Abbreviated breast MRI (AB-MRI) is similar to full diagnostic protocols (FDP-MRI). In this study, we retrospectively evaluate the use of surveillance AB-MRI in women with a personal history of breast cancer.

METHOD AND MATERIALS

An IRB approved and HIPAA compliant reader study was performed on 398 consecutive women with a personal history of breast cancer who underwent full protocol clinical breast MRIs from 9/13-12/15. There were 14 cancers detected (3.8%). An enriched reader study was performed consisting of 68 cases including the 14 cancer cases. Non-cancer cases had at least 1 year of follow-up. Interpretations from a limited image set simulating an AB-MR protocol (T2, pre, and post contrast) were compared with interpretations of the FDP-MRI clinical study.

RESULTS

The AB-MR interpretations were compared with those from the full, clinical protocol. The sensitivity (SN), specificity(SP), positive predictive value (PPV), and the negative predictive value (NPV) for the simulated AB-MR vs the FDP-MRI interpretations were: SN - 50% vs 71%, SP - 96% vs 77%, PPV- 74% vs 43%, NPV - 88% vs. 91%. The mean difference between reader 1 and reader 2 was 0.29 with 95% confidence interval: [-0.33, 0.90]. There were significantly fewer false positives with AB-MRI than FDP-MRI, but more false negatives were observed with AB-MRI.

CONCLUSION

Our preliminary results show higher specificity at the expense of sensitivity in our simulated AB-MRI reads compared to FDP-MRI in women with a history of breast cancer. Further evaluation is warranted.

CLINICAL RELEVANCE/APPLICATION

A simulated AB-MRI protocol resulted in fewer false positive exams than with a full, clinical MR protocol in women with a personal history of breast cancer, however, more research is needed.

SSQ01-02 Abbreviated Breast MRI : 'Ultrafast' DISCO Acquisition for Lesion Characterization

Thursday, Nov. 29 10:40AM - 10:50AM Room: E450A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The purpose of our study was to evaluate the diagnostic performance of a dynamic acquisition over-sampling the first minute after contrast administration in an abbreviated dynamic-contrast-enhanced (DCE) breast-MRI.

METHOD AND MATERIALS

153 women were retrospectively consecutively included between July 2016 and March 2017, regardless of indication. All these women had a full breast- MRI protocol, including a DISCO ultrafast acquisition with 7 phases, and an enhanced lesion histologically proven (age= 55 (28-88)). Two readers analyzed 179 lesions (73 benign, 5 B3, 101 malignant lesions) with BIRADS classification for each protocol: an abbreviated protocol (T1-weighted, T2-wheigthed, DISCO, T1-fat suppressed VIBRANT 2mn after contrast administration) and a standard full protocol with late post-contrast phases. Then readers studied DISCO's early enhancement curve with the following semi-quantitative parameters: Wash-In Rate (WIR), Maximal Slope Increase (MSI), Enhancement Amplitude (EA), and Time of Half Rising (THS). Heterogeneity was also assessed using Standard Deviation (STD) at the different DISCO phases.

RESULTS

176/179 (98%) lesions were detected by the abbreviated protocol regarding to the full protocol : 122 mass and 57 non-mass-like enhancement or foci (medium size : 18mm). The 3 undetected lesions were benign. Malignant lesions showed a WIR, a MSI a EA higher, a THS shorter and were more heterogeneous at all DISCO phases than benign lesions ($p<0.01$). In the group of masses with benign morphology (n= 42), THS was shorter for the malignant lesions (39.1 sec) than for the benign lesions (44.6 sec) ($p=0.01$).

CONCLUSION

Including an additional ultrafast-scan in an abbreviated breast-DCE-MRI protocol enables the early enhancement study that is useful for lesion characterization and is time efficient.

CLINICAL RELEVANCE/APPLICATION

DCE-abbreviated breast-MRI with ultrafast-scan is efficient for lesion detection and characterization; so might be considered as a screening tool in intermediate-risk women.

SSQ01-03 Ultrafast Breast DCE-MRI in the Evaluation of Tumor Size: Potential Utility in Moderate to Marked Background Parenchymal Enhancement

Thursday, Nov. 29 10:50AM - 11:00AM Room: E450A

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PURPOSE

Ultrafast breast DCE-MRI allows imaging of early kinetics within the first 30 seconds after contrast injection, when the background parenchymal enhancement (BPE) is minimal. This study was performed to explore the clinical utility of ultrafast MRI focusing on tumor size evaluation according to the level of BPE.

METHOD AND MATERIALS

A total of 360 consecutive women (median age, 54 years; range, 26 - 82 years) with 361 tumors (49 DCIS and 312 invasive) who underwent both the ultrafast and conventional breast MRI before surgery were included. Ultrafast MR images were obtained using TWIST or 4D-TRAK sequence (temporal resolution, 4.5 sec; voxel size, 1.1×1.1×1.0 mm3, TR/TE 4.1/1.3 ms). Then, conventional DCE-MR images were obtained using 3D FLASH sequence (temporal resolution, 90sec; voxel size, 0.8×0.8×1.0 mm3, TR/TE 4.7/1.7 ms). Tumor size was independently measured on each scan, respectively. Agreement between tumor sizes on MRI and those on surgical histopathology was assessed using the intraclass correlation coefficient (ICC) analysis.

RESULTS

The ICC on ultrafast MRI was comparable to that on conventional MRI (ICC = 0.657 vs. 0.634, P =.598). For conventional MRI, the ICC was lower in women with moderate to marked BPE (ICC = 0.568) than in women with minimal to mild BPE (ICC = 0.650) with borderline significance (P =.080). However, no difference was found on ultrafast MRI (ICC = 0.625 for moderate to marked vs. 0.663 for minimal to mild BPE, P =.385). In women with moderate to marked BPE, the ICC was slightly higher on ultrafast MRI than that on conventional MRI, although the difference was not statistically significant (ICC = 0.625 vs. 0.568, P = .236). No difference was found for the ICC according to the age, menopausal status, family history, histologic type, ER positivity, HER2 positivity, and lesion type on MRI (mass vs. non-mass enhancement) (All P >.05).

CONCLUSION

In women with moderate to marked BPE, tumor size measurement might be more accurate on ultrafast MRI than on conventional MRI.

CLINICAL RELEVANCE/APPLICATION

In women with moderate to marked BPE, ultrafast MRI can be applied for more accurate evaluation of tumor extent.

SSQ01-04 Maximum Slope as a Kinetic Parameter Based on Ultrafast Dynamic Contrast-Enhanced MRI of the Breast Using K-Space Weighted Imaging Contrast

Thursday, Nov. 29 11:00AM - 11:10AM Room: E450A

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PURPOSE

To investigate the diagnostic performance and inter-reader agreement of the maximum slope (MS) in breast malignant from benign lesions obtained by ultrafast dynamic contrast-enhanced magnetic resonance imaging (DCE MRI). Comparison with washout index (WI) was performed with the focus on discrepant cases.

METHOD AND MATERIALS

In total, 141 enhancing lesions (89 malignant, 52 benign) were included. Ultrafast DCE MRI sequences were acquired using a k-space-weighted imaging contrast (KWIC) sequence, obtained 0 to 1 min after gadolinium injection (3.75 s/frame; 16 frames) and followed by standard DCE MRI. The MS was calculated its percentage relative enhancement per second (%/s). The inter-reader agreement of MS values by two radiologists were evaluated using intra-class correlation coefficients (ICC). As a semi-quantitative parameter for conventional DCE MRI, washout index (WI: signal intensity [SI] delay - SI early) / SI pre × 100 (%) was calculated. The diagnostic performance (malignant/ benign differentiation) of the MS and WI was compared using ROC analysis.

RESULTS

Intra-class correlation coefficients (ICC) of the reading was 0.98 (95% confidence interval 0.97-0.99) for all, 0.96 (0.95-0.98) for malignant lesions and 0.99 (0.97-0.99) for benign lesions. The average MS was 25.4%/s (standard deviation: SD, 11.2 %/s) for malignant lesions and 11.8%/s (SD, 10.7 %/s) for benign lesions. The AUC of the MS (ICC: 0.98) was almost same as that of the WI (0.83 vs. 0.82, respectively; P = 0.80). Using the optimal cut-off points determined by the Youden index (>9.76% /s for the MS and <-23 % for the WI), MS tended to have higher sensitivity (92.1%) and specificity (65.4%) compared with WI (91.1% and 61.5%, respectively). False positive cases based on MS were FA (n=5) and intraductal papilloma (n=1), while false positive cases based on WI were fibrocystic change (n=6), intraductal papilloma (n=2) and flat epitherial atypia.

CONCLUSION

The overall diagnostic performance of MS in breast lesion was similar to the conventional kinetic parameter, with AUC of over 0.8. Excellent ICC was obtained. MS helped to reduce false positive in fibrocystic change, while FA tended to be false positive on MS.

CLINICAL RELEVANCE/APPLICATION

Our results suggest that maximum slope can be an alternative kinetic parameter to conventional kinetic curve, potentially shorten scan time, with excellent inter-reader agreement.

SSQ01-05 Combination of an Ultrafast TWIST VIBE Dixon Sequence Protocol and Diffusion-Weighted Imaging to a Highly Accurate Clinically Applicable Classification Tool for Suspicious Masses in Breast MRI

Thursday, Nov. 29 11:10AM - 11:20AM Room: E450A

Participants
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PURPOSE

To develop a statistical model for classification of suspicious masses in breast MRI when using TWIST VIBE Dixon (TVD) dynamic sequences in combination with diffusion-weighted imaging (DWI) and compare it to a model based on a combination of conventional dynamic contrast enhancement (DCE) and DWI. As ultrafast TVD sequences offer the potential to shorten breast MRI protocols, diagnostic accuracy might be hampered due to reduced kinetic information. A special focus of this study was thus to maintain high diagnostic accuracy in lesion classification.

METHOD AND MATERIALS

65 patients underwent clinically indicated breast MRI between 02/2014 and 04/2015, with 83 reported lesions (60 malignant, 23 benign). Inclusion criteria were suspicion of breast cancer or pre-therapeutic staging. Patients with non-mass-enhancements only were excluded. The protocol consisted of our institute's standard protocol complemented by an ultrafast TVD sequence. The apparent diffusion coefficient (ADC) and the peak enhancement of the TVD sequences were used to calculate a generalized linear model (GLM) for prediction of malignancy. A second model was calculated using ADC and the curve type derived from the conventional DCE sequence for the sake of comparison. Generalizability was ensured by applying leave-one-out cross validations. For easy application of the GLMs in clinical workflows, nomograms were created.

RESULTS

The GLM based on peak enhancement of the ultrafast TVD sequences and ADC performed comparably accurate to the model based on conventional DCE and ADC (Sensitivity 93.3% vs. 93.3%, specificity 91.3% vs. 87.0%, positive predictive value 96.6% vs. 94.9%, negative predictive value 84.0% vs. 83.3%; no significant differences).

CONCLUSION

This study presents a method to integrate ultrafast TVD sequences into a breast MRI protocol and reduce examination time while maintaining diagnostic accuracy. A GLM based on the combination of TVD-derived peak enhancement and ADC provides high diagnostic accuracy. The GLM can easily be applied in clinical routine using the supplied nomograms.

CLINICAL RELEVANCE/APPLICATION

One limiting factor hampering the comprehensive application of breast MRI is time. This study presents a breast MRI protocol with less than 5 minutes duration along with a classification scheme reaching high diagnostic accuracy. Use of this protocol could improve patient throughput and strenghten the role of breast MRI in screening.

SSQ01-06 Ultrafast Dynamic Contrast-Enhanced MRI for Detection of Invasive Components in Cases of Breast Ductal Carcinoma in Situ by Biopsy

Thursday, Nov. 29 11:20AM - 11:30AM Room: E450A

Participants
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PURPOSE

To evaluate whether ultrafast dynamic contrast-enhanced (DCE) MRI could identify invasive components in cases with ductal carcinoma in situ (DCIS) diagnosed by percutaneous biopsy.

METHOD AND MATERIALS

Fifty-three consecutive women with 53 lesions diagnosed with DCIS by biopsy underwent IRB-approved ultrafast DCE-MRI including a pre- and 18 post-contrast ultrafast 3D bilateral scans using a 3T system. Ultrafast 3D bilateral scans were acquired with temporal resolution of 3 seconds per image. We evaluated the heterogeneity of enhancement in a target lesion using model-based analysis. Regions of interest (ROIs) were placed where the strongest and weakest signal increases were found in ultrafast DCE-MRI to obtain kinetic curves of maximum and minimum enhancement, respectively. The kinetic curve obtained from ultrafast DCE-MRI was analyzed using an empirical mathematical model: $\Delta S(t)=A*(1-e-at)$. Where A is the upper limit of the signal intensity, a (min-1) is the rate of signal increase. The initial slope of the kinetic curve is given by 'A*a'. Amax, Amin, amax, amin, A*amax, and A*amin were obtained from ROIs for maximum and minimum enhancement, respectively. We obtained the following derivations for diagnostic parameters showing heterogeneity of enhancement: A difference=Amax - Amin; a difference= amax -amin; A*a difference= A*amax - A*amin.

RESULTS

Surgical specimens revealed 32 lesions with pure DCIS and the remaining 21 lesions with DCIS with invasive components (DCIS-IC). The A difference for DCIS-IC (132±235) was significantly higher than that of pure DCIS (49±34) ($p = 0.013$). No significant difference was found for a difference and A*a difference ($p = 0.24$ and 0.46, respectively). Receiver operating curve analysis revealed that the area under the curve of A difference was 0.70. The most effective threshold for A difference was 68, and the sensitivity, specificity, positive predictive value and negative predictive value were 62% (13/21), 72% (23/32), 59% (13/22), and 74% (23/31), respectively.

CONCLUSION

The A difference could suggest the presence of invasive components in cases with DCIS diagnosed by biopsy.

CLINICAL RELEVANCE/APPLICATION

The A difference showing the heterogeneity of enhancement of lesions in ultrafast DCE-MRI might suggest the presence of invasive components in cases of DCIS by biopsy.

SSQ01-07 Ultrafast Dynamic Contrast Enhanced Breast MRI in Differentiating between Subcentimeter Carcinomas and Benign Lesions: Quantitative versus Qualitative Assessments

Thursday, Nov. 29 11:30AM - 11:40AM Room: E450A

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PURPOSE

Ultrafast dynamic contrast enhanced (UF-DCE) breast MRI, characterized by high temporal and spatial resolution, enables image acquisition at multiple time points starting simultaneously with the beginning of contrast injection. In a preliminary study comparing several quantitative parameters calculated from UF-DCE MRI, we determined bolus arrival time (BAT) and maximum slope (MS) were most useful in the differentiation between subcentimeter carcinomas and benign lesions. This study aims to compare the performance of these parameters with qualitative assessments of UF-DCE MRI.

METHOD AND MATERIALS

We identified female patients between February-October 2017 with a: 1) UF-DCE MRI as part of hybrid protocol with conventional DCE MRI performed with a 3.0T MRI with a 16-ch coil and 2) biopsy proven BI-RADS 4-6 lesion. UF-DCE MRI were acquired continuously 15 times during the approximately 60 sec (temporal resolution, 3.0-4.3 sec) starting simultaneously with the beginning of contrast injection. BAT and MS were computationally calculated based on 3D volumetric segmentation. Qualitative assessments were visually performed by a reader, identifying the time from scan start to the beginning of lesion enhancement (vBAT) and evaluating the degree of enhancement relative to background parenchymal enhancement (vE) by a 4-point grading scale from 'prominent' to 'indistinguishable'. Wilcoxon signed-rank test or Pearson's chi-squared test were used for the statistical analyses. P value <0.05 was considered satistically significant. The diagnostic performance was evaluated using areas under the receiver operating characteristic curve (AUC).

RESULTS

In total, 77 subcentimeter lesions (carcinomas, 33 [43%]; benign lesions, 44 [57%]) were analyzed. BAT, MS and vBAT presented significant difference between carcinomas and benign lesions (p=0.0004, p<.0001, p=0.0063), while vE did not (p=0.0607). AUCs of BAT (0.737) and MS (0.790) were higher than those of vBAT (0.683) and vE (0.605).

CONCLUSION

Quantitative assessments of UF-DCE MRI presented higher performance than qualitative assessments in differentiating between subcentimeter carcinomas and benign lesions.

CLINICAL RELEVANCE/APPLICATION

There is no standardized way to evaluate ultrafast DCE breast MRI. Although diagnostic utility of some quantitative parameters is known, little is known about the performance of qualitative assessment, especially for subcentimeter lesions.

SSQ01-08 Comparison of Machine Learning Based Measurement and Visual Assessment of Fibroglandular Tissue and Background Parenchymal Enhancement in Breast MR Imaging: A Preliminary Study

Thursday, Nov. 29 11:40AM - 11:50AM Room: E450A

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PURPOSE

To design and validate a machine learning model for the measurement of fibroglandular tissue (FGT) and background parenchymal enhancement (BPE) in breast MR imaging, and compare with estimation of radiologist according to BI-RADS categories.

METHOD AND MATERIALS

195 women (mean age, 54.9 years; range 30 - 86 years) who were diagnosed with invasive breast cancer and underwent preoperative breast MR, between January and December 2017 were enrolled in this study. Two radiologists independently assessed the categories of FGT and BPE of contralateral breast, using with axial precontrast, early dynamic contrast enhancement T1-weighted image, and subtraction image between them. In case of discordance, two radiologists reached consensus. Machine learning model was designed to measure the volume of whole breast, FGT and BPE, using nonnegative matrix factorization (NMF). In this study, 50 and 145 samples were assigned to train and valid, respectively. Areas under the receiver operating characteristic curve was used to assess model performance of predicting dense breast (FGT category c, d) and prominent BPE (BPE category c, d). Correlation between the visual assessment of radiologist and machine learning based measurement was assessed using Spearman correlation analysis.

RESULTS

With the machine learning model, AUC of prediction of dense breast were 0.971 (0.880-0.998) in training set and 0.902 (0.784-0.968) in validation set. AUC of prediction of prominent BPE were 0.959 (0.912-0.985) in training set and 0.819 (0.746-0.848) in validation set (P < .001). Correlation between machine learning based measurement and visual assessment by radiologist was r = 0.871 of FGT, and r = 0.523 of BPE, respectively (P < .001).

CONCLUSION

Machine learning model showed reliable predictive power for FGT and BPE assessment and close correlation with FGT assessment by radiologist.

CLINICAL RELEVANCE/APPLICATION

FGT and BPE are known as risk factors for breast cancer and are associated with poor prognosis. Machine learning can provide quantitative and objective information of FGT and BPE volume in breast MR imaging and can be helpful to predict patient's prognosis.

SSQ01-09 Deep Learning of Breast MRI Tumor Volume Improves Tumor Proliferation Marker Ki-67 Estimation

Thursday, Nov. 29 11:50AM - 12:00PM Room: E450A

Participants
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PURPOSE

Ki-67 is a commonly used immunohistochemistry marker for cellular proliferation in invasive tumors. A few recent studies showed some association between Ki-67 and DCE-MR imaging features. We performed an investigation to compare effects of a 3D deep learning approach versus conventional radiomic features in deriving breast DCE-MRI information to predict Ki-67 rate.

METHOD AND MATERIALS

In an IRB-approved retrospective study of 141 patients, we identified 141 breast DCE-MRI scans (2011-2016) at our institution. All patients have the Ki-67 proliferation rates measured that are further categorized into High vs Low category according to a clinically defined threshold of 14. Breast tumor volume were automatically segmented in 3D space from the first post-contrast breast MR sequence images. From the segmented 3D tumor volume, we extracted 30 common radiomic features, including morphological and contrast enhancement kinetic characteristics of the tumor volume; those features were fed to a logistic least absolute shrinkage and selection operator (LASSO) regression model to predict High vs Low Ki-67 categories. Also, a 3D convolutional neural network (CNN) deep learning model was used to perform the same prediction but directly using the original image of the segmented 3D tumor volume (i.e., here no any pre-defined imaging features extracted nor used). We performed 10-fold cross-validation for both logistic regression and deep learning model evaluation and used average AUC as the metric of model classification accuracy.

RESULTS

There are 102 and 39 patients in the High and Low Ki-67 category, respectively. The average of the Ki-67 was 28.05%±21.63. The AUC of the logistic regression model was 0.74 (95% CI: 0.73-0.75) for 4 LASSO-selected top ranked radiomic features (1 morphological and 3 contrast-enhancement related), while the 3D deep learning model achieved an AUC of 0.80 (95% CI: 0.75-0.85).

CONCLUSION

In this study, the 3D CNN deep learning-based approach that automatically identifies and organizes hierarchical imaging features for predicting Ki-67 outperformed the LASSO regression model coupled with pre-defined radiomic features.

CLINICAL RELEVANCE/APPLICATION

Deep learning of breast DCE-MRI tumor volume using CNN models may improve interpretation on the association between radiological images and the immunohistochemistry tumor proliferation marker Ki-67.

SSQ02

Cardiac (Great Vessels and Cardiopulmonary Disease)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S404AB

CA CH CT MR VA

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

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Sub-Events

SSQ02-01 3rd Generation Dual Source CT Pulmonary Angiographic Study at Very Low Contrast Doses: A New Frontier

Thursday, Nov. 29 10:30AM - 10:40AM Room: S404AB

Participants
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PURPOSE

Pulmonary Angio-CT is the first diagnostic choice for the evaluation of pulmonary embolism and usually performed with iodinated contrast media (CM) injection. The purpose of this study is to evaluate the lower amount of iodinated CM required in order to obtain a diagnostic quality pulmonary Angio-CT with the new Dual Source CT technology.

METHOD AND MATERIALS

36 patients (16 males, 20 females; mean age 40 years) were enrolled with medium-high pre-test probability of pulmonary embolism and underwent a 3rd generation Dual Source CT (Somatom Force Siemens Healthineers) scan. Three groups of 12 patients each one were randomized using 400 mgI/mL iodinated CM with different doses: group A (<5 ml), group B (<10 ml) and group C (<15 ml). The Hounsfield Unit (HU) values were sampled at predefined points of the pulmonary arteries. Each exam was also assessed qualitatively with a 5-point scale.

RESULTS

HU evaluation did not show statistically significant difference between groups A and B, while they showed statistically significant difference between group C and groups A-B (Kruskal-Wallis, p=0.025). Qualitative analysis did not find statistically significant difference between groups A, B and C (Kruskal-Wallis, p=0.12).

CONCLUSION

The new 3rd Dual Source CT technology allows for an optimization of pulmonary angio-CT study in order to obtain a diagnostic quality images with low doses of iodinated CM.

CLINICAL RELEVANCE/APPLICATION

The purpose of this study is to evaluate a reduced contrast media administration in patients with suspected pulmonary embolism in an emergency setting, especially in patients with higher risk of contrast-induced nephropathy (CIN) (i.e. nephropatic or type 2 diabetic patients).

SSQ02-02 2D-PC MRI Measurement of Pulmonary Artery Blood Flow and Left Atrial Function in Smokers: A Correlational Research

Thursday, Nov. 29 10:40AM - 10:50AM Room: S404AB

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PURPOSE

To investigate the correlation between main pulmonary artery blood flow and left atrium functional parameters in smokers using two-dimensional phase contrast magnetic resonance imaging (2D-PCMRI).

METHOD AND MATERIALS

Twenty-eight smokers (all men, mean age: 39.8±7.0 years) were enrolled in this study. All of them underwent main pulmonary artery 2D-PC and cardiac scan at 3.0T MR from December 2017 to March 2018. Blood flow parameters include Peak Positive Velocity (PPV) (cm/s), Peak Negative Velocity (PNV) (cm/s), Average flow (AF) (ml/beat), Average Positive Flow (APF) (ml/beat), and Average Negative Flow (ANF) (ml/beat). The correlation between main pulmonary artery blood flow and left atrial functional parameters was analyzed.

RESULTS

There is a statistically correlation between pulmonary artery PPV and left atrial active ejection fraction (LAEFa) (p=0.022, r=0.431), and left atrium total ejection fraction (LAEFt) (p=0.032, r=0.406) respectively. Similarly, there is a statistically correlation between pulmonary artery AF and left atrium maximum volume (LAVi max) (p=0.048, r=0.378), LAEFa (p=0.040, r=0.391) and LAEFt (p=0.008, r=0.488) respectively. There is a statistically correlation between APF and LAVi max (p=0.039, r=0.392), LAEFt (p=0.028, r=0.415), respectively.

CONCLUSION

There is a positive correlation between the main pulmonary artery blood flow and left atrium function in smokers.

CLINICAL RELEVANCE/APPLICATION

This correlational research of pulmonary artery blood flow and left atrium function is helpful in further to understand and reveal the effect of smoking on the cardiovascular system.

SSQ02-03 Quantification of Pulmonary Emboli Burden by Novel 3D-Based Computed Tomography Method: Comparison with Qanadli Score, Biomarkers, and Clinical Information

Thursday, Nov. 29 10:50AM - 11:00AM Room: S404AB

Participants
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PURPOSE

Dedicated descriptions of pulmonary emboli (PE) morphology, total emboli burden, and the possible impacts on hemodynamics and diagnostic biomarkers remained largely unexplored.

METHOD AND MATERIALS

We consecutively studied subjects suffered from acute PE who visited emergency department. On arrival hemodynamics, oxygenation status, and markers of Troponin-I/D-dimer were all obtained. Contrast enhanced spiral computed tomography (CT) for pulmonary vasculature and 3-dimensional (3D) measures of emboli burden were performed (IntelliSpace Portal [ISP] 9.0 Philips Medical Systems Nederland B.V.).

RESULTS

Among 116 subjects (mean age: 70.1±16.0, 64% female) with clinical information and CT-based 3D embolism quantification available, the mean total emboli size were 8.6cm3, Qanadli scores was 7.4, 4.6, and 12.1 for right, left side and total pulmonary trunk (reference range: 0-20), respectively. Both greater total emboli mass and pulmonary emboli Qanadli score were positively associated with higher Troponin I level (r=0.23 & 0.33, both p<0.05), and marginally associated with lower on arrival oxygenation saturation (SpO2) (by blood gas, r=-0.38, p=0.05). Instead, total emboli burden within lung parenchyma was strongly inversely associated with SpO2 (r=-0.48 & -0.42, both p<0.05).

CONCLUSION

Total thromboemboli burden assessed by quantitative CT-based modality served as a useful index for stressed cardiopulmonary circulation, and possibly provide insights into oxygenation/perfusion status.

CLINICAL RELEVANCE/APPLICATION

Total thromboemboli burden assessed by quantitative CT-based modality served as a useful index for stressed cardiopulmonary circulation.

SSQ02-06 Evaluation of Coronary Artery in Kawasaki Disease By 3D Magnetic Resonance Coronary Angiography

Thursday, Nov. 29 11:20AM - 11:30AM Room: S404AB

Participants
Chuan Fu, BS,BMedSc, Chengdu, China (*Presenter*) Nothing to Disclose

Rong Xu, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Kawasaki disease causes inflammation that is inclined to cause heart complications, such as coronary artery vasculitis, myocarditis, and heart valve problems. Our study is aimed to assessment of coronary arteries in Kawasaki disease by 3D magnetic resonance imaging

METHOD AND MATERIALS

The study group consisted of 16 pediatric patients aged 2 to 10 years (males, 87.5%; mean age, 4.8 year) with Kawasaki diseases from Jan. 2017 to Mar. 2018. All patients underwent three-dimensional (3D) whole-heart magnetic resonance imaging (1.5T, Phiilps;) using two different sequences (3D TEE sequence; 3D BTEE sequence;). Sweep time were record and the image quality was graded (from 0 to 5).

RESULTS

there were six patients with enlarged left and right ventricles (37.5%), three patients with enlarged whole-heart (18.75%), two patients with double superior vena cavas and enlarged left atrium and ventricle (12.5%). The scan time of 3D TEE sequence was One minute and forty seconds to two minute and thirty seconds (1min 40s to 2 min 30s), The scan time of 3D BTEE sequence was five minute and twenty seconds to six minute and thirty seconds (5 min 20s to 6 min 30s). For the grade of imaging quality, five patients were classes as 0-2 grade (31.25%), 11 patients were 3-5 grade (68.75) by the 3D TEE sequence, and six patients were 0-2 grade (37.5%), 11 patients were 3-5 grade (62.5%) by the 3D BTEE sequence.

CONCLUSION

3D whole-heart coronary arteries magnetic resonance imaging could obtain similar imaging quality with less scan time, it may be an excellent method to image, evaluate, diagnose, and follow-up coronary arteries lesions in pediatric patients with Kawasaki diseases.

CLINICAL RELEVANCE/APPLICATION

(dealing with 3D coronary arteries magnetic resonance imaging) 3D whole-heart coronary arteries magnetic resonance imaging could obtain similar imaging quality with less scan time.

SSQ02-07 Automatic Segmentation of Lung Volumes in Population-based Whole-Body MR Imaging: Association with Subclinical Cardiac Impairment

Thursday, Nov. 29 11:30AM - 11:40AM Room: S404AB

Participants
Ricarda V. von Kruchten, MD, Heidelberg, Germany (*Presenter*) Nothing to Disclose
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Tanja Zitzelsberger, MD, Tuebingen, Germany (*Abstract Co-Author*) Nothing to Disclose
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Hans-Ulrich Kauczor, MD, Heidelberg, Germany (*Abstract Co-Author*) Research Grant, Siemens AG Research Grant, Bayer AG Speakers Bureau, Boehringer Ingelheim GmbH Speakers Bureau, Siemens AG Speakers Bureau, Koninklijke Philips NV Speakers Bureau, Bracco Group Speakers Bureau, AstraZeneca PLC
Holger Schulz, Neuherberg, Germany (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Both cardiac and pulmonary morphology and function can be simultaneously assessed during a single MR scan. Previous studies have shown an association between obstructive lung disease with cardiac dysfunction. Our aim is to evaluate the relationship between lung volumes and cardiac impairment in a population-based cohort study using whole-body MR scans.

METHOD AND MATERIALS

We studied 400 subjects who underwent whole-body MRI as part of the KORA FF4 cohort study, excluding subjects with established cardiovascular disease. Lung volumes were derived semi-automatically through an in-house algorithm (coronal acquired T1w sequences). Using Pearson correlation and multivariate regression (adjusted for age, sex, smoking status and BMI), lung volumes were compared with cardiac parameters of left and right ventricle (LV/RV, acquired from cine-SSFP sequences using cvi42), and standardized to body surface area.

RESULTS

A total of 356 subjects presented an average MRI-based lung volume of 4.0±1.1L and mostly standard values for cardiac parameters. In univariate analysis, a negative correlation of LV and RV stroke volume to lung volume was observed. After multivariate adjustment, stroke volume as well as end-diastolic volume of both LV (ß=-2.75, p=0.001; ß=-1.71, p=0.001) and RV (ß=-2.14, p=0.02; ß=-1.45, p=0.004) showed negative associations with lung volume, while ejection fraction, peak ejection rate and myocardial mass were not associated with lung volumes (Figure 1). These values were stronger for the LV than for the RV. In addition, for the LV, early but not late diastolic filling rate was negatively associated with lung volume.

CONCLUSION

Cardiac function and volume parameters derived from non-dedicated whole-body MRI, such as stroke volumes and biventricular end-diastolic volumes were significantly associated with lung volumes in a patient cohort without cardiovascular disease.

CLINICAL RELEVANCE/APPLICATION

These results suggest, that MRI could be an accurate, radiation-free, and possibly one-stop-shop screening tool, with the potential for early detection of subclinical heart disease in patients with emphysema and subclinical cardiovascular dysfunction.

SSQ02-08 Double Region of Interest Timing Bolus Technique to Perform Aortic CT Angiography with 40 Ml of Contrast Medium

Thursday, Nov. 29 11:40AM - 11:50AM Room: S404AB

Participants
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Hiroaki Arakawa, Matsudo, Japan (*Abstract Co-Author*) Nothing to Disclose
Kodai Yamamoto, Bunkyo, Japan (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

We developed a novel method to track the peak of the injected contrast medium by placing two regions of interest (ROI) at the timing bolus image. The purpose of this study was to compare the enhancement of the aorta when CT angiography was performed with 40 mL of contrast medium using the novel double ROI timing bolus (DRTB) technique with the enhancement using the conventional method.

METHOD AND MATERIALS

We prospectively included 21 patients from February to March 2018 who underwent repeated CT angiography of the aorta. In the prior scan, a total of body weight × 1.7 mL of contrast medium was injected for 25 s, and the scan timing was determined by the bolus tracking technique. The tube potential was 120 kVp and the table speed was set as fast as possible to acquire the entire aorta. In the DRTB method, timing bolus technique was performed using 9 mL of contrast medium at the level of the aortic root. An ROI was placed at the ascending and descending aorta, respectively. Time density curves of the two ROIs were drawn and the difference of the peak time (Tdiff) was recorded. The blood flow of the aorta was calculated by dividing the length of the thoracic aorta by Tdiff. The main scan was performed with a tube potential of 100 kVp. We injected 40 mL of contrast medium for 9 s and adjusted the table speed to follow the peak of the injected contrast bolus. We evaluated the attenuation of the aorta at the level of aortic root, arch, descending, celiac trunk, and iliac bifurcation.

RESULTS

The injected contrast medium during the main scan significantly reduced from 87 ± 11 to 40 mL (p <0.001). The attenuation of the aorta at the level of the aortic root, arch, descending, celiac trunk, and iliac bifurcation using the DRTB method were 408 ± 125, 425 ± 99, 421 ± 96, 414 ± 96, 417 ± 101 HU, respectively, which were all significantly higher than using the conventional method (341 ± 72, 370 ± 61, 362 ± 59, 349 ± 96, 362 ± 70 HU, respectively, all p <0.05).

CONCLUSION

DRTB method could dramatically reduce the contrast medium during aortic CT angiography while improving the enhancement than the conventional method.

CLINICAL RELEVANCE/APPLICATION

Aortic CT angiography using the DRTB method would reduce the risk of contrast induced nephropathy and also widen the indication of aortic CT to patients with chronic kidney disease.

SSQ02-09 Subclinical Changes in Cardiac Functional Parameters as Determined by Cardiovascular Magnetic Resonance (CMR) Imaging in Patients with Sleep Apnea and Snoring: Findings from UK Biobank

Thursday, Nov. 29 11:50AM - 12:00PM Room: S404AB

Participants
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Regina Schinner, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose
Aaron M. Lee, London, United Arab Emirates (*Abstract Co-Author*) Nothing to Disclose
Wieland H. Sommer, MD, Munich, Germany (*Abstract Co-Author*) Founder, Smart Reporting GmbH
Harald Kramer, MD, Munich, Germany (*Abstract Co-Author*) Research Consultant, Bayer AG; Speakers Bureau, b.e. imaging AG
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Elena Lukaschuk, Oxford, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Jackie Cooper, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Jose M. Paiva, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
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Stefan Piechnik, Oxford, United Kingdom (*Abstract Co-Author*) Nothing to Disclose
Steffen E. Petersen, London, United Kingdom (*Abstract Co-Author*) Consultant, Circle Cardiovascular Imaging Inc; Consultant, GlaxoSmithKline plc

PURPOSE

Obstructive sleep apnea (OSA) is a common disorder that shows an increased risk for left ventricular (LV) and, more rarely, right ventricular (RV) dysfunction. Most studies to date have examined populations with manifest cardiovascular disease and have used echocardiography to analyze ventricular dysfunction, with little or no reference to ventricular volumes or myocardial mass. We hypothesized that there would be stepwise increase in LV mass and RV volumes from the unaffected, to the snoring and the OSA group.

METHOD AND MATERIALS

We analyzed cardiac MRI data from 4493 UK Biobank participants free from cardiovascular disease. Participants were allocated into three cohorts: (i) with OSA; (ii) with self-reported snoring; and (ii) without OSA or snoring (n=38; 1919; and 2536 respectively). We determined ventricular volumes, ejection fraction and LV mass from balanced cine-SSFP sequences.

RESULTS

Trend analysis showed a stepwise increase for LV mass in both genders ($p<0.001$) and for LV and RV ejection fraction (EF) and stroke volume (SV) as well as LV end diastolic volume in males ($p<0.02$). There was no significant difference when comparing the OSA group to the unaffected group but we found a significant difference when comparing snoring to unaffected in LV mass of females (ß=1.45±0.55g; p=0.009) and in LVEF and RVEF as well as LVSV and RV end systolic volume of males (ß=0.80±0.28%; p=0.005, ß=1.17±0.28%; $p<0.001$, ß=1.68±0.76ml; p=0.027 and ß=-2.41±0.90ml; p=0.008) respectively.

CONCLUSION

Our study suggests that the transition from snoring to OSA is an evolving process which is associated with LV hypertrophy. The different results based on the gender in the pilot data point to a gender specific progression. Separate prospective studies are needed to further explore the direction of causality.

CLINICAL RELEVANCE/APPLICATION

Sleep apnea and snoring lead to gender specific alterations in cardiac function which may require diversified prevention and treatment strategies.

SSQ03

Science Session with Keynote: Cardiac (Coronary Artery Disease: CT and MR Techniques)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S404CD

CA CT MR

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

FDA Discussions may include off-label uses.

Participants
Borek Foldyna, MD, Boston, MA (*Moderator*) Nothing to Disclose
Cristina Fuss, MD, Portland, OR (*Moderator*) Spouse, Officer, ViewRay, Inc

Sub-Events

SSQ03-01 Cardiac Keynote Speaker: Technical Advances in Coronary Artery Imaging

Thursday, Nov. 29 10:30AM - 10:50AM Room: S404CD

Participants
Borek Foldyna, MD, Boston, MA (*Presenter*) Nothing to Disclose

SSQ03-03 Free-Breathing Coronary CT Angiography Using 16-Cm Wide-Detector for Challenging Patients: Comparison with Invasive Coronary Angiography

Thursday, Nov. 29 10:50AM - 11:00AM Room: S404CD

Participants
Tao Shuai, Chengdu, China (*Presenter*) Nothing to Disclose

PURPOSE

To detected the superiority of free-breathing coronary computed tomography angiography (CCTA) with 16-cm wide-detector CT for challenging patient who cannot hold breath.

METHOD AND MATERIALS

A total of 76 patients (62% with either heart rate >75bpm or arrhythmia) unable to hold breath underwent both free-breathing CCTA and ICA were included. Two reviewers evaluated coronary arteries on the per-segment (using 18-segment model), per-vessel and per-patient basis for image quality using a four-point scale and stenosis degree. CCTA results were compared with ICA to calculate the diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV).

RESULTS

Out of 1368 total segments, 228(16.7%) were less than 1.5mm in diameter and were excluded in CT, 32(2.3%) with calcification and 26(1.9%) with motion artifacts and were considered positive in CT. 1082 segments (79.1%) were evaluated both on CCTA and ICA and 128(11.8%) segments had stenosis >=50% on ICA. The diagnostic accuracy, sensitivity, specificity, PPV, and NPV of CCTA were 90.8%, 88.3%, 91.1%, 57.1% and 98.3% on a per-segment basis; 93.4%, 90.6%, 94.2%, 80.5% and 97.4% on a per-vessel basis; and 92.1%, 100%, 85%, 85.7% and 100% on a per-patient basis. For patients with high heart rates or arrhythmia, 81% (vs. 79.1%) segments were evaluable, and the accuracy, sensitivity, specificity, PPV, and NPV were statistically the same as the entire study population.

CONCLUSION

Free-breathing CCTA using 16-cm wide-detector CT has high accuracy for detecting coronary artery stenosis for challenging patients in comparison with ICA.

CLINICAL RELEVANCE/APPLICATION

Wide-detector CT has high clinical value for detecting coronary artery stenosis in CCTA for patients unable to hold breath.

SSQ03-05 Influence of Contrast Media Parameters on Image Quality in Cardiac Computed Tomography: Insights from a Multicenter Registry

Thursday, Nov. 29 11:10AM - 11:20AM Room: S404CD

Participants
Ludovico La Grutta, MD, Palermo, Italy (*Presenter*) Nothing to Disclose
Alberto Clemente, Massa, Italy (*Abstract Co-Author*) Nothing to Disclose
Erica Maffei, MD, Parma, Italy (*Abstract Co-Author*) Nothing to Disclose
Giambattista Privitera, Catania, Italy (*Abstract Co-Author*) Nothing to Disclose
Patrizia Toia, MD, Palermo, Italy (*Abstract Co-Author*) Nothing to Disclose
Filippo Cademartiri, MD, PhD, Rotterdam, Netherlands (*Abstract Co-Author*) Research Consultant, Somahlution
Marco Francone, MD,PhD, Rome, 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

A retrospective, multicenter, observational study on the use of contrast media (CM) in patients undergoing cardiac computed tomography (CCT) was conceived. The primary aim of the registry was to determine the influence on image quality of CM use.

METHOD AND MATERIALS

The registry included 1842 consecutive patients (>=50 per site; CCT indicated for suspected coronary artery disease) in 20 cluster sites. Every center collected demographics, CT scan parameters, CM administration protocols, radiation dose records, and adverse reactions reports. Image datasets were sent to a core lab who evaluated qualitative (intracoronary enhancement, motion artifacts) and quantitative (HU attenuation values, signal-to-noise ratio - SNR, and contrast-to-noise ratio - CNR) parameters.

RESULTS

The registry enrolled 891 men and 951 women (mean age 63±14 years, mean body mass index 26±4) who underwent CCT performed with >=64 detector rows CT scanners and several iodine contrast media protocols and molecules (iodixanol, iopamidol, iohexol, iobitridol, iopromide, and iomeprol). The core lab reported the following mean vascular attenuation: 504±147HU in the aorta, 451±146HU in the right coronary artery, 474±146HU in the left main, 451±146HU in the left anterior descending artery, and 441±149HU in the circumflex artery. SNR and CNR were improved with high iodine concentration CM (29±17 vs. 24±13 of low iodine concentration CM, p<0.0001; 35±19 vs. 30±15, p<0.0001) and >5ml/s flow rate (29±17 vs. 26±14 of <=5ml/s flow rate, p<0.0001; 35±19 vs. 32±16, p<0.0001), while they were not affected by decrease in CM volume <=80ml (28±17 vs. 27±14 of CM volume >80ml, p=0.0681; 34±20 vs. 32±16, p=0.1175). If compared to 120kV scanning, the use of low kV (n=393) improved SNR (33±21 vs. 25±13, p<0.0001) and CNR (39±23 vs. 31±16, p<0.0001). The use of iterative reconstructions (n=562) improved SNR (33±19 vs. 25±13, p<0.0001) and CNR (39±22 vs. 30±15, p<0.0001). In 80 patients the image quality was not satisfactory due to poor intra-coronary enhancement.

CONCLUSION

In a multicenter CCT registry image quality is influenced by the selection of CM parameters. The CM bolus geometry is affected by iodine concentration and flow, but it can be further refined by low kV scanning and iterative reconstructions.

CLINICAL RELEVANCE/APPLICATION

Optimization of CM parameters in conjunction with low kV scanning and iterative reconstructions improves image quality of CCT.

SSQ03-07 Deep Learning Analysis in Coronary Computed Tomographic Angiography Imaging for the Evaluation of Patients with Coronary Artery Atherosclerosis Stenosis

Thursday, Nov. 29 11:30AM - 11:40AM Room: S404CD

Participants
Dan Han, MMed, DMRD, Beijing, China (*Presenter*) Nothing to Disclose

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PURPOSE

To evaluate the feasibility of using deep learning and transfer learning approaches for coronary computed tomographic angiography (CCTA) imaging (termed coronary artery heart disease-artificial intelligence (CHD-AI)) in coronary artery atherosclerosis stenosis.

METHOD AND MATERIALS

A CCTA reconstruction pipeline was built by using deep learning and transfer learning approaches to generate simulated CCTA images from a series of two-dimensional (2D) CT images. A deep semantic segmentation network (SSN) was trained to identify coronary artery branch vessels, coronary lumen with more than 10,000 CCTA cases, which was treated as the Coronary BASE model. Based on the BASE model, retrospective CCTA images of 100 patients diagnosed with CHD by DSA were used to train a new model by transfer learning to further identify calcified plaque, non-calcified plaque and various degrees of coronary stenosis. The new model was then evaluated in 50 CHD patients by comparing the simulated CCTA images to CCTA images with digital subtraction angiography (DSA) images as the gold standard. Analysis of Kappa consistency test was used for statistical analysis to compare CHD-AI reconstruction with CCTA and DSA in detecting various degrees of coronary stenosis.

RESULTS

With only 100 CCTA cases as the training dataset, based on transfer learning, CHD-AI provided a relatively accurate simulated CCTA imaging with a Kappa value of 0.327 for detecting calcified plaque and non-calcified plaque compared to CCTA (P<0.001). For detecting coronary artery atherosclerosis with moderate and above stenosis, CHD-AI provided good sensitivity of 72% (11% more than CCTA) and negative predictive values of 80% (only 4% less than CCTA). Specificity (51%), coincidence (58%) and positive predictive values (40%) were relatively low.:

CONCLUSION

The proposed CHD-AI allows the generation of simulated CCTA images from a series of 2D CT images. This approach provides good sensitivity and negative predictive value for detecting stenosis and is relatively accurate for detecting calcified plaque and non-calcified plaque compared to CCTA. But it is still relatively high in false-positive rate.

CLINICAL RELEVANCE/APPLICATION

This CHD-AI can omit some CCTA reconstruction steps to some extent, reduce diagnostic time and the error of human eyes in assessing the degree of coronary stenosis compared with current CCTA imaging.

SSQ03-08 Deep Learning Enables Inline Image Reconstruction of Accelerated, Single-shot Coronary QISS MRA in Patients with Congenital Heart Disease

Thursday, Nov. 29 11:40AM - 11:50AM Room: S404CD

Participants
Daming Shen, Evanston, IL (*Presenter*) Nothing to Disclose
Hassan Haji-Valizadeh, Evanston, IL (*Abstract Co-Author*) Nothing to Disclose
Robert R. Edelman, MD, Evanston, 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

PURPOSE

Our previous study demonstrated the feasibility of 1-shot, real-time coronary Quiescent-Interval Slice-Selective (QISS) MRA in children with congenital heart disease using compressed sensing (CS). While CS produced clinically acceptable image quality, it is a poor fit for inline image reconstruction because of its slow reconstruction time (~60 s per image). Deep learning (DL) is an alternative framework for reconstructing MR images with considerably higher speed. The purpose of this study is to demonstrate the feasibility of inline image reconstruction of accelerated coronary QISS MRA using DL.

METHOD AND MATERIALS

This study entailed 2-fold accelerated, 2-shot coronary QISS MRA data sets obtained from 26 pediatric patients (mean age = 16.4 ± 7.9 years; 16 boys and 10 girls) scanned on a 1.5T scanner (Aera, Siemens). The QISS data were undersampled by an additional factor of 2 (i.e., 1-shot, real-time) and reconstructed using CS with total variation (TV) and a deep convolutional neural network adapted from a U-Net (layer depth = 5, 64 features on the first layer, GPU based tensorflow framework in Python). We fed 1-shot and 2-shot QISS images from first 20 patients (283 images) as input and output pairs to train the U-Net. Subsequently, images from the remaining 6 patients (69 images) were used to validate the trained U-Net. Using the 2-shot QISS with CS as control, we measured the DICE coefficients as a metric of reproducibility for 1-shot QISS with zero padding, 1-shot QISS with CS and 1-shot QISS with U-Net.

RESULTS

Both 1-shot QISS with CS and DL produced image quality that is comparable to 2-shot QISS (Fig. 1). The mean DICE coefficients for 1-shot QISS with zero padding, 1-shot QISS with CS and 1-shot QISS with U-Net images were 77.3 ± 7.4%, 90.0 ± 4.4% and 87.3 ± 4.1%, respectively. While the differences in DICE were significantly different for all pairs ($p < 0.05$), the difference between CS and U-Net was only 3%. The reconstruction time for U-Net (0.42 ± 0.04 s) was significantly lower ($p < 0.05$) than CS (52.3 ± 2.1 s).

CONCLUSION

This study demonstrates the feasibility of performing inline reconstruction of single-shot coronary QISS MRA using DL.

CLINICAL RELEVANCE/APPLICATION

Pediatric patients with congenital heart disease who require non-invasive evaluation of coronary origins for planning a surgical intervention may benefit from non-contrast, 1-shot coronary QISS MRA with inline image reconstruction using deep learning.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
104th Scientific Assembly and Annual Meeting
November 25–30 | McCormick Place, Chicago

SSQ04

Chest (Radiomics)

Thursday, Nov. 29 10:30AM - 12:00PM Room: E353A

BQ CH CT OI

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

FDA Discussions may include off-label uses.

Participants

Brett W. Carter, MD, Houston, TX (*Moderator*) Editor, Reed Elsevier;
Jin Mo Goo, MD, PhD, Seoul, Korea, Republic Of (*Moderator*) Research Grant, Samsung Electronics Co, Ltd; Research Grant, Lunit Inc

Sub-Events

SSQ04-01 Nodule Malignancy Prediction: A Systematic Comparison of Deep Learning and Radiomics

Thursday, Nov. 29 10:30AM - 10:40AM Room: E353A

Participants
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PURPOSE

Radiomics is a field of study that extracts features from medical images using data characterization algorithms. It has been applied to classify pulmonary nodule malignancy. Recent development in computer vision shows that deep learning is a powerful tool to extract image features. This paper systematically compares a deep learning (DL) method and previously established radiomics methods to extract features from chest CT scans to predict nodule malignancy.

METHOD AND MATERIALS

We collected CT scans of 463 patients from LIDC (a public dataset) and of 915 patients from a collaborating hospital. Each CT scan contained one nodule whose malignancy was pathology proven. The whole dataset was randomly separated into a training dataset (1154: 391 from LIDC) and a testing dataset (224: 72 from LIDC). Three methods were used to extract nodule features. (1) radiomics condition, all nodules were segmented first, and 1008 features were extracted from each nodule using PyRadiomics (van Griethuysen et al, 2017). PCA was applied to select 95.3%, 96.2%, 97.8%, 98.4% and 99.2% information from the original features. (2) DL condition, we used a 3D-CNN model and average pooling to extract 128 features based on the same segmented nodules. The same PCA method was applied to DL features. (3) radiomics&DL condition, we concatenated the features from both (1) and (2) after the PCA processing. In all 3 conditions, we trained a random forest classifier based on outputs from PCA to predict nodule malignancy. We replicated the experiment 10 times to average out randomness caused by random forest.

RESULTS

As shown in Table 1, (1) radiomics condition achieved classification AUCs between 0.840 and 0.845; (2) DL method's AUCs ranged from 0.841 to 0.858. (3) radiomics&DL condition (AUCs: 0.855 to 0.872) outperformed the above two conditions. Figure 1 shows ROC plot of the 98.4% situation in Replication 1.

CONCLUSION

Radiomics combined with DL consistently achieved significantly higher AUCs than the DL or radiomics method alone, and DL performed marginally better than radiomics at nodule malignancy prediction. This study suggests that features extracted by DL can to some extent complement information extracted by radiomics.

CLINICAL RELEVANCE/APPLICATION

This paper shows that deep learning methods could extract extra features from CT images to complement traditional radiomics methods to improve clinical evaluation of pulmonary nodule malignancy.

SSQ04-02 A Novel Prediction Model for Pulmonary Nodule Diagnosis Combining Plasma Biomarkers, Radiomics, Conventional Imaging Features, and Clinical Data

Thursday, Nov. 29 10:40AM - 10:50AM Room: E353A

Awards
Trainee Research Prize - Medical Student

Participants
Wei Wu, MD, Wuhan, China (*Presenter*) Nothing to Disclose
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Kristin Lastwika, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Sudhakar N. Pipavath, MD, Mercer Island, WA (*Abstract Co-Author*) Adjudicator, Gilead Sciences, Inc
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Haining Liu, Seattle, WA (*Abstract Co-Author*) Nothing to Disclose
Liming Xia, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose
Paul E. Kinahan, PhD, Seattle, WA (*Abstract Co-Author*) Research Grant, General Electric Company; Co-founder, PET/X LLC

PURPOSE

For both screening and incidental findings it is important but also challenging to classify pulmonary nodules as benign or malignant at first presentation. The objective of this study is to develop a novel prediction model for lung cancer diagnosis combining plasma biomarkers, radiomics, conventional imaging features and clinical data.

METHOD AND MATERIALS

We performed a retrospective study with 121 NSCLC patients and 117 controls. Specific tumor-derived autoantibodies were analyzed in plasma of all patients. The nodules were contoured by a thoracic radiologist from chest CT images and texture features were extracted using the PORTS radionics library. Another thoracic radiologist (blinded to the outcomes) evaluated semantic features including size, shape, density, emphysema, etc. All plasma biomarker variables, texture features, clinical and semantic features were input into a LASSO penalized logistic regression model. The most significant input variables for this regression are then determined and used to generate a new logistic regression model. We performed 5-fold cross-validation for the model to generate ROC curves. The AUC for these ROC curves was computed and the 95% confidence interval determined.

RESULTS

There were 11 plasma tumor biomarkers, 8 clinical and semantic features and 4 texture features selected by the LASSO penalized logistic model. The cross-validated AUCs for the model with all 23 plasma tumor biomarkers, clinical and imaging variables was 90% (CI:0.807-0.972), higher than the model with only clinical and imaging features with the AUC of 86%(CI:0.746-0.961).

CONCLUSION

Using a novel combination of plasma tumor biomarkers, radiomic texture features, conventional clinical and semantic features, our model classifies nodules with a AUC of 90% after cross-validation, which is higher than the performance reported by other models. The combination of these 4 sets of features outperforms each separate set of features in pulmonary nodule diagnosis.

CLINICAL RELEVANCE/APPLICATION

Combining plasma biomarkers, radiomics, conventional imaging features and clinical data has the potential to improve and facilitate management of pulmonary nodules.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Sudhakar N. Pipavath, MD - 2013 Honored EducatorSudhakar N. Pipavath, MD - 2015 Honored Educator

SSQ04-03 Combination of Intra- and Peri-Tumoral Radiomic Features on Baseline CT are Prognostic of Recurrence and Overall Survival in Early Stage Non-Small Cell Lung Cancer (ES-NSCLC) Patients

Thursday, Nov. 29 10:50AM - 11:00AM Room: E353A

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PURPOSE

ES-NSCLC has up to a 55% risk of recurrence following curative resection with a OS ranging between 35-50%. The ability to predict aggressiveness and prognosticating survival of ES-NSCLC from pre-treatment CT scans can aid oncologists in identifying which patients will benefit from adjuvant chemotherapy following curative resection.

METHOD AND MATERIALS

The single site study comprised 316 ES-NSCLC patients who had curative surgery and/or chemotherapy. Following retrospective chart review, pre-treatment CT scans with clinical follow-up and outcome data was obtained for each patient. All patients underwent surgery with the primary tumor having relapsed in 75 total cases. This cohort was randomly divided into a training

(n=60) and independent validation set (n=256). A total of 124 intratumoral (IT) and peritumoral (PT) radiomic textural features were extracted from every patient.

RESULTS

The top six most predictive features included a combination of two intratumoral (Gabor, Haralick) and four peritumoral (Laws-Laplace, Collage, Gabor) from an annular ring 0-12 mm outside the nodule. These features were also found to be relatively stable with an ICC of 0.8 calculated on the RIDER CT test-retest dataset. These features separated patients who recurred from those who did not (AUC=0.65; p<0.001) and also were prognostic of 5-year recurrence-free survival (RFS) (p<0.005) on the independent validation set (n=256).

CONCLUSION

We identified radiomic texture features from within and outside the lung nodule that are able to predict recurrence in early stage non-small cell lung cancer. These features were also found to be prognostic of 5-year RFS.

CLINICAL RELEVANCE/APPLICATION

ES-NSCLC patients who were predicted to recur based off diagnostic CT scans would be ideal candidates for treatment escalation including adjuvant chemotherapy following curative surgical resection.

SSQ04-04 CT-Based Quantitative Radiomic Features Predict Brain Metastasis in T1 Stage Lung Adenocarcinoma

Thursday, Nov. 29 11:00AM - 11:10AM Room: E353A

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PURPOSE

To retrospectively evaluate the use of computed-tomography (CT) based quantitative radiomic features (QRF) to predict brain metastasis (BM) in patients with T1 stage lung adenocarcinoma (LAD).

METHOD AND MATERIALS

Eighty patients with pathologically confirmed lung adenocarcinoma were collected. T1 stage was established by the 8th edition of the TNM staging system. All patients had brain MRI scans (BM+: 26; BM- :54). In total, 1160 QRFs were calculated from the primary lung cancer tumor in each patient. Three machine-learning algorithms were applied sequentially to build the radiomic prediction model. Firstly, unsupervised hierarchical clustering was used to exclude highly correlated QRFs; secondly, the minimum Redundancy Maximum Relevance (mRMR) feature selection algorithm was employed to rank QRFs according to their relevance to BM and redundancy with other features; finally, the K-Nearest-Neighbor (k=5) classification algorithm was adopted to construct model by using the informative and non-redundant QRFs. The area under the receiver operating characteristic (ROC) curve (AUC) and the ten-fold cross-validation were employed to evaluate the prediction model. Yuden's Index for the ROC curve was calculated to determine the optimal sensitivity and specificity.

RESULTS

The radiomic prediction model achieved AUC (95% CI) of 0.879 (0.694, 0.959), and sensitivity and specificity of 0.808 and 0.815, respectively. The most significant QRFs to build the prediction model were LoGU ('Uniformity of Laplacian of Gaussian Filter') and MGE ('Maximal Gabor Energy'), which were designed to characterize tumor homogeneity and boundary sharpness, respectively. We found that tumors with BM+ were of higher LoGU and MGE values than those with BM- (both p-values <0.001).

CONCLUSION

CT-based radiomic features could be used to predict brain metastasis in T1-stage LAD. For T1-stage LAD, solid tumor with sharp boundary were more prone to BM than those with ground glass opacity and unclear boundary.

CLINICAL RELEVANCE/APPLICATION

Radiomic features extracted from noninvasive and routinely acquired CT can be applied to help radiologists to predict brain metastasis in patients with T1 stage lung adenocarcinoma.

SSQ04-05 The Radiomics Prognostic Score (RadScore): The New Prognostic Imaging Biomarker After Stereotactic Body Radiation Therapy in Patients with Lung Cancer

Thursday, Nov. 29 11:10AM - 11:20AM Room: E353A

Participants
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PURPOSE

To develop the radiomics prognostic score (RadScore) for the patients with lung cancer treated with stereotactic body radiation therapy (SBRT) and to evaluate prognostic impact on progression free survival

METHOD AND MATERIALS

In this retrospective study approved by our institutional review board, we reviewed 241 patients who underwent SBRT for lung cancer between July 2006 and November 2016. After excluding patients who had no pathological diagnosis, no pretreatment computed tomography (CT) and clinical diagnosis of Stage III/IV, 43 patients were analyzed. The RadScore was developed using the linear predictor of multivariate Cox proportional hazard regression with LASSO (Least Absolute Shrinkage and Selection Operator) method for shrinkage of variables. The variables for the regression were the results of histogram (kurtosis and skewness) and texture analysis (gray level co-occurrence matrix) for solid part within the region of interest for the lung cancer which was placed on pre- and post-contrast-enhanced axial CT images. To reveal the impact of RadScore in the prediction of progression free survival (local / distant recurrence or death), an another multivariate Cox proportional hazard regression analysis was performed.

RESULTS

Among the 132 variables by histogram and texture analysis, 2 variables by histogram analysis and 2 variables by texture analysis were selected. In the multivariate Cox regression, the RadScore was the only significant predictive factor for progression free survival (95% confidence interval of hazard ratio: 1.89-24.14, p<0.005), whereas the following variables were not significant: male (0.53-4.34, p=0.44), age (0.94-1.12, p=0.53), pathological diagnosis of adenocarcinoma (0.81-7.06, p=0.11), and clinical stages (IB: 0.59-3.96, p=0.38; IIA: 0.17-15.33, p=0.67; IIB: 0.42-56.65, p=0.21).

CONCLUSION

The RadScore was an independent prognostic factor for progression free survival in patients of post-SBRT for lung cancer.

CLINICAL RELEVANCE/APPLICATION

The RadScore was a prognostic factor for progression free survival in patients of post-SBRT for lung cancer. The RadScore have potential to become one of indications of SBRT for lung cancer.

SSQ04-06 CT-Based Quantification of Lung Disease in Cystic Fibrosis Using Radiomics

Thursday, Nov. 29 11:20AM - 11:30AM Room: E353A

Participants
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PURPOSE

To build imaging biomarkers from chest computed tomography (CT) using radiomics to evaluate the severity of lung disease in adults with cystic fibrosis (CF).

METHOD AND MATERIALS

This single-center, retrospective, observational study was approved by an institutional ethics committee and the need for patient consent was waived. One hundred and sixty-two CF outpatients referred for unenhanced chest CT during follow-up between January 2013 and December 2015 were included and randomly divided into 2 equal cohorts. After lung segmentation, 38 imaging features were extracted. Chest CT from the development cohort were used to build 5 CT scores, each with a different machine learning technique (lasso, ENET, ridge regression, decision tree and SVM). The aim was to correlate these scores with a clinical prognostic score (Nkam score). Correlations between radiomics-based CT scores and 3 prognostic scores (Nkam, Liou and CF-Able), forced expiratory volume in 1 second (FEV1) and respiratory tract exacerbations were evaluated in the validation cohort.

RESULTS

Four of the 5 radiomics-based CT scores correlated well with the Nkam score in the validation cohort (R = 0.54 to 0.69; p<0.001) while they all correlated well with the Liou (R=-0.64 to -0.74; p<0.001), and moderately with the CF-able (R=0.46 to 0.62; p<0.001) scores. All CT scores correlated well with FEV1 (R=-0.65 to -0.77; p<0.001) and moderately with the number of pulmonary exacerbations in the 12 months after the CT exam (R=0.47 to 0.56; p<0.001).

CONCLUSION

Radiomics can be used to build imaging biomarkers that correlate well with clinical prognostic scores in adult CF patients

CLINICAL RELEVANCE/APPLICATION

Radiomic models were trained to predict the Nkam score, and were also well correlated with FEV1 and the Liou score, another prognostic score for CF, as well as with individual variables known to be markers of CF lung disease severity.

SSQ04-07 Radiomics Approach for Survival Prediction in Chronic Obstructive Lung Disease

Thursday, Nov. 29 11:30AM - 11:40AM Room: E353A

Awards
Trainee Research Prize - Fellow

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PURPOSE

To apply radiomics analysis on overall survival (OS) prediction in patients with chronic obstructive lung disease (COPD) and to evaluate prediction performance of the generated radiomics signature (RS).

METHOD AND MATERIALS

The study included 371 adult COPD patients (mean age, 64.2). Patients were followed up for an average of 68 months and 45 cases of mortality were observed. From 3-D volumetric chest CT data of each patient, 525 radiomics features were semi-automatically extracted. Radiomics features were extracted from four phenotypical compartments of COPD; emphysema, airway measurement, pulmonary vessels, and air-trapping. In order to remove features that were highly related to one and another, pairs with correlation coefficients greater than 0.9 were identified and the feature with lower c-index (Harrell's concordance index) was eliminated. Then, least absolute shrinkage and selection operator (LASSO) Cox regression model and used to select the features most useful for OS prediction. Afterward, a RS was generated through the summation of selected features multiplied by their respective coefficients and cut-off value was determined by X-tile plot analysis. The difference of survival between low and high RS groups was evaluated with Kaplan-Meier survival analysis.

RESULTS

Five features which remained after LASSO analysis were as follows: (1) Low attenuation area (LAA-950), (2) PI-10 at 6th generation bronchi, (3) Average vessel cross-section area at 18mm from pleural surface, (4) Lobar heterogeneity of PI-10, (5) Z-axis heterogeneity of WA%. On multivariate Cox regression analysis, prediction performance (c-index) of the 5 features was 0.774. The c-index for pulmonary function test (PFT) results alone (DLCO, FEV1, FEV1/FVC) was 0.758. When radiomics features were combined with PFT, c-index was increased to 0.805. Patients who were classified into the high-risk group based on the generated RS demonstrated significantly worse OS than the low-risk group (log-rank test, $p < 0.001$; hazard ratio, 7.18:1).

CONCLUSION

The radiomics signature demonstrated good survival prediction performance in COPD patients and adequately classified patients into high and low-risk groups.

CLINICAL RELEVANCE/APPLICATION

The radiomics approach yielded a reliable survival prediction performance in this study and could potentially be adopted as an effective imaging biomarker for estimation of OS in COPD patients after further validation.

SSQ04-08 Radiomic Prediction of Survival in Patients with Rheumatoid Arthritis-Associated Interstitial Lung Disease Based on Deep-Learning, Hyper-Curvature, and Texture Features of Lung CT Images

Thursday, Nov. 29 11:40AM - 11:50AM Room: E353A

Participants
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PURPOSE

To evaluate the comparative performance of deep-learning, hyper-curvature, and texture features of lung CT images in the prediction of the overall survival of patients with rheumatoid arthritis-associated interstitial lung disease (RA-ILD).

METHOD AND MATERIALS

We retrospectively collected 70 RA-ILD patients with thin-section lung CT and serial pulmonary function tests. After automated extraction of the lung regions on the CT images, an experienced observer delineated regions of interest (ROIs) and labeled them into one of four ILD patterns (ground-class opacity, reticulation, consolidation, and honeycombing). We computed deep-learning features by training a 5-layer convolutional neural network on these ROIs for classifying the 4 patterns and by extracting the output of the last convolutional layer. We also computed hyper-curvature features including principal curvatures, curvedness, bright/dark sheets, cylinders, blobs, and curvature scales for the lungs as well as gray-level co-occurrence matrix texture features on the ROIs. An elastic-net penalty method was used to select and combine these features with a Cox proportional hazards model for predicting patient survival. Concordance index (C-index) was used as a measure of the prediction performance of the feature combinations with bootstrapping by 1,000 replications, in comparison to an established clinical prognostic biomarker known as the gender, age, and physiology (GAP) index by a two-sided t-test.

RESULTS

Bootstrap evaluation yielded C-index values of (a) GAP: 78.3%, [95% confidence interval (CI): 70.1, 86.5]; (b) hyper-curvature features: 80.8% [CI: 71.9, 89.7], P<0.01 in comparison with (a); (c) deep-learning features: 81.8% [CI: 71.9, 89.7], P<0.01; and (d) combined radiomic features: 86.9% [CI: 81.3, 93.1], P<0.0001. Kaplan-Meier survival curves of patients stratified to low- and high-risk groups based on combined radiomic features showed statistically significant (P < 0.0001) difference.

CONCLUSION

The combined radiomic features yield higher performance than GAP in the prediction of overall survival. Thus, they can be an effective imaging biomarker for predicting overall survival of patients with RA-ILD.

CLINICAL RELEVANCE/APPLICATION

Combined radiomic features that are automatically calculated from lung CT images can provide an effective prognostic imaging biomarker for precise management of patients with RA-ILD.

SSQ04-09 Radiogenomics of Non-Small Cell Lung Cancer: Predictive Modeling of miRNA Signature and CT Imaging Features

Thursday, Nov. 29 11:50AM - 12:00PM Room: E353A

Participants
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PURPOSE

Radiomics and genomics characteristics have been widely explored to predict tumor responses to radiotherapy and in recent years, the combined application of them, radiogenomics, have increased. In this study, we developed a radiogenomics signature to estimate tumor responses to radiotherapy in patients with non-small cell lung cancer (NSCLC) and optimize management of this disease.

METHOD AND MATERIALS

This study consisted of 87 patients with non-small cell lung cancer and was approved by the institutional ethical board. The CT-based radiomics features were extracted by LIFEx. MiRNAs associated radiosensitivity was obtained from our previous study and literature retrieval. Then a radiogenomics signature was generated by LASSO and was associated with tumor responses to radiotherapy in non-small cell lung cancer patients. The Recist 1.1 was used for short-term effect and the overall survival (OS) was used for long-term effect evaluation. Multivariate Cox regression validated the radiogenomics signature as an independent biomarker. Then a radiogenomics nomogram with this signature was constructed, which was assessed to validation, calibration and discrimination.

RESULTS

The radiogenomics signature was significantly associated with radiosensitivity and OS, independent of other clinic pathologic factors. The radiogenomics nomogram has displayed a good performance for estimation of OS (C-index: 0.78, 95% confidence interval [CI]: 0.75, 0.80). Calibration curve for it was almost satisfactory, which indicated its clinical usefulness.

CONCLUSION

The radiogenomics signature is an independent biomarker and the nomogram combining it with other clinic pathologic factors could be used as a model to predict tumor responses to radiotherapy in non-small cell lung cancer, which might make a step forward individualized medicine.

CLINICAL RELEVANCE/APPLICATION

a biomarker to predict the radiosensitivity in non-small cell lung cancer

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104th Scientific Assembly and Annual Meeting
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SSQ05

Chest (Functional Lung Imaging/Dual-Energy CT/Radiation Dose Reduction)

Thursday, Nov. 29 10:30AM - 12:00PM Room: E353B

BQ CH CT MR NM OI 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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Mannudeep K. Kalra, MD, Boston, MA (*Moderator*) Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation

Sub-Events

SSQ05-01 Assessment of Changes in Regional Xenon Ventilation, Perfusion, and Ventilation-Perfusion Mismatch Using Dual-Energy Computed Tomography after Pharmacological Treatment in Patients with COPD

Thursday, Nov. 29 10:30AM - 10:40AM Room: E353B

Participants
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PURPOSE

To assess the changes of regional ventilation (V) and perfusion (Q) status in COPD patients after pharmacologic treatment using combined xenon-enhanced V and iodine-enhanced Q dual-energy CT (DECT).

METHOD AND MATERIALS

Combined V and Q DECT were performed at baseline and after 3-month pharmacologic treatment in fifty-three COPD patients. Virtual noncontrast images, V and Q maps were anatomically co-registered with in-house software. Normalization of V and Q values of each pixel were performed. For visual analysis, V/Q pattern was determined to be matched, mismatched, or reversed-mismatched and compared with the regional disease patterns-emphysema, bronchial wall thickening, or normal lung-in each segment in baseline and follow-up. Mean V, Q, and V/Q values, standard deviation of V/Q (V/QSD), and proportions of lung area with reversed-mismatch (Rev), mismatch (Mis) and match (Mat) of each patient were quantified and compared with pulmonary function test (PFT) parameters in baseline and follow-up. Changes of quantified CT parameters and PFT results between baseline and follow-up were compared.

RESULTS

Most of segments showed a matched V/Q, whereas about thirty percent of segments with bronchial wall thickening showed a reversed-mismatched V/Q. On follow-up, V/Q pattern did not change in most of segments with matched and mismatched V/Q. In about forty percent of segments with reversed-mismatched V/Q, V/Q pattern changed into matched. Quantified mean V, Q, V/Q and Rev values of baseline and follow-up CTs were positively correlated with PFT parameters, respectively ($r = 0.286$-0.630, $p < 0.05$), while V/QSD values were negatively correlated with PFT parameters ($r = -0.528$ and -0.375; $p < 0.05$). Changes of mean V, V/Q and Mat were positively correlated with change of FEV1 ($r = 0.315$-344; $p < 0.05$) and changes of Rev were negatively correlated with change of FEV1 ($r = -0.353$; $p = 0.010$).

CONCLUSION

Quantitative and visual analysis of combined V and Q DECT showed that the improvement of ventilation and V/Q mismatch may be associated with the response to pharmacological treatment in COPD patients.

CLINICAL RELEVANCE/APPLICATION

Combined V and Q DECT imaging can be applied to assessment of changes of regional V and Q status after pharmacologic treatment in COPD patients.

SSQ05-02 Quantitative Assessment of Emphysema Heterogeneity in Patients with Lung Cancer Using Volumetric Chest CT

Thursday, Nov. 29 10:40AM - 10:50AM Room: E353B

Participants
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PURPOSE

In COPD patients, distribution of emphysema shows various patterns (diffuse, unilateral, or focal), however, there is no report about distribution of emphysema in lung cancer patients. The purpose of the research is to compare heterogeneity of emphysema between lung cancer patients and lung cancer screening patients.

METHOD AND MATERIALS

Total 109 subjects with smoking history and thin section chest CT (51 patients with lung cancer M : F = 29 : 22, age = 68.10 ± 9.26, 58 lung cancer screening patients; M : F = 31 : 27, age = 64.03 ± 6.65) were retrospectively enrolled. Using commercial software (AVIEW, Coreline soft, South Korea), volume and low attenuation area under -950 HU were semi-automatically quantified in whole lung and each lobe by two radiologists. Emphysema index (EI) and emphysema heterogeneity were calculated. Intra-class correlation coefficient (ICC) and independent t-test were performed. ANOVA was performed for subgroup analysis according to cancer pathology.

RESULTS

ICC of each lobe volume among two radiologists were 0.993, 0.987, 0.999, 0.999, and 0.999. EI in RUL, RML, RLL, LUL, and LLL of two groups were 6.43 ± 9.94, 6.80 ± 9.28, 3.66 ± 5.54, 5.86 ± 6.60, and 3.83 ± 5.86 in the cancer group, and 6.56 ± 7.82, 8.24 ± 8.44, 5.68 ± 7.08, 7.16 ± 7.05, and 5.28 ± 6.66 in the screening group. EI and emphysema heterogeneity in whole lung of two groups were 5.10 ± 6.56, and 12.20 ± 5.14 respectively in the cancer group, and 6.43 ± 6.95, 8.44 ± 4.92 in the screening group. EI showed no significant difference between two groups. However, emphysema heterogeneity of the cancer group was significantly larger than that of the screening group ($p < 0.001$). In subgroup analysis, emphysema heterogeneity of the cancer subtypes of adenocarcinoma and squamous cell carcinoma were significantly larger than that of screening group ($p = 0.006$ and 0.042).

CONCLUSION

Semi-automated quantification of emphysema in each lobe was feasible. Smokers with lung cancer showed more heterogeneous distribution of emphysema than smokers without lung cancer.

CLINICAL RELEVANCE/APPLICATION

Quantification of regional and whole lung heterogeneity of emphysema may potentially help in risk stratification of COPD patients in developing lung cancer.

SSQ05-03 Hyperpolarized Xenon-129 MRI for Detection of Gas Exchange in Healthy Subjects and Lung Cancer Patients

Thursday, Nov. 29 10:50AM - 11:00AM Room: E353B

Participants
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PURPOSE

To determine whether a novel functional magnetic resonance imaging (MRI) technique using hyperpolarized Xenon-129 (HPX) can quantify the xenon gas transfer dynamics (XGTD) from alveoli into the Pulmonary Tissue and Blood Plasma (PTBP), and Red Blood Cell (RBC) compartments of the lungs, and identify XGTD differences in patients with COPD and lung cancer pre and post radiation.

METHOD AND MATERIALS

A novel spectroscopic MRI technique was developed using Iterative Decomposition of water and fat with Echo Asymmetry and Least-square estimation (IDEAL) approach. This technique allowed acquisition of the time-series IDEAL gas, PTBP and RBC compartment images of lungs with various gas transfer times in a single breath-hold interval. The time-series IDEAL gas, PTBP and RBC compartment images were acquired from five healthy subjects at two different time points. XGTD curves were obtained from 10 scans (n=10) that represented the control group. The control group was compared to two lung-cancer patients before radiation therapy started and after radiation therapy ended.

RESULTS

In the control group, there was no statistical difference in XGTD between the left and right lungs (P-value >0.4). XGTD in the control was statistically different than the lung cancer patients (P-value <0.01) suggesting that the novel time-series IDEAL technique was sensitive to the gas exchange abnormalities. Additionally, the ratio of XGTD from the irradiated lung to un-irradiated lungs was compared pre and post radiation therapy. We found that xenon gas in the alveoli diffused into the PTBP compartment with a slower rate of 20-35% in the radiated lungs from the lung cancer patients.

CONCLUSION

The feasibility of the novel IDEAL MRI technique has been successfully demonstrated in healthy subjects and lung cancer subjects. To our knowledge, this is the first-in-man study showing the time course of arrival of Xenon-129 gas from the alveoli to PTBP and RBC compartments of the lungs and to the pulmonary vasculature and the left ventricle of the heart in healthy subjects and patients with COPD and lung cancer.

CLINICAL RELEVANCE/APPLICATION

This technique may have potential clinical applications ranging from the detection of regional differences in gas transfer on imaging to the detection of early-stage radiation-induced lung injury.

SSQ05-04 Effect of Aging and Smoking on Regional Air Volume Change Distributions in Normal Chest CT

Thursday, Nov. 29 11:00AM - 11:10AM Room: E353B

Participants
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PURPOSE

Image registration has been increasingly used to assess pulmonary dynamics between paired inspiratory and expiratory CT images in patients with pulmonary disease. However, information of pulmonary dynamics of normal subjects is insufficient. The purpose of the study is to describe regional air volume change distributions of subjects with normal CT and to investigate the effects of aging and smoking.

METHOD AND MATERIALS

242 subjects (114 male, 128 female) over the age of 18 years with normal inspiration and expiration CTs were included in the study. VIDA Apollo software (Coralville, IA) and an image registration technique were used to compute regional distribution of air and tissue volumes, air volume fractions, and the relative regional changes between inspiration and expiration, including relative regional air volume changes (RRAVC). In each lobe, the upper lobes, the lower lobes, and the whole lung, the mean values and standard deviations were correlated with aging and compared to those of smoking groups. Regional volumetric changes were further analyzed using 3D visualization of acinar scale parenchymal units.

RESULTS

Inspiratory air volume of the lower/upper lobes decreased with age in both nonsmoking males and females ($r=-0.388$; $p=0.006$ and $r=-0.258$; $p=0.004$, respectively). RRAVC map demonstrates the increase of air volume change from apico-ventral to dorso-basal region in non-smokers, representing gravitational dependency in normal pulmonary dynamics. In comparison, the directionality of gravitational dependency of regional volume change tends to against normality in smokers, and the coefficient of variation (CV) of RRAVC decreased in the whole lung in the smokers (0.64 and 0.35, $p=0.020$).

CONCLUSION

The air volume of the lower/upper lobes tends to decrease with aging, and the directionality of gravitational dependency of the air volume change appeared to be against normality in smokers. Visualization of RRAVC map helped recognize these findings more easily.

CLINICAL RELEVANCE/APPLICATION

Regional air volume change distribution helped understand the gravitational volume change of the lung in normal adults, and so it is expected that the localized functional abnormalities of the lung effected by aging and smoking are easily comprehended.

SSQ05-05 Whole-Lung Dynamic Contrast-Enhanced Perfusion Area-Detector CT: Capability for Pulmonary Function Assessment and Morphological Change Evaluation in Stage IA Non-Small Cell Lung Cancer

Thursday, Nov. 29 11:10AM - 11:20AM Room: E353B

Participants
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PURPOSE

To prospectively and directly compare the capability of whole-lung dynamic contrast-enhanced (CE-) perfusion area-detector CT

(ADCT) for pulmonary functional loss assessment and morphological change evaluation in Stage IA non-small cell lung cancer (NSCLC) patients.

METHOD AND MATERIALS

63 consecutive NSCLC patients (39 males, 24 females; mean age 68 years) underwent dynamic CE-perfusion ADCT performed at two or three different positions as single examination, pulmonary function test, surgical treatment, and pathological examination. From all perfusion ADCT data in each subject, whole lung total perfusion (TP), pulmonary arterial perfusion (PAP) perfusion, systemic arterial perfusion (SAP) maps were computationally generated based on dual-input maximum slope method by previously reported software. In each subject, regional perfusion parameters were assessed by ROI measurements, and averaged to determine mean values. According to pathological examination results, all ROIs within operated lung were divided into following four structure groups: normal lung, emphysema, non-specific interstitial pneumonia (NSIP) and usual interstitial pneumonia (UIP). To determine the capability of each perfusion parameter for pulmonary function, Pearson's correlation was performed. To compare each perfusion parameter among all structure groups, Tukey's HSD test was performed. Finally, discrimination accuracy for morphological change evaluation was compared among all indexes and combined method.

RESULTS

All perfusion parameters except SAP had significant correlation with each pulmonary function parameter (TP: 0.47 **CONCLUSION**

Whole-lung dynamic first-pass CE-perfusion ADCT is useful for pulmonary functional loss assessment and morphological change evaluation in stage IA NSCLC patients.

CLINICAL RELEVANCE/APPLICATION

Whole-lung dynamic first-pass CE-perfusion ADCT is useful for pulmonary functional loss assessment and morphological change evaluation in stage IA NSCLC patients.

SSQ05-06 Denoised Ultra Low Dose for Screening Lung Cancer

Thursday, Nov. 29 11:20AM - 11:30AM Room: E353B

Participants
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PURPOSE

To assess the effect of a denoising method (D) for ultra low dose CT (ULDCT) LungRADS categorization.

METHOD AND MATERIALS

36 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. Reconstruction for lung and soft tissue kernels were performed for each scan. 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 a LungRADS category and a subjective suspicion for highly suspicious lesions for lung cancer (H).

RESULTS

Radiation dose using NDCT 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. For the three imaging methods, the same score was seen in 63.9% (n=23) and a different score in 36.1% (n=13). There was complete agreement on LungRADS 4A (or higher) between NDCT and D, but ULDCT categorized one of the 4A patients as LungRads 2. One lesion assigned as LungRads 4X by ULDCT was assigned LungRads2 by D and NDCT. Of the 8 patients highly suspicious for lung cancer by NDCT, D indicated so in all 8 whereas ULDCT indicated so only in 4.

CONCLUSION

Interpretation of ULDCT may cause errors in LungRADS categorization but implementation of the LCNLM algorithm for denoising improves ULDCT images so that LungRADS categorization is similar to normal dose scans.

CLINICAL RELEVANCE/APPLICATION

Denoising ULDCT with the LCNLM algorithm enables screening for lung cancer with dose reductions of greater than 90%.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Edith M. Marom, MD - 2015 Honored EducatorEdith M. Marom, MD - 2018 Honored Educator

SSQ05-07 Comparison of SENCEFUL-MRI and Lung Scintigraphy for Detection of Lung Perfusion Defects in

CTEPH Patients

Thursday, Nov. 29 11:30AM - 11:40AM Room: E353B

Participants
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Malte Kircher, Wuerzburg, Germany (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To compare self-gated non-contrast enhanced functional lung MRI (SENCEFUL) and V/Q (ventilation/perfusion) scintigraphy regarding detection of lung perfusion defects in patients with chronic thromboembolic pulmonary hypertension (CTEPH).

METHOD AND MATERIALS

Following review board approval and informed consent, 16 patients diagnosed with CTEPH and pathologic findings in V/Q scans were included into this prospective study. Patients were scanned at 3T using the SENCEFUL approach based on a 2D-FLASH sequence. Color-coded maps of the lung perfusion and the local blood arrival time i.e. the pulsation phase were manually segmented and rated for perfusion defects in lung quadrants by three independent radiologists using a 6-point Likert scale. Coronal V/Q scan images were rated by a nuclear medicine physician accordingly. Due to variation of slice thickness between both techniques, covered lung volumes were divided into four sectors in coronal orientation each containing four quadrants to improve comparability. Statistical tests included intraclass correlation coefficient (ICC) and Mann-Whitney-U-test.

RESULTS

Comparison of quadrant-wise rating between SENCEFUL-MRI and V/Q scans revealed good agreement between all raters when the lung perfusion and pulsation phase maps were rated simultaneously (ICC 0.75, 95% CI 0.69-0.80, $p<0.05$) and an improvement to perfusion rating alone (ICC 0.61, 95% CI 0.52-0.69, $p<0.05$). Interrater reliability of the radiologists for combined perfusion/pulsation phase rating was good (ICC 0.77, 95% CI 0.69-0.82, $p<0.05$). Analysis of a peak-to-offset ratio of pulsation phase histograms showed a significant difference between lung quadrants rated pathologic in scintigraphy and quadrants rated healthy ($p<0.05$).

CONCLUSION

SENCEFUL-MRI showed good agreement for detection of perfusion defects compared with V/Q scans being the current screening method for CTEPH. Analysis of MRI maps by a peak-to-offset ratio of pulsation phase showed a significant difference between quadrants rated pathologic and healthy by V/Q scans suggesting a quantifiable value for future determination of threshold values in SENCEFUL-MRI.

CLINICAL RELEVANCE/APPLICATION

SENCEFUL-MRI could be an alternative screening method for detection of lung perfusion defects in patients with suspected CTEPH without the need of contrast agent administration or radiation exposure.

SSQ05-08 Applicability of Monochromatic Energy with 40 keV for Pulmonary Embolism Detection in the Pulmonary Embolism CT Angiography: Experience Using a Dual-Layer Detector Spectral CT

Thursday, Nov. 29 11:40AM - 11:50AM Room: E353B

Participants
Mo In Ha, MD, Ansan, Korea, Republic Of (*Presenter*) Nothing to Disclose
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PURPOSE

Previous studies have shown that the optimal energy level of virtual monoenergetic images (VMI) for pulmonary artery (PA) enhancement is 40 keV in spectral CT. The aim of this study is to evaluate the applicability of VMI at 40 keV for pulmonary embolism (PE) detection in the CT angiography (PECT).

METHOD AND MATERIALS

A total of 876 consecutive PECT using spectral CT were identified between August 2016 and March 2018. Of these, PE at least 4 mm in diameter was detected in 73 PECT. Among these, suboptimal enhancement of PA (<250 HU) was shown in 19 cases. Contrast-to-noise ratio (CNR), signal-to-noise ratio (SNR) of VMI at 50 keV, 60 keV, 70 keV, and conventional 120-kVp images (COV) were compared with VMI at 40 keV in all PECT and suboptimal PECT. Readers' subjective scores for PE detection was also recorded. The mean diameters of PE were measured, and they were compared between VMI at 40-70 keV and COV. The frequency of significant PE diameter reduction (>40%) in VMI compared with COV was also recorded and compared between VMIs. The cut off

value of the minimum visible PE diameter at 40 keV was investigated in COV.

RESULTS

There was no significant difference in CNR between 40 keV and 50 keV, although the highest CNR and SNR were obtained at 40 keV. In the suboptimal subgroup, there were no significant differences in both CNR and SNR between 40 keV and 50 keV. The subjective scores was significantly lower at 40 keV, compared with other algorithms in both all PECT and the suboptimal subgroup ($P<0.05$). The mean diameters of PE were significantly decreased in 40 keV and 50 keV, compared with those in COV (40 keV, 5.6±5.8 mm; 50 keV, 7.2±5.3 mm; COV, 8.9±4.9 mm; all $P<0.05$). The frequency of significant PE diameter reduction was significantly higher in 40 keV than in 50 keV (36.8% vs.12.8%, $P<0.001$). The cut off value of the minimum visible PE diameter at 40 keV was 6.4 mm in COV.

CONCLUSION

VMI at 40 keV was not the best option for PE detection, although the best CNR and SNR were obtained at 40 keV. The diameter of PE was often decreased and small PE was not even detected at 40 keV.

CLINICAL RELEVANCE/APPLICATION

We propose that not only 40 keV but also other algorithms such as 50 keV should be used for PE detection to ensure that we do not miss small PEs.

SSQ05-09 Fluorine-19 MRI Ventilation Defect Analysis in Cystic Fibrosis

Thursday, Nov. 29 11:50AM - 12:00PM Room: E353B

Awards
Student Travel Stipend Award

Participants
Tyler Glass, BEng, Chapel Hill, NC (*Presenter*) Nothing to Disclose
Jennifer Goralski, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purpose of this study is to investigate the ability of novel fluorine-19 (19F) based MRI to characterize ventilation in subjects with cystic fibrosis.

METHOD AND MATERIALS

Coronal images of nine healthy controls and twelve subjects with CF were acquired using a multinuclear capable 3.0 T MRI scanner (PRISMA, Siemens) along with spirometry. Subjects inhaled 19F labelled perfluoro-propane (PFP) gas mixed with 21% O2 or room air 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. This was repeated five times after switching PFP gas to room air for the wash-out phase. A 19F maximum intensity projection image over time was created and segmented using a semi-automatic approach with an empirically determined ventilation threshold. Anatomic 1H series taken at full inspiration were then manually segmented for all subjects. After correcting for differences in respiratory effort by comparing apex-base measurements of the lung in 19F and 1H series, the ventilation defect volume (VDV) was computed by subtracting 19F segmentation volume from 1H volume and a ventilation defect percentage (VDP) was also computed relative to 1H volume.

RESULTS

In healthy controls, the mean ventilation defect percentage (VDP) was 10% (SD 11%); for mild CF 13% (SD 25%); and for severe CF 31% (SD 24%). A significant difference was found when comparing all CF patients to normal ($p=0.0275$ via t-test with Satterthwaite correction). VDP had a negative correlation with FEV1 (-0.56 via Spearman correlation, $p=0.011$). The rate constant for gas filling ($\tau 1$) was significantly increased in CF patients compared with controls, suggesting delay in filling. No safety concerns were detected throughout the study.

CONCLUSION

This study showed the ability of novel 19F ventilation MRI to rapidly and safely quantify regional ventilation defects and gas wash-in and wash-out dynamics. 19F MRI identified ventilation defects in cystic fibrosis subjects even in the setting of normal spirometry with some variability in healthy volunteers.

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.

SSQ06

Gastrointestinal (General Abdominal Imaging)

Thursday, Nov. 29 10:30AM - 12:00PM Room: E350

CT GI MR

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

Participants
William C. Small, MD, PhD, Atlanta, GA (*Moderator*) Nothing to Disclose
Lori Mankowski Gettle, MD , Madison, WI (*Moderator*) Nothing to Disclose
Erik K. Paulson, MD, Durham, NC (*Moderator*) Nothing to Disclose

Sub-Events

SSQ06-01 Abdomen Radiographs in the CT/MR Era: What the Surprising Numbers Tell Us

Thursday, Nov. 29 10:30AM - 10:40AM Room: E350

Participants
David J. DiSantis, MD, Jacksonville, FL (*Presenter*) Nothing to Disclose

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PURPOSE

To quantify 21st century abdomen radiograph volume trends as an indicator of that examination's current relevance, both clinically and in our training curriculum.

METHOD AND MATERIALS

Nationwide Medicare procedure data from 2000 through 2016 were analyzed to quantify volume trends for the three most common abdomen radiograph studies: • SINGLE VIEW ABDOMEN • TWO VIEW ABDOMEN (SUPINE plus UPRIGHT OR DECUBITUS) • COMPLETE ABDOMEN SERIES (TWO VIEW ABDOMEN plus FRONTAL CHEST)

RESULTS

In the latest year with data available (2016), 11.29 million abdomen radiographs were performed in the United States. Single view abdomen volume grew by a quite surprising 37% between 2000 and 2016, to 7.55 million. In contrast, two view abdomen 2016 volume fell 43% from its peak year of 2002, to 2.04 million. Similarly, 2016 acute abdomen series volume fell 55% from its peak year of 2004, to 1.7 million .

CONCLUSION

Despite the ascendancy of cross-sectional imaging, supine frontal abdomen radiograph volume has shown not merely resilience but remarkable growth in the 21st century.

CLINICAL RELEVANCE/APPLICATION

With over 11 million studies yearly, abdomen radiograph interpretation will remain a necessary skill in radiology practice, and our residency curricula must reflect that reality.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ David J. DiSantis, MD - 2014 Honored Educator

SSQ06-02 A Comparative Study Between Pseudomyxoma Peritonei and Ascites Due to Cirrhosis Using Spectral CT Imaging

Thursday, Nov. 29 10:40AM - 10:50AM Room: E350

Participants
ChunYan Zhang, Beijing, China (*Abstract Co-Author*) Nothing to Disclose
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Meng Huo, Beijing, China (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To explore the feasibility of differentiating pseudomyxoma peritonei from ascites due to cirrhosis on the basis of quantitative spectral features using spectral CT imaging.

METHOD AND MATERIALS

Six patients with pseudomyxoma peritonei and 5 patients with ascites due to cirrhosis were examined by spectral imaging of revolution CT. And pseudomyxoma peritonei was confirmed by subsequent operation and pathology. Using GSI viewer, various CT imaging parameters(CT values of different mono energy level , iodine-water concentration) were calculated and compared between the 2 groups. Thirty-seven regions of interest (ROI) were placed on pseudomyxoma peritonei and 52 ROIs were placed on cirrhotic ascites. The difference of these spectral parameters between the 2 groups was calculated statistically by independent sample t test.

RESULTS

From 40 to 140 keV images, the mono energy CT values of the 2 groups has statistical significant difference ($P<0.05$). On 60keV images, the difference of CT values of the 2 groups was the largest, the mean CT values of pseudomyxoma peritonei [(18.45±4.58)Hu] was significantly higher than that of cirrhotic ascites[(10.54±4.14)Hu] ($t=-8.32$, $P<0.00$). The iodine-water concentration of pseudomyxoma peritonei [(3.28±0.99)g/L] was significantly higher than that of cirrhotic ascites[(2.72±1.10) g/L] ($t=-2.22$, $P=0.01$).

CONCLUSION

The CT spectral curve and spectral imaging parameters of pseudomyxoma peritonei is found to be different from ascites due to cirrhosis. Revolution spectral CT imaging may provides a new multiparameter method to differentiate pseudomyxoma peritonei and ascites due to cirrhosis.

CLINICAL RELEVANCE/APPLICATION

The CT spectral curve and spectral imaging parameters may be helpful in differentiating pseudomyxoma peritonei and ascites due to cirrhosis.

SSQ06-03 Automated Spleen Volumetry Based on MR Hepatic Proton Density Fat Fraction Imaging in Patients with Nonalcoholic Fatty Liver Disease

Thursday, Nov. 29 10:50AM - 11:00AM Room: E350

Awards
Student Travel Stipend Award

Participants
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PURPOSE

In patients with nonalcoholic fatty liver disease (NAFLD), spleen volume is a marker of disease progression and can predict the likelihood of nonalcoholic steatohepatitis (NASH) and portal hypertension. Manual spleen segmentation for accurate spleen volumetry is laborious and impractical for routine use. Convolutional neural networks (CNNs) can automatically segment spleen volume using dedicated spleen imaging sequences, but are not well suited to estimate hepatic proton density fat fraction (PDFF) and are not routinely acquired in NAFLD research exams. It would be more practical to measure spleen volume on MR hepatic PDFF imaging sequences already obtained, even though the sequences are not optimized for spleen imaging. Here we assess the

feasibility of using an automated CNN method to measure spleen volume based on PDFF sequences.

METHOD AND MATERIALS

We retrospectively identified 172 patients (ages 28 to 71; 67% female) with confirmed NAFLD who underwent MR PDFF exams for clinical care at our institution. Each exam included a magnitude-based PDFF sequence comprising six gradient-echo images at sequential nominally out- and in-phase echo times. Manual-segmentation-determined spleen volumes were measured by an image analyst on 5th echo images for all 172 exams to serve as ground truth. We developed a spleen-segmentation CNN using a 2D U-Net to compute spleen volume separately on each of the six echoes to capture a range of T2* weighting. We trained the CNN in 100 of the 172 patients selected at random and then evaluated its accuracy (Dice score, linear regression, and Bland-Altman analyses) against the ground truth in the other 72 patients.

RESULTS

In the test cohort, spleen volumes were 318±148 mL for manual segmentation of the 5th echo, and 300±137 mL for automated segmentation of all six echoes. Mean Dice score was 0.88 ± 0.09. Regression slope and intercept were 0.90 and 13.0 mL with R2=0.94. The CNN underestimated spleen volume by 17 mL (p<0.0001) with Bland-Altman 95% limits of agreement of [-88 mL, 52 mL].

CONCLUSION

Automated spleen segmentation based on MRI-PDFF is feasible, but further CNN refinement is needed to ensure robust spleen volumetry amongst all patients and signal weightings.

CLINICAL RELEVANCE/APPLICATION

A CNN can measure spleen volume automatically based on MR PDFF images. With further refinement, this CNN may aid in monitoring disease progression in NAFLD and other diseases.

SSQ06-04 Characterization of Abdominal Lymph Node Enlargement: Value of Dual-Energy CT-Based Iodine and Fat Quantification

Thursday, Nov. 29 11:00AM - 11:10AM Room: E350

Participants
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Christian Booz, MD, Frankfurt am Main, Germany (*Abstract Co-Author*) Nothing to Disclose
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Thomas J. Vogl, MD, PhD, Frankfurt, Germany (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

To investigate the potential of dual-energy computed tomography (DECT)-derived iodine and fat quantification for the differentiation of varying entities in patients with abdominal lymph node enlargement.

METHOD AND MATERIALS

In this retrospective study, 94 patients (51 men; mean age, 64.5 years) with histopathologically confirmed diagnosis of malignant lymphoma, lymph node metastasis, or inflammatory lymph node enlargement were included. For each lesion, contrast-enhanced attenuation, as well as DECT-derived iodine density and fat fraction measurements were recorded. Mean attenuation and material density values were compared between different entities. The receiver operating characteristic (ROC) curve analysis was adopted to estimate the optimal threshold for the diagnosis of lymph node metastasis. A control group (n = 95) was analyzed for comparison of attenuation and material density values of normal abdominal lymph nodes.

RESULTS

Assessment of DECT-derived iodine density and fat fraction values revealed significant differences between lymph node metastases (1.7±0.4 mg/ml and 15.5±7.3%), malignant lymphomas (2.5±0.5 mg/ml and 26.7±12.2%), and inflammatory lymph nodes (2.9±0.7 mg/ml and 20.1±10.3%) (P<=0.022). Attenuation values showed no significant differences between the different entities (P>=0.054). Normal lymph nodes revealed an iodine density of 2.4±0.8 mg/ml and fat fraction of 24.1±10.8% with no significant differences compared to malignant lymphomas (P<=0.1.65). An iodine concentration of 2.0 mg/ml represented the optimal threshold for the diagnosis of lymph node metastasis with a sensitivity of 91% and a specificity of 89%.

CONCLUSION

The differentiation of enlarged lymph nodes due to inflammation, primary and secondary malignancy is feasible using DECT iodine density and fat fraction analysis.

CLINICAL RELEVANCE/APPLICATION

DECT material density analysis optimizes the clinical workflow in patients with abdominal masses as iodine density and fat fraction values differ significantly between malignant abdominal lymphomas, lymph node metastases, and inflammatory lymph nodes. This may be beneficial in order to reduce the frequency of additional MRI and ultimately, lymph node biopsy.

SSQ06-05 CT-Based Quantification of Abdominal Aortic Calcification is Superior to the Framingham Risk Score for Predicting Cardiovascular Events in Asymptomatic Adults

Thursday, Nov. 29 11:10AM - 11:20AM Room: E350

Participants
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PURPOSE

Determine if abdominal aortic calcification (AAC) predicts cardiovascular (CV) events independent of Framingham risk score (FRS).

METHOD AND MATERIALS

This retrospective HIPAA-compliant study was approved by the institutional review board. Electronic health records for 829 asymptomatic patients (mean age, 57.9 years; 451 women, 378 men) who underwent unenhanced screening CT colonography between April 2004-March 2005 were reviewed to identify patients with subsequent CV events (defined as MI, CVA, CHF, or death); mean follow-up interval was 11.2±2.8 years. CT-based AAC was quantified as a modified Agatston score using a semi-automated tool (V3D-Calcium Scoring, Viatronix). Kaplan-Meier curves and Cox proportional hazards models were used for time-to-event analysis; ROC curves and net reclassification improvement (NRI) were used to compare predictive abilities of AAC and FRS.

RESULTS

An index CV event occurred after CT in 156 (18.8%) of 829 subjects (6.7±3.5 years after CT). AAC was significantly higher in the CV event cohort (mean AAC, 3478 vs 664). AAC was a strong predictor of CV events at both univariate and multivariate Cox modeling, independent of FRS ($p<0.0001$). KM plots showed better separation with AAC over FRS. The ROC-AUC was higher for AAC than FRS at all evaluated time points (eg, AUC =0.819 versus 0.642 at 2-years; AUC for FRS-AAC combined =0.819). Using a cut-point of 200, AAC improved upon FRS risk categorization with NRI of 35.4%.

CONCLUSION

CT-based AAC is a strong predictor of future cardiovascular events, outperforming the FRS. This suggests a potential opportunistic role in abdominal CT scans performed for other clinical indications.

CLINICAL RELEVANCE/APPLICATION

Abdominal aortic calcification (AAC), which can be quantified at abdominal CT performed for other indications, can serve as a useful biomarker for estimating risk for future cardiovascular events.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Perry J. Pickhardt, MD - 2014 Honored EducatorPerry J. Pickhardt, MD - 2018 Honored Educator

SSQ06-06 Reduction of Artifacts in the Hepatic Arterial Phase of Gadoxetic Acid-Enhanced MR Imaging: Effect of Warming Before Injection

Thursday, Nov. 29 11:20AM - 11:30AM Room: E350

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PURPOSE

To investigate if the warming of gadoxetic acid affects the frequency and degree of artifacts in the arterial phase of magnetic resonance (MR) imaging.

METHOD AND MATERIALS

Two hundred and seventy-one patients who underwent gadoxetic acid-enhanced abdominal MR imaging were included in the study. All dynamic MR imaging was performed with a 1.5 T MR scanner (Achieva, Philips). Either warmed (37°C, n = 137) or non-warmed (24°C, n = 134) gadoxetic acid (Primovist; Bayer HealthCare) was intravenously injected at a dose of 0.025 mmol/kg for 5 seconds, followed by 20 mL of saline. Breath-hold time of each phase was fixed at approximately 20 s. Two abdominal radiologists evaluated the severity of artifact of precontrast, arterial and portal phase images in a consensus fashion as follows: 1 = none; 2 = mild; 3 = moderate; and 4 = severe. Comparison of artifact scores in precontrast, arterial and portal phases as well as patient background was performed between the 37 °C group and the 24 °C group.

RESULTS

There was no significant difference between the 37 °C and the 24 °C groups in terms of age, sex, body weight, body mass index or frequency of underlying medical conditions (liver cirrhosis, ascites, pleural effusion and pulmonary disease). The mean artifact score of the arterial phase in the 37 °C group was significantly lower than that in the 24 °C group (1.38 ± 0.78 vs 1.62 ± 0.92, $p < 0.05$), whereas those of the precontrast and portal phases did not show a significant difference between the two groups. The rate of substantial artifact (score = 3 or 4) in the arterial phase was significantly lower in the 37 °C group than in the 24 °C group (11.2% vs 21.1%, $p < 0.05$). The rate of patients that showed high artifact score in the arterial phase compared to the precontrast image was also lower in the 37 °C group than in the 24°C group (21.6% vs 36.0%, $p < 0.01$).

CONCLUSION

Warmed gadoxetic acid could reduce the artifact in the arterial phase of dynamic MR imaging. Since the viscosity of gadoxetic acid decreases as temperature increases, we speculate the warmed gadoxetic acid may get more homogenous in the vessel early after injection than non-warmed one. This homogeneity could influence the degree or frequency of the artifact.

CLINICAL RELEVANCE/APPLICATION

(dealing with MR artifacts) The artifact in the arterial phase of dynamic MR imaging can be easily reduced by warming of gadoxetic acid without spending time and effort.

SSQ06-07 Leakage After Laparoscopic Sleeve Gastrectomy (LSG): What Is the Role of Routine Postoperative CT Scan?

Thursday, Nov. 29 11:30AM - 11:40AM Room: E350

Participants
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PURPOSE

LSG has become one of the most common bariatric procedures; even so, gastric leak remains the most feared complication of this procedure with a difficult treatment. Our aim was to investigate the role of routine postoperative CT scan in the early identification of factors representing potential substrates of leakage after LSG.

METHOD AND MATERIALS

We enrolled 170 patients(112F,58M;43±12years;43±6.4kg/m2)who underwent primary LSG between September 2015 and February 2018. CT scan was performed within 72 hours from surgery; CT protocol included the use of intravenous and oral contrast. Imaging post processing consisted in measurement of the distance proximal from the pylorus to the first staple firing(stapler to pylorus distance - StP). We also evaluated the presence of perigastric hematoma and of any twisting of the stomach remnant(defined as rotation of all or part of the stomach around its longitudinal axis).

RESULTS

8 patients suffered from gastric leak(4.7%). The mean StP was 38.7±16.7mm; this distance was significantly lower in patients who suffered from gastric leak(24.2±11.9mm vs. 40.3±16.4mm; p=.005). By means of ROC analysis we identified as best threshold for StP 29.9mm below which patients demonstrate a higher risk of gastric leak(AUC:.83;Se:81.8%;Sp:75.4%). Hematoma was found in 9 patients(5.3%); patients with hematoma were found to be more likely to develop gastric leak after LSG(33.3%; p=.005). 15 patients developed twist of stomach remnant(8.8%); we identified two types of twist: type A(10 patients,5.9%), if the twist involves the first third of the gastric remnant; type B(5 patients,2.9%), if it involves its middle and distal part. 4 out of 5 type B patients suffered from gastric leak, while no gastric leak was found in type A group. Type B twisting of the gastric remnant significantly increases the probability of gastric leak after LSG(p=.004). A stepwise multivariate analysis identified this CT sign as the strongest risk factor for gastric leak after LSG(p=.005).

CONCLUSION

On routine postoperative CT scan the assessment of Stp<3cm and the presence of perigastric hematoma and type B twisting of gastric remnant are to be considered risk factors for leakage after LSG.

CLINICAL RELEVANCE/APPLICATION

Routine postoperative CT scan has a promising role in the risk stratification of patients who underwent LSG.

SSQ06-08 Real-Time MRI of the Gastroesophageal Junction: Dynamic Imaging in Patients with GERD-Like Symptoms After Surgical Fundoplication

Thursday, Nov. 29 11:40AM - 11:50AM Room: E350

Participants
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PURPOSE

To assess the diagnostic potential of dynamic real-time MRI in patients with persistent or recurrent GERD-like (gastroesophageal reflux disease) complaints after surgical fundoplication.

METHOD AND MATERIALS

22 consecutive patients (male n=11; female n=11; median age 59y) presenting with recurrent or persistent GERD-like symptoms after surgical fundoplication were enrolled between 2015-2017. Median duration of GERD-like symptoms was 21 months. MRI was performed at a median of 5 years after initial surgery. Real-time MRI at 3.0 Tesla was performed with temporal resolution of 40 ms. based on undersampled radial fast low angle shot (FLASH) acquisitions with iterative image reconstruction by regularized nonlinear inversion (NLINV). Dynamic MRI movies visualized bolus transit of pineapple juice through the gastroesophageal junction, position of the fundoplication wrap as well as recurring hernia or reflux during Valsalva maneuver. MRI results were compared to endoscopic findings.

RESULTS

Real-time MRI was successfully completed in all patients without adverse events and average examination time of 15 minutes. A morphological correlate for GERD-like symptoms was evident in 20 patients (90.1%): Gastric reflux was present in 19 of these cases. Nine patients (40.1%) were diagnosed with wrap disruption and recurrent gastric hernia. Wrap migration or telescoping hernia were detected in 9 patients (40.1%). Only 1 patient presented with continued reflux despite intact wrap. Esophageal dysmotility with delayed bolus passage was observed in 1 case. On endoscopy, gastric hernia or wrap migration were diagnosed in 6 cases. Repeated fundoplication was performed in 12 patients (54.4%) with gastric hernia or wrap migration based on MRI findings.

CONCLUSION

Real-time MRI is a fast and safe modality for dynamic imaging after fundoplication, without radiation exposure or administration of gadolinium-based contrast media. In a relevant number of cases real-time MRI reveals correlates for GERD-like symptoms.

CLINICAL RELEVANCE/APPLICATION

Dynamic real-time MRI is a novel imaging technique for postsurgical detection and characterization of fundoplication failure. Different patterns on MRI may assist planning of redo fundoplication.

SSQ06-09 Novel Murine Model of Liver Microbleeding Using Electric Field Ablation

Thursday, Nov. 29 11:50AM - 12:00PM Room: E350

Participants
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PURPOSE

Approximately 5% of gastrointestinal bleeding (GIB) cannot be identified on initial workup. Over two years, an average of 7.3 diagnostic tests, 5 hospitalizations, and 46 units of blood per patient are required during workup. Improved diagnostic approaches of obscure GIB are needed. To evaluate emerging diagnostic agents, we describe a novel murine GIB model using irreversible electroporation (IRE) which can be detected with contrast enhanced micro-computed tomography (micro-CT).

METHOD AND MATERIALS

C57BL/6 mice (n=10) were placed under anesthesia. Prior to the IRE procedure, 200U/kg heparin was injected followed by 300µl 1:1 v/v heparinized saline and 350mg/ml iohexol. The mice were divided into two experimental groups: 60 and 120V/mm IRE treatment. IRE was performed using 1cm2 tweezer electrodes applied to both sides of the right median liver lobe. Microperfusion was measured using Laser Speckle Contrast Analysis (LASCA) at baseline and at 2, 10, 20, 30 min post-IRE. Prior to euthanasia, another 300µl of heparinized saline-ioxhexol was injected. Whole body contrast enhanced micro-CT scan was performed with settings of: 32µm pixel size, 55kV, 181µA, rotation step 0.25°, frame average 3, with a 0.5mm aluminum filter. Liver tissues were harvested for additional micro-CT and histology.

RESULTS

Visual inspection of the IRE site showed evidence of contusion within the tissue in both groups. LASCA imaging demonstrated decreased, but maintained perfusion. 30min post-IRE perfusion for 60V/mm and 120V/mm was 71% and 35% of baseline, respectively (p=0.006). Micro-CT showed increased attenuation at the liver IRE site, suggestive of bleeding. Extravasation of erythrocytes within the hepatic parenchyma was evident on microscopy with a greater effect seen in the 120V/mm group.

CONCLUSION

We demonstrate a novel, non-traumatic model of liver microbleeding which can be identified using non-invasive micro-CT imaging and confirmed by histology. Although trauma induced animal hemorrhage models exist, this is the first described model of microbleeding of the abdomen. This model can be useful to test emerging bioengineered hemostatic and imaging agents.

CLINICAL RELEVANCE/APPLICATION

A GIB model can help test emerging diagnostic and therapeutic agents which can be targeted to sites of microbleed. New agents have potential to improve costs, morbidity and mortality of obscure GIB.

SSQ07

Gastrointestinal (Gastric Cancer)

Thursday, Nov. 29 10:30AM - 12:00PM Room: E351

CT GI OI

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

FDA Discussions may include off-label uses.

Participants
Rony Kampalath, MD, Houston, TX (*Moderator*) Nothing to Disclose
Olga R. Brook, MD, Boston, MA (*Moderator*) Nothing to Disclose
Desiree E. Morgan, MD, Birmingham, AL (*Moderator*) Institutional Research Grant, General Electric Company

Sub-Events

SSQ07-01 CT Detected Extramural Vessel Invasion combined with N Staging as the Prognostic Predictor in Patients with T4a Gastric Cancer

Thursday, Nov. 29 10:30AM - 10:40AM Room: E351

Participants
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PURPOSE

To investigate the 3-year progressive-free survival (PFS) of extramural vessel invasion (EMVI) and the nodal status detected with contrast MDCT in patients with clinical T4a gastric cancer.

METHOD AND MATERIALS

Between January 2009 and February 2015, 143 patients with preoperative ceMDCT diagnosed T4a gastric cancer based on the criteria of the AJCC 8th were included in this retrospective study. All patients underwent curative D2 gastrectomy, adjuvant chemotherapy and conventional follow-up. Potential prognostic factors including clinical and pathological N status, EMVI tumor location/growth pattern, histological type/tumor differentiation and tumor size were recorded. Disease progression was defined as the presence of radiological or/and pathology-confirmed metachronous metastases, local recurrence, or gastric cancer related death. Survival estimated for PFS were obtained in patients according to the following four categories: ctEMVI+/ctN+, ctEMVI+/ctN-, ctEMVI-/ctN+, ctEMVI-/ctN-, by using the Kaplan-Meier product limit. Hazard ratios for 3-year PFS were generated using a Cox proportional hazard regression on ceMDCT tumor characteristics.

RESULTS

The prevalence of EMVI detected with ceMDCT was 55.9% (80/143) in the entire cohort of patients with clinical T4a patients. The 3-year PFS according to ctEMVI and CT detected nodal status were ctEMVI+/ctN+ 25.0%, ctEMVI+/ctN- 53.1%, ctEMVI-/ctN+ 75.6% and ctEMVI-/ctN- 64.7%, respectively. There was significant difference in 3-years PFS with ctEMVI+/ctN+ (as the reference) and the other three groups (ctEMVI+/ctN-, ctEMVI-/ctN+, and ctEMVI-/ctN-) (Logrank test, $P<0.05$). In a Cox proportional hazards regression analysis, ctEMVI+/ctN+ was demonstrated as the independent factors for reduced 3-year PFS with HR of 2.169 (95%CI:1.300-3.618, $P=0.003$) .

CONCLUSION

EMVI combined with nodal status detected with ceMDCT, could be an more valuable preoperative factor to counsel patients regarding ongoing risks of metastatic disease, implications for surveillance, and systemic chemotherapy.

CLINICAL RELEVANCE/APPLICATION

Clinical N staging combined with the status of CT detected EMVI could be used as an independent poor prognostic predictors for the T4a gastric cancer patients. EMVI and ctN both positive might be a useful risk-stratified factors to balance benefit of survival with induced long-term toxicities from neoadjuvant chemotherapy for regional advanced gastric cancer.

SSQ07-02 Diffusion Kurtosis Imaging: Assessment of Poor Response to Neoadjuvant Chemotherapy in Advanced Gastric Cancer

Thursday, Nov. 29 10:40AM - 10:50AM Room: E351

Participants

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PURPOSE

To assess effectiveness of diffusion kurtosis (DK) imaging in treatment response to neoadjuvant chemotherapy in locally advanced gastric cancer.

METHOD AND MATERIALS

This study was approved by the local institute review board. A total of 28 patients (median age, 60.3years; age range, 35-79years) with gastric cancer were enrolled in this prospective study, and underwent MR imaging on a 1.5T MR scanner. All patients were underwent DKI examination (b=0,200,500, 800, 1000, 1500, 2000s/mm2) and conventional diffusion-weighted imaging (b = 0, 800s/mm2) before and after chemotherapy. ADC value, diffusivity (D), Kurtosis (K) were measured. Change value (ΔX) and ratio (%ΔX) of these parameters were calculated. The response to neoadjuvant chemotherapy was evaluated according to pathological tumor regression grade scores (NCCN) as the standard reference (good responders TRG 0-2, poor responders, TRG 3). Mann-Whitney U test, ROC curve were used for statistical analysis.

RESULTS

There were 16 cases of good response and 12 cases of poor response. The Kpre and Kpost values in poor response group were significantly higher than those in good response group [(0.671±0.026) and (0.641±0.019) vs. (0.584 ± 0.023) and (0.519±0.018) respectively, p<0.001)]. ADCpost and Dpost in the poor response group were significantly lower than those in good response group (p<0.05). In addition, significant difference were also observed for parameters %ΔK, ΔD andΔK between the two groups (p<0.05). The operating characteristic curve for the assessment of poor response was highest using Kpost (0.958, cutoff value=0.614) compared with other parameters. The Kpre and Kpost respectively had highest sensibility (91.70%) and specificity (93.8%) compared with other image indices.

CONCLUSION

Both DKI and conventional DWI exhibit potential in evaluation of treatment response in gastric cancer with neoadjuvant chemotherapy. The DKI parameters, especially K, showed better performance in differentiating poor response.

CLINICAL RELEVANCE/APPLICATION

DKI is a non-invasive imaging technique that may be useful in monitoring poor responser for advanced gastric cancer.

SSQ07-03 Predicting Gastric Cancer Response to Neoadjuvant Chemotherapy Using a Non-Gaussian Fractional Order Calculus Diffusion Model

Thursday, Nov. 29 10:50AM - 11:00AM Room: E351

Participants
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PURPOSE

To investigate whether pre-treatment MRI can predict tumor response grade (TRG) to neoadjuvant chemotherapy (NAC) of gastric cancer using a non-Gaussian fractional order calculus (FROC) diffusion model.

METHOD AND MATERIALS

With IRB approval, 30 patients (9 females and 21 males) with gastric cancer underwent MRI scans at 1.5T prior to NAC. The histologic TRG was evaluated based on the following grading system: TRG0: complete, TRG1: moderate, TRG2: minimal, and TRG3: poor response. According to this criterion, 3 patients were identified with TRG0, 2 with TRG1, 12 with TRG2, and 13 with TRG3. For analysis, TRG0-TRG2 groups were combined as low-TRG to be compared with high-TRG (TRG3) group. The MRI protocol included T1-weighted (VIBE), T2-weighted (turbo spin echo with respiratory trigger), and diffusion-weighted (DW) imaging with 11 *b*-values (0 to 2000 s/mm2). Diffusion coefficient *D*, fractional order parameter *ß* (which correlates with tissue heterogeneity), and a microstructural quantity *μ* were calculated by fitting the DW images to a FROC model. Apparent diffusion coefficient (ADC) was also computed using *b*=50 and 800 s/mm2 images. For group analysis, the test parameters were computed as the mean value from the tumor region-of-interest for *ß* and *μ*. For D or ADC, the mean values were computed from the lower 25% of their histograms to improve robustness against contamination from the body fluid. The low- and high-TRG groups were compared using a Mann-Whitney U test. A receiver operating characteristic analysis was performed to assess the performance of FROC model for predicting TRG in comparison with ADC.

RESULTS

The FROC parameters, *D* and *μ*, were significantly lower in high-TRG than low-TRG group (*p*-values<0.05), whereas ADC or *ß* did not show significant difference between the groups. The combination of *D* and *μ* produced higher accuracy (76% vs. 64%), specificity

(70% vs. 60%), sensitivity (80% vs. 70%), and area under the curve (80% vs. 60.6%) than ADC in differentiating low- and high-TRG groups.

CONCLUSION

The combination of pre-treatment FROC parameters, *D* and *μ*, improved the performance over ADC in predicting TRG in gastric cancer patients receiving NAC.

CLINICAL RELEVANCE/APPLICATION

The pre-treatment FROC diffusion model parameters can be used to predict gastric cancer response to NAC.

SSQ07-04 Prognostic Ability of Risk-Stratification Defined By ceMDCT of Patients with Gastric Cancer

Thursday, Nov. 29 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

To investigate the risk-stratification defined by preoperative abdominal contrast-enhanced multiple-row detector computed tomography (ceMDCT) in predicting 1-year DFS of patients with gastric cancer.

METHOD AND MATERIALS

Between January 2009 and December 2015, 237 patients with pathological-proved gastric cancer were included in this retrospective study. Two radiologists reviewed all abdominal ceMDCT images and reached a consensus on categories of tumor and lymph node (ctT/ctN), the presence of ctEMVI, tumor location/growth pattern, and tumor size. Kaplan-Meier method was used to compare the 1-year DFS rate between ctEMVI-positive and ctEMVI-negative group. Cox proportional hazard regression was used to find the independent risk factors of 1-year DFS rate. According to the number of independent risk factors, the patients were classified to the different risk stratifications, and the difference of 1-year DFS rate between different risk stratifications was compared.

RESULTS

The ctEMVI-positive group had significantly lower 1-year DFS rate (55.3%) than the ctEMVI-negative group (90.2%) (Log-rank test, $P < 0.0001$). In a Cox proportional hazards regression analysis, ctT, ctN and ctEMVI were identified as independent prognostic factors of 1-year DFS with hazard ratio (HR) of 3.35 (95% CI: 1.25-8.99, $P = 0.018$), 1.99 (95% CI: 1.08-3.63, $P = 0.0269$) and 3.40 (95% CI: 1.79-6.47, $P = 0.0002$), respectively. The risk stratification analysis showed that with the increase of the number of independent risk factors, 1-year DFS rate decreased gradually in patients with gastric cancer ($P < 0.0001$).

CONCLUSION

Preoperative TN stage and EMVI diagnosised by ceMDCT were independent risk factors for the prognosis of gastric cancer, and can be used for risk stratification to predict 1-year DFS rate of gastric cancer.

CLINICAL RELEVANCE/APPLICATION

Preoperative risk stratification based on TN stage and EMVI defined by ceMDCT can be used to predict 1-year DFS rate of gastric cancer.

SSQ07-05 CT-Based Radiomics Analysis for Evaluation of Serosa Invasion in Gastric Cancer

Thursday, Nov. 29 11:10AM - 11:20AM Room: E351

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PURPOSE

The purpose of this study was to develop and validate a radiomics model for evaluating serosa invasion in gastric cancer.

METHOD AND MATERIALS

We enrolled 428 patients (252 in the primary cohort and 176 in the validation cohort) with pathological confirmed T3 or T4a gastric cancer, the contrast enhanced CT images of three phases (arterial, portal, and delayed) of lesions were manually segmented. The subjective CT findings (nodular, cord, perigastric fat infiltration, high enhanced serosa sign) of serosa invasion were evaluated. Conventional hand-crafted features and convolutional neural network (CNN) based deep learning features were all automatically extracted based on CT images. The 2-sample t-test and the min-redundancy and max-relevance method were used for feature selection, whereupon 3 radiomics signature were built with support vector machines. Multivariable logistic regression analysis was

then used to develop a radiomics model incorporating the radiomics signature and subjective CT findings. A nomogram was displayed. The receiver operating characteristic (ROC) curve was constructed for each cohort and the area under the curve (AUC) was calculated to measure the diagnostic ability. DeLong test was used to verify whether there were statistical differences between the ROC curves.

RESULTS

The radiomics signature comprised 273 hand-crafted features and 30 features extracted based on the CNN. The individualized radiomics model, which incorporated the arterial radiomics signature and three CT findings (nodular, perigastric fat infiltration, high enhanced serosa sign) showed moderate discrimination. The AUC (95% confidence interval) in primary and validation cohort was 0.815 (0.759-0.870) and 0.804 (0.739-0.868), respectively. The accuracy, sensitivity and specificity of the primary cohort was 0.770, 0.798, 0.719, respectively. The prediction accuracy, sensitivity, and specificity of the validation cohort was 0.744, 0.756 and 0.734, respectively.

CONCLUSION

Based on the contrast enhanced CT images of three phases, we developed a radiomics model, which may be used to identify serosa invasion and provide reference for individualized clinical treatment.

CLINICAL RELEVANCE/APPLICATION

The radiomics model we developed and the derived nomogram that incorporates the radiomics signature and CT findings provides patients and doctors with an effective tool for evaluating serosa invasion and for determining further treatment plans.

SSQ07-06 Diagnostic Accuracy of Dual-Energy CT-Based Nomogram to Predict Lymph Node Metastasis in Gastric Cancer

Thursday, Nov. 29 11:20AM - 11:30AM Room: E351

Participants
Jing Li, Zhengzhou, China (*Presenter*) Nothing to Disclose

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PURPOSE

To develop and validate a dual-energy CT based nomogram for the preoperative prediction of lymph node metastasis (LNM) in patients with gastric cancer (GC).

METHOD AND MATERIALS

A total of 210 surgical confirmed GC patients (159 males, 51 females; mean age: 59.8 ± 7.7 years, range: 28-79 years) who underwent spectral CT scans were retrospectively enrolled and split into a primary cohort (n=140) and validation cohort (n=70). Clinical information and follow up data including overall survival (OS) and progression free survival (PFS) were collected. The iodine concentration (IC) of the primary tumours at the arterial phase (AP) and venous phase (VP) were measured and then normalized to aorta (nICs). Univariate analysis, multivariable logistic regression analysis and Cox regression analysis were performed to screen predictive indicators for LNM and outcome. A nomogram for risk factors of LNM was developed and its performance was measured using ROC, accuracy and Harrell's concordance index (C-index).

RESULTS

Tumour thickness, Borrmann classification and ICVP were independent predictors for LNM. The nomogram was significantly associated with LN status (P <0.001). The AUCs for predicting LNM were 0.760 (95% confidence interval [95% CI], 0.680-0.840) in primary cohort and 0.793 (95% CI, 0.678-0.908) in validation cohort. The nomogram also exhibited a prognostic ability with C-indices of 0.675 (95% CI, 0.571-0.779; P <0.001) for PFS and 0.643 (95% CI, 0.518-0.768; P =0.025) for OS.

CONCLUSION

This study presented a dual-energy quantification based nomogram, which can be used to facilitate the preoperative individualized prediction of LNM in patients with GC.

CLINICAL RELEVANCE/APPLICATION

Dual-energy CT based nomogram enables superior preoperative individual prediction of LNM in GC.

SSQ07-07 Evaluation of Iodine Concentration Measurement by Dual Energy CT Scan on Predicting Prognosis for Patients with Advanced Gastric Adenocarcinoma

Thursday, Nov. 29 11:30AM - 11:40AM Room: E351

Participants
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PURPOSE

To evaluate iodine concentration measurement by dual energy CT scan on tumor angiogenesis and predicting prognosis for patients with advanced gastric adenocarcinoma.

METHOD AND MATERIALS

This retrospective study included 97 patients with advanced gastric adenocarcinoma who had preoperative enhanced dual-energy CT scan. Standardized iodine concentration (SIC) of the primary tumor was measured. The correlations between SIC and clinical, pathological, angiogenic findings compared with patient survival were analyzed. The Kaplan-Meier test was employed to evaluate the patients' disease free survival (DFS) and overall survival (OS) . COX regression model was adopted to improve the multiple factors analysis .

RESULTS

Different values of SIC values were found 0.81 at diffuse, 0.54 at both intestinal and mixed type (F=18.717,P<0.001); 0.52 at non-T4 and 0.66 at T4 group (t=-2.728,P=0.008); 0.53 at N0 and 0.64 at N1-3 group (t=-2.084,P=0.040); 0.50 at non-III staging and 0.68 at III staging group (t=-4.135,P<0.001); 0.48 at VEGF negative and 0.69 at positive expression group (t=-4.684,P<0.001); 0.55 at low and 0.67 at high MVD group (t=-2.802,P<0.05); 0.72 at recurrence and 0.55 at non-recurrence group (t=3.791,P<0.001), respectively. DFS of low SIC (< mean value of 0.62) and high SIC (>= 0.62) groups were 28 and 22 months (X2=11.920,P=0.001). OS of the two groups were 29 and 26 months (X2=12.907,P<0.001). Invasion, metastasis, pTNM and SIC were identified as the independent risk factors affecting to DFS (0.195,0.379,6.623 and 2.802, respectively). Invasion, pTNM and SIC independent risk were affecting to OS (0.281, 7.225 and 2.835, respectively).

CONCLUSION

The SIC of advanced gastric adenocarcinoma has the relationship with Lauren classification, invasion depth, lymph node metastasis, pathological TNM staging and tumor angiogenesis. The SIC as a independent risk factor could affect DFS and OS, and has the potential to be used for predicating the patient prognosis.

CLINICAL RELEVANCE/APPLICATION

The SIC of advanced gastric adenocarcinoma has the relationship with Lauren classification, invasion depth, lymph node metastasis, pathological TNM staging and tumor angiogenesis. The SIC as a independent risk factor could affect DFS and OS, and has the potential to be used for predicating the patient prognosis.

SSQ07-08 Diagnostic Value of Multiparameter Dual-Energy CT in Regional Lymphatic Metastasis of Gastric Cancer

Thursday, Nov. 29 11:40AM - 11:50AM Room: E351

Participants
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PURPOSE

To evaluate the value of dual-energy CT iodine concentration and overlay combining with conventional morphological measurements in metastatic lymph nodes of gastric cancer.

METHOD AND MATERIALS

A total of 141 regional lymph nodes were collected from 40 gastric cancer patients who underwent dual-energy CT scan and confirmed by surgery and pathology. The short diameter, length, and CT value, iodine concentration, and overlay value of each lymph node were measured, and the short length ratio and enhanced CT value at the arterial phase were calculated. Independent sample t-test was used to compare the short diameter, short length ratio, CT enhancement values, iodine concentration and overlay values between the two groups.The ROC analysis was used with statistically significant parameters and diagnostic efficacy was calculated with each individual parameter and joint parameters.

RESULTS

Of the 141 regional lymph nodes, 73 were metastatic lymph nodes and 68 were non-metastatic lymph nodes. The iodine concentration, overlay value, short diameter and enhanced CT values of the metastatic lymph node at the arterial phase were (1.64±0.68) mg/ml, (29.06±11.42) HU, (7.35±3.38) mm, (26.34±14.98) HU, respectively; while the corresponding values of the non-metastatic lymph nodes were (2.51±0.68) mg/ml, (38.90±14.61) HU, (5.32±1.34) mm, (33.57±15.91) HU, and the difference was statistically significant (all P<0.05). There was no significant difference in short length ratio (P>0.05). The AUC of the diagnosing lymph node metastasis was 0.708, 0.650, 0.808, 0.695 for short diameter, CT enhancement, iodine concentration, and overlay value at the arterial phase, respectively. Four indicators combining to diagnose lymph node metastasis, the series sensitivity and specificity were 21.9% and 98.5%, and the parallel was 100.0% and 80.9%.

CONCLUSION

Multiparameter dual-energy CT combining with conventional morphological measurements can improve the diagnostic efficiency of lymph nodes in gastric cancer and has a role in the differential diagnosis of regional lymph nodes in patients with gastric cancer.

CLINICAL RELEVANCE/APPLICATION

It has a role in the differential diagnosis of preoperative regional lymph nodes in patients with gastric cancer.

SSQ07-09 Diagnostic Accuracy of CT for Lymph Node Metastasis in Gastric Cancer: Comparison of Spectral Parameters Developed Dual-Energy CT and Conventional CT

Thursday, Nov. 29 11:50AM - 12:00PM Room: E351

Participants
Yaru Chai, MD, Zhengzhou, China (*Presenter*) Nothing to Disclose

PURPOSE

To investigate the optimal diagnostic threshold and accuracy of spectral parameters for metastatic lymph nodes of gastric cancer with dual energy CT and to compare with conventional CT parameters.

METHOD AND MATERIALS

This study received institutional review board approval, and all participants provided written informed consent. From December 2014 to December 2016, 86 patients with gastric cancer confirmed by gastroscope pathology underwent preoperative enhanced CT that included precontrast, arterial phase(AP) and venous phase(VP) in Discover GSI CT scanner. The spectal parameters(iodine value of lymph nodes in AP and VP) and the conventional parameters(short diameter, long diameter, the ratio of short to long diameter and CT number in AP and VP) were measured and recorded in iodine based images and monochromatic images at 70 keV respectively. The diagnostic efficiency of each factor to lymph nodes metastasis was assessed by using t test and receiver operating characteristic(ROC) curve analysis.

RESULTS

Among 552 lymph nodes found in CT images, 338 nodes were positive and 214 were negative with pathological results as the gold standard. The results of t test showed that the short diameter, the ratio of short to long diameter, the CT number and iodine value in AP and VP of positive lymph nodes were higher than these of negative lymph nodes(all $P<0.05$). The area under curve of the short diameter, the ratio of short to long diameter, the CT number in AP and VP, the iodine value in AP and VP of lymph nodes were 0.600, 0.880, 0.832, 0.755, 0.864, 0.835, respectively. The diagnosis accuracy of iodine value in AP and VP were 86.9%, 82.2%, respectively with threshold of 9.65,15.65(100ug/cm3). These were higher than the CT number in AP and VP(86.9% vs 69.9%, 66.9% vs 82.2%, both $P<0.05$). Taking the ratio of short to long diameter over 7.25 as optimal diagnosis threshold, the diagnosis accuracy was 75.6%. Combined the ratio of short to long diameter with the iodine value in AP, the diagnosis accuracy was 89.2%.

CONCLUSION

The diagnosis accuracy of dual-energy CT parameters was higher than conventional CT for lymph nodes metastasis in gastric cancer and could be improved by combining size and spectral CT parameters.

CLINICAL RELEVANCE/APPLICATION

Multifunctional parameters of spectral CT can improved the diagnosis accuracy of lymph node metastasis in gastric cancer.

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SSQ08

Gastrointestinal (Advanced CT Techniques)

Thursday, Nov. 29 10:30AM - 12:00PM Room: E352

CT GI 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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Andrew D. Hardie, MD, Charleston, SC (*Moderator*) Nothing to Disclose
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Sub-Events

SSQ08-01 Can Fully Iterative Reconstruction Technique Enable Routine Abdominal CT at Less Than 1 mSv?

Thursday, Nov. 29 10:30AM - 10:40AM Room: E352

Participants
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PURPOSE

We assessed effect of a new fully iterative reconstruction technique (FIRST) on lesion detection and image quality of routine abdominal CT at radiation dose <1 mSv

METHOD AND MATERIALS

24 patients (age 64±1 years, BMI 27±3 kg/m) undergoing routine abdomen CT on 640-slice MDCT (Aquillion One, Canon Medical System), gave written informed consent for acquisition of an additional ULD CT series immediately after their clinically-indicated regular dose CT (SD). The ULD CT series were reconstructed with FIRST (at STD (Standard) and STR (Strong) levels), and SD CT series with filtered back projection (FBP). Two radiologists performed the subjective image evaluation on a five-point scale (1 = image quality better than SD CT; 5 = image quality unacceptable) to assess subjective image quality,and presence of artifacts on all image series (SD (n=24) and ULD (n=72). Lesions were first detected on ULD FBP images. ULD FIRST (STD and STR) and ULD FBP images were then compared side-by-side to SD-FBP images in an independent,randomized, and blinded fashion. Patient demographics, radiation dose descriptors (CTDIvol, DLP) and image noise were recorded. Descriptive statistics and inter-observer variability were calculated for data analysis

RESULTS

Mean CTDIvol for SD and ULD CT were 13±3 mGy and 2.2±0.4 mGy, respectively. There were 46 'true positive' lesions detected on SD CT. Radiologists detected 38/46 lesions on ULD FIRST STD series compared to 26/46 lesions on ULD FIRST STR series. Twenty lesions (0.5-1.5 cm) missed on ULD FIRST STR images (pancreatic lesions, liver and kidney cysts) were seen in patients with BMI >27.6. Eight lesions (liver and kidney cysts, pancreatic lesions, sub-cm peritoneal lymph node) missed on ULD FIRST STD were seen in patients with BMI>25.8. Diagnostic confidence for lesion assessment was optimal in ULD FIRST STD setting in most patients regardless of their size. The inter-observer agreement (kappa-value) for overall image quality were 0.98 and 0.84 for ULD FIRST STD and STR levels, respectively

CONCLUSION

FIRST enabled optimal lesion detection, and diagnostic confidence in submSv abdominal CT in most non-obese adult patients compared to SD CT at 85% lower radiation dose levels

CLINICAL RELEVANCE/APPLICATION

The new fully iterative reconstruction (FIRST) technique can allow routine abdominal CT at less than 1 mSv with sufficient diagnostic confidence in smaller patients (<27.6 BMI)

SSQ08-02 Contrast Volume Reduction Using Measured Lean Body Weight and Related to Image Quality for Abdomen CT Examinations: Preliminary Results of a Prospective Multicentric Study

Thursday, Nov. 29 10:40AM - 10:50AM Room: E352

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PURPOSE

To assess i.v. contrast media (CM) volume differences correlated to image quality (IQ) when using lean body weight (LBW) or total body weight (TBW) for abdomen CT examinations.

METHOD AND MATERIALS

A CT scanner i.v. contrast media (CM) volume optimization protocol based on LBW was implemented in a multicenter medical imaging group (8 CT scanners) following a dose optimization program according to clinical indication. Patients assessed for a suspected liver, pancreas or renal lesion, were prospectively included. A single i.v. CM (iopamidol 370mg/ml) was used. In phase 1, a 600mg/kg of TBW injection protocol was applied. 948 prospective patients were included (Group 1): M:438/F:510, mean age: 59, mean BMI: 26.06 (range 13.8-44.6). In phase 2, a 750mg/kg of LBW injection protocol was applied. 124 prospective patients were included (Group 2): M:59/F:65, mean age: 60, mean BMI: 26.3 (range 16.45 - 37.55). LBW was measured using a bi-frequency tetrapolar bioelectrical impedance technique (BIA-ACC®, Biotekna, Italy). Contrast volume and injection rate were recorded in a single dose management software (Dosewatch™, GE). IQ (level of enhancement) was assessed by two independent readers in pre- and post-contrast portal phase images on 3mm axial reconstructions, with quantitative HU measurements for liver parenchyma enhancement (Δ target: 50HU), using ROIs of identical size and location. Image noise was also quantitatively reported using image Hounsfield unit standard deviation (SD) values indicated with the ROI density measurement. Mann-Whitney U Test and One way Annova test were used to assess differences as appropriate.

RESULTS

Injected i.v. CM volume is statistically significantly different (-26%) between group1 (median: 118.3ml) and 2 (median: 87.6ml) ($p<0.001$). Enhancement of liver parenchyma (median group1/group2: 60/50, SD:15.7/17.3) presents a statistically significant difference ($p<0.05$), but remains in target range. There is no statistically significant difference between readers for image quality assessment (parenchymal enhancement): reader 1/2, group 1: 60/61 (SD16.3/15.1), group 2 : 49/50 (SD17.6/17).

CONCLUSION

For abdomen CT examinations, injected i.v. CM volume is significantly less when using LBW instead of TBW, without impairing image quality.

CLINICAL RELEVANCE/APPLICATION

Excessive amounts of i.v. CM is delivered when using TBW instead of LBW for abdominal CT examinations.

SSQ08-03 Personalized Contrast Media Injection Protocols for Abdominal CT Studies

Thursday, Nov. 29 10:50AM - 11:00AM Room: E352

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PURPOSE

To compare Abdomen CT exams performed using power injector generated customized contrast media (CM) injection protocols based on total body weight (TBW) and kV to fixed CM injection protocols.

METHOD AND MATERIALS

A total of 384 patients underwent abdominal CECT studies (GE Revolution and Siemens Edge). 263 of 384 patients were scanned using 100kV and 121 with DECT (65 keV). CM (370 mgI/mL, Iopamidol) was administered using a software platform (P3T, Certegra, Medrad), connected to the power injector, which customized the CM injection (*Cinj*) based on TBW in kg's. In 149-*Cinj* patients (80 with 100kV; 69 with DECT) a comparison with 120kV exams was available using fixed CM injections (*Finj*) using TBW based thresholds ([TBW]<= 59 kg, 80 ml= Group A; 60-89 kg, 90 ml= Group B; >=90 kg, 120 ml= Group C). Subjective image quality and mean HU and CNR were calculated from ROIs within the liver, pancreas, portal vein, and aorta.

RESULTS

In the 384-*Cinj* patients a mean CM volume of 85.7±14.8 was injected, 9.4% lower than using TBW. Group A received a mean CM volume of 70.3±1.2 vs 80ml (-12%), group B of 82.3±9.3 vs 90ml (-8.5%), and group C 108±6.9 vs 120ml (-10%). All exams were

judged diagnostic. In comparison to 120 kV *Finj*, 100kV-*Cinj* images showed comparable HU mean and significantly higher CNR (+36-87%; p=<0.05) in all three groups. DECT-*Cinj* images showed significantly higher HU (+7-22%; p=<0.05) and CNR (+14%-86%) mean.

CONCLUSION

The software platform (P3T) with power injector enables personalized CM injection protocols using substantially lower iodine dose for low kV/keV exams while yielding diagnostic quality images with comparable/higher attenuation and CNR values compared to 120kV exams using fixed CM injection volumes.

CLINICAL RELEVANCE/APPLICATION

Automation of Customized CM injection protocols using a power injector platform entails reduction of the iodine load with optimized image quality. There are potential benefits for the patients safety, CT workflow and lowering exam cost.

Honored Educators

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SSQ08-04 Improvement of Diagnostic Image Quality of Abdominal CT by Using a Deep-Learning Based Reconstruction: Initial Clinical Trial Targeting Hypervascular Hepatocellular Carcinoma

Thursday, Nov. 29 11:00AM - 11:10AM Room: E352

Participants
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PURPOSE

Deep learning is part of a broader family of machine learning methods based on learning data representations, as opposed to task-specific algorithms. We developed a new image processing reconstruction method, Deep Learning based Reconstruction (DLR), which could generate CT image with better quality using deconvolution neural network trained by CT images which are scanned with sufficient radiation dose and reconstructed with model-based iterative reconstruction. The purpose of this study was to confirm clinical feasibility of our method compared with conventional hepatic CT images targeting hypervascular hepatocellular carcinoma.

METHOD AND MATERIALS

We evaluated 43 hypervascular hepatocellular carcinomas in 40 patients who had undergone hepatic dynamic CT. The CT images at arterial phase were reconstructed with DLR and hybrid iterative reconstruction (Hybrid-IR). A radiologist measured standard deviation of the attenuation measured in the paraspinal muscle as image noise, and calculated contrast-to-noise ratio (CNR) = (ROIL - ROIT)/N, where ROIL is the mean attenuation of the liver parenchyma, ROIT is the mean attenuation of the tumor, and N is noise. Each liver lesion was reviewed by other two radiologists and graded on a 5-point confidence scale ranging from 1 = cannot identify to 5 = can detect lesion without diagnostic compromise. The difference between CT images processed with Hybrid-IR and DLR was determined using two-sided Wilcoxon signed-rank test.

RESULTS

Image noise was significantly lower on images with DLR compared to Hybrid-IR (median 12.8 and 20.0 HU for DLR and Hybrid-IR, respectively, p<0.01). In addition, CNR on images with DLR was significantly higher than that on images with Hybrid-IR (median 2.3 and 1.5 for DLR and Hybrid-IR, respectively, p<0.01). Confidence score for liver lesions was significantly higher on images with DLR compared to those with Hybrid-IR (p<0.01).

CONCLUSION

The DLR improved quantitatively and qualitatively image quality of abdominal CT for evaluation of hypervascular hepatocellular carcinoma.

CLINICAL RELEVANCE/APPLICATION

DLR yielded better image quality of abdominal CT compared to Hybrid-IR, indicating that DLR can improve identification and characterization of hypervascular hepatocellular carcinoma.

SSQ08-05 Prior Iterative Reconstruction (PIR) to Lower Radiation Dose and Preserve Radiologist Performance for Multiphase Liver CT: A Multi-Reader Pilot Study

Thursday, Nov. 29 11:10AM - 11:20AM Room: E352

Participants
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PURPOSE

Prior Iterative Reconstruction (PIR) is an iterative reconstruction technique for multiphase CT (MCT) exams that spatially registers the multiple phases and uses them collectively to inform the image reconstruction and reduce image noise. We evaluated PIR in contrast-enhanced MCT imaging of the liver.

METHOD AND MATERIALS

Patients with archived projection MCT data with proven malignant or benign liver lesions by reference criteria were included. Reference criteria for malignancy included histopathology or progression/regression, with stability on CT/MR > 6 months required for benign lesions. A validated noise insertion tool created reduced dose MCT images (50% dose in 2 phases, 25% dose in 1 phase). For each patient, the phase of enhancement most relevant to the diagnostic task was selected for evaluation. Four abdominal radiologists reviewed routine dose and lower dose PIR images in randomized and blinded fashion in two reading sessions, interpreting a patient's images once/session, and marking benign and malignant lesions, rating confidence for malignancy, and scoring image quality metrics. JAFROC Figures of Merit (FOM) were calculated for each dose/reconstruction using -0.10 as a limit of non-inferiority.

RESULTS

30 patients with 27 primary liver malignancies, 6 metastases, and 26 benign lesions were included. Pooled JAFROC FOM for malignancy for routine dose MCT was 0.615 (95% CI: 0.464, 0.767) compared to 0.662 for PIR (95% CI: 0.527, 0.797). The estimated difference between the routine dose and lower dose PIR images was + 0.047 (95% C.I.: -0.023, + 0.116). GEE sensitivity and specificity for routine dose images was 70%/68% compared to 73%/66% for lower dose PIR. Lower dose PIR had lower diagnostic image quality (mean 3.8 vs. 4.2, p = 0.0009) and was less sharp (mean 2.3 vs. 2.0, p = 0.0071).

CONCLUSION

PIR is a promising method to substantially reduce radiation dose for multiphase contrast-enhanced abdominal CT, preserving observer performance despite small reductions in image quality. Further work to develop and validate this technique is warranted.

CLINICAL RELEVANCE/APPLICATION

While multiphase CT is of great diagnostic importance, radiation is of concern. PIR is a promising method to reduce radiation dose while maintaining observer performance for multiphase exams.

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SSQ08-06 Prospective Colorectal Hepatic Metastases Detection in Abdominal CT Between Reduced Radiation Dose ASIR-V and Standard Dose FBP Including Reader Confidence, Characterization and Comparison to ASIR/MBIR

Thursday, Nov. 29 11:20AM - 11:30AM Room: E352

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PURPOSE

To prospectively evaluate colorectal cancer (CRC) hepatic metastasis detection and characterization between reduced-dose (RD) and standard dose (SD) contrast-enhanced CT (CECT) of the abdomen and to qualitatively compare between reconstruction algorithms.

METHOD AND MATERIALS

Fifty-one adults with biopsy-proven CRC and hepatic metastases by prior CT underwent portal venous phase SD-CECT followed by RD-CECT in the same breathhold. Three readers, blinded to reconstruction details and comparison examinations, performed detection and characterization of lesions 2-15 mm in size on the SD filtered back projection (SD FBP) and RD adaptive statistical iterative reconstruction-V 60 % (ASIR-V 60%) series. Readers then qualitatively assessed overall image quality and lesions side-by-side between 8 different reconstructions (SD FBP, SD ASIR 80%, SD ASIR-V 30%, SD ASIR-V 60% and RD model-based iterative reconstruction (MBIR), RD ASIR 80%, RD ASIR-V 30%, RD ASIR-V 60%) on a 0 to -4 Likert scale with 0 being best. Two, non-blinded consensus reviewers established the reference standard.

RESULTS

RD-CECT mean CTDIvol was 11.77 ± 3.28 mGy resulting in a mean radiation dose reduction of 53.86% compared to SD-CECT. Of the 260 lesions detected by reference standard (233 metastatic; 27 benign), RD-CECT only detected 82% of lesions, while SD-CECT detected 97% of lesions ($p<0.0001$); pooled data demonstrated a sensitivity of 0.79 and 0.93 ($p<0.0001$) and accuracy of 0.75 and 0.84 ($p=0.0005$), respectively. Mean qualitative scores for each series, in order from best to worst, were SD ASIR-V 60%, SD ASIR-V 30%, SD ASIR 80%, SD FBP, RD ASIR-V 60%, RD ASIR-V 30%, RD ASIR 80%, and RD MBIR.

CONCLUSION

Reduced radiation dose CECT demonstrates inferior diagnostic performance for detecting low-contrast liver lesions. Qualitative image evaluation suggests that performance of the RD scan may have been worse had FBP, ASIR or a lower percentage ASIR-V been utilized; the findings also suggest that SD exams benefit from iterative reconstructions.

CLINICAL RELEVANCE/APPLICATION

Oncologic CT evaluation of low contrast liver lesions is compromised in the setting of modest radiation dose reduction and iterative reconstructions appear to only partially mitigate this reduced performance. If the clinical task requires the detection of possible small, low-contrast liver lesions, proper radiation dose levels should be maintained with reference to the ACR dose index registry.

SSQ08-07 Comparison of Iterative Model-Based Reconstruction (IMR) with Hybrid Iterative Reconstruction (iDose-4) Technique for Assessing Small Hypervascular Hepatocellular Carcinomas Using Low Tube Voltage 256 Slice Multi-Detector Computed Tomography

Thursday, Nov. 29 11:30AM - 11:40AM Room: E352

Participants
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PURPOSE

To compare iterative model-based reconstruction (IMR) with hybrid iterative reconstruction (iDose-4) technique for assessing small hypervascular hepatocellular carcinomas (HCCs) using low-tube voltage (100 kVp) 256 slice multi-detector Computed Tomography scans.

METHOD AND MATERIALS

We prospectively evaluated 50 patients (Male:Female:45:5;average age- 60.68yrs) with 50 HCCs (3cm or less) between January 2016-December 2017,who underwent standard multiphase CT(HCC protocol) using 256 slice CT.Arterial phase (AP) was taken with 100kVp,two delayed phases(DP) at 90sec (100kVp,IMR) and 104sec (120 kVp,iDose-4) respectively. Reconstructed images with iDose-4,IMR were evaluated for tumor conspicuity, image noise.For subjective analysis,tumor conspicuity is graded on a 5-point scale on the AP and DP,with 5(definitely distinct),4(fairly distinct),3(moderately distinct,2(barely distinct), and 1(not distinct).Subjective image noise with diagnostic confidence is graded as follows:5(well seen with minimum/no noise),4(mild noise with high diagnostic confidence),3(average noise with moderate diagnostic confidence),2(above average noise with low diagnostic confidence),and 1(unacceptable noise).

RESULTS

Contrast-to-noise ratio of HCCs (CNR-HCC) in AP was significantly higher in IMR (9.1+/-6.6) compared to iDose-4 (5.6+/-3.5) , $P<0.0001$. CNR-HCC in DP was significantly higher in IMR (2.5+/-2.1) compared to iDose-4(1.7+/-1.4), $P<0.0001$. Image noise was significantly lower in IMR (arterial-6.8+/-3.7; delayed-7.4+/-4.2) than in iDose-4 (arterial-9.8+/-3.4; delayed-9.3+/-3.2), in both AP ($P<0.0001$) and DP ($P<0.0001$).The subjective analysis showed that, tumor conspicuity was significantly better in IMR both in AP(IMR-4.8+/-0.3; iDose-4 -4.3+/-0.5 ,$P=0.012$) and DP (IMR-4.8+/-0.4 ; iDose-4 -4.5+/-0.5, $P=0.001$) with the good interobserver agreement (kappa value for IMR: AP-0.78; DP-0.86,and iDose-4:AP-0.91, DP-0.91).The subjective analysis also showed that Image noise was significantly lower both in AP (IMR-4.8+/-0.3; iDose-4 -3.9+/-0.2, $P=0.0004$) and DP (IMR-4.8+/-0.4; iDose-4 -4.1+/-0.3, $P=0.04$) with the good interobserver agreement (kappa value for IMR:AP-0.81, DP-0.85,and iDose-4: AP-0.77,DP- 0.78).

CONCLUSION

IMR provides better tumor conspicuity than iDose-4 for small HCCs with a considerable decrease in noise, even at low kVp.

CLINICAL RELEVANCE/APPLICATION

IMR confidently detects small HCCs,even with low kVp CT and can positively impact treatment.

SSQ08-08 Participants Quantitative Comparison of Metal Artifact Reduction Techniques in Abdominopelvic CT

Thursday, Nov. 29 11:40AM - 11:50AM Room: E352

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PURPOSE

To compare the performance of various metal artifact reduction (MAR) approaches for different metals on low-tube voltage single energy CT, and dual-energy CT exams.

METHOD AND MATERIALS

In this phantom study, seven metal implants from titanium [Ti] or cobalt chromium [CoCr] (n=2 hip prosthesis, n=2 embolization coil, and n=3 spinal hardware) were suspended, sequentially, in an iodinated gelatin medium (0.4%; CT density 40-50HU). The phantom was scanned on three CT scanners (Somatom Definition Flash (scanner A) and Edge (scanner B); Siemens HC, and Discovery 750HD (scanner C); GE HC) using SECT (120/100/80kVp), and DECT (80/140 kVp) acquisitions. SECT images and high-energy (110-140keV) VMC images from DECT were reconstructed with and without vendor-specific MAR algorithms (iMAR; Siemens HC, and MARS; GE HC). Metal-related artifacts/noise (SD) was measured in the near (<3cm) and far (>3cm) fields. Differences among MAR approaches were tested using ANOVA.

RESULTS

Metal-related noise was comparable for Ti and CoCr on 120kVp images from all scanners (p=0.23), except on scanner C, where lower near-field noise was observed for Ti (48±12SD vs. 122±24SD; p<0.01). Higher near- and far-field noise on low-kVp images (37-54%) decreased substantially (63-72%) when using different modes of iMAR (p<0.001). High-keV VMC reduced both near- (16 to 32%) and far-field noise (32-41%) for both metals, with a slight variability between vendors. MARS (on scanner C) showed significant near-field noise reduction (59-91%) for both metals when added to VMC images (p<0.001). However, no effect on far-field noise was observed for Ti (14±8 vs. 13±1SD; p=0.51).

CONCLUSION

CT platforms from different vendors show variable metal-related noise, depending on the metal type. MAR algorithms applied to 80 or 100kVp have significant benefit for noise/artifact reduction and yield lower noise than 120kVp without MAR. While high-keV VMC alone reduce metal-related noise, further reduction is achieved by including MAR algorithms.

CLINICAL RELEVANCE/APPLICATION

Knowledge about existing MAR-approaches is desired for consistent IQ across vendors and to use MAR algorithms tailored to specific types of metallic implants.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Dushyant V. Sahani, MD - 2012 Honored EducatorDushyant V. Sahani, MD - 2015 Honored EducatorDushyant V. Sahani, MD - 2016 Honored EducatorDushyant V. Sahani, MD - 2017 Honored Educator

SSQ08-09 Reducing Bowel Peristalsis Artifact with Dual-Energy CT: A Phantom Study Across Multiple Dual-Energy CT Platforms

Thursday, Nov. 29 11:50AM - 12:00PM Room: E352

Participants
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PURPOSE

The purpose of this study was to evaluate the ability of different dual-energy CT (DECT) platforms to reduce peristalsis artifact in a bowel phantom.

METHOD AND MATERIALS

In a water filled cylinder we placed a z-direction 1.7 Hz oscillating air filled 3 cm diameter corrugated tube to simulate peristalsing bowel. We scanned the phantom at similar CTDIvol 5 times on each of four different DECT platforms: spectral-detector (SD), rapid-

kVp-switching (RS), split-filter (SF) and dual-source (DS) DECT. Material decomposition (iodine and virtual unenhanced (VUE)) and 120 kVp-like images were reconstructed. On 50 random slices for each scanner, both material decomposition images and 120 kVp-like images were rated for overall artifacts (4-Point Likert-scale: none (0), mild (1), moderate (2), severe (3)) on 50 random slices. The value of material decomposition images to assess pseudoenhancement was rated (reveals pseudoenhancement (0), no added value (1), falsely confirms true enhancement (2)). Comparisons between images and scanners were made using ANOVA with Bonferroni correction.

RESULTS

120kVp-equivalent images showed moderate to severe artifacts on all 4 DECT platforms, but were less severe for the DS (1.5±0.84) and SF (1.72±0.78) systems than for SD (2.56±0.73, $p<0.001$) and RS (2.52±0.65, $p<0.001$). Peristalsis artifacts were markedly reduced in iodine images for SD- (1.00±0.08, $p<0.001$) and RS-DECT (1.34±0.07, $p<0.001$), and were unchanged or worse on the VUE images. For DS and SF-DECT artifacts were more severe on both the iodine (2.36±0.14 & 2.6±0.09, respectively) and VUE images (2.38±0.14 & 2.62±0.09, respectively) ($p<0.001$ for each). Iodine images helped reveal true from pseudoenhancement on SL-detector and RS-DECT on all evaluated slices, but at DS and SF-DECT did not exclude pseudoenhancement.

CONCLUSION

DECT scanners reduce bowel peristalsis artifact. For SD and RS-DECT, iodine images minimize peristalsis artifact and reveals artificial hyperdensities as pseudoenhancement. For DS and SF-DECT, mixed 120 kVp-like images are preferred. Inter-scanner differences likely relate to geometry and postprocessing.

CLINICAL RELEVANCE/APPLICATION

Peristalsis artifact reduction is a valuable benefit of DECT, knowledge of scanner-type allows for selection of appropriate image reconstructions to minimize artifact and associated pseudoenhancement.

SSQ09

Genitourinary (Functional Renal Imaging)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S103CD

GI GU MR

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

Participants
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Sub-Events

SSQ09-01 T1ρ Mapping for Assessment of Fibrosis in Renal Allografts

Thursday, Nov. 29 10:30AM - 10:40AM Room: S103CD

Participants
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PURPOSE

To investigate the utility of T1ρ MRI for the assessment of fibrosis in renal allografts.

METHOD AND MATERIALS

T1ρ imaging was performed at 1.5T in 15 patients with stable functional allograft (M/F 9/6, mean age 56y) and 10 patients with chronic dysfunctional fibrotic allograft (M/F 4/6, mean age 50y). Repeatability of the T1ρ measurement, as determined by coefficient of variation (CV) measurements, was tested in 4 patients. Average T1ρ values in ROIs in the cortex and medulla were quantified. Differences in T1ρ values between the groups were assessed using Student t-tests. ROC analysis was employed to determine the diagnostic performance of T1ρ for differentiation between functional and fibrotic allografts. In 12 patients who had renal biopsy within one year of the MRI exam, quantitative analysis of Masson's trichrome stained sections was performed to determine collagen content. The correlation between T1ρ and Masson's trichrome stained fractions was assessed using Spearman correlation analysis.

RESULTS

T1ρ measurements were more repeatable in the cortex than in the medulla (mean CV T1ρ cortex 6.4%, medulla 14.6%). While T1ρ values were not significantly different between functional and fibrotic allografts in the medulla (T1ρ medulla functional 122.6±20.8 ms, fibrotic 128.0±16.9 ms, P=0.503), significant differences were observed in the cortex (T1ρ cortex functional 99.0±11.0 ms, fibrotic 113.3±17.6 ms, P=0.020). ROC analysis showed an AUC of 0.80 (sensitivity 80.0%, specificity 86.7%, T1ρ threshold 106.9 ms) for differentiation between functional and fibrotic allografts. Cortical T1ρ was significantly associated with Masson's trichrome stained fractions (r=0.629, P=0.032).

CONCLUSION

In this preliminary study, we observed significant elevation of cortical T1ρ in fibrotic renal transplants. The significant correlation between cortical T1ρ and Masson's trichrome stained fraction suggests a direct association of cortical T1ρ with collagen content.

CLINICAL RELEVANCE/APPLICATION

T1ρ may be a suitable MRI biomarker for noninvasive assessment of fibrosis in renal transplants.

SSQ09-02 T1-Mapping and Diffusion-Weighted Imaging for Evaluation of Chronic Renal Allograft Rejection in a Translational Mouse Model

Thursday, Nov. 29 10:40AM - 10:50AM Room: S103CD

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PURPOSE

Non-invasive assessment of renal pathology in a mouse model of chronic rejection after allogenic and isogenic kidney transplantation (ktx) using T1-mapping und diffusion-weighted imaging (DWI).

METHOD AND MATERIALS

Chronic rejection was induced by allogenic transplantation of BALB/c-kidneys into C57BL/6-mice with short ischemia times (n=13). Mice after isogenic ktx without rejection (n=8) and non-transplanted, healthy animals (n=22) served as control group. Using a 7T MRI system respiratory-gated DWI- (7 b-values, 0-800 s/mm2) and inversion recovery EPI-sequences (13 inversion times, 30-8000 ms) were acquired 3 and 6 weeks after ktx and in healthy controls. T1-relaxation times and apparent diffusion coefficients (ADCs) were calculated. Mean values and the heterogeneity of parameters within kidneys were determined using ROI- and histogram-based analysis. MRI results were compared to histopathological analysis of inflammation and fibrosis.

RESULTS

Chronic rejection after allogenic ktx was associated with a significant prolongation of T1-relexation time after 3 (1995 vs 1457 ms, p<0.001) and 6 weeks (1899 vs 1397 ms, p<0.001) compared to isogenic kidney grafts. Mean ADC after isogenic and allogenic ktx was similarly reduced compared to healthy controls (week 3: 1.27 and 1.41*10-3 mm2/s vs 1.61*10-3 mm2/s, week 6: 1.39 and 1.44*10-3 mm2/s vs 1.61*10-3 mm2/s). However, in the allogenic group, increased heterogeneity of ADC-values was observed compared to isogenic kidneys (standard derivation, entropy and interquartile range, p<0.001). In accordance with MRI results, only allogenic kidney grafts showed serve inflammation and graft fibrosis (p<0.001 vs controls and isogenic ktx).

CONCLUSION

T1-mapping und DWI enable assessment of renal pathologies in chronic renal allograft rejection. The combined quantitative assessment of mean values and data heterogeneity provides additional information on renal allograft pathology.

CLINICAL RELEVANCE/APPLICATION

Functional MRI allows assessment and monitoring of chronic renal allograft rejection. In patients, it may refine characterization of renal allograft pathology and help to improve patient management.

SSQ09-03 Multiparametric MRI of Renal Transplant: Preliminary Comparison of Advanced MRI Parameters in Renal Transplant Patients with Stable Allograft Function and Chronic Allograft Dysfunction with Established Fibrosis

Thursday, Nov. 29 10:50AM - 11:00AM Room: S103CD

Participants
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PURPOSE

The goal of our study is to develop a quantitative multiparametric MRI (mpMRI) protocol for the evaluation of renal transplant fibrosis.

METHOD AND MATERIALS

25 patients including 15 with functional renal allografts (M/F 9/6, mean age 55y, MDRD serum eGFR 47.6-87 ml/min/1.73m2) and 10 with chronic dysfunction and fibrosis (M/F 4/6, mean age 50y, eGFR 11.8-62.7 ml/min/1.73 m2, biopsy 150 ± 48 d before MRI) were enrolled in this prospective study. All patients underwent mpMRI at 1.5T (Aera, Siemens) including intravoxel-incoherent motion DWI (IVIM-DWI), diffusion tensor imaging (DTI), blood oxygen level dependent (BOLD) and T1 mapping. Parameters were measured from circular ROIs placed in the cortex (Cx) and medulla (Med) at the upper, middle and lower renal Tx poles. IVIM-DWI parameters (true diffusion D, pseudodiffusion D*, perfusion fraction PF) were obtained by Bayesian fitting. Corticomedullary differences [100 x (cortex-medulla)/cortex] in ADC (ΔADC), FA (ΔFA), R2* (ΔR2*), and T1 (ΔT1), were calculated. Banff scores ci for interstitial fibrosis (IF), ct for tubular atrophy (TA) and iIFTA for inflammation in area of IF/TA were evaluated by an expert renal pathologist on biopsies from 13 patients (stable/fibrosis 4/9).

RESULTS

Cx ADC (functional/fibrosis 2.10±0.14/1.90±0.15 10-3 mm2/s, p=0.006) and D (functional/fibrosis 1.78±0.16/1.65±0.18 10-3

Cx ADC (functional/fibrosis 2.10±0.14/1.90±0.15 10-3 mm2/s, p=0.006) and D (functional/fibrosis 1.78±0.16/1.65±0.18 10-3 mm2/s, p=0.033) as well as Med ADC (functional/fibrosis 2.07±0.11/1.90±0.13 10-3 mm2/s, p=0.006) were significantly decreased in fibrotic allografts. Cx T1 was significantly elevated (functional/fibrosis 1149.34±185.10/1354.53±226.8ms,p=0.038) and ΔT1 significantly decreased (-36.95±15.14/-11.52±14.62 %,p=0.0031) in fibrotic allografts. Cx D was negatively correlated with ci (Fig. 1; Spearman's r=-0.64, p=0.017), and T1 had a strong positive correlation to ct (Fig. 1; r=0.72, p=0.008).

CONCLUSION

Our study confirms earlier findings of decreased diffusion parameters and ΔT1 with renal allograft fibrosis. The negative correlation of true diffusion coefficient D with IF shows restricted water diffusion due to collagen deposition in fibrosis, while the positive correlation of T1 with the TA score shows prolonged T1 in the context of edema and inflammation associated with TA.

CLINICAL RELEVANCE/APPLICATION

IVIM-DWI and T1 parameters are sensitive to renal allograft fibrosis. The value of MRI metrics in combination for characterizing renal transplant fibrosis will be confirmed in a larger study.

SSQ09-04 High Renal Donor Visceral Adipose Tissue Predicts Decreased Donor Recovery of Function and Functional Decline

Thursday, Nov. 29 11:00AM - 11:10AM Room: S103CD

Participants
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PURPOSE

High donor Body Mass Index (BMI) has long been recognized as a risk factor for adverse outcomes in kidney donation. Recent data has shown a significant short-term decline in donor renal function in patients with an elevated visceral adipose tissue (VAT) to subcutaneous adipose tissue ratio on preoperative computerized tomography (CT). We evaluated the relationship between donor VAT with histologic changes in the renal allograft and mid-term renal function decline.

METHOD AND MATERIALS

VAT was measured on pre-donation CT scans at a single lumbar level in 210 donors from 2010 to 2015 using semiautomated segmentation (Terarecon). Kidney histology, obtained from implant biopsy during transplant, was available in 162 patients. Chronic histologic change was defined as the presence of at least 2 of the following 3 features: > 5% global glomerulosclerosis, interstitial fibrosis, or arteriosclerosis. The decline in renal function from pre-donation to 2 years post-donation was assessed using estimated glomerular filtration rate (eGFR) with paired T-testing, repeated measures analysis (MANOVA), and linear regression analyses.

RESULTS

Mean donor age was 42 and 60% were female. Mean BMI and VAT were 27±3 kg/m2 and 96±64 cm2, respectively. On univariate linear regression, there was a significant association between elevated VAT and decreased recovery of donor renal function, ($p < 0.0001$, Figure). On MANOVA, high VAT predicted decreased renal recovery at 1, 6, 12, and 24 months (p=0.03). Biopsies from donors with high VAT were more likely to have chronic histologic changes than donors with low VAT ($p < 0.001$). On univariate analyses both BMI and VAT were associated with chronic histologic change and decreased renal function recovery, however, on multivariate analyses VAT remained independently associated with both outcomes, while BMI did not.

CONCLUSION

Preoperative VAT appears to be a more significant indicator of renal decline in living donors than BMI. This is further evidenced by the chronic histologic changes seen in kidneys from donors with high VAT. Morphometrics, including the measurement of VAT, should be incorporated into the standard preoperative evaluation of potential kidney donors.

CLINICAL RELEVANCE/APPLICATION

Elevated preoperative VAT leads to decreased post-operative renal recovery and biopsy findings of chronic histological changes.

SSQ09-05 Preliminary Application of Incoherent Motion Diffusion Weighted Imaging (IVIM) in Renal Function Assessment of Diabetic Nephropathy

Thursday, Nov. 29 11:10AM - 11:20AM Room: S103CD

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PURPOSE

To evaluate renal function impairment in patients with diabetic nephropathy using IVIM technology.

METHOD AND MATERIALS

20 patients(average age 56.60±9.38)with clinically diagnosed diabetic nephropathy were enrolled as the observation group, and 20 healthy volunteers(57.60±6.08)as the control group. All diabetic nephropathy patients were enrolled according to laboratory tests of glomerular filtration rate (eGFR) before admission.The IVIM(b=0,50,100,150,200,400,600,800sec/mm²)and Diffusion weighted imaging(DWI,b=50,800 sec/mm²) sequence were obtained on a 3T scanner(Skyra, Siemens Healthineers). A total of 12 regions of interest were drawn for each subject in the cortex and medulla region of the upper pole, the renal hilum and the lower pole of the kidneys.The average value of all results is taken to ensure consistency of measurement results.ADC map was automatically generated on the Siemens MRWP workstation after DWI sequence executed. IVIM parameters(ADC,D,f and D* values) were generated by using a prototype software body diffusion toolbox(Siemens healthineers). A two-sample t-test was used to compare the difference in ADC,D, f, and D* values between the two groups of the cortex and medulla of the observation group and the control group. The Pearson correlation analysis was performed to determine the relationship between the ADC, D, f, and D* values in patients with diabetic nephropathy and eGFR.

RESULTS

In the two groups, the ADC, D, f, and D* values of the renal cortex were higher than that in medulla. Compared with the control group, the ADC, D, F, and D* values of the renal cortex and medulla in the observation group were all decreased, with statistical significance ($p<0.0001$) (Figure 1,Table 1).ADC,D,F and D* values in patients with diabetic nephropathy were positively correlated with glomerular filtration rate. ($p<0.0001$) (Figure 2).

CONCLUSION

IVIM is feasible in the examination of diabetic nephropathy. IVIM can supply useful information for kidney damage cause by diabetic nephropathy. Combined with the eGFR, the progress of diabetic nephropathy can be monitored.

CLINICAL RELEVANCE/APPLICATION

IVIM can help provide a more scientific basis for clinical changes in diabetic nephropathy, reflect the changes in microstructure, and have potential application value in the evaluation of renal function.

SSQ09-06 Magnetic Resonance Magnetization Transfer Imaging in Patients with Diabetic Nephropathy

Thursday, Nov. 29 11:20AM - 11:30AM Room: S103CD

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PURPOSE

Magnetization transfer(MT)technique used in the evaluation of renal function in patients with diabetic nephropathy.

METHOD AND MATERIALS

Two-kidney gradient echo sequence (GRE) imaging was performed on 40 subjects (including 20 patients with clinically diagnosed diabetic nephropathy and 20 healthy subjects) using Siemens Skyra 3.0 T MRI scanner. MT study was conducted using a 3D fast low angle shot(FLASH) sequence, this sequence was run two times; first one without a MT saturation pulse(MToff), second one with a MT(MTon) saturation pulse. For MT imaging postprocessing, MTR =(MToff-MTon)×100/MToff, MTR values were expressed in percentage units.The magnetization transfer rate (MTR) of the renal cortex and medulla 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.A two-sample t-test was used for statistical analysis. The glomerular filtration rate (eGFR) for diabetic nephropathy patients was recorded and correlation between MTR and eGFR was analysed.

RESULTS

eGFR was significantly reduced in patients with diabetic nephropathy compared to healthy controls. The renal cortical MTR of the diabetic nephropathy group (824.15±77.45)%, was significantly higher than healthy control group(572.60±59.18)% ($P<0.0001$) (Figure 1,Table 1); there was no significant difference about renal medullar MTR between patient and normal groups. Pearson correlation analysis showed that there was a significant correlation between MTR and eGFR in renal cortex of diabetic nephropathy renal cortical($r=-0.880$, $P<0.0001$) (Figure 2).

CONCLUSION

Renal cortical MTR was higher in diabetic nephropathy patients than control subjects, and which has a certain correlation with eGFR.There was no significant change in the medulla MTR between patient and control groups.

CLINICAL RELEVANCE/APPLICATION

MT can provide non-invasive information about renal function, reflect the changes in microstructure.MTR may be a potential use as a observation index during clinical treatment.

SSQ09-07 DTI of the Kidney in Healthy Controls and in Patients with ARPKD

Thursday, Nov. 29 11:30AM - 11:40AM Room: S103CD

Participants

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PURPOSE

Diffusion tensor imaging (DTI) has the potential to quantitatively assess the microstructure and morphology of tissues, including kidney. Fractional anisotropy (FA) describes the degree of anisotropy reflecting the fiber density and axonal diameter. Autosomal recessive polycystic disease (ARPKD) causes displacement of coherent renal fiber orientation, which can potentially be measured using DTI. Our aim was to evaluate the feasibility of using DTI and its derived FA values to compare normal controls and patients with ARPKD.

METHOD AND MATERIALS

In this IRB-approved study, we evaluated the use of DTI to compare FA values in 'healthy' controls (patients with no history of renal disease) vs patients with ARPKD. A 20 direction DTI with b-values of b=0 and b=400 s/mm2 was used to acquire data in coronal direction using a fat-suppressed spin-echo echo-planar sequence (TR/TE 2600-3600/64-74 msec). A slice thickness of 4 mm, a matrix size of 128x96, acceleration factor of 2, and a bandwidth of 1698 Hz/pixel were used. For the DTI analysis and segmentation, Diffusion Toolkit version 0.6 and TrackVis version 0.6 were used. Tractography was reconstructed using a deterministic fiber tracking algorithm with a minimum FA threshold of 0.10 and a maximum turning angle of 55° between two adjacent voxels based on published parameters for renal tractography. TrackVis was used to draw ROI covering the entire volume of the renal parenchyma, excluding the collecting system by evaluating the anatomical images, ADC and FA maps. These images were used to avoid problems of alignment related to patient motion in-between sequences. The FA values based on the ROI data, and the mean length and volume of the tracks based on the fiber track data were exported.

RESULTS

14 healthy controls with no known history of renal disease (mean age = 9.5 years ± 3.7; 11/14 females; mean FA =0.47) and 8 patients with ARPKD (mean age = 15.5 years ± 4.7; 2/8 females; mean FA = 0.25) were included in the study. FA values were significantly lower in patients with ARPKD versus controls ($p<0.0001$) (Figure 1).

CONCLUSION

DTI was feasible and successfully performed on kidneys of patients with renal disease. Significantly lower FA values were observed in patients with ARPKD as compared to patients with normal renal function.

CLINICAL RELEVANCE/APPLICATION

DTI of the kidney offers a novel approach for detecting renal disease based on changes in diffusion anisotropy.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Kassa Darge, MD,PhD - 2016 Honored Educator

SSQ09-08 Magnetic Resonance T2 Mapping Derived Kidney Parenchyma T2 as a Novel Imaging Biomarker for Monitoring Disease Severity in Patients with Autosomal-Dominant Polycystic Kidney Disease (ADPKD)

Thursday, Nov. 29 11:40AM - 11:50AM Room: S103CD

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

To evaluate whether magnetic resonance T2 mapping of the kidneys can deliver novel and rapidly assessable quantitative imaging biomarkers for monitoring disease severity in patients with ADPKD.

METHOD AND MATERIALS

One-hundred forty-one ADPKD patients from the AD(H)PKD registry and 10 healthy controls underwent magnetic resonance imaging on a clinical 1.5T system. Height-adjusted total kidney volume (htTKV) was calculated on axial T2-weighted images using a standard post-processing platform. T2 mapping was acquired using a Gradient-Spin-Echo (GraSE) T2 mapping sequence covering both kidneys. Kidney cyst fraction and mean T2 relaxation times of both kidneys (kidney-T2) were calculated using a plugin for Osirix. For calculation of T2 times of the residual kidney parenchyma (parenchyma-T2), a region of interest (ROI) was manually placed at 3 distinct slices per kidney and results were averaged over all 6 ROIs. ADPKD patients were divided into 3 groups

according to kidney cyst fraction (<35%, 36-70%, >70%) as a surrogate marker for disease severity and Glomerular filtration rate (GFR) was recorded.

RESULTS

Calculation of parenchyma-T2 was 6- to 10-fold faster than calculation of htTKV and kidney-T2 (0.78 ± 0.14 vs. 4.78 ± 1.17 min., p<.001; 0.78 ± 0.14 vs. 7.59 ± 1.57 min., p<.001). Parenchyma-T2 showed a similar strong correlation to cyst fraction (r=0.77, p<.001) as kidney-T2 (r=0.76, p<.001) and allowed for the most distinct separation of patient groups divided according to cyst fraction (Fig. 1A). In contrast, htTKV showed an only moderate correlation to cyst fraction (r=0.48, p<.001) and did not allow for clear group separation (Fig. 1A). These observations were even clearer when considering only patients with preserved kidney function (GFR > 90 ml/min/m2; n=47; Fig. 1B) with similar correlations to cyst fraction (parenchyma-T2: r=0.81; kidney-T2: r=0.79; htTKV: r=0.48, p<.001 for all).

CONCLUSION

T2 mapping provides interesting novel parameters with potential to serve as quantitative imaging biomarkers in ADPKD. Especially the rapidly assessable parenchyma-T2 shows a strong association with disease severity and is far superior to the established imaging biomarker htTKV.

CLINICAL RELEVANCE/APPLICATION

Parenchyma-T2 has potential to serve as a novel imaging biomarker in ADPKD and should be examined in future studies with respect to its predictive value for disease progression.

SSQ09-09 Assessment of Renal Fibrosis in a Rat Model of Unilateral Ureteral Obstruction with Diffusion Kurtosis Imaging: Comparison with a-SMA Expression and 18F-FDG PET

Thursday, Nov. 29 11:50AM - 12:00PM Room: S103CD

Participants
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PURPOSE

To investigate the utility of diffusional kurtosis imaging (DKI) magnetic resonance imaging (MRI) in evaluation of renal fibrosis in rats with unilateral ureteral obstruction (UUO).

METHOD AND MATERIALS

Eighteen rats had UUO that was created by complete ligation of the left ureter and three normal rats without UUO were included as control. DKI was performed on a 3.0T MRI scanner before ligation and on days 1, 3, 5, and 7 after ligation. All rats then underwent 18F-fluorodeoxyglucose (FDG) dynamic positron emission tomography (PET) to evaluate metabolic activity in the kidneys, followed by histological analysis to examine a-smooth muscle actin (a-SMA) expression. DKI metrics were assessed among the time points and between both sides, and they were compared with renal function index standardized uptake value (SUV) and expression of the fibrosis marker a-SMA.

RESULTS

The axial kurtosis (Ka) on days 3 and 7, mean diffusivity (MD) on days 1 and 3, and fractional anisotropy (FA) on days 5 and 7 of cortex and medulla between the UUO sides and contralateral sides were significantly different. The medulla MD and FA of the UUO sides on days 1, 3, 5 and 7 were significantly lower than those of normal control group (all $P < .05$). FA of medulla was positively correlated with SUV ($r = 0.826$, $P < .001$), and MD of cortex was negatively correlated with a-SMA expression on the UUO sides ($r = -0.661$, $P = .002$).

CONCLUSION

DKI shows high potential in noninvasive assessment of renal fibrosis induced by UUO.

CLINICAL RELEVANCE/APPLICATION

DKI metrics may be useful noninvasive biomarkers for monitoring the severity of renal fibrosis in patients with chronic kidney disease.

SSQ10

Genitourinary (New Techniques in Prostate Imaging and Intervention)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S102CD

GU MR

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

Participants
Aytekin Oto, MD, Chicago, IL (*Moderator*) Research Grant, Koninklijke Philips NV; Research Grant, Guerbet SA; Research Grant, Profound Medical Inc; Medical Advisory Board, Profound Medical Inc; Consultant, AbbVie Inc; ;
Aradhana M. Venkatesan, MD, Houston, TX (*Moderator*) Research Grant, Canon Medical Systems Corporation;

Sub-Events

SSQ10-01 Machine Learning and Radiomics Applied to Multiparametric MR in the Prediction of Prostate Pathology in PI-RADS 3/5 Patients

Thursday, Nov. 29 10:30AM - 10:40AM Room: S102CD

Participants
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PURPOSE

The purpose of this study is to assess the clinical relevance of focal prostate lesions complementing the PI-RADS scoring method using a Radiomic approach and machine learning systems.

METHOD AND MATERIALS

94 patients with a Contrast Enhanced (CE) multiparametric prostate MR (mpMR) and lesions covering all the PI-RADS score range were collected from the hospital archive. For all the lesions a confirmative biopsy was available. 23 out of 94 patients with PI-RADS score 3/5 (7 malignant and 16 benign) were selected form preliminary tests. PI-RADS score 3/5 represents an intermediate condition associated to diagnostic uncertainty. In this pilot study the analysis was limited to T2 weighted (T2w) and CE sequences. Parametric maps were calculated from CE sequences to spatially characterize the wash in/wash out curves. 700 imaging features were extracted using the PyRadiomics platform from T2w images and parametric maps. Shape, texture and intensity based features were calculated. Using a genetic search method the most discriminating subsets of features were identified using four ML systems: linear discriminant analysis (LDA), k-nearest neighbour (kNN), naive Bayes classifier (NB) and C4.5 decision tree. Classification accuracy was evaluated by 5 fold cross-validation.

RESULTS

LDA showed the best performances with 100% sensitivity and 94% specificity. KNN, ND and C4.5 provided 86%, 86% and 71% sensitivity and 100% specificity. Selected features derived both from T2w images and from parametric maps. In particular average and maximum enhancement maps and time-to-peak maps seems to provide the most useful information.

CONCLUSION

Preliminary analysis limited to patients with PI-RADS 3/5 score (n=23) showed promising results, encouraging further development of a Radiomic approach complementing the PI-RADS scoring method.

CLINICAL RELEVANCE/APPLICATION

The identification of malignancy within suspicious prostatic lesions classified by the proposed mpMR radiomic approach can improve the diagnostic workflow while minimizing procedure invasiveness.

SSQ10-03 Manual Versus Robotic Assisted MRI Guided Prostate Biopsies

Thursday, Nov. 29 10:50AM - 11:00AM Room: S102CD

Participants
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PURPOSE

To compare the procedure time and the percentage of positive samples per prostate cancer (PC) patient between manual and robotic in-bore MR guided prostate biopsy (MR-PB).

METHOD AND MATERIALS

All consecutive in-bore MR-PB performed in our Institution between January 2015 and March 2018 using either a manual or robotic device were retrospectively analyzed and grouped as follows: Group 1, the first 30 consecutive MR-PBs using a manual device (n=30); Group 2, the last 30 MR-PBs performed using the manual device after 2 years of experience (n=30); Group 3, the first 27 biopsies using a robotic device (n=27). The same 1.5 T MRI scanner was used for all MR-PBs. For each of the three groups, we calculated the overall procedure time, time to first biopsy and time for every additional sample, as well as the percentage of positive cores in patients who were diagnosed with PC.

RESULTS

Average overall procedure time was 57.5min (Interquartile range -IQR-: 47-63.5min; Group 1), 37.7min (IQR:31-43min; Group 2) and 31.1min (IQR:27.3-35min; Group 3); average time to first biopsy was respectively 29.4min, 22.5min and 26.5min; average time for every additional sample was 9.5min, 4.9min and 3.8min. 12 patients were positive for PC in Group 1 (average core involvement 44.6%), 19 in Group 2 (average core involvement 52.3%) and 16 in Group 3 (average core involvement 52.1%), with a percentage of positive cores per PC patient of 76.31%, 73.7% and 83.8%, respectively.

CONCLUSION

MR-PB using a robotic device decreased procedure time and increased the percentage of positive cores per PC patient. This has the potential to improve patient comfort as well as PC characterization in clinical practice.

CLINICAL RELEVANCE/APPLICATION

Robotic devices for in-bore MR guided prostate biopsy decrease the procedure time and increase accuracy of samples, thus facilitating its application in clinical routine.

SSQ10-04 Free-Hand Transperineal MRI/US Fusion-Guided Targeted Biopsy with Virtual Navigation Platform in the Diagnosis of Clinically Significant Prostate Cancer: Preliminary Experience

Thursday, Nov. 29 11:00AM - 11:10AM Room: S102CD

Participants
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PURPOSE

Free-hand transperineal MRI/US fusion-guided targeted biopsy (fhTFTB) is a promising technique that may reduce biopsy core's number, possible complications and overdiagnosis/overtreatment. The aim of this study was to evaluate the impact of fhTFTB with virtual navigation platform in the diagnosis of clinically significant prostate cancer (csPCa).

METHOD AND MATERIALS

We retrospectively selected 68 patients with a positive MRI result (PIRADS v2 score >=3) who underwent fhTFTB, from 160 prostate multiparametric MRI performed for suspicious PSA levels. fhTFTB included 3-4 targeted cores for each lesion plus at least 8 random cores and was performed under local anesthesia.

RESULTS

Overall biopsy detection rate (DR) was 63% and the Gleason Score (GS) was >=7 in 47% (32/68). In all patients with a positive histopathological report, PCa was detected in at least one of the targeted cores and in one or more random cores in 13/43 patients (30%). PCa was identified in 41/52 patients with a PIRADS score >=4, so the DR was 79% in PIRADS 4 patients, 100% (16/16) in PIRADS 5 and 12,5% (2/16) in PIRADS 3. Among the PIRADS 5 patients the 93,8% of them had a csPCa, followed by the 44% and the 6% in those with a PIRADS score of 4 and of 3, respectively. Overall, the 60% of patients with a csPCa had a PIRADS score >=4. 30/68 patients had anteriorly located lesions on MRI, the 70% (21/30) of them had a positive histopathologic report. No major complications were noted. Overall mean biopsy time was 40 minutes.

CONCLUSION

In our experience, fhTFTB with virtual navigation platform is a valid tool in the diagnosis of csPCa. Thus, biopsy technique is fast, safe and cost effective. Moreover, a transperineal approach provides an accurate sampling of anteriorly located prostate lesions. A follow-up is necessary in patients with a negative histopathological report.

CLINICAL RELEVANCE/APPLICATION

Free-hand transperineal MRI/US fusion-guided targeted biopsy with virtual navigation platform is a fast, safe and cost-effective technique for the diagnosis of clinically significant prostate cancer.

SSQ10-05 Interreader Variability of Radiologists in Segmentation of the Prostate and Its Anatomic Zones: How Good Does Artificial Intelligence Have to Become?

Thursday, Nov. 29 11:10AM - 11:20AM Room: S102CD

Participants
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PURPOSE

To investigate interreader variability of radiologists in segmenting prostatic contours and anatomical zones of the prostate on prostate MRI and compare it to published accuracy metrics of segmentation algorithms in the machine learning literature.

METHOD AND MATERIALS

In a retrospective search, we collected 67 patients who had undergone prostate MRI for workup of suspected prostate cancer at our institution. Three board certified radiologists with extensive experience in multiparametric prostate MRI segmented the prostate into two distinct zones: Peripheral (PZ) and transitional zone (TZ). The central zone and AFMS were counted as transitional zone. Furthermore, the seminal vesicles (SV) were segmented. We used the open-source software ITK-snap for segmentation. Interreader variability/congruence of segmentations was assessed with the dice coefficient. For the descriptive statistics, median and interquartile range (IQR = 1st-3rd quartile) were computed.

RESULTS

Highest agreement was found for the TZ with a median dice coefficient of 0.85 (IQR: 0.80-0.89), 0.85 (0.81-0.89) and 0.85 (0.80-0.89). The dice coefficients for the SV were 0.81 (0.75 - 0.85), 0.77 (0.72-0.82) and 0.76 (0.70-0.84). For the the PZ, the Dice coefficients were 0.77 (0.71-0.81), 0.75 (0.70-0.79) and 0.74 (0.69 - 0.79). Variability was low when considering all structures with dice coefficients of 0.89 (0.86-0.91), 0.88 (0.85-0.90) and 0.87 (0.86-0.91).

CONCLUSION

There is considerable variability in expert segmentation of the prostate into its anatomic zones. Variability between different lies within or slightly below published performance of state-of-the-art algorithms in methods using artificial intelligence.

CLINICAL RELEVANCE/APPLICATION

Physicians treating men with prostate cancer by means of focal therapy should be aware that there is a small but considerable variability in segmentation of the prostate even if performed by expert radiologists. Future machine learning research should focus on robustness rather than achieving 'perfect' accuracy for segmentation.

SSQ10-06 Magnetic Resonance Elastography of the Prostate: Feasibility of Using High-Frequency Transurethral Vibrations.

Thursday, Nov. 29 11:20AM - 11:30AM Room: S102CD

Participants
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PURPOSE

To demonstrate the feasibility and diagnostic value of magnetic resonance elastography (MRE) in evaluating prostate disease using high-frequency transurethral vibrations.

METHOD AND MATERIALS

Following ethics committee approval with a waived informed consent requirement, 23 patients were enrolled in this study. The patients had a silicone urinary catheter in place and underwent prostate MRE with 60-, 90-, 120-, 150-, and 200-Hz vibration frequencies using a transurethral driver developed at Mayo Clinic. These patients were divided into three groups: 12 patients with benign prostatic hyperplasia (BPH), 5 with clinically significant prostate cancer (PCa) and 6 with prostatitis. The success of prostate MRE was defined as having visually detectable wave propagation in the prostate. The MRE-processing confidence map was used to summarize the MRE image quality. The stiffness of the prostate was recorded. The MRE confidence and stiffness were compared across the different frequencies. Receiver operating characteristic (ROC) analysis was performed to assess the diagnostic performance for detecting clinically significant PCa.

RESULTS

From 60 to 150 Hz, all MRE acquisitions with the transurethral driver were successful, but 13 cases failed at 200 Hz (Figure 1). The confidence values were significantly lower at 60 and 90 Hz than at 120 and 150Hz (all pairs $P<0.001$). The stiffness of clinically significant PCa was significantly higher than the peripheral zone (PZ) of BPH at each frequency, and higher than prostatitis and the

central gland (CG) of BPH at 90 and 120 Hz (all $P<0.05$). The sensitivity, specificity and accuracy for differentiating PCa from other tissues are shown in Table 1.

CONCLUSION

Prostate MRE using a transurethral driver had a 100% success rate in this study using vibration frequencies of 60-150 Hz, however image quality is better at higher frequencies (120, 150Hz). Prostate MRE may have the potential to differentiate PCa from BPH and prostatitis at these higher frequencies. Additional studies are warranted to investigate its utility.

CLINICAL RELEVANCE/APPLICATION

This study presents a potentially new approach for performing prostate MRE with high resolution using a transurethral driver at high vibration frequencies.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Sudhakar K. Venkatesh, MD, FRCR - 2017 Honored EducatorRichard L. Ehman, MD - 2016 Honored Educator

SSQ10-08 To Evaluate the Role of Gallium-68 PSMA PET/CT Scan For Prostate Cancer

Thursday, Nov. 29 11:40AM - 11:50AM Room: S102CD

Participants
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PURPOSE

Prostate cancer is one of the commonest biologically and clinically a heterogeneous disease in males which has varied diagnostic challenges. The biggest challenge in this is to detect recurrent disease. Biochemical response using Prostate Specific Antigen (PSA) and various imaging modalities including F FDG PET-CT has limited role as most of them have poor sensitivity and specificity. Thus we evaluated the role of Ga68-PSMA (Prostate Specific Membrane Antigen) imaging in prostate cancer, which is a new PET tracer.

METHOD AND MATERIALS

We evaluated Ga68-PSMA PET scans of 65 patients with diagnosed prostate cancer. Whole body PET-CT was done after injecting Ga68-PSMA for either staging or re staging to evaluate the response to therapy.

RESULTS

65 PSMA scans were performed initially . Ga68-PSMA scan showed more number of areas involved by extra-prostatic disease in 53.2% of cases when done at baseline before commencing any treatment. The sensitivity of Ga68-PSMA at baseline when compared with histopathological diagnosis was 95% with 95% CI ranging from 86% to 98%. The positive predictive value was high at 98% with 95% CI ranging from 91% to 99%. In 7 (12%) patients who underwent surgical management post therapy Ga68-PSMA scan was able to detect disease progression / post surgical relapse in 100% of cases. The outcome of post surgical prostate cancer was compared with other cases where surgery was not done. In those who did not surgery due to higher staging these cases showed better response by hormone therapy (p 61; 0.03) and radiotherapy (p 61; 0.01) on Ga68-PSMA. The sensitivity of Ga68-PSMA response with biochemical response was 66.7% with 95% CI ranging between 46 %- 82.7%. Ga68-PSMA response did not correlate with biochemical response.

CONCLUSION

Thus Ga68-PSMA has very good sensitivity for diagnosis, staging, restaging, evaluation of therapy response and prognostication in prostate cancer.

CLINICAL RELEVANCE/APPLICATION

Thus PET-CT PSMA has very high sensitivity as compared with F FDG PET-CT.

SSQ10-09 Technique and First Results: Targeted MRI and [68Ga]-PSMA PET/MRI Ultrasound Fusion-Guided Transperineal Prostate Biopsies

Thursday, Nov. 29 11:50AM - 12:00PM Room: S102CD

Participants
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PURPOSE

The aim of this study was to examine whether patients with elevated PSA-levels benefit from targeted MRI and [68Ga]-PSMA PET/MRI ultrasound fusion-guided biopsies, compared to systematic saturation biopsy.

METHOD AND MATERIALS

This retrospective study evaluated 219 patients with increased PSA-level (median PSA 8.3ng/ml) examined according to a multiparametric prostate protocol on a 3T MR-scanner (PI-RADSvs2). Additionally, 23 patients were examined on an integrated 3T PET/MRI-scanner. [68Ga]-PSMA-11 PET/MR-images were assessed for major functional (SUVmax) and for morphological variables (e.g.lesion delineation, diffusion restriction). All patients underwent systematic transperineal prostate biopsy and targeted MRI biopsy using rigid image-fusion (MiM software, USA) in case of PI-RADS 3-5 lesions (median 26 systematic cores and 9 targeted cores). Detection rates for prostate cancer (WHO grading system) of MRI and [68Ga]-PSMA-11 PET/MRI targeted ultrasound fusion-guided biopsies were compared to systematic transperineal saturation prostatic biopsy.

RESULTS

Altogether 5979 systematic cores, 1407 MRI-targeted cores and 217 PET/MRI-targeted cores were obtained. Per core targeted MRI ultrasound fusion-guided biopsy (35%, positive target lesions 247/716) and [68Ga]-PSMA PET/MRI ultrasound fusion-guided biopsy (48.5%, positive target lesions 49/101) showed a significantly higher detection rate of prostate cancer than non-targeted systematic biopsies (17.5%, positive systematic cores 492/2800). Altogether 2287 systematic biopsy cores revealed no atypical proliferation compared to 726 MRI- and PET/MRI-targeted cores. In the saturation prostatic biopsy histological grading was distributed as follows: grade groups (1) 15.7%; (2) 32.7%; (3) 14.3%; (4) 5.8% and (5) 2.5%. MRI- and PET/MRI-targeted biopsies identified clinically significant prostate cancer with following histological distribution: grade groups (1) 19.7%; (2) 30.1%; (3) 14.8%; (4) 6.6% and (5) 9.5%.

CONCLUSION

The [68Ga]-PSMA PET/MRI ultrasound fusion-guided biopsy is a promising technique for histological tissue verification. It contributes to accurate prostatic biopsies at a considerably lower level of biopsy tissue cores.

CLINICAL RELEVANCE/APPLICATION

Patients with elevated PSA-levels may benefit from targeted MRI- and PET/MRI ultrasound fusion-guided biopsy by a lower biopsy strain and at the same time by a higher confidence for targeting clinical significant prostate cancer.

SSQ11

Informatics (Reporting, Education Decision Support)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S103AB

ED IN

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

Participants
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Sub-Events

SSQ11-01 Development of a Structured Reporting System to Automate-RADS Schema

Thursday, Nov. 29 10:30AM - 10:40AM Room: S103AB

Participants
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CONCLUSION

Structured reporting provides a means to prompt radiologists to record essential information to describe disease processes, and when applicable, automate the determination of -RADS assessment categories.

Background

With the success of BI-RADS for improving mammography report quality, there has been a proliferation of other -RADS schema including C-RADS, CAD-RADS, HI-RADS, LI-RADS, Lung-RADS, NI-RADS, PI-RADS, and TI-RADS. Unless a radiologist is well-versed in one of these practice areas, it is often difficult to recall the details of a particular -RADS schema. We have developed a structured reporting system that prompts a radiologist to record salient disease features, and when applicable, automate the determination of the appropriate -RADS assessment category based on the recorded disease features.

Evaluation

We developed a structured reporting system that captures key images and verbal descriptions of image findings, tags the finding with metadata describing the anatomical location and radiological finding using natural language processing, and assembles a multimedia report. When a particular finding is recorded (e.g., lung nodule or colon polyp), the system prompts the radiologist with menus to record certain disease features. If the radiologist mentions the features in the dictation, the system will automatically populate the appropriate fields using natural language processing. If the radiologist fails to mention particular features, the radiologist can then select them from the menu display. Upon completion of data entry, the system automatically calculates the appropriate -RADS assessment category based on the anatomy and findings for inclusion in the Impression section of the structured report.

Discussion

The various -RADS schema are intended to improve the content and clarity of radiology reporting, especially for the communication of suspicious findings during screening examinations. However, these schema are difficult to recall for most radiologists unfamiliar with the details of how they are implemented. We demonstrate that a structured reporting system that records discrete features of disease can be used to automate the determination of the appropriate -RADS assessment category.

SSQ11-02 The MESH Incubator: Accelerating Core Competency in Technological Innovation, Artificial Intelligence, and Design Thinking in Radiology Training

Thursday, Nov. 29 10:40AM - 10:50AM Room: S103AB

Participants
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CONCLUSION

The MESH Incubator and MESH Core Innovation Design Curriculum rotation demonstrates that education in technological innovation, informatics, and artificial intelligence is in high-demand by radiology trainees.

Background

Radiology lacks core competency training in the basic tenants of innovation. This includes but is not limited to training in idea generation and validation, artificial intelligence and informatics, device and software prototyping, intellectual property, and entrepreneurship. To elevate radiology's position as a value-player in the evolving healthcare reimbursement landscape landscape, we must train our residents, fellows, and staff in these fundamental competencies.

Evaluation

The Medically Engineered Solutions in Healthcare (MESH™) Incubator was created at an academic radiology training program. MESH is a novel innovation center initially composed a physical invention workshop integrated in the clinical reading room and an innovator lecture series to foster industry alliances. At the one-year point, we conducted a Likert survey of current radiology residents, building on prior feedback. Key metrics revealed that 100% had little or no idea how to develop and idea from bedside to prototype, 95% had little or no understanding of 3-D printing and its clinical use in radiology, and 50% planned to be involved in a startup in the future. Notably, 75% agreed or strongly agreed that core competency in technological innovation should be part of the residency curriculum. Based on this feedback, a novel resident rotation in technological innovation, artificial intelligence, and informatics was designed. Qualitative and quantitative performance measures were collected.

Discussion

The MESH Core Innovation Design Curriculum is the first core curriculum in technological innovation in any residency program. MESH also includes a technological prototyping workshop and lecture series to foster product creation, intellectual property licensing, and industry collaboration. Our data demonstrates a clear desire by our trainees to institute core competency in technological innovation as part of the radiology training.

SSQ11-03 Medical Students' Attitude Towards Artificial Intelligence: A Multicenter Survey

Thursday, Nov. 29 10:50AM - 11:00AM Room: S103AB

Participants
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PURPOSE

Artificial intelligence (AI) and deep learning have recently gathered a lot of attention in radiology. Some senior radiologists describe being approached by students asking whether choosing radiology training could be a mistake considering that algorithms could potentially take over the task of interpreting images. However, apart from anecdotal episodes little is known about how students feel with respect to AI and deep learning in radiology and medicine.The aim of this study was therefore to perform a questionnaire-based survey amongst students and to assess their attitude towards these topics.

METHOD AND MATERIALS

A questionnaire was designed and implemented in SurveyMonkey (Surveymonkey, Portland, Ore). The questionnaire consisted of various parts (demographics, self-assessment, potential application of artificial intelligence in radiology, attitude towards artificial intelligence in radiology and medicine in general). A corresponding link was sent out via email to students of three major medical schools.

RESULTS

A total of 263 students responded (166 female, 94 male, median age 23 years). Around half (52.8%) were aware that AI is being discussed in radiology, but only around one third (30.8%) stated that they had a basic understanding of the technologies involved.The majority of students agreed that AI could be able to detect pathologies in imaging exams (83.7%) but only around half agreed that it would be able to automatically make a diagnosis (56.7%).While the majority was convinced that AI will revolutionize radiology and medicine in general (77.2% and 73%), they were confident that radiologists and physicians will not be replaced in the foreseeable future (82.9% and 96.6%). There was strong agreement that the use of AI will lead to improvement in care (85.5% and 83.6%).Most respondents agreed on the need of AI being included in medical training (70.1%).

CONCLUSION

Contrary to the what could have been expected, medical students are quite aware of the potential of AI in radiology and medicine but do not expect radiologists or physicians to be replaced in the foreseeable future. Basic principles of AI and computer science should be included in medical curricula.

CLINICAL RELEVANCE/APPLICATION

As one of the first subspecialties to broadly discuss the impact of artificial intelligence on medicine, radiology should take the lead in educating students on these emerging technologies.

SSQ11-04 Thyroid Nodule Biopsy: A Novel Mobile Phone App to Facilitate and Standardize the Decision Making Process

Thursday, Nov. 29 11:00AM - 11:10AM Room: S103AB

Participants
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CONCLUSION

This study presents a novel mobile phone App which simplifies and standardizes real-time decision making on when to proceed with thyroid nodule FNAC, providing the clinican with a user-friendly tool to assess thyroid nodules and provide guideline supported clinical practice.

Background

Thyroid nodules are prevalent and demonstrate a wide spectrum of sonographic characteristics. No single feature is pathognomonic of malignancy. The decision on when to proceed to fine needle aspiration cytology (FNAC) is not clear-cut, and is facilitated by a large number of international guidelines which mostly use a pattern-orientated approach. As such, they are difficult to apply in real-time in the clinical setting and can lead to interuser variation.We introduce a novel locally-derived mobile phone application ('App') to streamline this process.

Evaluation

We present an App which guides the user through the evaluation of a thyroid nodule using multiple parameters with pictorial examples (including consistency, heterogeneity, edge, margin, halo, echogenicity, vascularity and calcification) which feature in the risk stratification process of international guidelines (ACR-TIRADS, ATA 2016, ASRU 2005, AACE 2016, BTA 2014, Kim 2002, Korean 2016, Zayadeen 2016, Sanchez 2014, Russ 2011, EU-TIRADS 2017 and Kwak 2011). On completion of nodule assessment, a summary table provides the recommendation (in Yes/No format) of the international guidelines on whether to proceed with cytological sampling. An overall consensus recommendation is also provided. A worked through sample case would be presented to demonstrate the App in use, and highlight it's ease and swiftness of use.

Discussion

Numerous international guidelines, each with their strengths and limitations, have attempted to simply the decision making process on when to perform thyroid nodule biopsy. This novel App both simplifies and standardizes this process, providing the user with guideline supported practice that limits unnessary sampling of benign nodules without missing biologically active malignancy.

SSQ11-05 Advancing Interoperability of Image Annotations: Automated Conversion of Image Annotations in PACS to the Annotation and Image Markup Format for Longitudinal Lesion Tracking

Thursday, Nov. 29 11:10AM - 11:20AM Room: S103AB

Participants
Nathaniel Swinburne, MD, New York, NY (*Presenter*) Nothing to Disclose
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Daniel L. Rubin, MD, MS, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose

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CONCLUSION

As quantitative imaging becomes more prevalent in radiology, interoperability of image annotations gains increasing importance. Our work provides a mechanism to leverage image annotations in vendor systems and utilize it in automated lesion tracking. Our approach may facilitate large-scale analysis of image annotations and aid in the generation of high-quality labels for deep learning.

Background

Sharing radiologic image annotations among multiple institutions is important in many clinical scenarios such as tracking cancer lesions; however, interoperability is prevented because different vendors' PACS store annotations in non-standardized, proprietary formats. Interoperability of image annotations is also crucial for data sharing efforts such as the RSNA Image Share initiative and for mining training data for deep learning efforts. Our goal was to develop software to automate conversion of image annotations in a commercial PACS to the Annotation and Image Markup (AIM) standardized format and match lesion measurements across timepoints to enable lesion tracking.

Evaluation

Utilizing the Pixelmed toolkit for DICOM and AIM application programming interface (API), we created software in Java to parse the DICOM presentation state (DPS) objects for imaging studies exported from a commercial PACS (GE Centricity v3.x). Our software

identifies line annotations encoded within the DPS objects and exports the annotations in the AIM format. A separate Python script processes the AIM annotation files to match line measurements (lesions) across timepoints by tracking the 3D coordinates of annotated lesions. To validate the interoperability of our approach, we exported annotations from Centricity PACS into ePAD (http://epad.stanford.edu), a freely available AIM-compliant workstation, and the lesion measurement annotations were correctly matched across timepoints.

Discussion

Our work demonstrates that proprietary image annotations in a vendor system can be automatically converted to a standardized metadata format such as AIM, enabling interoperability and automated lesion matching across timepoints. Conversion of AIM to DICOM-SR is also possible. This effort could be extended for use with other vendors' PACS.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel L. Rubin, MD, MS - 2012 Honored EducatorDaniel L. Rubin, MD, MS - 2013 Honored Educator

SSQ11-06 Determining the Need for CT Intravenous Contrast from Free-Text Clinical History Using Natural Language Processing

Thursday, Nov. 29 11:20AM - 11:30AM Room: S103AB

Participants
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CONCLUSION

We demonstrate that a linear SVM classifier with TF-IDF on bag-of-words embeddings can predict the need for intravenous contrast for CT examinations with high accuracy.

Background

Incorrect ordering of CT contrast by clinicians leads to unnecessary communication between radiologists and clinicians. An automated tool for determining contrast assignment would reduce incorrect contrast ordering and increase workflow efficiency. We developed a natural language processing (NLP) model to predict whether intravenous contrast is needed for various CT examinations, based on free-text clinical history provided by requesting physicians.

Evaluation

We extracted 15,456 reports of CT studies from a single institution. A radiologist labeled each unique study type with ground truth label of whether the study was a contrast enhanced one or not. For each report, the clinical history was extracted and preprocessed using word normalization, negation detection with NegEx, stopword removal, and replacement of synonyms using RadLex. The dataset was then split into 80% training and 20% test sets. We trained a text classification model with a linear support vector machine (SVM) classifier on term frequency - inverse document frequency (TF-IDF) vectors constructed from bag-of-words representations of the clinical history. The test set consisted of 2,767 clinical histories with corresponding ground truth label of CT contrast assignments. Various accuracy measures of the machine learning classifier were reported.

Discussion

The model achieved an AUC value of 0.89 on the ROC space, an F1 score 0.86 along with 81% recall, and 90% precision. Most important words for contrast studies were 'PE, abscess' while for no contrast studies were 'low dose, fall' (Figure 1). Data visualization with latent semantic analysis confirmed adequate separation of contrast vs no contrast categories. Error analysis by clinical radiologist revealed that the most important and inherent limitation of the prediction was due to inadequacy of provided clinical history (e.g. 'pain' as clinical history).

SSQ11-07 Biomarker Assessment Tool for Evaluation of Treatment Response

Thursday, Nov. 29 11:30AM - 11:40AM Room: S103AB

Participants
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Cavit Altindag, Stanford, CA (*Abstract Co-Author*) Nothing to Disclose
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CONCLUSION

Assessing the treatment response is important for decision making in clinical trials and tools are needed to automate computation and comparison of different imaging biomarkers of response. Our plugin to ePAD permits computing and comparing imaging biomarkers for assessing treatment response.

Background

Imaging biomarkers are key indicators of the response of cancer to treatment. Although tumor size is the most commonly used biomarker that is used in criteria such as RECIST, it is recognized that simple linear measures are limited, and there is great interest in acquiring data to validate the utility of new imaging biomarkers. Our objective is to develop tools to streamline capturing these data in large scale as part of routine workflow of viewing and evaluating cancer images.

Evaluation

The electronic Physician Annotation Device (ePAD) is a web-based quantitative imaging platform that allows researchers to view and annotate radiological images, and it is extensible through a plugin mechanism. We developed an image annotation and analysis plugin for ePAD that computes image biomarker assessments in longitudinal imaging studies and analyzes and compares treatment response based on those image biomarkers by producing waterfall plots of cohort-based response. We evaluated our plugin by collecting 8199 annotations in ePAD from 419 cancer patients who had one baseline and several follow up CT scans. Our plugin generated waterfall plots using longitudinal measurement (RECIST criteria) and standard deviation of pixel intensity as an alternative biomarker. The output plots produced by our ePAD plugin permits comparing different imaging biomarkers in terms of effectiveness in showing treatment response (see Figure 1).

Discussion

Our ePAD plugin permits automated summary of the response of patient cohorts to treatment (see Figure 1) as well as comparing response based on using different imaging biomarkers of response. It may thus give valuable insight to the effectiveness of different imaging biomarkers for use in clinical trials. The charts can also be exported easily to be used in radiology reports.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel L. Rubin, MD, MS - 2012 Honored EducatorDaniel L. Rubin, MD, MS - 2013 Honored Educator

SSQ11-08 Natural Language Processing for Automated Radiology Pathology Correlation of PIRADS and TIRADS Lesions

Thursday, Nov. 29 11:40AM - 11:50AM Room: S103AB

Participants
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CONCLUSION

Using NLP and structured reporting, radiology and pathology report data can be mined to automate performance outcome tracking.

Background

Structured reporting systems convey estimates of malignancy risk for thyroid nodules (TIRADS) and prostate lesions (PIRADS). There is no automated system to track biopsy yield and link those results back to the structured radiological estimate. Such a tool would be invaluable for individual and group-level performance metrics. We describe a method involving natural language processing (NLP) to extract malignancy risk estimates from radiology reports and cancer diagnoses from pathology reports.

Evaluation

Using cTAKES, an open-source NLP tool for clinical text, we analyzed more than 120,000 radiology and pathology reports, sampled from the previous 5 years at our institution. We first segmented the reports using regular expressions. Then with NLP, we identified unique anatomic concepts referring to prostate and thyroid tissue by mining them from the "specimen" section of pathology reports. Next, from the "diagnosis" section of the pathology reports, we mined unique disease/disorder concepts which referred to clinically significant malignancy. We then extracted PIRADS and TIRADS classifications from structured radiology reports using basic RegEx pattern matching.From these sets of annotations, we can correlate the radiologist's estimate of malignancy with the biopsy or resection rate, and with rate of malignancy detection. This information is provided in an easy to use dashboard that provides radiologists with automated feedback on their diagnostic accuracy, including anonymous comparisons with their peers.

Discussion

This system makes performance outcomes easily trackable by radiologists. We expect that by providing radiologists with feedback on pathology outcomes from their diagnoses, radiologists will ultimately improve their performance. We plan to expand this system to other risk stratification systems (e.g. BIRADS, LIRADS), and eventually to all diagnostic reports by linking pathology specimens to anatomic terms and organ-specific disease entities used in radiology reports.

SSQ11-09 RapRad: Validation of an E-Learning Platform with Gamification, Rapid Case Reading, and Instant Gratification

Thursday, Nov. 29 11:50AM - 12:00PM Room: S103AB

Participants
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PURPOSE

The rise of social media with seemingly shorter attention span prompts e-Learning platforms to motivate and engage users during participation. The purpose of this study was to validate a new e-Learning concept featuring gamification elements, rapid case

reading, a large case number and instant feedback.

METHOD AND MATERIALS

An e-Learning concept was devised offering various game levels, blocks of questions to be read in rapid succession with instant feedback, health/experience points to be gained/lost and player level-up, if successful. The first version focusses on training pneumothorax detection in 321 cases. The user's task is to locate the pneumothorax, if present, on chest x-rays by mouse click; receives instant feedback per case. The levels were designed as follows: entry test (n=15), three training levels with increasing difficulty and a final test (n=30; 15 entry test + 15 new cases). 126 participants (medical students, 1st-year radiology residents and technicians) were invited to participate via e-Mail and asked to fill in a survey before and after playing the game.

RESULTS

59 participants responded to the first survey and finished the game (47%), while 29 of these responded to the second survey after completion the game (49%). Confidence in pneumothorax detection improved significantly from 4.3 ± 2.1 to 7.3 ± 2.1; $p < 0.01$ (mean+/-SD, 10-point scale, 10 highest score) after using RapRad. 97% of the participants would recommend the use of RapRap to others; 93% would use RapRap for learning purposes again; 86% had fun using RapRad (7% neutral, 6% negative) and 62% indicated their interest in Radiology increased (28% neutral, 7% negative). The error-rate, number of failed attempts to answer a question correctly, was 38.8% for the entry test and 21.8% for the final test following training.

CONCLUSION

The RapRad e-Learning concept is capable of improving diagnostic confidence, reducing error rates and offering fun in the interaction with the platform.

CLINICAL RELEVANCE/APPLICATION

Gamification elements and rapid case reading e-Learning can assist residency training by offering fun elements, friendly competition and promote an accelerated learning curve.

SSQ12

Molecular Imaging (Musculoskeletal, Gastrointestinal, Cardio)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S504CD

CA GI MR MI MK NM

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

Participants
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Sub-Events

SSQ12-01 Histological Validation of Chemical Exchange Saturation Transfer (CEST) imaging for the Measurement of Metabolism Status in Infarcted Myocardium

Thursday, Nov. 29 10:30AM - 10:40AM Room: S504CD

Participants
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Yingkun Guo, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

The purpose of this study was to test if the distribution of creatine shown on Chemical Exchange Saturation Transfer (CEST) MRI could differentiate infarct myocardium from the normal on pigs, by referring to LGE images and pathologic results.

METHOD AND MATERIALS

We prospectively enrolled 27 Bama miniature pigs. MI model was built by applying a ligation at the remote ending of the left anterior descending artery. CMR scan was arranged at 3 days and 2 months later for the AMI and CMI group on a 3 T whole-body scanner. A single SAX slice was used for CEST scanning by using Amide proton transfer (APT) sequence before the injection of contrast. 36 samples were collected from a saturation frequency offset from -5.0 ppm to + 5.0 ppm. The scanned pigs were humanely euthanized under deep anesthesia with KCl and the heart was excised. Triphenyl tetrazolium chloride was used to manifest the infarcted region. CEST values at the frequency of ~1.8ppm, ~2.5ppm, ~2ppm and ~3ppm were recorded respectively for each pig and Color code map was plotted based on the CEST values at a frequency offset of ~1.8ppm (Matlab). Statistic analysis was performed on R project.

RESULTS

A total of 5 AMI pigs (M, 7 months, 16.6 ± 1.2 kg), and 14 CMI pigs (M, 9 months, 27.8 ± 2.1 kg), were finally included. Statistic differences were observed for Cr, ATP, and Glu between the infarct myocardium and the normal myocardium for CMI pigs, while only Cr and ATP for AMI pigs. The color code CEST maps showed a prominent larger abnormal region with a lower concentration of creatine than the MI regions recognized on the LGE sequences and the pathology images.

CONCLUSION

This study demonstrated that the metabolic conditions measured on CEST imaging could be used for infarcted myocardium recognition and the region of myocardium with a lower creatine concentration was larger than the region confirmed with infarction, which again provided proof of the existence of the injured or stunned myocardial tissue surrounding the infarction region.

CLINICAL RELEVANCE/APPLICATION

CEST MRI provided a promising invasive way to observe metabolism status of infarcted myocardium and further studies on MI patients would be needed to validate its clinical application.

SSQ12-02 Molecular Lumbar Intervertebral Disc Alterations in Patients with Leg Length Discrepancy Before and After Therapy

Thursday, Nov. 29 10:40AM - 10:50AM Room: S504CD

Participants
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PURPOSE

Leg length discrepancy (LLD) is a frequent incidental finding during orthopedic physical examination and can be found in about two-thirds of the population without any physical complaints. According to recent studies, LLD greater than 10 mm could be a predisposing factor for early degenerations of lumbar intervertebral discs or vertebral facet joints. However, the need of its treatment is still controversial. Previous findings suggest that degeneration of the lumbar disc correlates with a decrease of glycosaminoglycan content (GAG). The purpose of this study was to elucidate the effect of LLD on GAG content in lumbar discs and to show therapy effects after the usage of shoe inserts and physical therapy.

METHOD AND MATERIALS

11 patients (25.6 ± 4.3 years) with LLD greater than 10 mm and 14 control subjects (23.9 ± 3.5 years) without LLD were examined using a 3T MR scanner. 8 patients were re-examined 6 months after physical therapy and the usage of shoe inserts. Morphological T2-weighted sequences in sagittal and transversal orientation and Glycosaminoglycan chemical exchange saturation transfer (gagCEST) sequence were performed. Subjects with bulged or herniated discs were excluded.

RESULTS

Nucleus pulposus-gagCEST values of L5/S1 disc were significantly lower in patients with LLD compared to control group ($p = 0.0008$). For all other disc levels, no significant difference was found. At follow-up, no significant difference of NP-gagCEST values at baseline and 6 months after therapy could be found ($p > 0.05$).

CONCLUSION

This study supports the hypothesis that LLD greater than 10 mm could be a predisposing factor for early molecular alterations of lumbar discs of L5/S1. Remarkably, we observed lower gagCEST values of the lumbar disc of L5/S1 caused by LLD even before any morphological pathology could be found. Biochemical disc alterations of patients with LDD could be stopped under therapy.

CLINICAL RELEVANCE/APPLICATION

This study supports the hypothesis that LLD could be a predisposing factor for early molecular alterations of the lumbar disc of L5/S1. Furthermore, lower gagCEST values of the lumbar disc of L5/S1 caused by LLD were observed before any morphological pathologies were detectable. This molecular alterations of L5/S1 of patients with LLD could be delayed under the effect of shoe inserts and physical therapy.

SSQ12-03 Blood Oxygen Level-Dependent MRI Can Evaluate the Oxygenation of Visceral Adipose Tissue in Zucker Diabetic Fatty Rats

Thursday, Nov. 29 10:50AM - 11:00AM Room: S504CD

Participants
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PURPOSE

Visceral adipose tissue (VAT) hypoxia is associated with insulin resistance and obesity-related chronic low-grade inflammation (metaflammation). Its evaluation is then of great importance for prevention and therapy, but current methods are invasive and focus on subcutaneous fat rather than VAT. The purpose of this study is to investigate the feasibility of evaluating VAT hypoxia with Blood Oxygen Level-Dependent (BOLD) MRI, which is sensitive to hemoglobin oxygenation, in Zucker Diabetic Fatty (ZDF) rats.

METHOD AND MATERIALS

Seven-week old ZDF rats (n=18) were provided with water and high-fat diet ad libitum; their body weight and blood glucose were monitored. At 13 weeks of age they were divided into two subgroups, receiving a daily dose of pioglitazone (ZDF-PGZ, n=9) or saline (ZDF-VE, n=9) respectively. BOLD MRI was performed at 13 and 23 weeks of age using a multi-echo spoiled gradient-echo sequence (5 echo times from 3.75 to 29.07 ms with 6.33 ms echo spacing, TR = 408 ms, voxel size = 0.47x0.38x3 mm3). R2* values were measured in the perirenal VAT. The trygliceride, cholesterol and insulin levels were measured by blood biochemistry analysis, and insulin resistance was calculated by HOMA-IR = insulin[mU/L] x glucose[mmol/L] / 22.5. Immunofluorescence was used to evaluate hypoxia by pimonidazole adduct-positive area. The proportion of Th17 and Treg cells, CD34+ and CD34++ monocytes were evaluated by flow cytometry.

RESULTS

The ZDF-VE group had hyperlipidemia ($p < 0.01$) and hyperinsulinemia ($p < 0.001$) and higher HOMA-IR ($p < 0.001$) compared to the ZDF-PGZ group. There was a significant R2* increase between the two scans for ZDF-VE (20.14 ± 0.23 vs. 21.53 ± 0.20, $p = 0.012$) but not for ZDF-PGZ (figure 1A). VAT R2* values showed a positive correlation with pimonidazole adduct-positive area, HOMA-IR, the percentage of Th17 cells and CD43+ monocytes, and a negative correlation with the percentage of Treg cells and CD43++ monocytes (figure 1B).

CONCLUSION

This study showed the feasibility of VAT oxygenation by BOLD MRI in ZDF rats with obesity induced by high-fat diet. The R2*

values obtained by BOLD MRI are also associated with insulin resistance and metaflammation.

CLINICAL RELEVANCE/APPLICATION

BOLD-MRI can be a non-invasive tool for the evaluation of visceral adipose tissue hypoxia and obesity-related insulin resistance and systemic inflammation

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Vahid Yaghmai, MD - 2012 Honored EducatorVahid Yaghmai, MD - 2015 Honored EducatorVahid Yaghmai, MD - 2017 Honored Educator

SSQ12-04 Baseline Pancreatic Beta Cell Imaging Post Pancreatic Transplantation Using Whole Body 68Ga-DOTA-Exendin-4 PET/CT: Our Initial Experience

Thursday, Nov. 29 11:00AM - 11:10AM Room: S504CD

Participants
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PURPOSE

Whole-pancreatic transplant and islet cells transplantation are currently available strategies aiming towards diabetes cure. Beta cell specific non-invasive functional imaging using novel PET radiotracers are now available.68Ga-DOTA-Exendin-4 PET/CT is used for detecting localised Insulinomas. However this tracer can also be used for beta cell imaging and quantification. We have attempted in this study to recognise the pattern of uptake by this tracer in patients with pancreatic transplants.

METHOD AND MATERIALS

8 patients who had undergone pancreatic transplant for Diabetes Mellitus were included in the study. After obtaining informed consent from the patients 4-5 mCi of 68Ga-DOTA-Exendin-4 was injected intravenously. One hour after injection whole body PET CT was performed and the images were analysed.

RESULTS

Among the 8 patients who had pancreatic transplant, 4 patients had Type I Diabetes Mellitus and 4 patients had Type II Diabetes Mellitus. The mean age of the patients were 36 yrs. All the 8 patients were male patients. One of the patient had undergone simultaneous pancreatic and renal transplant. Anterior and lateral MIP images demonstrated diffuse heterogeneous GLP-1R expression in vertically oriented transplanted pancreas in 7 out of 8 patients. Three dimensional PET CT imaging along revealed increase tracer uptake in the transplanted pancreas. There was no uptake in the native pancreas in 6 out of the 8 patients. There was atrophy and calcification of the native pancreatic tissue in these 6 patients. Mild tracer uptake was noted in 2 out of the 8 patients. In one patient there was very low tracer uptake in the transplanted pancreas. Fat stranding was noted surrounding the transplant tissue with areas of necrosis within. This patient was later confirmed to have transplant rejection.

CONCLUSION

In our initial study of 8 patients we conclude Exendin-4 PET/CT is very sensitive tracer for beta cell imaging. It can be used for baseline and flow up of graft imaging. Currently biopsy is the only method to prove graft rejection. However with the use of Exendin-4 PET/CT early graft rejection can be detected non invasively. We further hypothesize the future use of Exendin-4 PET/CT for quantification of beta cell mass using volumetric analysis.

CLINICAL RELEVANCE/APPLICATION

68Ga-DOTA-Exendin-4 PET/CT can be used as baseline and for follow up pancreatic transplant patients for analysis of beta cell mass.

SSQ12-05 In Vivo Bioluminescence Imaging of Transplanted Mesenchymal Stromal Cells and Their Rejection Mediated by Intrahepatic NK Cells

Thursday, Nov. 29 11:10AM - 11:20AM Room: S504CD

Participants
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PURPOSE

Mesenchymal stromal cells (MSCs) hold promise in the treatment of liver disease.However, short survival time of MSCs after intrahepatic transplantation limits their value; therefore,understanding the basis of MSCs survival and rejection may increase their utility. This study was aimed at determining the role of intrahepatic natural killer (NK) cells on MSCs survival and their retention in the liver shortly after transplant.

METHOD AND MATERIALS

Human MSCs were labeled with the Luc2-mKate2 dual-fusion reporter gene (MSCs-R), and the residence time and survival of MSCs-R xenografts after intrahepatic transplantation were evaluated by in vivo bioluminescence imaging (BLI). Coculture of MSCs and NK cells was performed to assess cytotoxicity. To evaluate the role of NK cells in rejection of the xenografted cells, the fates of transplanted MSCs-R were then assessed in vivo by BLI after activation of intrahepatic NK cells.

RESULTS

We observed a linear correlation between luciferase activity from live MSCs-R and cell number in vitro (R2 = 0.9956). In vivo, we observed a gradual decline in bioluminescent signals from transplanted MSCs-R over a region corresponding to the liver in both the control group and the NK-activated group.However, the survival time and retention of intrahepatic MSCs-R decreased more rapidly in the NKactivated group of mice compared to the control group. This indicated that activated NK cells accelerate the elimination of transplanted MSCs. Also, we found that the number of hepatic NK cells and the expression of NK activation markers significantly increased after intrahepatic delivery of MSCs. This suggested that resident NK cells, in a resting state, were activated by intrahepatic transplantation of human MSCs. Taken together, the data suggests that activated hepatic NK cells mediate, in part, rejection of the MSCs xenografts. Cytotoxicity assays showed that activated NK cells may inhibit the proliferation of MSCs and, to a certain extent, induce MSCs death.

CONCLUSION

Human MSCs could be followed dynamically in vivo by BLI, and the role of murine hepatic NK cells, especially activated NK cells, could be inferred from the loss of signals from MSCs.

CLINICAL RELEVANCE/APPLICATION

This finding may have practical clinical implications in MSCs transplantation in treating liver disease.

SSQ12-06 Assessment for NASH-Related Hepatocarcinogenesis Inhibition of Shikonin in a Murine Model Using DW-MRI

Thursday, Nov. 29 11:20AM - 11:30AM Room: S504CD

Participants
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PURPOSE

Nonalcoholic steatohepatitis (NASH) is a major risk factor for hepatic carcinogenesis. This study was assess the effect of shikonin using diffusion-weighted magnetic resonance imaging (DW-MRI) in an NASH-related hepatocarcinogenesis murine model.

METHOD AND MATERIALS

On the second day after birth, male pups were subjected to a single subcutaneous injection of 200 μg streptozotocin (STZ) and fed high-fat (45% kcal from fat) diet from the age of 4 weeks. The mice were randomly divided into groups when the tumor area was about > 0.5 mm² as follows: STZ + high-fat diet (SH; n=6) and STZ + high-fat diet + shikonin (SHS; n=7). For the experimental group, shikonin (2.0 mg/kg) was injected intraperitoneally daily for 14 days (with diluted PBS). DW-MRI was performed to assess effects of shikonin at pre-and post-treatment. Aspartate aminotransferase (AST) and alanine aminotransferase (ALT), glucose, cholesterol, and triglyceride were determined in plasma. The liver tissues were collected at 14 day post-treatment for hematoxylin and eosin staining.

RESULTS

The mean area of tumors were 2.56 ± 2.12 mm² at the SH and SHS groups, before treatment initiation. The tumor area changes of the SH and SHS groups were 326.28 ± 320.81% and 91.58 ± 78.22% after post-treatment. The tumor area change in the SHS group significantly lower compared to the SH group ($p < 0.05$). The mean ADC changes of the SH and SHS groups were 41.97 ± 50.48% and -9.24 ± 30.46% after post-treatment. The ADC change in the SHS group significantly decreased compared to the SH group ($p < 0.01$). AST and ALT levels were significantly lower in the SHS group than in the SH group after post-treatment. Plasma glucose, total cholesterol and triglyceride levels were not significantly different between SH and SHS groups. The SH group exhibited numerous tumors on the liver surface, whereas the SHS group exhibited fewer and smaller liver tumors. The histological findings at SH and SHS groups revealed that the tumors were hepatocellular carcinoma.

CONCLUSION

In this study, we found that the cancer inhibition effects of shikonin in a NASH-related hepatocarcinogenesis murine model by using DW-MRI.

CLINICAL RELEVANCE/APPLICATION

Shinkonin might be considered a novel preventive or therapeutic approach for NASH-related hepatocarcinogenesis.

SSQ12-07 Management of Complex Regional Pain Syndrome (CRPS) with Sigma-1 Receptor Radioligand and PET/MRI

Thursday, Nov. 29 11:30AM - 11:40AM Room: S504CD

Participants
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PURPOSE

Complex regional pain syndrome (CRPS) is a severe chronic pain condition affecting millions worldwide. Unfortunately, there is no specific diagnostic test to identify the pain generators in CRPS, leading to poor pain management of this disease. Given sigma-1 receptors (S1Rs) specific association for pro-nociceptive processes, we determine the clinical impact of a more pain-specific PET/MRI approach for CRPS, adopting a novel high affinity sigma-1 receptor (S1R) PET radioligand ([18F]FTC-146; Ki = 0.0025 nM).

METHOD AND MATERIALS

IRB and FDA approval were obtained. Fifteen patients suffering from CRPS were referred directly from specialists in pain medicine. Whole-body (head-to-toe) PET/MR (time-of-flight PET; 3.0T MR bore; GE Healthcare) imaging was perfmored following 10 mCi IV injection of [18F]FTC-146. MR sequences included 3D axial LAVA-FLEX, high-resolution 3D axial DESS and 2D axial T2-weighted FSE scans. ROI analysis was performed (OsiriX v.6.0 64-bit). Findings from the PET/MR scans were discussed with the referring pain specialists, subsequent alterations in the pain management plan were recorded and, in a subset of cases, new treatments were applied to which outcomes were measured.

RESULTS

Fourteen out of 15 patients showed unexpected findings on [18F]FTC-146 PET/MRI, which lead to a change in the patients' pain management plans. In one specific case, a CRPS patient had severe (8-10/10) unilateral knee pain despite 2 previous unsuccessful surgeries. [18F]FTC-146 PET/MRI showed a high, focal [18F]FTC-146 PET uptake of a lesion which co-localized to an abnormal mass-like lesion in the intercondylar notch on the MRI. Subsequent arthroscopic surgery removed the [18F]FTC-146-avid lesion, which completely relieved the knee pain (0/10 pain). A separate CRPS patient with severe bilateral foreleg pain showed increased uptake of [18F]FTC-146 in the anterior compartment of both forelegs. Botulinum toxin injection in the areas of high [18F]FTC-146 uptake resulted in significant improvement in pain score (9-10/10 down to 2/10). We continue to follow the other patients to further evaluate our image findings.

CONCLUSION

A whole-body PET/MRI approach with a novel S1R PET tracer, [18F]FTC-146, can potentially identify pain generators in CRPS and improves treatment outcomes.

CLINICAL RELEVANCE/APPLICATION

The proposed whole body PET/MRI approach could alter the pain management for CRPS patients to achieve better pain-relief outcome.

SSQ12-08 Inflammation Focus Search with 18F-FDG-PET/MRI: Comparative or Additive Value of PET and MRI

Thursday, Nov. 29 11:40AM - 11:50AM Room: S504CD

Participants
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PURPOSE

To evaluate the comparative or additive value of 18F-FDG PET and MRI for identifying the etiology of inflammation of unknown origin.

METHOD AND MATERIALS

A total of 24 patients (13 m, 11 w, age 42±23 [8-82] y) with suspicion of an inflammation focus due to laboratory inflammation markers (increased CRP, leukocytes) or fever and up to now non-leading conventional imaging underwent a whole-body PET/MRI. Image analyses included the detection and localization of pathologically (focal) increased tracer uptake in PET including determination of SUVmax using VOI technique and evaluation of the contrast enhancement and diffusion restriction (ADC values) of abnormal lesions in MRI. Descriptive analysis included mean values, standard deviation and range. PET/CT, clinical, and radiological follow-up as well as histopathology served as standards of reference.

RESULTS

In 17/24 patients the PET/MRI contributed to the diagnosis of a (focal) pathological etiology of the inflammatory disease (vasculitis n=5, inflammatory bowel disease n=4, pneumonia n=1, infected vascular prosthesis n=2, (active) retroperitoneal fibrosis n=1,

peritonitis and cholecystitis n=1, synovitis n=1, mycotic infection (hepatic candidosis) n=1, bone marrow activation n=1). In PET all pathological foci showed a moderately to significantly increased FDG uptake (SUVmax 5.3 ± 3.5, range 1.4-14.2). The MRI satisfactorily allows the localization of the findings, but only in 12/17 a corresponding contrast-enhancement and in 13/17 a corresponding diffusion restriction could be found. 3/17 patients showed neither a contrast-enhancement nor a diffusion restriction, but only an increased FDG uptake.

CONCLUSION

Integrated 18F-FDG-PET/MRI shows high potential in identifying the etiology of inflammation of unknown origin. The MRI satisfactorily allows the localization of the findings, but a significant higher detection rate could be found in PET compared to MRI. Considering the significantly lower dose of ionizing radiation, PET/MRI may serve as a powerful alternative to PET/CT.

CLINICAL RELEVANCE/APPLICATION

Inflammation focus search with 18F-FDG-PET/MRI

SSQ12-09 Early Detection and Measurement of Disease Activity in Experimental, Inflammatory Bowel Disease Using Target-Specific Molecular Imaging and Fluorescence Colonoscopy

Thursday, Nov. 29 11:50AM - 12:00PM Room: S504CD

Participants
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PURPOSE

Pro-inflammatory monocytes comprise the majority of the early inflammatory infiltrate in inflammatory bowel disease (IBD). In mice, these cells are characterised by high expression of Ly6C. Purpose of this study was to evaluate Ly6C-specific imaging for visualisation and measurement of IBD activity in comparison to perfusion-type contrast agents and assess the performance in fluorescence mediated tomography (FMT) and fluorescence colonoscopy (FC) for whole body and local application respectively.

METHOD AND MATERIALS

IBD was induced in 10 female Balb/c wild type mice by application of DSS with the drinking water. The weight was monitored as a marker of disease activity. FMT was performed before and 5 and 10 days after IBD induction. Mice received a Cy5.5-labelled Ly6C antibody (2nmol dye) or an equivalently labelled, unspecific IgG to reflect perfusion effects. In parallel, all mice underwent FC for detection and scoring of local disease activity. Histology served for correlation and validation of in vivo imaging.

RESULTS

On day 5 after IBD induction, weight loss did not allow for safe identification of IBD activity and was only significantly increased at day 10 (2% vs. 15%). Perfusion was elevated on day 5 as compared to baseline already but did not increase significantly towards day 10 as reflected by the IgG-driven signal (192 vs. 328 vs. 342 pmol tracer). Ly6C-specific tracer accumulation was, in contrast, significantly elevated on day 5 already; a further increase towards day 10 reflected the growing disease activity (110 vs. 700 vs. 1166 pmol; $p<0.001$). In vivo colonoscopy allowed for safe identification of inflammatory foci based on the specific probe accumulation but not the unspecific control. FC-based disease scoring was clearly reflected by Ly6C-specific imaging.

CONCLUSION

Target-specific imaging of Ly6C as a marker for early infiltrating, pro-inflammatory monocytes allows for sensitive and specific measurement of IBD activity in vivo by non-invasive and endoscopic approaches. It is superior over clinical examination and perfusion type contrast.

CLINICAL RELEVANCE/APPLICATION

In IBD, monitoring of disease activity and sub-clinical inflammation e.g. under therapy is a relevant challenge. Specific imaging can aid research and potentially improve multi-modal clinical imaging.

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SSQ13

Musculoskeletal (Arthritis and Cartilage)

Thursday, Nov. 29 10:30AM - 12:00PM Room: E451A

MR MK

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

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Sub-Events

SSQ13-01 Longitudinal MRI Findings in Accelerated Knee Osteoarthritis: Data From the Osteoarthritis Initiative

Thursday, Nov. 29 10:30AM - 10:40AM Room: E451A

Awards
Trainee Research Prize - Resident

Participants
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PURPOSE

Our aim was to systematically analyze longitudinal MRI findings during the development of accelerated knee osteoarthritis (AKOA) to identify patients that may benefit from an intervention.

METHOD AND MATERIALS

Knees progressing from no radiographic osteoarthritis (OA, KL 0/1) to advanced-stage OA (KL 3/4) within 4 years (AKOA definition) at any time point within the Osteoarthritis Initiative were selected. OA risk factors including knee injury or surgery were noted. MRIs were graded using the modified Whole-Organ Magnetic Resonance Imaging Score (WORMS) at baseline, 2 and 4 years. Additional findings such as root tears and meniscal extrusion were noted. Presence or absence of features associated with KL 3/4 onset within 2 years compared to 4 years were assessed using Pearson's chi-square test for OA risk factors and multivariable logistic regression models for baseline imaging parameters.

RESULTS

AKOA was present in 162 knees in 149 subjects (age 63.25±8.3 years; 103 females; BMI 29.4±3.9). Knee injury was documented in 22% (36/162), meniscal resection in 27% (43/162). Moderate to severe meniscal lesions WORMS >= grade 3 were present in 25% (41/162) at baseline, 65% (105/162) at 2 years and in 94% (152/162) at 4 years. Meniscal extrusion was the most prevalent finding associated with AKOA (18% bl; 45% 2y; 94% 4y). Root tears were the most common types of meniscal tears (9% bl; 22% 2y; 38% 4y). Risk factors associated with KL 3/4 onset within 2 years (n=116) compared to 4 years (n=46), included higher baseline maximum scores of the weight-bearing cartilage (adjusted odds ratio [OR], 1.22; 95% confidence interval [CI]: 1.02, 1.46; p=0.033), presence of root tears at baseline (adjusted OR, 2.82; 95% CI: 1.33, 6.00; p=0.007) and presence of knee injury during the observation period (42%, 49/116 vs. 24%, 11/46, p = 0.032).

CONCLUSION

Meniscal abnormalities were the most prevalent morphological feature associated with AKOA and are likely responsible for rapid cartilage loss. Knee injury and meniscal resection were frequently present in our cohort and probable risk factors for AKOA. Root tears were associated with substantial increased risk for progression of radiographic joint space loss.

CLINICAL RELEVANCE/APPLICATION

Meniscal pathology/damage was associated with accelerated radiographic progression with joint space loss and identifies a subgroup of patients that may benefit from an intervention.

SSQ13-02 Amount of Partial Meniscectomy Impacts Severity and Worsening of Knee Osteoarthritis: Data from the Osteoarthritis Initiative

Thursday, Nov. 29 10:40AM - 10:50AM Room: E451A

Participants
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PURPOSE

Previous studies have suggested that meniscectomy is a significant risk factor for osteoarthritis (OA), but it is not known how the amount of meniscal resection impacts disease burden and progression. The goal of this study was therefore to develop a MRI-based semi-quantitative scoring technique for postoperative assessment of the amount of meniscal resection, to test its reproducibility and to investigate how the meniscal resection scores correlate with the severity and worsening of degenerative changes.

METHOD AND MATERIALS

The right knees of 135 participants from the Osteoarthritis Initiative were selected, who underwent meniscal resection. Using a newly developed semi-quantitative meniscal resection score (MenRS) the extent of meniscal resection was assessed on baseline 3.0T MRIs. Dividing the meniscus into radial and circumferential zones amount of meniscal resection was scored from 0 (none) to 18 (complete resection). In addition knee osteoarthritic abnormalities at baseline and 48-month were graded using a modified Whole-Organ Magnetic Resonance Imaging Score (WORMS). Statistical analysis included linear and logistic regression to correlate MenRS with baseline and change in WORMS grades as well as intra-class correlation coefficient (ICC) to determine reproducibility.

RESULTS

Using the new MenRS system high ICC values for both intra- and inter-observer reproducibility of 0.980 and 0.977, respectively were found. Most importantly the amount of meniscal resection was significantly correlated with baseline WORMS grades throughout the knee: higher MenRS were associated with higher total WORMS grades ($p=0.004$) as well as cartilage ($p=0.004$), and ligament ($p<0.001$) subscores. Correlations were higher when analyzing the associations between WORMS abnormalities in the index compartment separately ($p<0.001$). There were no significant correlations of MenRS and change in WORMS grades over 4 years.

CONCLUSION

Using MenRS to assess the amount of meniscal resection showed excellent reproducibility and significant correlations with the amount of cartilage and ligamentous abnormalities, with the strongest association in the index compartment.

CLINICAL RELEVANCE/APPLICATION

The new meniscal resection score allows to analyze the amount of meniscal resection with high reproducibility and is directly correlated with the severity of degenerative knee abnormalities.

SSQ13-03 Three Tesla Multiparametric Combined Imaging Evaluation of Axial Spondyloarthritis And Pelvic Enthesopathy

Thursday, Nov. 29 10:50AM - 11:00AM Room: E451A

Participants
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PURPOSE

To evaluate patients with suspected axial spondyloarthritis (SpA) to determine technical success of multiparametric rheumatology lumbosacral MR imaging (MRLI) protocol, disease distribution, inter-reader reliability, and effect on patient management.

METHOD AND MATERIALS

41 consecutive patients with suspected axial SpA reffered by rheumaologists were included. Two rheumatologists recorded the clinical and lab findings as well as the disease activity based on a confidence scale before and after imaging results of 3T MRLI. Two radiologists interpreted the studies to record the findings of SpA and its activity. Prevalence-adjusted and bias-adjusted kappa (PABAK) was used for reader agreement. Changes in diagnostic confidence, treatment and patient response were evaluated using the sign rank test and the Fisher's exact test. P value less than 0.05 was considered statistically significant.

RESULTS

There were 41 patients; 31 females and 10 males with ages of 41+/-10 and 41+/-12 (mean+/- SD), respectively. The spine T2W

imaging received highest quality scores followed by whole abdomen-pelvis 3DT2W imaging, 3DCEMR, and DWI, respectively. On T2W, acute and chronic lesions of LS spine and SIJ were seen in 4/41, 18/41, 6/41, and 27/41 of the patients, respectively. Many enthesopathy lesions were seen in abdomen and pelvis. In the abnormal area of the bones, ADC measured 0.95+/-0.23 (mean+/-SD) versus normal bone (0.20+/-0.1). In synovial linings, there was overlap of ADC. PABAK for acute and chronic findings were 0.70-1.0 and 0.41-0.51, respectively. Clinical confidence scale after imaging changed in 20 out of 41 patients, however, with the change was not statistically significant. The changes in diagnosis occurred in 17/41 and no association existed with respect to change in treatment (p=1) or patient response (p= 0.2).

CONCLUSION

The study validates the whole abdomen and pelvis multiparametric imaging approach for axial spondyloarthritis with successful assessment of multiple regional enthesopathy sites in the same setting.

CLINICAL RELEVANCE/APPLICATION

High field multiparametric MRLI is technically successful and identifies multiple active SpA sites in the same setting. Larger scale studies can be performed using this novel protocol to evaluate the effect on patient outcomes.

SSQ13-04 Monosodium Urate Burden Assessed with Dual-Energy Computed Tomography Predicts the Risk of Flares in Gout: A 12-Month Observational Study

Thursday, Nov. 29 11:00AM - 11:10AM Room: E451A

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PURPOSE

To determine if the extent of urate burden measured with dual-energy computed tomography (DECT) and ultrasonography (US) is predictive of the risk of gout flares.

METHOD AND MATERIALS

This prospective observational study recruited gout patients to undergo monosodium urate (MSU) burden assessment with DECT (volume of deposits) and US (double contour sign) scans of knees and feet. Patients attended follow-up visits at 3, 6 and 12 months. Patients having presented with at least one flare at 6 months were compared versus those who did not flare. Odds-ratios (ORs) [95% confidence interval] were calculated on relevant data stored by the automatic selection procedure applied on the binary logistic regression model.

RESULTS

Overall, 64/78 included patients attended at least one follow-up visit. In bivariate analysis, the number of joints with the double contour sign was not associated with risk of flare (p=0.67). Multivariate analysis retained a unique variable: DECT MSU volume of the feet. For each 1cm3 increase in DECT MSU volume in feet deposits, the risk of flaring increased 2.03-fold during the first 6 months after initial assessment (OR 2.03 [1.15 - 4.38]) and 1.57-fold during the first 12 months (OR 1.57 [1.01 - 2.86]). The threshold volume best discriminating flarers from non-flarers was 0.81 cm3 (specificity 61%, sensitivity 77%).

CONCLUSION

This is the first study showing the usefulness of DECT for the management of gout patients beyond diagnosis by demonstrating that the extent of MSU burden measured with DECT but not US is predictive of the risk of flares.

CLINICAL RELEVANCE/APPLICATION

This is the first study to show the predictive value of DECT for gout flares.

SSQ13-05 Association Between Gout and Longitudinal 3T MRI-Based Knee Osteoarthritis (OA) Worsening: Initial Observation and Preliminary Analysis from the FNIH OA Biomarkers Consortium

Thursday, Nov. 29 11:10AM - 11:20AM Room: E451A

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PURPOSE

To determine whether the presence of gout is associated with increased odds of knee osteoarthritis (OA) worsening in participants

of the Foundation for the National Institute of Health (FNIH) study.

METHOD AND MATERIALS

Using 1:3 propensity score matching method, 25 subjects with positive history of physician confirmed gout (symptomatic and/or subclinical gout in any joints) and 75 controls who were matched for OA and gout confounding variables (age, sex, BMI, and race) were included in this IRB approved HIPAA compliant study. Baseline and follow-up knee radiographic measurements and MRI Osteoarthritis Knee Score (MOAKS) variables for cartilage damage, bone marrow lesions (BMLs), osteophytes, effusion-synovitis, and Hoffa-synovitis were extracted. The association between gout and 48-months radiographic OA progression (>0.7mm reduction in medial tibiofemoral joint space width) was evaluated using conditional regression model. The relationship between gout and 24-months change in MOAKS measurements was determined using conditional regression. A mediation effect analysis was utilized to explore the variable mediating the association between gout and knee OA.

RESULTS

There was no significant association between gout and 48-months radiographic OA progression (OR 95%CI: 1.21 (0.66-2.21)). However, in comparison with matched controls, subjects with gout showed higher odds of worsening tibial cartilage damage (OR 95%CI: 2.02 (1.01-4.04)) and Hoffa-synovitis (OR 95%CI: 5.20 (0.89-30.48)), but not for osteophyte or BML worsening, over 24-months. Mediation analyses suggested a non-significant trend for the mediatory role of Hoffa-synovitis for the association between gout and tibial cartilage damage worsening (Sobel's test p-value: 0.086; indirect effect 95%CI: -0.084-2.087).

CONCLUSION

Positive medical history of gout is associated with longitudinal MRI-based OA-related structural damage worsening including tibial cartilage defect and Hoffa-synovitis.

CLINICAL RELEVANCE/APPLICATION

Presence of symptomatic or subclinical gout in any joints can be considered as a potential risk factor for future tibiofemoral OA progression.

Honored Educators

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SSQ13-06 Does Metabolic Syndrome Increase the Risk of Osteoarthritis - Analysis of Subjects with Metabolic Syndrome and Healthy Controls from the KORA Cohort

Thursday, Nov. 29 11:20AM - 11:30AM Room: E451A

Participants
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PURPOSE

The purpose of the study was to assess the effects of the metabolic syndrome on osteoarthritis of the hip joint.

METHOD AND MATERIALS

Included were 356 patients of the KORA cohort (Cooperative Health Research in the Augsburg Region) with metabolic syndrome and a healthy control group. All subjects underwent a detailed assessment for the waist circumference as well as the presence of diabetes mellitus (fasting glucose), hypertension (systolic and diastolic), elevated triglycerides as well as an MR scan. MR measurements were performed on a 3 Tesla scanner (Magnetom Skyra, Siemens Healthcare, Erlangen, Germany) using a dual-echo Dixon and a T2 Haste sequence for anatomical structures. In order to quantify osteoarthritis of the hip, assessment was performed by two experienced radiologists for joint gap narrowing, osteophytes and subchondral sclerosis according to the Kellgren-Lawrence classification. Statistical analysis was performed using odds ratios from univariate and multivariate logistic regressions.

RESULTS

Age was found the only parameter in univariate and multivariate analysis to be significantly influencing on osteoarthritis of the hip joint. There was no correlation in univariate and multivariate analysis shown for any parameter of the metabolic syndrome as the waist circumference (OR left hip: 1.00, p= 0.933 ; OR right hip: 1.00, p= 0.833), triglyceride (OR left hip: 1.00, p= 0.925; OR right hip: 1.00, p= 0.209), HDL (OR left hip: 1.01, p= 0.084; OR right hip: 1.01, p= 0.111), systolic (OR left hip: 1.01, p= 0.469; OR right hip: 1.01, p= 0.404) or diastolic (OR left hip: 1.01, p= 0.407; OR right hip: 1.00, p= 0.736) blood pressure and fasting glucose (OR left hip: 1.00, p= 0.573; OR right hip: 1.02, p= 0.102) in comparison to osteoarthritis of the hip joint. Neither did the complex of metabolic syndrome in total show any significant correlation (OR left hip: 1.69, p= 0.104; OR right hip: 1.35, p= 0.313) to osteoarthritis of the hip joint.

CONCLUSION

Despite the strong influence of the metabolic syndrome on a wide range of inter alia cardiovascular diseases, we were able to show that metabolic syndrome does not affect osteoarthritis of the hip joint.

CLINICAL RELEVANCE/APPLICATION

Since a pathological mechanism has not yet been confirmed, growing research tries to associate osteoarthritis with the metabolic syndrome. This study wants to assess which subgroup of the metabolic syndrome is associated with osteoarthritis.

SSQ13-07 Association Between Patellofemoral Cartilage Damage and Frequency of Kneeling Activity in Subjects with/without Patella Alta: An FNIH OA Biomarkers Consortium Study

Thursday, Nov. 29 11:30AM - 11:40AM Room: E451A

Participants
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PURPOSE

It has been suggested that kneeling in occupational/sport activities is associated with knee OA. Studies suggested the association between kneeling and tibiofemoral joint cartilage damage, but reports of patellofemoral joint (PFJ) involvement are controversial. We aimed to investigate whether kneeling activity is associated with the worsening of MRI measures of PFJ cartilage damage in subjects with/without patella alta (PA) using the Foundation for the National Institute of Health (FNIH) study participants.

METHOD AND MATERIALS

The study was IRB-approved and HIPAA-compliant. Baseline and 24-month follow-up semi-quantitative MRI Osteoarthritis Knee Score (MOAKS) measures of PFJ of 600 subjects from the FNIH study were extracted. At the baseline visit, subjects were asked how many days per week they participated in activities with kneeling activity >=30 minutes. Insall-Salvati ratio (ISR) (patellar tendon/patellar height) was measured by a musculoskeletal radiologist using the baseline MRIs; knees with ISR>=1.3 were considered as PA. Logistic regression adjusted for age, sex and BMI, Chi-square test and Breslow-Day Homogeneity test were used to assess the impact of kneeling on worsening of MOAKS cartilage scores over 24-months in subjects with/without PA.

RESULTS

Worsening in MOAKS cartilage scores was seen in subjects with >=6 days/week of kneeling activity compared to subjects with less kneeling activity (adjusted OR(95%CI): 2.95(1.08-8.07)). However, despite the trend, 2-5 days/week kneeling was not associated with worsening of PFJ cartilage damages compared to less kneeling activity (<2 days/week). Stratifying analysis showed that only PA+ subjects, not PA-, had significant association between the kneeling and worsening of PFJ cartilage damage, especially in surface cartilage score (OR: 45.01(1.40-1444.2)) and medial side (OR:44.0(4.55-425.7)). Homogeneity test demonstrated significant difference between PA+ and PA- groups (P-value: 0.005).

CONCLUSION

Kneeling activity in >=6 days/week is associated with the worsening of PFJ MRI cartilage scores compared to less kneeling activity, especially in subjects with underlying PA.

CLINICAL RELEVANCE/APPLICATION

Frequent daily kneeling activity is associated with the higher risk of PFJ cartilage damage resulting in PF OA, especially in subjects with associated patella alta.

Honored Educators

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SSQ13-08 3D T1 Mapping of Hip Cartilage: Comparison of a New Inversion-Recovery Based Method with Conventional Dual-Flip Angle Acquisition

Thursday, Nov. 29 11:40AM - 11:50AM Room: E451A

Participants
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PURPOSE

Although commonly used for quantitative imaging of hip cartilage, 3D dual flip angle techniques are highly sensitive to flip angle

Although commonly used for quantitative imaging of hip cartilage, 3D dual flip angle techniques are highly sensitive to flip angle variation (B1 inhomogenities) which is even more pronounced at 3 T. To compare precontrast T1 values of (1) hip cartilage and (2) periarticular musculature using a new inversion-recovery based method with conventional dual-flip angle acquisition in asymptomatic volunteers.

METHOD AND MATERIALS

IRB-approved study of 18 asymptomatic hips (9 volunteers; mean age 27 ± 2 years, 60% female). All subjects underwent non-contrast, quantitative T1 imaging of hip cartilage at 3T with two different methods: (1) 3D dual-flip angle GRE-based technique (0.9 mm3 isotropic T1 VIBE; acquisition time 8:30 min) including a prescan for B1 correction. (2) 3D dual inversion-recovery approach that has been recently introduced in brain imaging (0.9 mm3 isotropic T1 MP2RAGE; acquisition time 7:30 min) in which T1 values are calculated based on two different inversion pulses. Radial images were reformatted for both T1 techniques. Regions of interest were placed manually, based on anatomic landmarks within the (1) cartilage at each hour position of the clockface. (2) At the 3/9 o`clock position 2 quotients (%) of the peri-articular musculature were calculated as a measure for antero-posterior (T1 psoas /gluteus maximus muscle) and medio-lateral (T1 iliacus/gluteus medius muscle) flip-angle variations over the field of view.

RESULTS

(1) MeanT1 values and standard deviations of overall (1488±174ms vs 1036±41ms), anterior (1533±219ms vs 1026±45ms) and posterior (1444±157ms vs 1047±43ms) hip cartilage were higher for the dual-flip angle compared to the inversion-recovery based method (all p<0.001). (2) T1 psoas/gluteus maximus muscle quotient (105±11% vs 97±4%, p=0.01) and T1 iliacus/gluteus medius muscle quotient (131±16% vs 98±2%, p<0.001) were higher for the dual-flip angle compared to the inversion-recovery based method.

CONCLUSION

Despite the used B1 prescan inter-individual differences (= standard deviation) in T1 values of cartilage were greater with the dual-flip angle method compared to the inversion-recovery method due to the greater flip-angle variations at 3 T.

CLINICAL RELEVANCE/APPLICATION

A more robust method for acquisition of 3D maps of hip cartilage could help in defining thresholds to differentiate intact from biochemical cartilage degeneration at 3 T.

SSQ13-09 Evaluating Variability in Knee CartiGram MRI - A Quantitative Study

Thursday, Nov. 29 11:50AM - 12:00PM Room: E451A

Participants
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PURPOSE

MRI cartilage assessment using CartiGram is a widely used T2 mapping sequence to non-invasively detect changes in cartilage. We tested the robustness of the technique by quantitatively measuring intra- and inter-scanner variability of T2 values.

METHOD AND MATERIALS

Our study had two parts. First, a phantom containing NaCl, GdCl3 and Agarose was created to mimic human meniscus, muscles, cartilage and synovium. A T2 CartiGram (test) and T1w IR-TSE (gold standard) were performed on a 3.0T (750W, GE Healthcare) and 1.5T (HDxt, GE Healthcare) MRI scanners. A phantom integrity test was performed at the end. Obtained data was evaluated by creating T2 maps and calculation of T2 mean±SD. Second, in two healthy volunteers, a T2 CartiGram was performed twice, at an interval of 10 minutes with subject lying still in the scanner, each on both the scanners on the same day. T2 maps were created and mean±SD and Relative Percentage Difference (RPD) calculated. Additional 2-D wear maps were created to check for anatomical variability.

RESULTS

Phantom: 3.0T MRI showed T2 values of 26.5±1.4 in meniscus, 61±3.5 in muscles and 56±2.9, 71.4±3.8 and 78±5.5 in three cartilage samples. The 1.5T MRI showed T2 values of 28±1.2 in meniscus, 62.3±3.4 in muscles and 52.9±2.9, 77.5±5.4 and 89±7.3 in the three cartilage samples. Healthy Volunteers: The RPDs on the same scanner for subject 1 were 3.5% (on 3.0T) and 3.8% (on 1.5T) on the medial femoral cartilage and -1.7% (on 3.0T) and -1% (on 1.5T) on the lateral, and for subject 2, they were -0.4% (on 3.0T) and 4.8% (on 1.5T) on the medial and 1.2% (on 3.0T) and 5.5% (on 1.5T) on the lateral. The 1.5T scanner reported a lower overall T2 value than the 3.0T, in contrast to the phantom results. Visual inspection of the 2D wear maps by a musculoskeletal radiologist revealed variability of T2 signal with no observable pattern.

CONCLUSION

There exists variability in T2 values of CartiGram when performed in healthy volunteers across both, different time points and different field-strengths. Further studies are needed to re-evaluate the threshold of 40ms for cartilage pathology and define MRI machine-specific guidelines.

CLINICAL RELEVANCE/APPLICATION

Significant differences in T2 values on CartiGram can lead to difficulty in diagnoses of borderline cases in clinical practice.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
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SSQ14

Nuclear Medicine (Technical Innovations and Emerging Opportunities)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S505AB

CT MR NM

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

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Participants

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Chadwick L. Wright, MD,PhD, Lewis Center, OH (*Moderator*) Nothing to Disclose

Sub-Events

SSQ14-01 Initial Results From the World's First Total-Body Positron Emission Tomograph

Thursday, Nov. 29 10:30AM - 10:40AM Room: S505AB

Participants
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PURPOSE

Positron Emission Tomography (PET) offers the most sensitive method for *in vivo* imaging assays of physiologically important compounds, but it is fundamentally limited by low signal and/or high radiation dose to the subject, which negatively impacts image quality, scan times and the kinds of diseases that may be investigated. PET also has the capacity to dynamically track the fate of biomolecules *in vivo*, allowing for pharmacokinetic analysis. However, standard clinical scanners have an axial field of view (AFOV) of 15-30 cm, which limits such analysis to single organs. This research program aims to address all these limitations by building extended AFOV scanners. Here we report initial results from a 194 cm long device - the first medical tomograph capable of simultaneously imaging the entire human body.

METHOD AND MATERIALS

The scanner consists of 8 rings of 24 PET detector modules, each containing 5 x 14 detector blocks. Blocks consist of 6 x 7 LYSO crystals of size 2.76 x 2.76 x 18.1 mm3 (total ~560 kg of LYSO), read out by silicon photomultipliers. The PET component is paired with an 80-channel CT scanner. PET detector performance has been characterized and system construction and integration has been completed. Static data from a 200 cm phantom has been acquired and reconstructed to investigate detector response uniformity. A 30-second dynamic scan of activity moving through a tube has also been acquired to verify dynamic frame generation.

RESULTS

Detector time-of-flight resolution is 409±39 ps and energy resolution is 11.7%±1.5% at 511 keV. Detector dead-time of 3.5% was found at count-rates similar to those expected in clinical operation. Images of the 200 cm phantom show reasonable uniformity even though not all corrections have been implemented yet. The dynamic dataset shows that frame creation is working as expected.

CONCLUSION

The world's first total-body PET/CT scanner has been built. Detector performance is in line with expectations. The system is operational and producing images. Implementation and validation of corrections for accurate quantification is under way. Further performance characterization is planned.

CLINICAL RELEVANCE/APPLICATION

Total-body PET aims to improve all clinical PET through ultra-fast (<1min) scans; ultra-low-dose (<0.35mSv) scans; improved image quality; and total-body kinetic modeling for precision medicine.

SSQ14-02 The Effect of a Novel Bayesian Penalised Likelihood (BPL) PET Reconstruction on the Herder Risk Prediction Model of Malignancy in Solitary Pulmonary Nodules Undergoing Assessment with 18F-FDG PET-CT

Thursday, Nov. 29 10:40AM - 10:50AM Room: S505AB

Participants
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PURPOSE

The British Thoracic Society (BTS) guidelines recommend using 18F-FDG PET-CT with the Herder model to assess the risk of malignancy in solitary pulmonary nodules (SPNs). Qualitative assessment of FDG uptake in SPNs, using an ordinal scale, integral to the Herder model, is based on analysis of standard Ordered Subset Expected Maximisation (OSEM) reconstruction PET images. Novel PET reconstructions improve image quality by increasing signal-noise ratio and suppressing image noise. Our aim was to assess the impact of a novel Bayesian Penalised Likelihood (BPL) PET reconstruction on the Herder risk prediction model of malignancy in SPNs in comparison with standard OSEM images.

METHOD AND MATERIALS

Subjects with a SPN who underwent 18F-FDG PET-CT between 2014-2017, with assessable OSEM and BPL reconstructions, and either histological confirmation of malignancy or histological and/or imaging follow-up confirmation of benignity were included. Two readers independently and blindly classified FDG uptake in each SPN on both OSEM and BPL images (BTS score; 1=none; 2=MBP but <2x liver; 4=>2x liver). The BTS score in combination with other clinico-radiological features was used to calculate the Herder risk score (%) for both OSEM and BPL images.

RESULTS

97 subjects (age 69±10 years, 52% male, 84% current/former smokers, mean nodule size 16±6mm) with 75 (77%) malignant SPNs were included. There was very good inter-observer agreement for the BTS score for both OSEM (κ=0.85) and BPL images (κ=0.87). BPL images increased the BTS score in 25 (26%) SPNs (20 malignant & 5 benign); 9 SPNs (7 malignant) increased from a BTS score 2 to 3, and 16 (13 malignant) from a BTS score 3 to 4, with a mean increase of 18±22% in Herder risk score. The mean Herder score using BPL images was significantly higher than OSEM for all SPNs (73±29 vs 68±32% respectively, p=0.001), and for malignant SPNs (83±19 vs 78±25%, p=0.004), but not for benign SPNs (42±35 vs 37±34%, p=0.07).

CONCLUSION

The use of BPL PET reconstruction increases the Herder score in approximately 25% of SPNs compared to standard OSEM datasets with the potential to affect subsequent management decisions.

CLINICAL RELEVANCE/APPLICATION

Novel BPL PET reconstruction, compared to standard reconstruction, may increase the estimated risk of malignancy in a SPN, using the Herder model, thus potentially affecting management decisions.

SSQ14-03 Impact of Point Spread Function Reconstruction on 68Ga DOTATATE PET/CT Quantitative Imaging Parameters

Thursday, Nov. 29 10:50AM - 11:00AM Room: S505AB

Awards
Trainee Research Prize - Medical Student

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PURPOSE

68Ga DOTATATE PET/CT has been increasingly used for diagnosis and therapy response assessment of patients with neuroendocrine tumors (NETs). We investigated the impact of point spread function (PSF) reconstruction and lesion size on 68Ga DOTATATE PET/CT quantitative parameters.

METHOD AND MATERIALS

A total of 38 patients with 42 68Ga DOTATATE PET/CT scans and 125 lesions were included. Scans were reconstructed with and without PSF modulation. For each lesion, one reader measured the maximum and peak standardized uptake value (SUVmax and SUVpeak), metabolic tumor volume (MTV), total lesion somatostatin avidity (TLS), and tumor somatostatin receptor expression heterogeneity (TH) using area under the curve method. Intraclass correlation coefficient (ICC) and Bland-Altman analyses were used to compare PSF and non-PSF values. Subgroup analysis was performed to determine the impact of lesion size.

RESULTS

Mean age of the patients was 55 ± 15 years. 21 patients were male and 17 were female. Of the 42 scans, 11 were baseline scans and 31 were follow-up scans. Of the 125 lesions, 51 were located in the liver, 31 in lymph nodes, 17 in bone, 8 in pancreas, 4 in lung, and 14 in other sites. Correlation coefficients between PSF and non-PSF values were excellent for SUVmax (ICC=0.97), SUVpeak (ICC=0.99), MTV (ICC=0.98), and TLS (ICC=0.99), and was good for TH (ICC=0.81). Comparison of PSF with non-PSF values showed a bias (mean percent change ± SD) of +27.5 ± 14.7% for SUVmax, +15.5 ± 9.5% for SUVpeak, -18.6 ± 37.6% for MTV, +0.8 ± 28.1% for TLS, and -7.1 ± 11.0% for TH. For lesions less than 2 cm in size (n=75), comparison of PSF with non-PSF values showed a bias of +32.7 ± 15.8% for SUVmax, +19.3 ± 9.3% for SUVpeak, -27.9 ± 45.4% for MTV, -1.7 ± 35.4% for TLS, and -5.0 ± 12.2% for TH. For lesions 2 cm or more in size (n=50), comparison of PSF with non-PSF values showed a bias of +19.7 ± 8.0% for SUVmax, +9.8 ± 6.2% for SUVpeak, +0.01 ± 23.1% for MTV, +4.6 ± 8.8% for TLS, and -10.4 ± 7.9% for TH.

CONCLUSION

PSF and non-PSF values for 68Ga DOTATATE PET/CT quantitative parameters were highly correlated. PSF reconstruction increased SUVmax and SUVpeak, decreased TH, and had a variable effect on MTV and TLS depending on lesion size.

CLINICAL RELEVANCE/APPLICATION

PSF reconstruction increases SUVmax and SUVpeak and should be considered in evaluating 68Ga DOTATATE PET/CT quantitative parameters for diagnosis and therapy response assessment of NETs.

SSQ14-04 Value of CT Iterative Metal Artifact Reduction in PET/CT: Clinical Evaluation in 103 Patients

Thursday, Nov. 29 11:00AM - 11:10AM Room: S505AB

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To assess the technical feasibility and diagnostic benefit of CT iterative metal artifact reduction (iMAR) in patients with metal implants undergoing PET/CT.

METHOD AND MATERIALS

PET/CT examinations of 103 consecutive patients with metal implants in different localization performed between 10/2017 and 03/2018 using a state-of-the-art clinical PET/CT scanner (Siemens Biograph mCT) were included. As PET tracers 18F-FDG (75/103), 68Ga-PSMA (25/103) and 68Ga-DOMITATE (3/103) were used. Diagnostic CT data were reconstructed with iMAR and without iMAR (noMAR) and used in comparison for PET attenuation correction, generating iMAR-corrected and noMAR-corrected PET data. The effect of iMAR on quantitative CT and PET analysis was assessed by HU and SUV measurements in predefined normal anatomical structures and pathological lesions in the vicinity of metal implants. Qualitative diagnostic confidence for lesion delineation was assessed by 2 radiologists using a 3-point Likert Scale (1=not delineated; 2= fair delineated; 3=good delineated).

RESULTS

For artifact-affected anatomical structures, mean HU of iMAR CT images were significantly different compared to noMAR CT and respective standard deviations were significantly lower (e.g., M. masseter in case of dental fillings/implants: 105.1 HU, SD 43 [noMAR] vs. 72.2 HU, SD 14 [iMAR] P<.01; M. gluteus maximus in case of hip endoprostheses: 79.4 HU, SD 23 vs. 50.0 HU, SD 15; P<.01). However, SUVs did not differ significantly in these artifact-affected anatomical structures (SUVmean 0.90 [iMAR] vs. 0.91 [noMAR]; P>.05) and pathological findings (SUVmean 10.65 [iMAR] vs. 10.67 [noMAR]; P>.05) between the iMAR and noMAR PET data. In the qualitative analysis, a significantly improved delineation of pathologic findings was observed using iMAR in CT for both the interpretation of physiological (score: 1.23 [noMAR] vs. 2.26 [iMAR]; P<.01) and pathological structures (score: 2.31 [noMAR] to 2.80 [iMAR]; P<.01).

CONCLUSION

The use of iMAR in PET/CT significantly improves delineation of both physiological and pathological structures in the vicinity of metal implants in CT. The PET quantification and image quality are not significantly affected by the use of iMAR based attenuation correction.

CLINICAL RELEVANCE/APPLICATION

Metal related artifacts impair image quality and increase the risk of missing pathological findings in PET/CT. Lesion delineation is quantitatively and qualitatively improvable by iMAR.

SSQ14-05 PET/CT versus PET/MR: Quantitative Accuracy in Y-90 Dosimetry Analysis

Thursday, Nov. 29 11:10AM - 11:20AM Room: S505AB

Participants
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PURPOSE

The purpose of this study is to compare Y-90 dosimetry estimates based on PET/MR versus PET/CT, identify errors in PET/MR dosimetry related to MR-based attenuation correction (AC) and PET detector equipment, and offer methods to avoid these errors.

METHOD AND MATERIALS

An IRB-approved prospective study was performed on eight patients receiving Y-90 radioembolization for liver malignancies. Following the intervention, patients were scanned by PET/CT (Siemens Biograph mCT) and PET/MR (Siemens Biograph mMR). PET/CT scans were performed arms-up, while the PET/MR scans were performed either arms-up, arms-down, or both. AC for PET/CT was derived from a low-dose CT scan. AC for PET/MR was performed with three class segmentation using the Dixon technique. Dosimetry calculations were performed using MIMs 6.5 software (MIM Software Inc.). PET/CT dosimetry was used as the standard to compare PET/MR dosimetry analysis. Accuracy of PET/MR dosimetry was analyzed in relation to injected activity, background liver and tumor dose, and PET/MR arm location.

RESULTS

PET/MR dosimetry provided accurate dosimetry estimates (within 20% of PET/CT) in the majority of cases. Inaccuracies in PET/MR dosimetry estimates were most pronounced in studies having segmentation errors or truncation errors in the PET/MR AC map, causing inappropriate attenuation correction. Inaccurate PET/MR dosimetry also occurred in cases with high Y-90 injected activity (>3 GBq). Such errors were attributed to the slow characteristics of the Biograph mMR's PET detectors given the high singles rate arising from bremsstrahlung x-rays, leading to inaccurate dead-time correction and increased noise and inaccurate corrections for random coincidences. These causes for error can be avoided by ensuring the AC map is accurate, checking for truncation errors, and using Y-90 doses less than 3 GBq.

CONCLUSION

PET/MR can provide accurate Y-90 dosimetry estimates as compared to PET/CT, provided that the injected activity is not excessive and the MR-based AC map has no major errors. Newer technologies, namely high-speed PET detectors using silicon photomultipliers and new atlas-based methods for PET/MR AC, are expected to improve accuracy of PET/MR Y-90 dosimetry.

CLINICAL RELEVANCE/APPLICATION

PET/MR can provide accurate Y-90 dosimetry estimates as compared to PET/CT, provided that the injected activity is not excessive and the MR-based AC map has no major errors.

SSQ14-06 Evolution of PET/MR Protocols Since 2011: A Single-Center Observational Study Including 1797 Examinations

Thursday, Nov. 29 11:20AM - 11:30AM Room: S505AB

Participants
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PURPOSE

PET/MR is a versatile hybrid imaging modality especially used for oncologic imaging. Since the introduction of combined PET/MR systems in 2011 this relatively new technology has undergone significant developmental stages and has evolved into a robust clinical modality. The purpose of this study was to record and evaluate the development of clinical PET/MR examinations in our institution with respect to acquisition times, protocol complexity and tracer dosage.

METHOD AND MATERIALS

Essential parameters of 1797 clinical PET/MR examinations were recorded in an institutional database between 01/2013 and 12/2017 including total examination time, PET acquisition time, number of PET bed positions, number of generated images, injected tracer dose and administration of MR contrast agent. All examinations were conducted on a clinical PET/MR system (Siemens Biograph

mMR, 3 T). PET/MR protocols were iteratively adjusted according to available optimal settings over the observation period. We evaluated the recorded PET/MR parameters with respect to their development over time and with respect to their variation among different examination groups (adult patients, pediatric patients and brain studies).

RESULTS

The 1797 examinations included in the final database consisted of 1004 adult patient studies, 278 pediatric patient studies, and 515 brain studies. Average examination time decreased significantly between 01/2013 and 12/2017 from 75.7±26.7 to 66.6±23.4 min ($P < 0.5$). Compared to adult patients, the average pediatric examination time was longer but also significantly shortened between 01/2013 and 12/2017 (from 96.8±21.2 min to 84±23.0 min ($P < 0.5$)). In the same period however, overall examination complexity measued by the number of acquired images significantly increased from 2697 to 3696 acquired images per examination ($P < 0.01$).

CONCLUSION

PET/MR is a complex and time-consuming imaging modality producing a large number of complex image data. Despite increasing protocol complexity however, examination times were significantly reduced by the introduction of accelerated MR imaging techniques and protocol optimization.

CLINICAL RELEVANCE/APPLICATION

By optimizing examination protocols PET/MR scan times can be reduced, potentially increasing patient comfort and patient compliance, which is particularly important when examining children.

SSQ14-07 Feasibility of "Low Dose MR" Dixon Technique for Imaging FDG PET-MR Lymphoma

Thursday, Nov. 29 11:30AM - 11:40AM Room: S505AB

Participants
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PURPOSE

Clinical whole body PET-MR imaging has wrestled with the problem of acquiring high quality multiplanar MR sequences compared to lower resolution fast MR sequences. "Low dose MRI" is a term used in the nuclear medicine community to describe fast acquired PET-MR scan protocols that relied heavily on PET images for diagnosis. In this study, we sought to determine if the Dixon sequences obtained for attenuation correction could be used as a diagnostic sequence for interpreting PET-MRI lymphoma cases.

METHOD AND MATERIALS

We retrospectively identified 40 patients who underwent 88 FDG PET-MR body imaging studies for staging or restaging lymphoma. Brain images were not reviewed. A radiologist and nuclear medicine physician blindly reviewed PET images, attenuation correction coronal Dixon MRI, PET-MR fusion with Dixon, and multisequence (ms) MR, and ms PET-MR images. Lesions were characterized based on location, imaging characteristics, size, max SUV, and malignant potency.

RESULTS

All patients were adults with average study age 43.8 y. Studies consisted of 40 females and 48 males with 7 for staging and 81 for restaging. All patients had systemic lymphoma with 29 being diffuse large B-cell lymphoma. 37 studies had active lymph nodes (LN) on Dixon PET-MR that agreed with ms PET-MR in 33 positive cases (89.1%) having avg SUV 10.2 +/-7.74 SD. 4 Dixon PET-MR cases did not detect lesions, avg SUV 2.3 +/-0.55 SD, read as minimal residual activity. ms MR identified 11 patients with enlarged LN without FDG uptake, not seen on Dixon. All 5 studies with bones lesions were detected by Dixon PET-MR as well as 2 soft tissue organ lesions. ms MR identified 1 patient with nonactive healed bone lesions. 55 true negative. Compared to ms PET-MR, Dixon had 89.2% sensitivity, 100% specificity with no false positive studies.

CONCLUSION

In this retrospective study, Dixon PET-MR was shown to be sensitive and specific compared to ms PET-MR in the detection of lymphoma. Low number of cases not detected had minimally active LN that resolved on subsequent imaging and probably were not clinically important.

CLINICAL RELEVANCE/APPLICATION

Low dose MRI sequences using the Dixon technique for interpretation may a play role in PET-MR imaging when scan time becomes important. This may be necessary in patients with comorbidity, claustrophobia, or when multiplanar MR of particular areas be necessary.

SSQ14-08 An Unsupervised Dixon-Based Five-Tissue 18F-Sodium Fluoride Synthetic CT Generation for PET/MR Attenuation Correction

Thursday, Nov. 29 11:40AM - 11:50AM Room: S505AB

Participants
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PURPOSE

To create accurate voxel-wise attenuation correction (AC) maps for PET/MR using Na18F images and obviate the need for both specialized MR pulse sequences and conventional methods that typically lack bone information.

METHOD AND MATERIALS

Sixteen breast cancer patients received research PET/MRI exams (Philips Ingenuity TF) following clinical Na18F PET/CT exams. Free-breathing 3D T1-weighted (T1W), breath-holding mDixon, and (clinical) low-dose CT images were acquired. Rigid-body registration and local-phase deformable registration were used to transform CT, Dixon-water (Water), and Dixon-fat (Fat) to match free-breathing T1W images. A bone feature image was segmented from the non-AC Na18F image. Water, Fat, and bone features were classified into five tissue types using fuzzy c-means clustering. CT numbers of -1000, -741, -98, 40, 380 HU were assigned to estimated air, lung, fat, soft tissue, and bone classes, respectively. Synthetic CT (sCT) was generated as a linear combination of these. Mean error (ME) and mean absolute error (MAE) were estimated to evaluate the accuracy of the sCT generated by water-filled (WF), three-class T1W-based (3C-T1W), four-class Dixon-based (4C-Dx), four-class deformed Dixon-based (4C-defDx) and five-class deformed Dixon-Na18F (5C-DxBone) methods. A threshold-based CT bone mask was used to assess the accuracy of the sCT in bone regions.

RESULTS

The MAE of the sCT from WF, 3C-T1W, 4C-Dx, 4C-defDx, 5C-DxBone were 135±8, 133±19, 111±14, 105±11, 103±10 HU, respectively. The 4C-defDx group showed better agreement to measured CT than the conventional 4C-Dx. The ME in the bone mask (MEbone) of the 4C-defDx and 5C-DxBone were -351±27 and -225±29 UH. The 5C-DxBone group presented robust Na18F-derived bone information especially in spine and pelvis; it reduced by 33-37% the MEbone when compared with the other AC methods and resulted in the lowest ME and MAE.

CONCLUSION

The deformable registration mitigated the mismatch between Na18F and Dixon due to different breathing conditions. The results suggest that the Dixon-based sCT can be improved by having a Na18F-derived bone feature to increase the accuracy of PET/MR Na18F quantification.

CLINICAL RELEVANCE/APPLICATION

PET/MR Na18F for bone metastasis detection is not well-established as the lack of bone information for attenuation correction (AC). We propose a feasible five-tissue method for PET/MR Na18F AC.

SSQ14-09 Investigation on PET/MR Image Fusion Mismatch Due to Expanding Bladder: A Pilot Study

Thursday, Nov. 29 11:50AM - 12:00PM Room: S505AB

Participants
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Tuoyu Cao, PhD, Houston, TX (*Abstract Co-Author*) Employee, Medical Device Manufactor
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Hongcheng Shi, Shanghai, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

A considerable change of the urinary bladder shape between consecutive bed positions poses a unique challenge on a multi-bed simultaneous PET/MR scan. Our aim is to report our initial experience on the fusion error caused by expanding bladder.

METHOD AND MATERIALS

120 patients (63 males and 57 females, average age = 51.3 years, range 22-70 years) who had been diagnosed with cancer or had previous history of cancer were recruited. Each patients were scanned on a simultaneous whole-body PET/MR system with 5 bed positions (feet in first, 4 bed positions for body and 1 for head). All PET/MR images were visually examined by two independent experts to evaluate the pelvis fusion accuracy with a Likert scale scoring system (1-5, 5 as the best quality).

RESULTS

The mean and standard deviation of the score is 4.57 and 0.75 correspondingly. 14 patients(11.7%) were rated less or equal to 3 by both readers all because of mismatch in the bladder area. This is due to the fact that the bladder area is in the overlap region of PET images from two consecutive bed positions, so the image of the bladder area is a weighted sum of these two PET images based on the sensitivity curve. Because the bladder expanded significantly between these two bed positions, the average of the two very different bladder images cannot match the MRI image from either bed position. This effect is magnified with PET/MR scanning because the scan duration for each bed position is usually significantly longer than that of a PET/CT system due to the limitation of MRI.

CONCLUSION

Our initial clinical results shows that, in most scenarios PET/MRI can achieve very good image fusion accuracy in the pelvis area. However, it is important to know that expanding bladder might cause mismatch between PET and MRI images when the bladder area is in the PET overlap region of two bed positions. Special care might be needed if there is diagnostic interests of the area near bladder. This effect can be avoided by arranging bed position accordingly so that bladder is close to the center of one bed position.

CLINICAL RELEVANCE/APPLICATION

This study provides a guideline for simultaneous PET/MR scan protocol to avoid the fusion error in pelvis area due to expanding bladder.

SSQ15

Neuroradiology (Dots and Dashes: Image Analysis in Neuroradiology)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S503AB

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

SSQ15-01 Gray Matter Network Organization in Psychotic Disorders

Thursday, Nov. 29 10:30AM - 10:40AM Room: S503AB

Participants
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Du Lei, Chengdu, China (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Abnormal structural brain networks are believed to be an important cause of serious mental illness. Detailed studies of brain networks using advances neuroimaging approaches continues to advance understanding of these network disturbances. In the present study, we used a relatively novel approach for identifying atypical gray matter network organization in a large cohort of patients with serious mental illness and their first degree relatives, and examine their genetic associations.

METHOD AND MATERIALS

N=854 subjects (330 probands with psychotic disorders, 320 of their nonpsychotic relatives and 204 healthy controls) were recruited. Single-subject gray matter networks were extracted from structural MRI scans using a recently developed automated and data-driven method. In gray matter graphs, nodes represent small cortical areas whereas edges represent statistical similarities in regional gray matter morphology between nodes. Small-world properties and nodal centrality metrics were calculated and compared among participant groups. Genetic associations of abnormal network metrics were examined using GWAS.

RESULTS

Psychotic probands showed decreased nodal degree and nodal efficiency mainly in right superior frontal gyrus and bilateral superior temporal regions relative to healthy controls. The connectivity matrix analysis showed that the impaired connections between frontal and temporal regions were found highly replicated for each abnormal node. Genome-wide significant association with nodal degree of right frontal cortex was observed with SNPs in the cell proliferation regulating inhibitor of protein phosphatase 2A gene (CIP2A) at chromosome 3q13.13, while temporal nodal metric changes were associated with psychotic symptomatology. The network metrics of nonpsychotic relatives did not differ from healthy controls.

CONCLUSION

By investigating single-subject gray matter graphs to define neuroanatomic networks in a large group of individuals with psychotic disorders, our findings provide novel evidence indicating disorganizations of anatomical gray matter network mainly involving the fronto-temporal circuit that were related to genetic and clinical factors, which may underpine the neuropathology of psychotic disorders.

CLINICAL RELEVANCE/APPLICATION

Our study provide novel evidence indicating gray matter disorganizations in fronto-temporal circuit that are related to the genetic origin and severity of psychotic symptomology.

SSQ15-02 Synthetic MRI in 3D

Thursday, Nov. 29 10:40AM - 10:50AM Room: S503AB

Participants
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PURPOSE

Synthetic MRI is based on absolute quantification of R1 and R2 relaxation rates and proton density PD, where image contrast is synthesized as a post-processing step. A limitation thus far has been the lack of a 3D sequence with a clinically relevant image quality and scan time. The aim of this work was to assess a new 3D quantification method, QALAS, for high-resolution brain imaging in 6 minutes scan time.

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 QRAPMASTER sequence (MDME or MAGiC) is a saturation recovery multi-slice TSE sequence with multi-echo read-out. Twenty-four phantoms with various combinations of R1 and R2 relaxation rates were scanned with an inversion recovery (IR) sequence with 6 inversion delay times at 100, 200, 500, 1000, 2000 and 5000 and a multi-echo (ME) TSE sequence with 20 echoes. Additionally, a group of 10 volunteers was acquired with the two quantification methods to correlate automatically segmented brain volumes of white matter, grey matter, cerebrospinal fluid and myelin. Post-processing was performed by a prototype SyMRI 12 (SyntheticMR, Sweden). The scanner was a patched Philips Ingenia 3T.

RESULTS

Linear regression showed a slope of 0.97 and an intercept of 0.01 of QALAS R1 and IR. A slope of 1.02 and an intercept of 0.01 was observed for QALAS R2 and ME. The Pearson correlation coefficient was >0.99 for R1, R2, PD and for the synthetic T1W, T2W and FLAIR. The observed mean brain volume for QALAS was 1337 ml, the mean intracranial volume was 1493 ml, a difference of -36 ml and -34 ml, respectively, compared to QRAPMASTER. WM volume was 552 ml, GM 744 ml, CSF 157 ml and myelin 176 ml, a difference -9, -45, -1, -11 ml, respectively. Normalized for ICV, no significant differences were observed, the brain fraction BPF was 89.5%, WM fraction 36.9%, GM fraction 49.8%, CSF fraction 10.5% and myelin fraction 11.8%.

CONCLUSION

Absolute quantification in 3D isotropic resolution using QALAS provides very similar values for R1, R2 and PD, synthetic T1W, T2W, FLAIR and automatic brain segmentation in comparison to a known 2D quantification method in the brain.

CLINICAL RELEVANCE/APPLICATION

Synthetic MRI provides many image contrast in a short scanning time. Being based on quantitative maps it also provides robust input to automatic brain segmentation.

SSQ15-03 Abnormal Cerebellar-Default Mode Network Connectivity in Unmedicated Bipolar II Depression

Thursday, Nov. 29 10:50AM - 11:00AM Room: S503AB

Participants
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PURPOSE

Objective: Bipolar disorder (BD) is a common psychiatric disease. Previous studies have found abnormalities in structural and functional brain connectivity in BD patients. However, few studies have focused on the functional connectivity (FC) of the cerebellum and its sub-region in patients with BD. The present study aimed to examine the FC of cerebellar subregion-default mode network (DMN) in patients with BD II.

METHOD AND MATERIALS

Materials and Methods: All patients met Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (known as DSM-V) criteria for BD II according to the diagnostic assessment by the Structured Clinical Interview for DSM-V Patient Edition (SCID-P). And they were diagnosed with total YMRS score<7 and HDRS-24 score>21. In total, 92 patients with unmedicated BD II depression and 100 healthy controls (HCs) were recruited, and they underwent the resting-state functional magnetic resonance imaging. Three pair subregions of the cerebellum the DMN-related had been selected as seed regions (bilateral Crus I, Crus II, and lobule IX) and calculate the whole brain FC for each subregion. The two-sample t test was performed to assess the significant differences of the FC for each subregion between BD II and HCs. Age, gender and the mean framewise displacement were included as nuisance covariates. Statistical maps were thresholded using permutation tests (1000 trials). The threshold-free cluster enhancement and voxel-wise correction with permutation tests were tested at two-tailed $p<0.05$ for multiple comparisons.

RESULTS

Results: Compared with HCs, the patients with BD II depression showed increased FC in the right Crus I-bilateral precuneus, decreased FC in the left Crus II-right medial prefrontal cortex (mPFC), -bilateral medial frontal gyrus (MFG) and the right Crus II-left MFG. There were no significant difference in the whole FC of the left Crus I and bilateral lobule IX between the BD II depression group and the HCs group.

CONCLUSION

Conclusions: The findings showed impaired FC between the cerebellum and the DMN in BD, partially FC of the Crus I-precuneus, the Crus II-prefrontal cortex, suggest the importance of abnormal cerebellum-DMN FC in the pathophysiology of BD.

CLINICAL RELEVANCE/APPLICATION

The work described has not been submitted elsewhere for publication, and all the authors have approved the manuscript that is

enclosed. The authors do not have any possible conflicts of interest.

SSQ15-04 Denoising fMRI Data Using Random Matrix Theory Improves Language Mapping Sensitivity in Brain Tumor Patients

Thursday, Nov. 29 11:00AM - 11:10AM Room: S503AB

Participants
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Timothy M. Shepherd, MD, PhD, New York, NY (*Abstract Co-Author*) Investigator, BrainLAB AG Research Grant, BrainLAB AG Institutional research collaboration, Siemens AG Co-founder, Velona Technologies Officer, Velona Technologies

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PURPOSE

Functional MRI improves preoperative planning in brain tumor patients, however BOLD signal changes for task-based 3T fMRI are only 2-3% and the tumor often compromises patient performance. This study tested the hypothesis that Marchenko-Pastur Principle Component Analysis (MP-PCA) denoising significantly improves statistical power for pre-operative fMRI language mapping.

METHOD AND MATERIALS

This IRB-approved, HIPAA-compliant study retrospectively identified 22 brain tumor patients (13 female; 42.5±18.1yrs, all left language dominant) that successfully performed verb generation, sentence completion and listening comprehension language fMRI paradigms. Original and MP-PCA denoised volumes for the 3 language tasks were processed using FSL-FEAT. For each task, we created histograms of z scores for original and MP-PCA denoised data within the left frontal operculum (LFO) and left parieto-temporal junction of the contralateral homologous region. Mean Z-scores were compared using paired 2-sided t-tests and their distributions compared with Kolmogorov-Smirnov tests.

RESULTS

MP-PCA denoising resulted in increased volume and magnitude of fMRI activation for all 3 language tasks. In the LFO during sentence completion, MP-PCA denoised statistic maps showed 12% average greater volume of voxels with $Z>3$ ($p=0.0002$) and mean z-score increased from 4.9±1.1 to 5.7±1.5 ($p<0.0001$) (almost an order of magnitude increase in statistical power). Mean z-scores did not increase after MP-PCA denoising in contralateral regions not involved in language. Histogram of z-scores in cortical language regions shifted to stronger statistical correlations to the task (KS test; $p<0.0001$) and appeared less Gaussian than typically observed with fMRI, which may better reflect known widespread cortical recruitment during language performance.

CONCLUSION

MP-PCA denoising demonstrated increased sensitivity for cortical regions recruited during language task-based fMRI paradigms in brain tumor patients. This could improve the clinical value and practical utility of performing preoperative fMRI in more brain tumor patients.

CLINICAL RELEVANCE/APPLICATION

A recently described denoising approach can significantly increase the statistical power of task-based fMRI to improve language mapping sensitivity in patients with brain tumors.

SSQ15-05 Assessment of Zygomatic Bones Symmetry through 3D Segmentation and Mirroring Procedure on CT Scans (MFCT) for Reconstructive Maxillofacial Surgery Work-Up

Thursday, Nov. 29 11:10AM - 11:20AM Room: S503AB

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PURPOSE

Zygomatic bones contribute to overall facial morphology: their integrity and symmetry is of pivotal interest in reconstructive maxillofacial surgery. Our aim was to prove the feasibility of a new technique for zygomatic bones symmetry assessment through registration and calculation of point-to-point distances between the mirrored 3D models.

METHOD AND MATERIALS

100 patients (50 male, 50 females), divided in 2 groups (18-49 years ; 50-95 years) were randomly selected from our CT-scans

database. CT acquisition parameters were: 150 mAs, 120 kV, collimation: 128 x 0.6 mm, pitch: 0.55, recon. thickness: 1 x 0.8 mm, recon.algorithm: H60 sharp. 1 operator performed a 2 -step semi-automatic segmentation of bone volumes through ITK-SNAP software; first the bone surface from zygomatic, maxillary, frontal and temporal areas was acquired; then the obtained 3D model was elaborated with a 3D-elaboration software (VAM© software) to manually select the zygomatic bone according to sutures. Once the 2 zygomatic bones are acquired, the left bone is automatically mirrored and registered on the right one according to the least point-to-point distance between the 2 models by the VAM© software, which provides point-to-point mean and root mean square (RMS) distance and a graphical representation of constant and variable areas between the 2 surfaces.

RESULTS

According to Bland-Altman test, repeatability of RMS measurements performed by the same operator and by a different observer was 79% for both. TEM for intra- and inter-observer error was respectively 4.3% and 3.5%. No statistically significant differences were found according to sex, neither for mean point-to-point distance ($F = 0.15$, $p = 0.670$) nor for RMS value ($F = 0.4$, $p = 0.529$). No statistically significant difference was found according to age groups, neither for mean point-to-point distance ($F = 0.58$, $p = 0.448$) or RMS value ($F = 0.05$, $p = 824$). Interaction between sex and age was negligible for both the parameters ($F = 0.38$, $p = 0.539$; $F = 0.82$, $p = 0.367$, respectively). Effect size for sex and age groups was respectively 0.15 and 0.00: in the former case the value corresponds to a small effect, whereas in the latter one to no effect.

CONCLUSION

We confirmed the feasability of this new 3D method for assessing zygomatic symmetry.

CLINICAL RELEVANCE/APPLICATION

The use of this technique can help a precise planning for surgical reconstruction of zygomatic bones fractures.

SSQ15-06 Which Standardized T1-Weighted Brain MRI Template to Use in Studies on Older Adults?

Thursday, Nov. 29 11:20AM - 11:30AM Room: S503AB

Participants
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PURPOSE

Atlas-based MRI investigations on older adults typically utilize young adult standardized structural templates, such as those of the ICBM. In addition, a quantitative assessment of how different available standardized structural templates perform in an aging population has not yet been performed. Here, a new standardized T1-weighted template designed specifically for studies on older adults was developed and compared to 15 other standardized templates in terms of image quality and inter-subject spatial normalization accuracy.

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 included in this work. A template was constructed from these data based on ANTs registration and is referred to in the following as the IIT-Aging template. The IIT-Aging template and 15 other standardized templates were compared in terms of image sharpness by means of the normalized power-spectral density. All templates were also compared in terms of the inter-subject spatial normalization accuracy achieved when used as references for normalization of T1-weighted data from 222 non-demented ADNI participants. Normalization accuracy was assessed for each template by means of the average pair-wise normalized cross-correlation, standard deviation, and average absolute log-Jacobian determinant in gray matter of ADNI participants.

RESULTS

The IIT-Aging template has higher image sharpness compared to other templates, also demonstrated as higher energy at high spatial frequencies in the normalized power spectra Fig (A, B). Inter-subject spatial normalization accuracy was higher when using the IIT-Aging compared to all other templates Fig (C, D). The IIT-Aging and MCALT templates required lower spatial deformation for spatially normalizing ADNI datasets Fig (E).

CONCLUSION

The new IIT-Aging T1-weighted template is characterized by superior image quality and allows higher inter-subject spatial normalization accuracy for studies on older adults, compared to other available standardized templates.

CLINICAL RELEVANCE/APPLICATION

Evaluate older adult templates for use in aging population

SSQ15-07 Three Dimensional Deep Neural Network Based Multi-Modality and Multi-Organ Automatic Segmentation for Brain Radiosurgery

Thursday, Nov. 29 11:30AM - 11:40AM Room: S503AB

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PURPOSE

Tumor and critical organ delineation is the most critical step in automatic stereotactic radiosurgery (SRS) treatment planning workflow for brain metastases. Recent progress in 3D convolutional neural networks has made it feasible to produce voxel-wise predictions of volumetric images and provide a powerful tool for automatic segmentation. The present study aims to develop a 3D convolutional networks algorithm for tumor and multi-organ segmentation on multi-modality imaging including contrast-enhanced computed tomography (CTc) and contrast-enhanced T1-weighted magnetic resonance imaging (MRI-T1c).

METHOD AND MATERIALS

Our training and testing dataset are acquired from one brain metastases cohort (n=95) treated with SRS using CyberKnife system. Each data included volume mask for brain tumors, brain stem, optic chiasm, bilateral eyes and optic nerves with associated CTc and MRI-T1c. We develop a workflow to organize the raw data, perform image preprocessing including data augmentation and registration, construct 3D U-Net models containing 19 million parameters, train and test the models then visualize the results. The workflow was developed by using Python 3.5 programming language and Google TensorFlow framework. All models were trained on NVIDIA Tesla P100 or V100 GPUs.

RESULTS

Our preliminary results of DICE scores for tumors and multi-organs ranged around 0.72-0.76 and 0.58-0.64 in the training set for CTc and MRI-T1c images, respectively. The DICE scores for the testing set for multi-organs ranged from 0.53-0.61 for CTc and 0.46-0.51 for MRI-T1c images.

CONCLUSION

The present work demonstrated the feasibility of simultaneous tumor and multi-organ segmentation using 3D neural network based on multi-modality imaging. Further work to elaborate the algorithm and incorporate it into SRS planning process is warranted and will shed light on future automated radiation therapy workflow.

CLINICAL RELEVANCE/APPLICATION

Simultaneous tumor and multi-organ segmentation is the very first step in automatic radiotherapy treatment planning, and multi-modality imaging schemes will help the precise delineation of the target region. The combined approaches will possess the key position in comprehensive automatic radiotherapy workflow.

SSQ15-08 Deep Learning Segmentation for Detection of Brain Metastases in the Small Data Regime

Thursday, Nov. 29 11:40AM - 11:50AM Room: S503AB

Participants
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PURPOSE

Detecting brain metastases can be a tedious and time-consuming task for many radiologists, particularly with the routine use of 3D imaging. By leveraging a fully CNN's ability to learn from the detailed pixel-wise labels of segmentation data, we have trained a network that can scalably detect brain metastases on MRI.

METHOD AND MATERIALS

In this retrospective cohort study at a single academic institution, we included 48 pre-surgical patients who had brain metastases from several primary malignancies. MRIs, all of which included a contrast-enhanced axial IR-prepped FSPGR T1-weighted images, were performed on a combination of 1.5T (n=8) and 3T (n=40) scanners. 42 patients were used for training, and 6 patients were used for testing. The input to our segmentation network is a 2D image slice from the aforementioned sequence. Manual segmentation was performed by an experienced neuroradiologist using OsiriX software by drawing region of interests around each enhancing metastatic lesion. We used a GoogLe net architecture modified for segmentation.

RESULTS

The mean age of patients was 63.7 yrs (range: 29-90 yrs). Primary malignancies included 29 lung, 13 breast, 3 melanoma, 1 esophageal, 1 renal, and 1 multiple cancers in the setting of Li Fraumeni syndrome. The test set of 6 patients had a total of 38 lesions. Our segmentation IoU (averaged per scan) was 0.46. We detected brain metastases at a sensitivity of 0.89 with a false positive rate of 5 lesions per scan. Similar experiments were done with a variety of different network architectures with very similar results. Adding additional slices as input channels (i.e., 2.5D) yielded similar results.

CONCLUSION

Even training with as few as 48 patients, our network could learn and provide usable results and ultimately yielded high sensitivity for the detection of brain metastases. By leveraging pixel-data, our network could learn from richer pixel-wise target labels rather

than construct robust features from scan-wise class labels.

CLINICAL RELEVANCE/APPLICATION

Our study provides proof of concept for the application of a widely available deep learning network to detect brain metastases on contrast-enhanced MRI with high sensitivity and illustrates the potential use of this technique in a clinically relevant setting.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Daniel L. Rubin, MD, MS - 2012 Honored EducatorDaniel L. Rubin, MD, MS - 2013 Honored Educator

SSQ15-09 Dictionary Based T1 Mapping Algorithm for the Tri-TSE Pulse Sequence

Thursday, Nov. 29 11:50AM - 12:00PM Room: S503AB

Participants
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PURPOSE

Quantitative T1 mapping provides absolute measures of tissue hydration and integrity. In addition it facilitate cross-platform comparison. Traditional T1 mapping can be slow, thus it has not been adopted in clinical settings by radiological community. Most qT1 methods require solving steady-state Bloch equations for each voxel, which is time consuming and generates numeric solution. Here, we propose using two standard clinical sequences, T1-weighted single echo (SE) and dual echo (DE), as well as an adaptive T1 dictionary, to efficiently and accurately access T1 relaxation in addition to T2 map generated from DE.

METHOD AND MATERIALS

Theory and data analysis scheme is illustrated. Briefly, instead of solving the non-linear equation, we establish a dictionary for each T1 values in the 0 to 5000ms (interval=0.01ms) range, by calculating the corresponding PVRdictionary (the signal ratio of SSE and SDE1)using the Bloch equation. To generate T1 map, the minimal absolute difference between obtained PVRvoxel and PVRdictionary was used to quickly identify the matching T1. The algorithm was tested on 20 clinical subjects without radiological findings or exposure to Gd, using a 3T system (Ingenia, Philips, Best, The Netherlands). The key parameters were: TRSE/DE=500/2129ms, FA= 90, ES=10ms, ETLSE/DE=7/14. The study was approved by our IRB. Data was analyzed in Matlab (Mathworks, MA). Histogram of T1/T2 values for each subject was also generated.

RESULTS

Representative T1/T2 maps from a subject were shown. The corresponding T1/T2 histograms of the whole brain were shown. The average of all patients, the peak value of gray matter was 1267.036.4ms, white matter 771.438.8ms. The averaging processing time for T1 map is 78.8±4.4s.

CONCLUSION

The combination of clinical available SE/DE sequence and dictionary searching method provides an accurate and efficient T1 mapping in addition to T2 maps provided by DE, hence, have the potential for facilitating the adaption of quantitative MRI in the clinical setting.

CLINICAL RELEVANCE/APPLICATION

The triFSE sequence are commonly available and could provide T1/T2-weighted images that match diagnostic standards. Our method creates additional relaxometry measures without extra time burden in clinics, which would have an impact on cross-platform researches, and also provide a better quantitative tool to understand diseases.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Hernan Jara, PhD - 2014 Honored Educator

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104th Scientific Assembly and Annual Meeting
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SSQ16

Neuroradiology (Cervicocranial Vascular Imaging)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S504AB

MR NR VA

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

SSQ16-01 Individually Targeted CO2 CVR with BOLD MR Imaging is Safe and Well-Tolerated in a Large and Diverse Clinical Cohort

Thursday, Nov. 29 10:30AM - 10:40AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

To retrospectively assess, in a large and diverse clinical population, the feasibility, safety and tolerance of cerebrovasuclar reactivity (CVR) mapping with a well-controlled CO2 stimulus protocol. Images were obtained using blood oxygen level-dependent (BOLD) magnetic resonance (MR) imaging during the CO2 protocol.

METHOD AND MATERIALS

We performed a retrospective chart review of all CVR studies at a tertiary care hospital between Jan 1, 2006 and March 19, 2018. The CO2 protocol included elevations in CO2 over resting baselines between 10 and 15 mmHg. Demographic data, past medical history, incidence of adverse events and reasons for failed examinations were collected in addition to study parameters. The diagnostic quality of CVR mapping was conducted by two independent and blinded observers. Studies were graded as good, diagnostic but suboptimal, non-diagnostic, requiring reassessment or failed/missing. Data are presented as raw values using descriptive statistics (means +/- standard deviations), and inter-observer variability was evaluated using the intra-class correlation coefficient.

RESULTS

One thousand fifty consecutive CVR examinations from 597 patients (47.5% male patients) were studied. Patient age ranged from 9 to 88 years (mean age, 55.0; median 46.8). There were no cerebrovascular accidents, myocardial infarctions, or other major complications. The success rate of generating diagnostic scans was 70.0% (735 of 1050) and those requiring reassessment was 17.4% (183 of 1050). Among the 735 diagnostic examinations, good quality CVR maps were obtained in 672 (64.0%) and diagnostic but suboptimal in 63 (6.0%). Of the 315 non-diagnostic and failed scans, 67 (24.0%) were due to discomfort, 27 (8.6%) due to head motion, 8 (2.9%) due to inability to cooperate, 19 (6.8%) due to technical difficulties, and 158 (55.6%) due to unknown or unspecified conditions. Factors that influenced the successful completion of these scans included patient characteristics such as anxiety, claustrophobia or a pre-existing medical condition.

CONCLUSION

Prospectively targeted CO2 stimulus for CVR mapping with BOLD MR imaging is technically feasible and well tolerated. Importantly, in this large and diverse clinical cohort, patient safety was maintained.

CLINICAL RELEVANCE/APPLICATION

Prospectively targeted CO2 stimulus with BOLD MR imaging is a safe and effective technique for imaging cerebral vascular activity in a diverse clinical population.

SSQ16-02 Visualizing Wall Enhancement Over Time in Unruptured Intracranial Aneurysms Using 3D Vessel Wall Imaging

Thursday, Nov. 29 10:40AM - 10:50AM Room: S504AB

Participants
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PURPOSE

High resolution MRI vessel wall imaging provides important capabilities in assessment of intracranial vascular disease including intracranial aneurysms. This study aims to compare the aneurysm wall visualization on pre- and post- 3D isotropic T1-weighted SPACE images and to explore whether there is a change in wall enhancement at follow up.

METHOD AND MATERIALS

Twenty-nine patients with thirty-five unruptured intracranial aneurysms were scanned on a 3T Siemens Skyra scanner with pre- and post-contrast 3D T1-weighted SPACE (0.5mm isotropic). Follow up studies were performed on all patients. Aneurysm wall visibility and enhancement scores were assigned by three neuroradiologists on pre- and post-contrast SPACE respectively. The aneurysm wall visibility between pre- and post-contrast images as well as the wall enhancement between follow up and baseline studies were compared. Differences in wall visibility and enhancement were also investigated as a function of aneurysm diameter and location.

RESULTS

Agreement among three reviewers in grading wall visibility and enhancement was excellent. Post-contrast images had significantly higher wall visibility. A wall enhancement score >=2 was found on 71% (25/35) of the aneurysms. Changes in levels of wall enhancement were found on 17% (6/35) of the aneurysms at follow up studies, but those changes were small. Wall visibility and enhancement scores of large aneurysms were significantly higher than that of small aneurysms.

CONCLUSION

3D T1-weighted high resolution SPACE can be used to assess changes in enhancement at follow up studies. Contrast SPACE image provides better aneurysm wall visibility and improves diagnostic confidence.

CLINICAL RELEVANCE/APPLICATION

Advances in vessel wall imaging techniques using high-resolution MR sequences now allow for improved visualization of the walls of intracranial vessels. In this study, we present results obtained with a 3D variable flip angle fast spin echo sequence (SPACE) to visualize the walls of intracranial aneurysms and to grade the extent of aneurysm wall enhancement in subjects whose aneurysms were monitored over time. Our studies showed that visualization of the aneurysm wall is significantly better on post-contrast images than on pre-contrast images, and the majority of unruptured aneurysms show wall enhancement. Furthermore, we found the wall enhancement scores to remain essentially unchanged on follow up studies.

SSQ16-03 Branching Pattern of Lenticulostriate Arteries in Moyamoya Disease and Atherosclerotic Moyamoya Syndrome by Whole-Brain Vessel Wall Imaging

Thursday, Nov. 29 10:50AM - 11:00AM Room: S504AB

Participants
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PURPOSE

Moyamoya disease (MMD) and atherosclerotic moyamoya syndrome (A-MMS) have a great overlap in luminal imaging, which brings difficulties to differential diagnosis. Whole-brain (WB) magnetic resonance vessel wall imaging (VWI) enables visualization of vessel wall structure and lenticulostriate arteries (LSAs) in one image setting, allowing distinguishing different vasculopathies. We hypothesized that the pattern of branching of the LSAs and vessel wall characteristics is different between the two diseases. For the purpose of the study, we made a comparative analysis of the pattern of branching of the LSAs and vessel wall characteristics using WB-VWI between MMD and A-MMS.

METHOD AND MATERIALS

WB-VWI was performed on 19 adult patients with clinically defined MMD and 21 adult patients with A-MMS. The pattern of branching of the LSAs (pattern 1=no dilation or proliferation, pattern 2=mild dilation and proliferation, pattern 3=dense dilation and proliferation), wall thickening pattern (eccentric and concentric), morphology of occluded middle cerebral artery (MCA) (plugged and vanishing), and intraluminal thrombosis (absent and present) were evaluated.

RESULTS

A total of 80 involved hemispheres were analyzed (38 in MMD and 42 in A-MMS). The pattern of branching of the LSAs was

different (P=0.004) between MMD (pattern 1=55.3%; pattern 2=31.6%; pattern 3=13.2%) and A-MMS (pattern 1=88.1%; pattern 2=7.1%; pattern 3=4.8%). Concentric wall thickening was more frequently observed in MMD than A-MMS (78.9% versus 21.4%, P < 0.001). Morphology of occluded MCA and intraluminal thrombosis were not statistically different between the two groups (P < 0.05 for both).

CONCLUSION

MMD has a distinct vascular pathophysiology in terms of the pattern of branching of the LSAs and wall thickening characteristics compared with A-MMS. WB-VWI enables the combination of vessel wall and LSA imaging, which together may improve the differentiation of MMD and A-MMS.

CLINICAL RELEVANCE/APPLICATION

(dealing with whole-brain MR vessel wall imaging) whole-brain MR vessel wall imaging detects distinct pattern of branching of the LSAs and wall thickening characteristics in patients with MMD and is recommended in the differential diagnosis of moyamoya disease and atherosclerotic moyamoya syndrome.

SSQ16-04 Strain Discontinuities in Carotid Atherosclerotic Plaques - A Novel Marker for Plaque Vulnerability?

Thursday, Nov. 29 11:00AM - 11:10AM Room: S504AB

Participants
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PURPOSE

We aim to develop and validate a novel method using ultrasound radiofrequency (RF) measurements to determine intraplaque inhomogeneities in the strain distribution with a high axial resolution.

METHOD AND MATERIALS

Ultrasound examinations were performed on common (CCA) and internal carotid arteries (ICA) of 22 patients, 17 with recent ischemic stroke / transient ischemic attack and 5 asymptomatic patients (39 CCAs and ICAs). The strain distribution was computed from RF data with a depth resolution <0.5mm using a custom MATLAB algorithm. In the plaque-free CCA, the radial wall strain was compared with the relative diameter change to validate the strain computation. Two observers analyzed the data for intra-observer variation analysis. In the ICAs, strain inhomogeneities in symptomatic and asymptomatic plaque were studied.

RESULTS

Within the CCA wall, the strain (observer 1: -7.4±2.7%, observer 2: -6.4±2.6%) had reasonably good intra-subject precision (1.6%) and accuracy (correlation with relative distension, observer 1: r=0.69; p<0.0001, observer 2: r=0.68; p<0.0001). Intra-observer variability had an ICC of 0.681 (two-way mixed, single measure). In the ICA, strain inhomogeneities had an elongated shape (mean: 0.7x11mm) and demarcated in 58% of the cases the plaque-adventitia boundary. The percentage of ICAs with 1 or more strain inhomogeneities was increasing with the degree of stenosis (p=0.03, 95%-CI). Strain inhomogeneities were more frequent in ICAs at the symptomatic side of stroke/TIA patients as compared to the contralateral arteries and both carotid arteries of the asymptomatic subjects combined (odd's-ratio=4.7; p=0.07). In contrast to the average strain, strain in the deviating strain regions was higher at the symptomatic compared to the asymptomatic side (p=0.02).

CONCLUSION

The proposed method to assess local radial strain distribution proved to be accurate and precise in the CCA. In the ICA, areas with high strain inhomogeneities were more frequent in symptomatic plaques as compared to asymptomatic plaques. These strain inhomogeneities could be a promising novel marker for plaque vulnerability.

CLINICAL RELEVANCE/APPLICATION

Rupture of atherosclerotic plaques is an important underlying cause of stroke and is ultimately a biomechanical event. Local ultrasound strain measurements may identify vulnerable plaques.

SSQ16-05 Quantitative Susceptibility Mapping Analysis of Carotid Intraplaque Hemorrhage

Thursday, Nov. 29 11:10AM - 11:20AM Room: S504AB

Participants
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PURPOSE

Intraplaque hemorrhage is considered an important factor in carotid plaque vulnerability. We investigated whether quantitative susceptibility mapping (QSM) can be used to characterize the composition of carotid plaques and to detect intraplaque hemorrhage.

METHOD AND MATERIALS

We obtained 3T MR data on 9 carotid plaque specimens from 9 patients who had undergone carotid endarterectomy. QSM images were generated using the morphology-enabled dipole inversion method. One radiologist measured the susceptibility values (SVs) on QSM images by using a region-of-interest (ROI) method. Pathologists performed histo- and immunopathologic analyses for tissue characterization and the identification of intraplaque hemorrhage. Areas immunopositive for glycophorin A, a sialoglycoprotein of the red blood cell membrane, were semi-quantified using color image analysis software. These areas were expressed as the ratio of positively-stained areas per ROI area (PSA/RA). The relationship between the mean SVs and the PSA/RAs was assessed using the Spearman rank correlation coefficient.

RESULTS

We examined 24 areas (intraplaque hemorrhage, n=7; lipid-rich necrotic core, n=7; calcification, n=10). The average SV for intraplaque hemorrhage, lipid-rich necrotic core, and calcification was 201 ± 115 parts per billion (ppb), -10.8 ± 17.3 ppb, and -157.7 ± 78.1 ppb, respectively. The difference in the mean SV among the three tissue components was statistically significant ($p < 0.05$). The PSA/RA was positively correlated with the mean SV ($r=0.65$, $p<0.0001$).

CONCLUSION

Our preliminary study suggests that QSM can be used to characterize the carotid plaque composition and to detect intraplaque hemorrhage.

CLINICAL RELEVANCE/APPLICATION

QSM is useful for evaluating the presence of carotid intraplaque hemorrhage.

SSQ16-07 Deep Learning based Computer-Aided Detection of Unruptured Cerebral Aneurysms

Thursday, Nov. 29 11:30AM - 11:40AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

To demonstrate the usefulness of deep learning based Computer-Aided Detection (CAD) for reader performance in detecting unruptured cerebral aneurysms from the data of MR Angiography (MRA).

METHOD AND MATERIALS

100 head MRA datasets (39 men and 61 women; mean age, 63.8 years ± 12.3; mean aneurysm size, 3.5 mm ± 1.3), 40 with one or more unruptured cerebral aneurysms and 60 without, were retrospectively evaluated. Twenty doctors (10 expert radiologists, and 10 non-specialists) were asked to detect cerebral aneurysms on MRA scans with associated projection images. The readers indicated their confidence level rating on a visual analog scale for each detected lesion, first without and then with CAD output. Our CAD algorithm consisted in the following steps: (1) volume reconstruction from MRA images; (2) vessel segmentation using a threshold-based method; (3) key point extraction based on principal curvature method; (4) ranking of key points using a deep learning method (convolutional neural network composed of 39 convolutional, one average pooling, and one fully connected layers); (5) clustering of the key points with score higher than 0.5. The observers' performance was evaluated using receiver operating characteristic (ROC) and jackknife free-response ROC curves.

RESULTS

For the cases used in this study, the sensitivity of the CAD software was 90.5% (57/63) with an average of 1.6 false-positive detections per case. Using the software, the area under the inferred ROC curve (AUC) improved on average from 0.850 to 0.888 across all readers ($P = 0.0002$). The AUC for non-specialists improved from 0.794 to 0.855 ($P = 0.0006$) and from 0.910 to 0.926 for expert radiologists ($P = 0.0236$). The figure-of-merit values computed using the jackknife free-response ROC program improved from 0.735 to 0.810 for non-specialists ($P = 0.0001$) and from 0.884 to 0.908 for expert radiologists ($P = 0.0064$). Whereas the average sensitivity increase from 90.3% to 93.1% for expert radiologists was not statistically significant, average sensitivity significantly improved from 67.9% to 80.1% for non-specialists.

CONCLUSION

The diagnostic accuracy of cerebral aneurysms improved among all readers with the use of CAD.

CLINICAL RELEVANCE/APPLICATION

In the detection of unruptured cerebral aneurysms, the use of CAD can reduce the oversight of radiologists, and enable non-

in the detection of unruptured cerebral aneurysms, the use of CAD can reduce the oversight of radiologists, and enable non-specialists to improve their reading performance as an educational tool.

SSQ16-08 4D Flow MRI Analysis of Cerebral Blood Flow before and After Extracranial-Intracranial Bypass Surgery for Atherosclerotic Disease

Thursday, Nov. 29 11:40AM - 11:50AM Room: S504AB

Participants
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PURPOSE

The purpose of this study was to clarify the change in the hemodynamics after superficial temporal artery to middle cerebral artery (STA-MCA) bypass surgery for atherosclerotic steno-occlusive disease by using time-resolved 3D-phase contrast (4D Flow) MRI.

METHOD AND MATERIALS

We retrospectively enrolled 20 patients (14 men; mean age 63.9) undergoing STA-MCA bypass surgery for internal carotid artery (ICA) stenosis (10 pt.) and MCA stenosis (10 pt.). We excluded moyamoya disease. All patients underwent 4D Flow MRI preoperatively and 3 weeks after surgery. The imaging parameters; 3.0-T MRI (Achieva, Philips), TR/TE = 8.4/5.4, VENC = 100cm/sec, voxel size = 0.82X0.82X1.4mm, heart phase = 15, scan time = approx. 6 min. We measured blood flow volume (BFV) of bilateral ICAs, basilar artery (BA), and bilateral STAs using GT Flow (Gyro Tools). The BFV of each vessel and total brain BFV (total-BFV = bilateral ICAs + BA + ipsilateral STA (after surgery)) was compared between before and after surgery with the paired t-test. We evaluated postoperative hyperperfusion syndrome based on the clinical chart.

RESULTS

4D Flow MRI data were successfully generated in all patients. Hyperperfusion syndrome occurred in 1 case. BFV of ipsilateral STA significantly increased after surgery (0.53 ± 0.22 vs. 1.78 ± 0.54 ml/sec ($p < 0.001$)). BFV of ipsilateral ICA significantly decreased after surgery (2.37 ± 5.09 vs. 1.82 ± 3.42 ml/sec ($p = 0.03$)). While, no significant difference was observed in total-BFV (12.40 ± 5.55 vs. 12.94 ± 6.71 ml/sec ($p = 0.24$)) or BFV of contralateral ICA (5.14 ±5.87 vs. 4.72 ± 4.60 ml/sec ($p = 0.06$)), BA (4.89 ± 2.89 vs. 4.61 ±2.48 ml/sec ($p = 0.11$)), and contralateral STA (0.33 ± 0.06 vs. 0.40 ±0.06 ml/sec ($p = 0.07$)) between before and after surgery.

CONCLUSION

BFV of ipsilateral STA significantly increased after surgery. While, there was no significant difference in total-BFV between before and after surgery. It may indicate that ipsilateral STA and native intracranial arteries (i.e., bilateral ICAs and BA) supply blood flow complementarily after surgery.

CLINICAL RELEVANCE/APPLICATION

4D Flow MRI can quantify the change of hemodynamics after EC-IC bypass surgery for intracranial atherosclerotic steno-occlusive disease.

SSQ16-09 Imaging Characterization and Differentiation of Intracranial Vasculopathies Using 3T MR Vessel-Wall Imaging

Thursday, Nov. 29 11:50AM - 12:00PM Room: S504AB

Participants
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PURPOSE

The purpose of this study is to evaluate the ability of MR VWI to differentiate between various types of intracranial vasculopathies.

METHOD AND MATERIALS

Patients who presented with new non-traumatic intracranial hemorrhage and/or MRI-confirmed ischemic stroke and who also demonstrated vascular abnormalities suggestive of underlying intracranial vasculopathy on initial CT, MR or catheter angiography were identified between January 1, 2013 and July 1, 2017. All patients received our institution's MR VWI protocol (high-resolution multiplanar T1W pre- and post-contrast and 3D SPACE T2W sequences) and underwent CSF collection with or without image-guided brain biopsy. An expert clinical neurologist panel retrospectively evaluated each patient's history, imaging, labs, and

pathology in order to produce a consensus diagnosis of the underlying vasculopathy. A radiologist, blinded to patient identity and diagnosis, evaluated each MR VWI study. The distribution and severity of intracranial vascular stenoses, vessel wall thickening, and vessel wall enhancement were assessed. Statistical analysis was performed in order to identify the correlation between these imaging features and the specific underlying vasculopathy.

RESULTS

Thirty-eight patients (22F, 16M) were included in the final analysis. Reversible cerebral vasoconstriction syndrome (RCVS) presented with an average of 5 stenoses per patient which was the largest number of stenoses per patient amongst all of the vasculopathy types evaluated. RCVS was 4.6 times more likely to demonstrate moderate-to-severe stenoses than infectious vasculopathies (p=9.73E-05). Infectious vasculopathies presented with the greatest number of enhancing lesions per patient, with varicella zoster virus (VZV) vasculitis and miscellaneous infectious vasculopathies presenting with on average 4.7 and 4.3 enhancing lesions per patient, respectively. Overall, these infectious vasculopathies were 2.3 and 2.7 times more likely to show enhancing lesions relative to RCVS (p=0.045).

CONCLUSION

MR VWI can aid in differentiating intracranial vasculopathies based on imaging features. Infectious vasculopathies are more likely to demonstrate abnormal vessel-wall enhancement whereas RCVS is more likely to demonstrate high grade multifocal stenoses.

CLINICAL RELEVANCE/APPLICATION

Pertinent MR VWI findings may be used to both guide therapy decisions and monitor patient response as well as to direct surgical biopsy.

SSQ17

Physics (CT: Imaging Performance)

Thursday, Nov. 29 10:30AM - 12:00PM Room: N229

CT PH

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

Participants
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Sub-Events

SSQ17-01 Radiopaque 3D Printing of Patient Phantoms for Computed Tomography and Radiation Therapy

Thursday, Nov. 29 10:30AM - 10:40AM Room: N229

Participants
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PURPOSE

To develop methods for 3D printing realistic anthropomorphic phantoms of individual patients for simulation of patient exposure in computed tomography and radiation therapy.

METHOD AND MATERIALS

In a first step, patient CT images are printed with inkjet technology and radiopaque ink on paper. In a second step, the printed paper sheets are processed with paper based 3D printing methods to mechanically stable phantoms with the attenuation properties and the external contour of the patient. The resulting patient phantoms are examined in the CT scanner (Canon Aquilion One and Aquilion Prime). Acquisition parameters (tube voltage, tube current, acquisition mode, pitch, reconstruction technique) are systematically combined and dose and image quality are analyzed.

RESULTS

Radiopaque 3D printing achieves detailed patient phantoms with individual anatomy and pathology. Phantom Hounsfield units correlate linearly with patient Hounsfield units ($r = 0.9925$) and phantom attenuation values correspond to patient values for different radiation energy levels. Systematic analysis of 72 combinations of acquisition and reconstruction parameters on patient phantoms yields a dose optimum with automated tube potential selection in combination with automated tube current modulation, volume acquisition and iterative reconstruction. Dose reduction potential of iterative reconstruction is >60% in comparison with filtered back projection.

CONCLUSION

Radiopaque 3D printed patient phantoms provide a detailed simulation of patient exposure and allow systematic investigation of dose and image quality.

CLINICAL RELEVANCE/APPLICATION

Realistic patient phantoms allow systematic development and analysis of dose reduction, optimization and imaging techniques.

SSQ17-02 Rapid Measurement of Low Contrast Detectability

Thursday, Nov. 29 10:40AM - 10:50AM Room: N229

Participants
Scott S. Hsieh, MS, Los Angeles, CA (*Presenter*) Nothing to Disclose
Akinyinka O. Omigbodun, PhD, Los Angeles, CA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Low contrast detectability (LCD) is a metric of fundamental importance in CT imaging, but cannot easily be measured with nonlinear reconstruction methods because concepts such as contrast-noise ratio (CNR), modulation transfer function (MTF) and noise power spectrum (NPS) do not directly apply. We introduce a new framework for rapidly measuring LCD using model observers with a single scan.

METHOD AND MATERIALS

We place a large number of low-contrast markers into the field of view and assess their detectability using a model observer. In this work, we used a non-prewhitening (NPW) observer that searches the image for candidate marker locations by subtracting an estimate of the local background signal, convolving with a template disk image, and then identifying local maxima above a response threshold. More sophisticated alternatives to NPW could also be used. By varying the threshold, we can produce free-response ROC curves. We used this framework to compare iterative reconstruction (IR) with filtered backprojection (FBP) in simulations. We also tested the framework on experimental data, fabricating a phantom consisting of small polycarbonate spheres interspersed in acrylic spheres and placed in 13.5% sugar solution. The sugar solution was iso-attenuating with acrylic, leading to a dispersion of low-contrast polycarbonate bead markers of about 20 HU.

RESULTS

In simulations with anisotropic noise, IR+NPW showed consistently better performance than FBP+NPW, with sensitivity at one false positive (FP) of 80% compared to 57%. With uniform noise, the difference disappeared and the sensitivities at 1 FP were 70% and 67% for IR+NPW and FBP+NPW, respectively. Experimental scans demonstrated the feasibility of low-contrast automated detection (of polycarbonate spheres) with an easily constructed phantom.

CONCLUSION

An objective metric for LCD can be produced by scanning a specialized, target-rich phantom and using model observer software. This framework holds equally well for iterative or analytic reconstruction algorithms, and could be used for comparison of scanners, assessment of new reconstruction algorithms, or routine quality assurance.

CLINICAL RELEVANCE/APPLICATION

Automatic detection of LCD could be used in routine quality assurance and could also be used to elucidate conditions (for example, non-uniform statistics) that affect detectability.

SSQ17-03 Diagnostic Accuracy of Sub-Millisievert Coronary CT Angiography on 16cm Wide-Detector CT Using 70kVp for Patients with High Heart Rate: Comparison with Digital Subtracted Angiography

Thursday, Nov. 29 10:50AM - 11:00AM Room: N229

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To investigate the image quality and diagnostic accuracy of coronary CT angiography (CCTA) on a 16cm wide-detector CT using 70kVp for patients with high heart rate using Digital Subtracted Angiography (DSA) as reference standard.

METHOD AND MATERIALS

Forty-three patients with heart rates higher than 80 bpm underwent both CCTA on a 256-row, 16cm wide-detector CT (Revolution CT) and DSA. All CCTA scans were acquired in one heart beat with bolus-tracking technique using 70 kVp and automatic tube current modulation for noise index of 36HU at 0.625mm image thickness, and at weight-dependent contrast dose rate of 16mgI/kg/s for 8s injection. Images were reconstructed at the best cardiac phase with the least motion with 80%ASIR-V and with Snapshot Freeze Motion Correction in all patients. Two experienced cardiovascular radiologists and two cardiovascular specialists evaluated the subjective and objective image quality of CCTA study and the DSA results, separately and independently . CCTA performance for diagnosing >=50% stenosis was analyzed against the DSA results. The sensitivity and accuracy of CCTA were calculated. The volumetric CT dose index (CTDIvol), dose length product (DLP) were recorded to calculate the effective dose.

RESULTS

The mean heart rate was 96.2±17.1bpm (range: 81-156bpm). The mean effective radiation dose was 0.46?±?0.21 mSv. All CCTA images were deemed to have diagnostic quality, and 94.2% (650/690) of the coronary segments were analyzed for stenosis. Using DSA as the reference standard, sensitivity and accuracy for diagnosing >=50% stenosis with CCTA were 100% and 90.7% on a per-patient basis. These values were 92.3% and 89.0% on the per-vessel basis and 77.6% and 87.2% on the per-segment basis.

CONCLUSION

CCTA on a 16cm wide-detector CT using low tube voltage of 70kVp provides high quality images and high accuracy for diagnosing stenosis at sub-millisievert radiation dose even for patients with high heart rates.

CLINICAL RELEVANCE/APPLICATION

CCTA with 70kVp on 16cm wide-detector CT that enables 1-beat imaging at sub-mSv radiation may be used to provide high image quality and diagnostic accuracy for cardiac patients with heart rates.

SSQ17-04 Low Contrast Detectability Observer Study For Four Different Reconstruction Algorithms in CT

Thursday, Nov. 29 11:00AM - 11:10AM Room: N229

Participants
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PURPOSE

This report performs a comparative human and model observer study for low contrast detectability, following the MITA recommendations. Standard filtered backprojection (FBP) is compared to model based iterative reconstruction (MBIR) and two different methods for noise reduction in image space: edge preserving denoising and deep learning algorithm.

METHOD AND MATERIALS

Data was scanned 50 times at 3 different dose levels each using MITA low contrast module phantom and subsequently reconstructed with the aforementioned four reconstruction methods. We used 120kV scans with 50, 40 and 30 mAs. Dose levels were chosen to be low enough to make the signals seemingly saturated with noise, making the detectability task difficult in standard FBP for a human observer. Eight human observers were asked to review obtained images using 4-alternative-forced-choice method with 3 signal-absent images and 1 signal-present image. The objective was to understand the capability of advanced image reconstruction methods to improve the low contrast detection over the standard FBP reconstruction. The same images were also fed into a publically available model observer tool to understand whether a model observer can be used in place of human observers in the future examinations.

RESULTS

Human observers consistently performed with approximately two times higher detectability indices in images reconstructed using MBIR when compared to the standard FBP. A similar result was also repeated in detectability indices for images denoised by the deep learning method. An edge preserving denoising used in this study had relatively same detectability index as the standard FBP (between 0.8 and 1.2). Model observer technique for low contrast detectability task performed with similar trends as the human observers, but absolute values for the detectability indices were higher by a factor of 1.5.

CONCLUSION

Advanced reconstruction and noise reduction methods can improve the low contrast detectability indices in CT imaging, but not all methods perform the same way. One has to perform tuning when attempting to replace human observers with the model observers.

CLINICAL RELEVANCE/APPLICATION

Low contrast detectability tests with MITA phantom and diagnostic tasks in liver and brain studies are closely related. Clinical users should expect an improved performance in imaging with MBIR and deep learning algorithms, when compared to the standard reconstruction methods.

SSQ17-05 The Weight of ASiR-V in Low Radiation Dose Craniocerebral CT Scan

Thursday, Nov. 29 11:10AM - 11:20AM Room: N229

Participants
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PURPOSE

To explore the weight of ASiR-V under low radiation dose craniocerebral CT scan that was comparable that obtained in conventional scanning

METHOD AND MATERIALS

60 Patients who underwent craniocerebral CT scan were prospectively and randomly divided into two groups. Group A (n=30) use conventional 120kVp scanning protocol while group B (n=30) use 100kVp scanning protocol.The data in Group A were reconstructed with ASiR-V 50% images while the data in Group B were reconstructed with ASiR-V weights of 60%, 80% and 100% images. Three slices were selected in each group of patients. The CT values of bilateral frontal gray matter, parietal gray matter and centrum ovale white matter were measured at the centrum ovale slice. The CT values of bilateral frontal gray matter, temporal lobe gray matter, occipital lobe gray matter, lenticular and white matter were measured at the basilar nucleus slice. The CT values of bilateral cerebellum gray matter, temporal lobe gray matter, and white matter were measured at the cerebellum slice. The ROI were drawn in the front of the forehead to measure the air standard deviations (SD). SD of air is used as the background noise. Three slices of gray/white matter SNR were calculated and the CNR of gray-white matter were calculated. The subjective noise, contrast of gray-white matter and posterior fossa artifacts score was evaluated blindly by two radiologists independently using a 5-point scoring system.

RESULTS

The effective dose in group B (1.02mSv) decreased by 34.3% compared to group A (0.67mSv). Group B with ASiR-V 60% was only higher than group A ($p<0.01$), and the other was similar to group A (all $p>0.05$). Gray/white matter SNR with ASiR-V 100% was

higher than group A in the three slices (all p<0.05), and the other was similar to group A (all p>0.05). the gray-white matter-CNR with ASiR-V 80% and 100% was higher than group A in the basilar nucleus slice (all p<0.05), and the other was similar to group A (all p>0.05). There were no significant difference in noise, contrast of gray-white matter and posterior fossa between the Group B with ASiR-V 60% and Group A (all Adjust-p>0.05).

CONCLUSION

The image quality of ASiR-V 60% in group B was similar to group A in objective parameters and subjective evaluation in craniocerebral CT scan.

CLINICAL RELEVANCE/APPLICATION

In craniocerebral CT scan, low radiation dose scan combined with the increased ASiR-V weight could ensure adequate image quality.

SSQ17-06 Low-Contrast Detectability of Clinical CT Images in 3D Reformatted Planes

Thursday, Nov. 29 11:20AM - 11:30AM Room: N229

Participants
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PURPOSE

3D reformatted images are frequently generated in clinical CT for diagnostic purposes. Due to the difference between axial and 3D-reformatted images in terms of spatial resolution and noise correlation, it is unknown if the low-contrast detectability of 3D-reformatted images is comparable to that of axial images from the same data. The purpose of this work was to use a Channelized Hotelling Observer (CHO) to evaluate the index of detectability for low-contrast objects of various sizes in the coronal plane compared to in the axial plane.

METHOD AND MATERIALS

A 3D-printed phantom with embedded spheres of various sizes and contrast levels was scanned 50 times on a 192-slice scanner (Force, Siemens) to provide an ensemble dataset for CHO calculation. Images were reconstructed in the axial and coronal planes using filtered backprojection (FBP) with a Br40 kernel and an iterative reconstruction (IR) method (ADMIRE, Siemens) with the same Br40 kernel but two strength settings, Br40-3 and Br40-5. The reconstruction planes were across the center of the spheres. Pixel size was kept the same between reconstructions. A CHO with 12 Gabor channels (previously validated against human observer performance) was used to calculate the index of detectability, d', for two low contrast spheres (3 and 9 mm in diameter, both with a contrast of -36 HU from background) in the axial and coronal planes.

RESULTS

For FBP, d' in the coronal plane was similar to that in the axial plane for both size spheres (9 mm: 5.78±0.58 in coronal vs. 5.87±0.61 in axial; 3 mm: 2.15±0.24 in coronal vs. 1.96±0.25 in axial). When IR was applied, d' improved over FBP for the large sphere in both planes, but the improvement in the coronal plane was less than that in the axial plane. For the smaller sphere, applying IR appeared to have no effect on d'.

CONCLUSION

Given the same slice thickness and reconstruction kernel, the low-contrast detectability was similar in the axial and coronal planes using the FBP reconstruction. When IR was used, the low-contrast detectability in coronal planes appeared to improve less than that in axial planes, especially for large objects.

CLINICAL RELEVANCE/APPLICATION

Low-contrast detectability in 3D-reformatted planes appears to be similar to that in routine axial planes using FBP reconstruction method. The performance may differ when IR is used.

SSQ17-07 Assessment of Beam-Hardening Artifact Reduction Effect on CT

Thursday, Nov. 29 11:30AM - 11:40AM Room: N229

Participants
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PURPOSE

To evaluate the effect of beam-hardening artifacts reduction technologies on 256 Multi-Detector wide-coverage CT and high-definition gemstone spectral CT(HDCT) by comparing the two CT models.

METHOD AND MATERIALS

A cylindrical plastic phantom with 9 hard plastic tubes which were filled with different concentrations(20, 10, 0 mgI/ml) of iodine

solution was used in phantom(The diameter is 18mm), the highest concentration (20mg/ml) is the center of the plastic phantoms , and the other 8 tubes were located clockwise in outer circle. The phantom was scanned using three different modes respectively: 1) a 256 Multi-Detector CT (Revolution CT) scanner equipped with Multi-Material Artifact Reduction (MMAR) technology and Volume High Definition (VHD) image reconstruction technology, which scans by axial mode(Group A),2) HDCT(Discovery CT)scans with conventional 120kvp mode(Group B) and GSI mode (Group C) were respectively performed. In each of the three groups, ROIs with the same area were placed on regions that were most significantly affected by beam-hardening artifact (between tubes with 20 and 10 mgI, 20 and 10 mgI, 20 and 0 mgI iodine solution). Image noise (SD) in these ROIs were measured and artifact index (AI) was calculated as AI2=SD2-SDb2 (SDb was the background noise).

RESULTS

The average image noise in the three groups (Group A, Group B and Group C) were 6.4±0.6,8.7±2.1 and 2.7±0.2, and the AI were 8.3±0.5,10.3±1.8 and 6.8±0.1 respectively. Compared with conventional 120kvp mode of HDCT, Revolution CT with VHD technology and MMAR technology, and GSI mode of HDCT can reduce image noise and AI, the effect of GSI mode is better than Revolution CT.

CONCLUSION

Revolution CT scan with VHD technology and MMAR technology, and HDCT-GSI mode can reduce hard-artifact index (AI), and improve image quality, but the effect of HDCT-GSI mode is best.

CLINICAL RELEVANCE/APPLICATION

256 Multi-Detector CT (Revolution CT) with 16 cm wide body detector, by one rotation can complete a single organ (such as the heart, brain, substantial / hollow organs) imaging .It return to the origin of CT scan- axial scan equipped with Multi-Material Artifact Reduction (MMAR) technology and Volume High Definition (VHD) image reconstruction technology for better image quality.

SSQ17-08 Evaluation of CT Image Quality and Liver Lesion Detectability with Different Dose Levels and Different Levels of the Iterative Reconstruction Algorithm ASiR-V

Thursday, Nov. 29 11:40AM - 11:50AM Room: N229

Participants
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PURPOSE

The aim of this study was to optimize image quality and dose levels with different levels of ASiR-V.

METHOD AND MATERIALS

A novel anthropomorphic liver phantom customized for quantitative and qualitative image analysis (Phantom Laboratory, NY US) was scanned at three different dose levels (CTDIvol 15, 10, and 5 mGy) and 120 kVp on a GE Revolution 16 CT scanner (GE Healthcare, Milwaukee, WI US). Images were reconstructed using a standard abdominal kernel and different levels of the iterative reconstruction (IR) algorithm ASiR-V (0-100%). Mean CT values, noise, signal to noise ratio (SNR), contrast to noise ratio (CNR), low contrast detectability and noise power spectrum (NPS) was analyzed. Noise texture deviation (NTD) was evaluated to look at IR specific artifacts. Lesion detectability was assessed on a 5-point scale by 5 readers. The areas under the receiver operating characteristic (ROC) curve were calculated.

RESULTS

Mean CT-values and low contrast detectability did not change with increasing level of ASiR-V. Compared to filtered back projection the noise was reduced while SNR and CNR increased for ASiR-V levels 10-100%. The NTD analysis showed that the mean NTD was not different from NTD calculated for FBP for ASiR-V 10-40 % for CTDI 15 mGy and ASiR-V 10-50 % for CTDI 10 and 5 mGy ($p>0.05$). Mean NTD increased to be different from FBP for ASiR-V 50-100% for CTDI 15 mGy and ASiR-V 60-100 % for CTDI 10 and 5 mGy ($p<0.05$). The area under the ROC curve increased with increasing level of ASiR-V. For the CTDIvol 15, 10 and 5 mGy reconstructing with 90%, 80 % and 100% ASiR-V gave the highest area under the ROC curve respectively. Lower dose levels reduced the lesion detectability, low contrast detectability, SNR and CNR. Preliminary analysis of the NPS showed that the peak frequency decreased slightly as the level of ASiR-V increased.

CONCLUSION

This study showed that increasing the level of ASiR-V improved liver lesion detectability when using a standard abdominal kernel. SNR and CNR increased at increasing level of ASiR-V while low contrast detectability remained constant. Noise texture deviation analysis showed that IR artifacts increased for higher levels of ASiR-V (above level 40%).

CLINICAL RELEVANCE/APPLICATION

Iterative reconstruction aims to reduce patient dose in CT. Lesion detectability and image quality need to be assessed to ensure satisfactory examination quality, which was the purpose in this study.

SSQ17-09 Technical Assessment of a Mobile CT Scanner for Image-Guided Brachytherapy: Image Quality, Dose, and Technique Protocols

Thursday, Nov. 29 11:50AM - 12:00PM Room: N229

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PURPOSE

A technical assessment of imaging performance and radiation dose is reported for a recently introduced mobile CT scanner (Airo, Brainlab, Munich, Germany), with application to image-guided brachytherapy. Such quantitative assessment guides selection of technique protocols for pertinent imaging tasks and facilitates translation to new applications.

METHOD AND MATERIALS

Four studies were performed to assess 3D image quality and dose of the system: (1) Objective measures of uniformity and noise (20 cm diameter water phantom), HU accuracy and contrast (tissue-simulating materials (Gammex RMI)), and spatial resolution (modulation transfer function, MTF); (2) Visual image quality using anthropomorphic phantoms with realistic bone and soft-tissue anatomy of the head, chest, abdomen, and pelvis; (3) Image quality and artifacts measured using custom phantoms emulating transvaginal brachytherapy via cylindrical or tandem-and-ring applicators adjacent to soft-tissue; and (4) Radiation dose (CTDI) measured in 16 cm (head) and 32 cm (body) cylinders. Image quality and dose were assessed for manufacturer-specified techniques as well as custom protocols spanning a wide range of kV, mA, scan mode (axial or helical), smoothing kernel, and (optional) metal artifact reduction (MAR).

RESULTS

The technical assessment provided quantitative insight on system performance and limitations. Image uniformity and HU accuracy were within 5%, supporting dose calculation in brachytherapy. Helical scans (1.4 pitch) reduced dose and scan time compared to axial scans, but also reduced z-direction MTF and introduced windmill artifacts about high-contrast structures and instrumentation, diminishing soft-tissue visibility. Contrast and noise performance were sufficient for soft-tissue visualization in brachytherapy of the cervix and uterus. The MAR algorithm greatly improved soft-tissue visualization in the presence of needles and applicators.

CONCLUSION

The imaging system provided excellent accuracy and uniformity with sufficient contrast and spatial resolution for application in transvaginal brachytherapy. The technical assessment identified opportunities for dose reduction (lower kV protocols) and artifact reduction in helical scan mode.

CLINICAL RELEVANCE/APPLICATION

New mobile CT systems can improve precision and safety of image-guided interventions. Rigorous assessment of image quality and dose helps guide adoption and future application of such technology.

SSQ18

Physics (CT: Organ Dose)

Thursday, Nov. 29 10:30AM - 12:00PM Room: N228

CT PH

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

Participants
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Sub-Events

SSQ18-01 Estimating Embryo and Fetal Dose from Abdomen/Pelvis CT Scans That Use Tube Current Modulation

Thursday, Nov. 29 10:30AM - 10:40AM Room: N228

Participants
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PURPOSE

Estimates of embryo and fetal dose have previously been limited to fixed tube current exams. However, tube current modulation (TCM) is used routinely in clinical practice. Therefore, the purpose of this work is to develop patient size-specific CTDIvol-to-fetal-dose conversion coefficients from TCM abdomen/pelvis (A/P) CT exams of pregnant patients of various gestational ages.

METHOD AND MATERIALS

Twenty-four publicly available voxelized pregnant patient models were used in Monte Carlo (MC) simulations of A/P CT scans using TCM. The models represent a range of gestational ages from less than 5 to 36 weeks and have maternal and fetal anatomy identified from image data. Attenuation characteristics were estimated from simulated topograms of each voxelized patient model. Predicted TCM schemes were then generated for each patient model using a validated method that accounts for both patient attenuation and scanner model characteristics. Embryo and fetal doses were obtained by incorporating each TCM scheme into an MC source model of a 64-slice MDCT scanner, simulating the A/P exam and tallying dose to the fetus. If the fetus was not visible (i.e. early gestational age) then dose to the gestational sac or uterus was used to estimate embryo dose. Water equivalent diameter (Dw) was used as the size metric and was calculated at the image containing the three-dimensional geometric centroid of either the fetus or the gestational sac. All embryo and fetal doses were normalized by scan-specific 32 cm CTDIvol values based upon the average tube current across the entire simulated scan. Normalized embryo and fetal doses were then parameterized as a function of Dw using an exponential function similar to SSDE.

RESULTS

Embryo and fetal doses from the 24 simulated CT A/P exams using TCM demonstrate an exponential relationship between normalized dose and Dw which has a coefficient of determination of 0.79. This relationship is slightly different from that of SSDE, which is not an explicit representation of organ or fetal dose.

CONCLUSION

A method to estimate embryo and fetal dose that account for patient size (through Dw) and TCM has been developed which uses an exponential function similar to SSDE.

CLINICAL RELEVANCE/APPLICATION

Using this methodology, embryo and fetal dose at various gestational ages can be reasonably estimated with the scanner-reported CTDIvol and a metric of patient size such as Dw.

SSQ18-02 Web-Platform for Fast and Accurate Assessment of Radiation Dose Received by Conceptus in Clinical CT

Thursday, Nov. 29 10:40AM - 10:50AM Room: N228

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PURPOSE

Computed tomography (CT) is sometimes required during pregnancy. In this case the radiation dose received by conceptus should be evaluated. Existing methods are either limited in their accuracy or require complicated measurements and calculations. The aim of this study is to develop a web-based tool for radiation dose assessment received by conceptus in CT; validate this tool and implement it in clinical routine.

METHOD AND MATERIALS

The tool is based on the doses derived from Monte Carlo (MC) simulations performed for generic CT system on virtual phantoms, representing a range of various patient sizes and gestational ages. For validation, the values calculated by the online tool were compared against dose values calculated by detailed MC simulations performed on real patients' data. The data for 30 pregnant patients, underwent clinically indicated examinations on CT scanner of two different vendors (Siemens, GE) were collected. Detailed MC simulations took individual patient geometry and scan parameters into account. After the validation the software framework was designed in order to provide the free of charge access to the tool for multiple clients, without installing the software locally. The feedbacks from the users have been collected.

RESULTS

The validation of the tool has shown that the average error of the dose values calculated by the online tool was 23%, with the overestimation of about 41% in case of obese patients. The biggest error of 56% was found in patient when additional hardware (i.e. fixation device) was applied and visible in the reconstructed image, resulting in the higher current values applied by the CT system, and thus higher fetal dose values estimated by the program. The users have found the program convenient and intuitive for use in clinical routine. The average time required for calculating single patient case is less than 2 minutes.

CONCLUSION

The online platform provides fast and reliable evaluation of the radiation dose, received by conceptus from CT examination.

CLINICAL RELEVANCE/APPLICATION

This tool can be used by physicians for fetal dose assessment and performing risk-benefit analysis. It can be also used for training purposes.

SSQ18-03 The Impact of Scanning Heads Within a Dedicated Head Holder Versus the Table Top on Effective Mas, Image Quality, and CTDI

Thursday, Nov. 29 10:50AM - 11:00AM Room: N228

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PURPOSE

Often, especially in the CT trauma setting, heads must be placed on the table top instead of in a head holder. A head holder attenuates the beam less than the table top requiring less effective mAs to obtain the same image quality. The purpose of this study is to quantify this difference.

METHOD AND MATERIALS

264 adult head (193 head holder, 71 table top) head data was collected under IRB approval. The effective mAs and CTDIvol were recorded for each case. Phantom scans were performed with a 16 cm CTDI phantom placed on the table top and in the head holder. Regional (center, top, bottom of the phantom) noise values and regional (center, top hole, bottom hole) CTDI100 values were measured. The use of AEC, which allowed the scanner to account for the extra attenuation of the table versus the head holder, and manual mA were used to scan the phantom. For the human scans, we also documented the presence or absence of patient transport "slider boards" and dental amalgam to evaluate their impact on scanner output.

RESULTS

The mean effective mAs for the clinical scans increased by a factor of 1.7 times for heads imaged on the table top relative to the head holder. Statistically significant differences in image noise were observed from the phantom scans for table top versus head holder positioning in manual mA mode. A statistically significant difference in image noise between the top and bottom of the CTDI phantom was observed for table top imaging, but not for head holder imaging indicating noise is more uniform for head holder scans. The presence of dental amalgam and "slider boards" did not cause a statistically significant difference in CTDIvol. Head holder and table top positioning produced statistically significant differences (6% versus 23% respectively) between top and bottom hole CTDI100 measurements.

CONCLUSION

This study demonstrates the superiority of using AEC versus a manual technique for head. Using a manual technique inhibits one's scanner from being able to compensate for the attenuation differences between the table and head holder.

CLINICAL RELEVANCE/APPLICATION

Using manual mA for head imaging does not account for attenuation differences between table top and head holder patient positioning leading to poorer image quality for the latter.

SSQ18-04 Clinical Study of Measurement of Mammary Gland Dose Using Organ-Based AEC

Thursday, Nov. 29 11:00AM - 11:10AM Room: N228

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CONCLUSION

For plain chest CT of Japanese women, Organ-Based AEC reduces the exposure dose to mammary glands by 14.6%. Earlier studies, conducted using phantoms, overestimated the reduction effect of Organ-Based AEC.

Background

Chest CT requires suppression of exposure to mammary glands. Many reports of earlier studies have described that Organ-Based AEC can reduce the exposure dose by 25-60%. In a report that analyzed CT images retrospectively, it is considered that most of the mammary glands are not included in the dose reduction area. However, these phantom data and simulation studies did not actually measure patients. Therefore, the effect of Organ-Based AEC exposure dose reduction in clinical research has not been clarified. This clinical study measured mammary gland doses using Organ-Based AEC in chest CT. Furthermore, the properties of Organ-Based AEC were examined by phantom study.

Evaluation

This observational study study examined plain chest CT scans of female patients: 30 using Organ-Based AEC, and 30 not using Organ-Based AEC. Subjects were randomly extracted. Their mammary gland doses were measured. An OSL dosimeter was affixed to 12 patients' breasts. The equipment used was Aquilion ONE® (Toshiba Medical systems). Organ-Based AEC used OEM (Organ Effective Modulation). In the Organ-Based AEC, as the size of the subject became smaller, the reduction effect was also lower. The Organ-Based AEC had the greatest reduction effect in the anterior side of the subject, the reduction effect got lower as approaching the lateral side. In clinical study, results show that 9.18 ± 1.96 mGy doses were received when Organ-Based AEC was used, but 10.76 ± 2.58 mGy doses were received when Organ-Based AEC was not used. The radiation dose reduction ratio of mammary glands was therefore 14.6%.

Discussion

The results of phantom studies of earlier studies have a greater dose reduction effect than our clinical studies. The reason is that in the earlier study, part of the mammary gland is out of the dose reduction zone, and it is not considered that the physique affects the reduction ratio of Organ-Based AEC.

SSQ18-05 How Much Does Low kV Imaging Increase Skin Radiation Dose in Contrast-Enhanced CT? - A Simulation Study on a Virtual Population of Patient Models

Thursday, Nov. 29 11:10AM - 11:20AM Room: N228

Participants
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PURPOSE

To compare the effect of utilizing a lower kV setting over a standard high kV setting (70 vs 120 kV) on skin dose in contrast enhanced CT.

METHOD AND MATERIALS

The scanner-specific geometry was modeled for a state of the art CT scanner (Revolution CT, GE Healthcare) on a GPU-based Monte Carlo tool based on the MC-GPU framework. This tool was utilized in association with a virtual population of 58 anthropomorphic XCAT patient models (age, 18-78 y.o.; BMI, 18.21-38.81 kg/m2; sex #(M/F), (34/24)) to estimate organ doses for the abdominopelvic protocol (1.375 pitch, 80 mm collimation) at tube voltages of 70 and 120 kV. The organ dose values for both tube voltages were then normalized to a volumetric CTDI value of 12, to make them representative of a typical abdominopelvic scan. In addition to tabulating an average skin dose value for each tube voltage, the ratio of the skin dose to the effective dose (reff) and cumulative dose (rcum) was also computed as additional metrics of dose comparison. The standard deviation for each metric was calculated to represent the dose variability over the virtual patient population.

RESULTS

The absorbed dose values for skin were estimated to be 1.49±0.16 and 1.36±0.14 mGy for 70 and 120 kV tube voltages,

respectively. The corresponding values for reff were 0.80±0.12 and 0.59±0.06 respectively. For the same pair of tube voltages, the rcum value were 0.030±0.004 and 0.023±0.002. Lowering tube voltage from 120 to 70 kV didn't translate to a statistically significant increase in the absorbed skin dose as observed over a virtual population of 58 XCAT patients.

CONCLUSION

The lowering of kV setting from 120 to 70 kV did not lead to a significant increase in skin dose for the virtual patient population, thereby mitigating potential concerns related to the detrimental effects of low kV on skin dose.

CLINICAL RELEVANCE/APPLICATION

CT imaging at lower kV potentially leads to greater dose efficiency and increased image quality, especially for contrast enhanced CT. Concerns about drastic increases in skin radiation dose seem to be overstated with only marginal increases in skin dose.

SSQ18-06 Retrospective Assessment of Radiation Dose in Abdominopelvic CT: Inter- and Intra-Scanner Variability

Thursday, Nov. 29 11:20AM - 11:30AM Room: N228

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PURPOSE

To develop a practical data-crunching solution for retrospectively assessing inter- and intra-scanner variabilities and inconsistencies in abdominopelvic CT dose using clinical patient data.

METHOD AND MATERIALS

This IRB-exempt study evaluated CT abdominopelvic (AP)-related examinations performed in 2016 and 2017 from 12 scanners (4 GE 750 HD,2 GE VCT, 4 Siemens Flash, and 2 Siemens Definition AS) in 3 site hospitals in an enterprise. An in-house developed informatics system automatically extracted protocol information, patient size (cross-sectional diameter), radiation dose, and *in vivo* noise magnitude within images. Protocol nomenclature categorization was performed using a decision-tree machine learning algorithm. Dose reference and fit lines were defined for each scanner by using machine learning logistic regression algorithms between dose and patient size. For a predefined reference patient size, Reference dose (RfD: intersect point of dose fit line and reference patient size) and dose deviation index (DDI: a ratio of received dose and ideal dose minus one) were then calculated.

RESULTS

17,000 (Data2016) and 17,000 (Data2017) AP studies for patients ages 0-70 and sizes 13-48 cm were identified. 12 dose reference lines with slopes 0.03-0.1 from Data2016 and 24 dose fitting lines (1th and 99th) from Data2017 were constructed. RfDs were calculated using a reference size of 31 cm and ranged from 466-568 mGy-cm for GE 750 HD, 630-674 mGy-cm for GE VCT, 401-428 mGy-cm for Siemens Flash, and 220-306 mGy-cm for Siemens Definition AS. DDIs ranged from 0.15-0.55. A multi-dimensional metrics compositing the above results was then established and visualized for system performance evaluation across systems.

CONCLUSION

This study offers the first even data-crunching solution for assessing inter- and intra-scanner variabilities in CT dose with clinical patient data. High dimensional metrics built upon patient data are essential for quantitatively assess protocol- and system-inconsistencies as well as optimize the quality, patient safety, and clinical operation.

CLINICAL RELEVANCE/APPLICATION

This study fulfilled an unmet need for quantitative assessment of system-inconsistencies, along with device performance assessment and optimization, to ensure rigorous patient safety and consistent image quality.

SSQ18-07 Explore the Feasibility of 'Four-Low' Scanning Protocol in Coronary Imaging Using Wide-Detector Revolution CT

Thursday, Nov. 29 11:30AM - 11:40AM Room: N228

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PURPOSE

To investigate the feasibility of low-kvp, low-contrast medium, low-flow rate, low-dose 'four-low'scans for coronary artery imaging using wide-detector Revolution CT.

METHOD AND MATERIALS

60 patients underwent coronary artery CT imaging with coronary heart disease diagnosed in our hospital were divided into two groups. Group A use 100 kVp and group B use 80 kVp with 30 cases in each group. Contrast agent iopamidol (370 mgI/mL), both use standard (25 mgI/kg/s) iodine flow rate, dose and flow rate calculation formula. Scanning parameters: cardiac axial scan, Smart mA (200-650 mA), NI=26, fixed collimator width 140mm, Auto gating ECG, Pre-Asir-V=70%, Post-Asir-V=80. The CT values and SD standard deviations of aortic root, coronary artery RCA, LAD, LCX proximal lumen and surrounding adipose tissue were measured, SNR, CNR were calculated, CTDI, DLP were recorded, and the effective radiation dose ED was calculated. Subjective evaluations were conducted using a 4-point grading system by two senior-level physicians by double-blind method according to the American Heart Association (AHA) coronary 13 segments. The radiation dose, image quality, contrast agent dosage, and flow rate were statistically analyzed.

RESULTS

Age and heart rate in the two groups have no statistical significance (P> 0.05). The two groups of contrast agents were: (41.52±5.14) ml, (22.64±2.70) ml, and group B contrast was 45.5% less than that of group A. The flow rates in the two groups were: (3.45±0.43)ml/s, (1.90±0.21)ml/s, and group B was 44.9% lower than that of group A. ED was: (41.52±5.14) mSv in group A and (22.64±2.70) mSv in group B, group B dose was 41.0% lower than that of group A with statistical significant difference (P<0.05). There was no statistically significant difference in image quality subjective scores at the distal end (P>0.05).

CONCLUSION

Low-kVp, low-contrast, low-flow rate, low-dose, CT coronary artery imaging in wide-detectors is feasible. Image quality was not affected and the contrast agent dosage was reduced by 45.5%, the effective radiation dose was reduced by 41.0%, and the flow rate was reduced by 44.9%.

CLINICAL RELEVANCE/APPLICATION

The"four-low"scan scheme is feasible in coronary imaging without affecting the image quality. At the same time, the radiation dose, the contrast agent dose, and the injection rate of the contrast agent are greatly optimized and is recommended for clinical promotion.

SSQ18-08 A Comparison of Lung and Breast Doses from CT Scans Using Organ-Based Tube Current Modulation (TCM) vs. Conventional Attenuation-Based TCM Using Monte Carlo Simulations

Thursday, Nov. 29 11:40AM - 11:50AM Room: N228

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PURPOSE

Organ-based Tube Current Modulation (TCM) was designed to reduce organ dose to anteriorly-located, radiosensitive organs such as the breast in CT exams. The purpose of this work was use Monte Carlo simulation techniques to compare lung and breast doses from chest CT exams using organ-based (TCM) to those using conventional TCM.

METHOD AND MATERIALS

Under IRB approval, raw projection and image data were collected from thirty-four patients (17 females, 17 males) who underwent CT chest/abdomen/pelvis (CAP) examinations employing organ-based TCM (XCARE + CAREDose4D, Siemens Healthineers). The actual organ based TCM schemes for the chest portion were extracted from the raw projection data for each patient. Lung and glandular breast tissue were semi-automatically segmented from patient image data for each case to create voxelized models of patient anatomy for use in a validated Monte Carlo (MC) transport code. Additionally, for these patients, TCM schemes from conventional, attenuation-based modulation only (CAREDose4D) were also estimated using a recently developed method that accounts for patient attenuation characteristics and scanner design. Absolute lung and breast doses for each TCM scenario were estimated for each patient model using MDCT source models in Monte Carlo simulations. The resulting lung and breast doses from each scheme were compared using within-patient percent difference using the from conventional TCM as the reference.

RESULTS

The differences of lung and breast dose from organ-based TCM across patients ranged from -35% to 73% and -53% to 45%, respectively. The mean female lung and breast dose differences were -11% and -21%, respectively. The average male lung dose difference was -21%. When pooled, on average, organ-based TCM reduces breast dose by 21% while dose lung dose remained nearly constant with a 5% increase.

CONCLUSION

Organ-based TCM may reduce breast dose while not incurring a substantial lung dose penalty when compared to conventional TCM. However, there can be some patients in which this may not be the case and may increase lung dose for men.

CLINICAL RELEVANCE/APPLICATION

On average, organ-based TCM may reduce breast dose relative to conventional TCM without increasing lung dose, but some patients may receive higher lung or breast from organ-based TCM.

SSQ18-09 Coronary CT Angiography Using a 70 kVp Protocol on 16cm Wide-Detector CT: Improved Vascular Enhancement with Reduction of Both Radiation and Contrast Agent Doses

Thursday, Nov. 29 11:50AM - 12:00PM Room: N228

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PURPOSE

To investigate image quality, radiation dose, and diagnostic efficiency of prospectively ECG-triggered coronary CT angiography (CCTA) on 16cm wide-detector scanner using 70 kVp with low contrast dose compared with routine 100 kVp CCTA protocol.

METHOD AND MATERIALS

Forty patients (29 men and11 women; mean age, 55±14 years) received CCTA using either 70 kVp, noise index (NI) of 36HU, and at weight-dependent contrast dose of 16mgI/kg/s rate for 9s injection (Group A, n=20) or the conventional 100kVp, NI of 28HU, and at 25mgI/kg/s rate for 10s injection (Group B, n=20). Adaptive statistical iterative reconstruction (ASIR-V) was used with 80% strength for the 70 kV group and 60% strength for the 100 kV group. All CCTA image quality was evaluated by two experienced cardiovascular radiologists using a 5-point scale (5: best, 1: worst, >=3 scores diagnosable) and signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated and compared. The volumetric CT dose index (CTDIvol) in mGy, dose-length-product (DLP) in mGy-cm of CT scan were recorded. The Mann-Whitney U-test was used to compare the subject image quality scores and the unpaired t-test was used to compare the continuous variables including CT value, SNR, CNR and radiation dose and contrast dose.

RESULTS

There was no significant difference in age, heart rate and body mass index (21.18±2.08kg/m2 vs. 22.00±2.33kg/m2) between the two groups (all P>0.05); Mean CT values, SNR and CNR of the two groups were statistically the same(all P > 0.05). Subjective image quality showed no difference between the two groups (P=0.458) with good interobserver agreement (k=0.820). However, there was a significant difference in CTDIvol between Group A (2.20±1.0mGy) and Group B (9.03±5.50mGy) (P<0.05), resulting in 76.1% effective dose reduction for the 70kVp group (Group A) (0.43±0.20mSv vs. 1.80±1.28mSv, p<0.001). Moreover, the contrast dose for Group A was significantly lower than for Group B (22.01±3.11ml vs. 38.21±5.40ml) (P<0.001), a reduction of 42.4%.

CONCLUSION

Our proposed 70kVp CCTA protocol provides diagnostic information with substantial reduction in both radiation and contrast agent doses compared to the routine CCTA at 100 kVp.

CLINICAL RELEVANCE/APPLICATION

CCTA with 70kVp on a 16cm wide-detector CT that reduces both radiation and contrast agent doses while maintaining image quality compared with the routine 100 kVp CCTA protocol.

SSQ19

Pediatrics (Neuroradiology)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S402AB

NR PD

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

FDA Discussions may include off-label uses.

Participants
Daniela Prayer, MD, Vienna, Austria (*Moderator*) Nothing to Disclose
Michael J. Paldino, MD, Houston, TX (*Moderator*) Nothing to Disclose

Sub-Events

SSQ19-01 Development and State-Related Gradients in Infant Brain Functional Connectome

Thursday, Nov. 29 10:30AM - 10:40AM Room: S402AB

Participants
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PURPOSE

Early brain functional development studies using resting-state functional MRI (rs-fMRI) has been recently emerging. However, little is known whether the development of brain functional connectome can be embedded in the high dimensional connectome space and, if so, how such embedding looks like in the context of developmental neuroscience. This study is to explore the large-scale neuromechanism that encode the developmental functional connectome.

METHOD AND MATERIALS

Whole-brain region-wise functional connectome was built for each infant from a longitudinal rs-fMRI dataset with a large sample size (# subjects = 87, # scans = 302, natural sleeping from neonate to 2 years old, while passive movie watching for older subjects up to 6 years old). Principal component analysis (PCA) was conducted on the multi-subject, multi-scan functional connectome and each component was examined with age information. Based on a pure data-driven method, a 2-D embedding of the functional connectomes was adopted to unravel any development-related gradient(s).

RESULTS

Different age groups show clear clustered patterns with the first two principal components used even they accounted ~10% variance across subjects/scans. Two intriguing gradients were identified, one encoding development (span from younger to older ages), the other encoding brain states during the rs-fMRI scan ('natural sleeping' or 'awakening while movie watching'). The developmental gradient shows dominant inter-modular connections, with several hubs in auditory and spatial attention-related regions, and the thalamus. The state-related gradient shows prominent connections within visual, default mode, and executive control networks, with hubs in high-order cognitive function-related regions.

CONCLUSION

This is the first developmental study on 0-to-6-year-old functional connectome. The pure data-driven method could reveal changes in functional connectome due to early development and different brain states. The functional connectome gradients could be informative for better understanding brain functional development in the first years of life, a previously less investigated period.

CLINICAL RELEVANCE/APPLICATION

Reveal brain functional changes in the first years of life by detecting two 'gradients' and highlight regions and links that are most important to the rapid, dynamic development in this pivotal stage.

SSQ19-02 Longitudinal Strain Measures of White Matter Tracts in Youth Football Players

Thursday, Nov. 29 10:40AM - 10:50AM Room: S402AB

Participants
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Christopher T. Whitlow, MD, PhD, Winston-Salem, NC (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

We characterized longitudinal strain of the white matter in youth football players compared to non-contact sport control athletes and tested the hypothesis that axial and radial shape changes of fiber bundles would be associated with participation in contact sports and serve as a new neuroimaging biomarker of subconcussive head impact exposure.

METHOD AND MATERIALS

Twenty-three male youth football players (Age=12.1±1.2 yrs) and 13 male non-contact sports control participants (Age=10.6±1.7 yrs) were recruited for this IRB approved study. Longitudinal brain MRI data, including diffusion tensor imaging (DTI) were acquired before and after a single sports season (approximately 3-months) . Longitudinal registration was performed between pre-season and post-season T1-weighted images. DTI processing included geometric distortion correction, eddy-current correction, fitting of diffusion parameters, and co-registration to T1-weighted images. The voxel-wise fiber-specific deformations (axial and radial strains) were estimated by aligning 3D deformation tensor derived from longitudinal T1-weighted images to the co-registered eigenvectors from DWI. Parameter maps for axial and radial strains were registered to the study-specific template. We compared total and voxel-wise white matter volume change rates between football players and control participants using a linear regression and multiple comparison correction.

RESULTS

There was greater axial strain (contraction) among football players compared to controls in the body and right splenium of the corpus callosum ($p < 0.01$, 340 vox) (upper panel of figure). There was greater radial strain (expansion) in the splenium of the corpus callosum among controls compared to football players ($p < 0.01$, 219 vox) (lower panel of figure).

CONCLUSION

Axial and radial strain data demonstrated more directional contraction and less expansion, respectively, in the football group compared to non-contact sports controls. These tract-specific strains in white matter tracts may reflect changes associated with repetitive sub-concussive head impact exposure.

CLINICAL RELEVANCE/APPLICATION

There is growing concern regarding the long-term consequences of repetitive sports-related subconcussive head impact exposure on the developing brain. We propose a novel white matter tract-specific morphometry method to analyze the effects of repetitive subconcussive impacts on brain developmental trajectory.

SSQ19-03 White Matter Microstructural Correlates of Sensory Processing Disorder (SPD) on Connectome Edge Density Imaging and Probabilistic Tractography: Potentials of Machine Learning Models for Devising New Imaging Biomarkers

Thursday, Nov. 29 10:50AM - 11:00AM Room: S402AB

Participants
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Pratik Mukherjee, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Research Grant, General Electric Company Medical Adivisory Board, General Electric Company
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PURPOSE

SPD - affecting up to 16% of children - is associated with Autism Spectrum Disorders, and ADHD. We aimed to evaluate white matter microstructure of children with SPD, and apply machine-learning models for devising image-based diagnostic biomarkers.

METHOD AND MATERIALS

Children (aged 8 to 12 years) were prospectively recruited via our 'Sensory Neurodevelopment and Autism Program'. The connectome Edge Density (ED) and probabilistic Tract Density (TD) maps were developed using DTI and high-resolution T1 scans. Tract-Based Spatial Statistics (TBSS) was used for voxel-wise analysis. Stepwise penalized logistic regression was used to identify independent tract-based ED/TD variable(s) distinguishing children with SPD. Five different machine-learning models were used for identification of SPD: random forest, neural network, naïve bayes, and support vector machines with 'linear' and 'polynomial' kernels. Cross-validation of models was performed applying stratified random sampling of cohort into training and validation datasets (x500), preserving SPD-to-TDC ratio.

RESULTS

44 children with SPD and 41 typically developing children (TDC) were included. There was no significant difference in average age ($p=0.191$) and gender ratio ($p=0.338$) between SPD and TDC groups. On voxel-wise analysis, children with SPD had lower ED and TD in body and splenium of corpus callosum, posterior corona radiata, posterior thalamic radiation, and tapetum. On stepwise penalized logistic regression analysis, the average TD of splenium was the only independent variable differentiating SPD from TDC ($p<0.001$). Among different machine learning models, the random forest algorithm using ED had the best test characteristics NPV for identification of SPD with 75.6% accuracy, 79.4% sensitivity, 71.3% specificity, 77.5% PPV, and 75.1% among validation datasets.

CONCLUSION

Children with SPD have lower density of connectome edges and probabilistic tracts in body/splenium of corpus callosum and posterior white matter pathways, with 'lower splenium TD' as the most distinctive pattern. Machine learning models - particularly random forest algorithm using tract-based ED - can help identify children with SPD.

CLINICAL RELEVANCE/APPLICATION

Edge density imaging and probabilistic tractography can be used to identify white matter microstructural abnormalities in children with SPD, and to devise imaging biomarkers for SPD based on machine-learning models.

SSQ19-04 The Brain Network Architecture Classification of Pediatric Patients with Autism

Thursday, Nov. 29 11:00AM - 11:10AM Room: S402AB

Participants
Michael J. Paldino, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Although many cases are genetic in etiology, no clinical method exists to diagnose autism before its syndrome appears. Earlier diagnosis could allow intervention before the brain network fully developed. Brain imaging is a promising method to probe brain network organization without requirement for patient cooperation. In this study, we measured morphologic and diffusion-based brain network metrics in terms of their capacity to differentiate autism patients from controls. Those metrics can be measured individually and have the potential to be used as one of biomarkers for autistic diagnosis and prediction.

METHOD AND MATERIALS

17 age-matched pairs of autistic-control sibling were selected in this HIPAA-compliant study. The T1-weighted structural data was processed using FreeSurfer 5.3 resulting in 148 cortical parcels. Further division results in around 600 fine parcels with roughly equal size. We transformed parcels from anatomical space to diffusion space. First, cortical thickness was measured over the whole brain. Next, probabilistic tracking (FSL) on 32 directional diffusion data generated a connectivity matrix where the connection between each pair of network nodes was defined as the probability that a white matter connection exists between nodes. Based on the connection matrix, we computed five topologic properties of network organization (table 1) using the Brain Connectivity Toolbox. Univariate comparison between groups were performed for age and all measured metrics. A machine learning algorithm was used to measure the importance of each metric to autism classification after adjusting for the contribution of all other metrics.

RESULTS

The cortical thickness and brain network modularity are metrics showing significant group differences (Table 1). Further, the machine learning analysis demonstrated that the cortical thickness and modularity stand out as most important metrics in autism classification (figure 1).

CONCLUSION

In this cohort of pediatric autistic patients cortical thickness and brain network modularity were important discriminators between autistic patients and normal subjects.

CLINICAL RELEVANCE/APPLICATION

MR imaging provides a potential tool to predict/diagnose brain network disorder in early age. We investigates the importance of imaging-based brain network architecture in autism classification.

SSQ19-05 Integrating U-Net and Dilated Dense Network for Infant Hippocampus Subfield Segmentation

Thursday, Nov. 29 11:10AM - 11:20AM Room: S402AB

Participants
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PURPOSE

Accurate and automatic segmentation of hippocampus (HC) subfields from magnetic resonance (MR) brain images is important for studying both normal and abnormal early brain development. The goal of this study is to develop an automatic HC subfield segmentation method for infant MR brain images.

METHOD AND MATERIALS

Image Dataset: We used infant MR brain images of ten subjects, each with T1w and T2w images acquired at age of 12 months. Five HC subfields were manually labeled for each subject by the consensus of two neuroradiologists, including cornu ammonis sector

1 (CA1), CA2/3, subiculum (SUB), CA4/dentate gyrus (DG), Uncus. Methods: We propose a novel deep neural network for HC subfield segmentation. It is based on U-net, consisting of a contracting path to extract abstract features and an expansive path to recover spatial resolution. However, the contracting-expansive process in U-net can often miss detailed image information, thus affecting the accurate segmentation of small structures, such as HC subfields. To overcome this limitation, we embed the dilated dense network in the U-net to obtain a new network (DUnet). In the DUnet, the embedded dilated dense network can provide multi-scale features with relatively high spatial resolution. To further improve the performance, we group every two convolutional layers with one residual connection in the DUnet, and obtain the Residual DUnet (ResDUnet).

RESULTS

Our proposed methods were compared with U-net, using Dice ratio. The results show that our proposed DUnet outperforms the U-net in all subfields. Our proposed ResDUnet can further improve the segmentation performance by introducing residual connections. In particular, ResDUnet increases Dice ratios: 0.024 for CA1, 0.031 for CA2/3, 0.026 for SUB, 0.020 for CA4/DG and 0.024 for Uncus, compared with U-net.

CONCLUSION

We propose a new network for infant hippocampal subfield segmentation by integrating U-net and dilated dense network. Our proposed network can avoid losing detailed image information in the successive down-sampling steps, and effectively extract multi-scale features, which are important for image voxel localization and classification.

CLINICAL RELEVANCE/APPLICATION

Our proposed method for automatic segmentation of infant hippocampal subfields from MR brain images can be used for studying neurodegenerative diseases.

SSQ19-06 Alterations of Structural and Functional Connectivity in Bilateral Severe-to-Profound Sensorineural Hearing Loss Infants within an Early Sensitive Period: A Combined fMRI and DTI Study

Thursday, Nov. 29 11:20AM - 11:30AM Room: S402AB

Participants
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PURPOSE

The development of central auditory system has a sensitive period during the first few years of life. This study was aimed to characterize the patterns of whole-brain structural and functional connectivity change in infants with bilateral severe-to-profound sensorineural hearing loss (SNHL) within an early sensitive period.

METHOD AND MATERIALS

36 infants with bilateral severe-to-profound SNHL (mean age = 16 months, range 6-35 months) and 33 age and sex matched healthy controls were recruited for the present study based on referral for clinical MRI and other inclusion criteria. All subjects underwent 3.0T anatomical and functional MRI included DTI and resting-state fMRI. DTI data were processed using Tract-Based Spatial Statistics (TBSS) to describe white matter (WM) impairment across the whole brain. fMRI data were analyzed to map functional connectivity (FC) feature related to left/right primary auditory cortex (A1) using a seed-based correlation method with the voxels in the whole-brain.

RESULTS

In comparison to controls, SNHL infants showed pronounced and wide-spread WM abnormalities, including the cortico-cortical WM tracts (SLF, ILF, UF and inferior fronto-occipital fasciculus), the cortico-fugal WM tracts (CST, external capsule, corona radiata, as well as thalamic radiation) and the interhemispheric connections of corpus callosum. In addition, SNHL infants exhibited enhanced functional connectivity between left A1 with right insula and right superior temporal gyrus, right A1 with right superior temporal gyrus.

CONCLUSION

Using DTI-TBSS in conjunction with rs-fcMRI analysis, the present study provides new evidences in support of the disconnection hypothesis caused by hearing loss, revealing the characteristics of early brain reorganization and compensatory activation changes in congenital severe-to-profound SNHL infants within early sensitive period.

CLINICAL RELEVANCE/APPLICATION

Improvements in our understanding of early brain development after auditory deprivation can promote individually customized rehabilitation programs targeted at improving clinical outcomes for cochlear implanted children.

SSQ19-07 Brain Language Network Architecture and Verbal Intelligence in Children with Focal Epilepsy

Thursday, Nov. 29 11:30AM - 11:40AM Room: S402AB

Awards
Student Travel Stipend Award

Participants
Farahnaz Golriz, MD, Houston, TX (*Presenter*) Nothing to Disclose
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Zili David Chu, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose
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Michael J. Paldino, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

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PURPOSE

Higher order functions of the human brain depend on the efficient integration of information across a functionally specialized brain network. The aim of this study is to examine the relationship between verbal intelligence and language network architecture in the pediatric, epileptic brain.

METHOD AND MATERIALS

Patients were retrospectively identified with the following criteria: 1) localization-related epilepsy; 2) brain MRI imaging at 3T, including resting-state fMRI sequence; and 3) Full-scale IQ subscales, including verbal comprehension index (VCI) measured by a pediatric neuropsychologist. The cerebral cortex was subdivided into approximately 1500 gray matter network nodes. Language network map was generated based on the automated Neurosynth meta-analysis. The strength of a connection between each pair of nodes within the language network was defined as the correlation between their resting BOLD time-series. The following network architecture metrics were calculated: clustering coefficient, global efficiency, modularity, transitivity, and path length. A machine-learning algorithm was used to measure the independent contribution of each metric to the verbal comprehension index while adjusting for age, gender and seizure duration.

RESULTS

Forty-six patients met the criteria with mean age 12.9 years (age range: 3 - 18). The male: female ratio was 28/18. After accounting for age, sex, and seizure duration, all five metrics including clustering coefficient, global efficiency, transitivity, modularity and path length were shown to be independently associated with verbal comprehension index. Clustering coefficient was the strongest predictor of verbal comprehension index.

CONCLUSION

These findings show that the topology of the constructed language network in children with focal epilepsy is associated with a core aspect of the brain function.

CLINICAL RELEVANCE/APPLICATION

Quantification of specific functional networks is an important step toward the clinical utility of network-based biomarkers.

SSQ19-08 Brain Structural Damage and Atrophy Correlates of Impaired Processing Speed in Pediatric Onset Multiple Sclerosis

Thursday, Nov. 29 11:40AM - 11:50AM Room: S402AB

Participants
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PURPOSE

Brain atrophy (anatomical imaging), and structural damage (diffusion imaging), are commonly used to quantify neurodegeneration in multiple sclerosis (MS) and its impact on neurocognitive impairment. However, very few studies have investigated such relationships in pediatric onset MS (POMS) patients. The goal of this study was to investigate atrophy and diffusivity changes in pediatric onset MS patients and to correlate them with cognitive impairment.

METHOD AND MATERIALS

T1-weighted and diffusion tensor imaging (DTI) at 3T, and neuropsychological tests - symbol digits modality test (SDMT), brief visuospatial memory test (BVMT), Rey's audio verbal memory test (RAVLT), wide range achievement test (WRAT) and CogState brief battery - were performed on N=25 POMS patients (14F, 20.8 ± 4.5 years, age at onset = 15 ± 3.7 years, EDSS= 1.1 ± 1.26, mild disability) and N=24 age/sex-matched healthy controls (HC) (14F, 20.3 ± 3.7 years). Normalized total gray (GM), white matter (WM) and deep gray matter structures (DGM) volumes were quantified from T1-w images. Mean diffusivity (MD) was mapped across WM from DTI images, and normalized to standard space for voxelwise analyses. Volumetric and diffusivity metrics were analyzed for group differences, and correlated with age-adjusted neuropsychological test scores.

RESULTS

POMS showed decreased total WM, Thalamus (Thal), Putamen (Put) and Pallidum (Pall) volumes when compared to HC. In POMS group only, significant association was found between Put and Thal volumes and SDMT ($p<0.01$), Hippocampus volume and RAVLT ($p<0.05$), and total GM and Put volumes and WRAT ($p<0.05$). Voxelwise analyses showed widespread increases in MD in POMS when compared to controls. SDMT (processing speed) correlated negatively and CogState (processing time) scores correlated positively with increased MD in the corpus callosum, L/R superior and posterior corona radiata, and L/R superior longitudinal fasciculus ($p<0.05$, corrected). There were no significant correlations of MD with other neuropsychological scores.

CONCLUSION

In our mildly disabled POMS cohort, processing speed impairment was significantly associated with reduced DGM volumes and increased MD indicative of tissue loss and structural damage, respectively.

CLINICAL RELEVANCE/APPLICATION

Improved understanding of MS pathophysiology and progression in patients with pediatric disease onset could help develop strategies for early detection and treatment.

SSQ19-09 Effects of Repetitive Non-Concussive Head Impact Exposure on Default Mode Network Connectivity among Youth Football Players

Thursday, Nov. 29 11:50AM - 12:00PM Room: S402AB

Participants
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PURPOSE

The purpose of this investigation was to determine if repetitive sports-related head impact exposure alters default mode network (DMN) connectivity in a cohort of youth football players compared to a non-contact sport control group.

METHOD AND MATERIALS

Twenty-nine male football players (mean±SD; 11.62±0.78 yrs; age range 10-13 yrs) and 19 age-matched male non-contact sports controls (mean±SD; 11.64±0.8 yrs; age range 10-13 yrs) were recruited for this IRB approved study. None of the participants had a history of concussion before or during the sports season. Participants received pre- and post-season MRI, including resting-state BOLD imaging. Pre-processed BOLD data were coregistered to structural T1-weighted images. A DMN seed was created from the orthogonal slices of spatial cross-correlation of the ICA spatial maps and used to extract individual DMNs for pre- and post-season data. A delta metric was computed by subtracting pre- and post-season DMN data for each individual to estimate changes in DMN connectivity strength. Voxel-wise linear regression with covariate (age) was conducted to examine between-group differences in longitudinal DMN connectivity strength. Lastly, we estimated the size of false positive clusters and applied this threshold to remove noise-only clusters.

RESULTS

Four clusters demonstrated between-group differences in DMN connectivity strength: 1. right middle/superior temporal cortex and right angular gyrus, 2. left middle temporal and left angular gyrus, 3. right superior/middle frontal gyrus, and 4. left middle/superior gyrus and left anterior cingulate cortex. Regression analyses demonstrated statistical significant differences in DMN connectivity strength between these regions ($P<0.05$). Overall, DMN connectivity strength increased among non-contact-sport controls, but decreased for footballers.

CONCLUSION

A single season of youth football was associated with decreases in DMN connectivity strength among football players compared to controls. These changes were not associated with clinically diagnosed concussion, and more work is necessary to determine potential functional significance among youth athletes with repetitive non-concussive sports-related head impact exposure.

CLINICAL RELEVANCE/APPLICATION

Decreased resting-state DMN connectivity strength could reflect disruption of related functions in youth athletes with repetitive sports related non-concussive head impact exposure.

SSQ20

Vascular Interventional (Non-Vascular Interventions)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S403A

GI GU IR

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

Participants
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Alexios Kelekis, MD, PhD, Athens, Greece (*Moderator*) Medical Advisory Board, BTG International Ltd; Medical Advisory Board, Merit Medical Systems, Inc; Research Grant, Mindray Medical

Sub-Events

SSQ20-01 Utility of Microcatheter for Adrenal Venous Sampling in Primary Aldosteronism

Thursday, Nov. 29 10:30AM - 10:40AM Room: S403A

Participants
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PURPOSE

To evaluate the utility of using microcatheter for the assessment of aldosterone hypersecretion and the laterality in adrenal venous sampling (AVS) for patients with primary aldosteronism.

METHOD AND MATERIALS

This prospective study was approved by our institutional review board and written informed consent was obtained. Thirty-seven consecutive patients with primary aldosteronism underwent AVS. A microcatheter was inserted in right adrenal central vein (RCV), left adrenal central vein (LCV), and left adrenal common trunk (CT). Aldosterone hypersecretion was diagnosed if the plasma aldosterone level after cosyntropin injection was >= 14,000 pg/mL. Laterality of aldosterone hypersecretion was determined based on the lateralized ratio and contralateral ratio. The diagnosis of aldosterone hypersecretion and laterality were compared between the results with 5-French (5-Fr) catheter and microcatheter.

RESULTS

The plasma aldosterone levels were significantly higher in RCV, LCV, and CT selected with microcatheter than in the right and left adrenal vein selected with 5-Fr catheter (*P < 0.0001-0.029). Five and twenty-two patients for right and left AVS were diagnosed aldosterone hypersecretion only with microcatheter. The diagnosis of aldosterone hypersecretion from left adrenal gland was statistically more accurate with microcatheter than with 5-Fr catheter (P < 0.0001). Diagnostic change of the laterality from unilateral to bilateral was found in 3 patients (8%) with microcatheter.*

CONCLUSION

The microcatheter was useful for the assessment of aldosterone hypersecretion and the laterality, especially in the left adrenal vein.

CLINICAL RELEVANCE/APPLICATION

The clinical diagnosis and treatment options potentially are changed on the basis of the results in AVS with microcatheter.

SSQ20-02 *Fluoroscopic Gastrojejunostomy with Lumen-Apposing Metal Stent: Feasibility and Safety in Swine*

Thursday, Nov. 29 10:40AM - 10:50AM Room: S403A

Participants
Jingui Li, Beijing, China (Presenter) Nothing to Disclose
Jiaywei Tsauo, Beijing, China (Abstract Co-Author) Nothing to Disclose
Xiaowu Zhang, Beijing, China (Abstract Co-Author) Nothing to Disclose
He Zhao, Beijing, China (Abstract Co-Author) Nothing to Disclose
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Xiao Li, PhD, Chengdu, China (Abstract Co-Author) Nothing to Disclose

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PURPOSE

To evaluate the feasibility and safety of fluoroscopic gastrojejunostomy (GJ) with lumen-apposing metal stent (LAMS) in a miniature swine model.

METHOD AND MATERIALS

The animal experiments were approved by the institutional animal care and use committee. Six female miniature swine (range, 2.5-3.0 kg) were included in this study. With the animals under general anesthesia, a pigtail catheter was inserted through the mouth and negotiated into the proximal jejunum with a hydrophilic guidewire under fluoroscopic guidance as the puncture target. A Rösch-Uchida liver access set was introduced into the stomach over a separate hydrophilic guidewire, and the proximal jejunum was punctured under continuous fluoroscopic monitoring. A 16-mm-diameter and 20-mm-length LAMS was placed between the stomach and the proximal jejunum, and contrast medium was injected to confirm the stent position.

RESULTS

Technical success was achieved in all animals. The number of needle puncture ranged from 1 to 2. All procedures were completed within 45 minutes. One animal had vomiting for 3 days after the procedure. No other procedure-related complications were observed. All animals were alive and well at 1 month after the procedure, with no signs of stent malfunction.

CONCLUSION

Fluoroscopic GJ with LAMS is feasible and safe in a miniature swine model.

CLINICAL RELEVANCE/APPLICATION

(dealing with gastric outlet obstruction(GOO)) 'Fluoroscopic GJ is an alternative to surgical bypass for the palliation of GOO with simple operation and minimal invasion.'

SSQ20-03 Biodegradable Magnesium Stent Insertion for the Treatment of Benign Esophageal Stricture in a Rabbit Model

Thursday, Nov. 29 10:50AM - 11:00AM Room: S403A

Participants
Yingsheng Cheng, MD, Shanghai, China (Presenter) Nothing to Disclose
Yueqi Zhu, MD, Shanghai, China (Abstract Co-Author) Nothing to Disclose

PURPOSE

To determine the technique feasibility, therapeutic effect and tissue response to silicone-covered biodegradable magnesium stent insertion into the benign esophageal stricture in rabbits.

METHOD AND MATERIALS

Benign esophageal stricture was surgically created in 12 rabbits. Twelve silicone-covered biodegradable magnesium stents were inserted to treat benign esophageal stricture in rabbit models under fluoroscopic guidance. Esophagography was performed at 1, 2 and 3 weeks. Four rabbits in each group were euthanized at each time point for histological examination

RESULTS

All stent insertions were well tolerated. The esophageal diameters at immediate,1, 2 and 3 weeks were 9.8 ± 0.3mm, 9.7 ± 0.7mm, 9.4 ± 0.8mm and 9.2 ± 0.5 mm, respectively (vs. 4.9 ± 0.3 mm before stent insertion; $P < 0.05$). Magnesium stents migrated rate was 9.3% (1/12) at 1 week, 25% (2/8) at 2 weeks and 100% (4/4) at three weeks respectively. Esophageal wall remodeling (thinner epithelial and smooth muscle layers) was found more significant in the stent groups than in the normal esophageal wall ($P < 0.05$). Esophageal injury and collagen deposition following stent insertion were similar and did not differ to the normal esophageal wall ($P > 0.05$).

CONCLUSION

Esophageal silicone-covered biodegradable magnesium stent insertion was feasible for the treatment of benign esophageal stricture, without causing severe injury or tissue reaction.

CLINICAL RELEVANCE/APPLICATION

Biodegradable magnesium stent can further be applied for the treatment of benign esophageal stricture in clinical.

SSQ20-04 Adhesive Embolization of Truncal Varicosities: Can It Be an Alternative to Thermal Ablation of Varicose Veins?

Thursday, Nov. 29 11:00AM - 11:10AM Room: S403A

Participants
Venkatesh Kasi Arunachalam, MBBS, DMRD, Coimbatore, India (Presenter) Nothing to Disclose

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PURPOSE

1. To evaluate the success rate of Glue embolisation using N Butyl 2 Cyanoacrylate. 2. To compare the occlusion rate with thermal ablation (we are comparing with Radiofrequency ablation as it is performed in our hopital) for varicose veins(Truncal veins) 3. To compare the cost of adhesive embolisation and RFA.

METHOD AND MATERIALS

Study period: October 2017 to August 2018. Inclusion criteria: Patients with symptomatic SFJ incompetence Exclusion criteria:

Deep vein thrombosis Glue embolisation of great saphenous vein(GSV) is planned atleast for thirty patients with N Butyl 2 cyanoacrylate. The great saphenous vein in thigh was punctered directly with 21 G needle atleast at 7 - 10 sites with a gap of 5cms and 0.1-0.2ml of glue is injected at each sites. After injection, compression is done with ultrasound probe for 45 seconds at that site. The injection is started from the caudal to cranial direction. The cranial most site of injection is 3cm distal to SFJ. The procedure is performed without perivenous tumescence. The patients are followed with ultrasound at one week, one month and six months intervals. The Patients will be evaluted for occlusion of GSV as well as complications associated with it. The results are compared with the results of RFA of varicose veins in literature. The cost of the procedure is also calculated and compared with the cost of the RFA in our hospital.

RESULTS

Till now 15 cases were performed with glue embolisation. We are planning to perform atleast 30 cases with glue and follow them atleast for 6 months. The cost of glue embolisation in our institution is about 15000 INR and RFA is about 60000 INR. If we are able to acheive the results of RFA with glue embolisation , the expenditure for the patient will be 1/4th of RFA.. The complications associted with glue embolisation including Inflammation , soft tissue necrosis and ulcer will be assesed and has to be compared with complictions assocaited with RFA.

CONCLUSION

The hypothesis of this exhibit is that efficacy of glue embolisation of varicose veins done with direct puncture is similar to RFA and it can be done with decreased cost (<1/4th of RFA).

CLINICAL RELEVANCE/APPLICATION

In a developing country like India, if we have a procedure which can give an acceptable rate of occlusion of varicose veins with decreased cost , it will be the procedure of choice and many patients will be benefitted.

SSQ20-05 Neutropenia in Adults at the Time of Subcutaneous Chest Port Insertion is a Risk Factor for Early Infection-Related Port Removal

Thursday, Nov. 29 11:10AM - 11:20AM Room: S403A

Participants
Andrew Perez, BS, Nashville, TN (Presenter) Nothing to Disclose
Jennifer M. Watchmaker, PhD, Nashville, TN (Abstract Co-Author) Nothing to Disclose
Filip Banovac, MD, Navshville, TN (Abstract Co-Author) Nothing to Disclose

PURPOSE

To determine if neutropenia at the time of subcutaneous, implantable chest port placement in adults confers an increased risk for early, infection-related removal.

METHOD AND MATERIALS

This retrospective cohort study was approved by the institutional review board and compliant with the Health Insurance Portability and Accountability Act. It included 2580 ports placed at a single tertiary medical center between June of 2007 and July of 2017. A total of 159 of these ports were placed in neutropenic patients. Neutropenia was defined as an absolute neutrophil count (ANC) <1500 cells/mm3. Electronic medical record follow-up was conducted for 30 days following port placement. Absolute percentages were calculated for port removal within 30 days in neutropenic and non-neutropenic groups. A chi-squared test was used to compare categorical data between the groups, and a t-test was used to compare continuous variables. Infection-related port removal was defined as a port removed due to a confirmed port infection. Port infection included central line-associated bloodstream infections (CLABSI) or local infections evidenced by either deep erythema, induration and/or tenderness overlying the catheter tunnel and port, or superficial erythema and induration overlying the port.

RESULTS

Within 30 days of port placement, ports placed in neutropenic patients had a significantly greater incidence (P = 0.01) of infection-related removal (3.8%, 6/159) compared to ports placed in nonneutropenic patients (1.1%, 27/2421). There was no significant difference between the neutropenic and nonneutropenic groups in gender or age (P = 0.31 and P = 0.77, respectively). Neutropenic patients had a greater, but not statistically significant, incidence of death related to port infection within the first 30 days (0.63%, 1/159) compared to the nonneutropenic group (0.12%, 3/2421; P = 0.22).

CONCLUSION

Neutropenia at the time of implantable, subcutaneous port placement is associated with an increased risk for early infection-related port removal. Incidence of death related to port infection, while increased in the neutropenic population, is not significantly higher than in the nonneutropenic population.

CLINICAL RELEVANCE/APPLICATION

Neutropenia in adults at the time of subcutaneous, implantable chest port placement confers an increased, although still low, risk for early infection-related port removal and should be taken into account when considering port placement.

SSQ20-06 Point of Care Ultrasound by Nonradiologist Physicians: Do the Trends Indicate a Shift Away from Radiologists?

Thursday, Nov. 29 11:20AM - 11:30AM Room: S403A

Participants
Sarah I. Kamel, MD, Philadelphia, PA (Presenter) Nothing to Disclose
David C. Levin, MD, Philadelphia, PA (Abstract Co-Author) Consultant, HealthHelp, LLC; Board Member, Outpatient Imaging Affiliates, LLC
Laurence Parker, PhD, Philadelphia, PA (Abstract Co-Author) Nothing to Disclose
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PURPOSE

"Point of care" ultrasound (POC US) is defined as US performed at the patient's bedside in real-time by a nonradiologist provider (NRP) versus formal ultrasound interpreted by a radiologist. Given the continued encouragement and development of POC US specialty based guidelines, our purpose was to assess the trends in use of POC US to determine if there has been a shift from radiologists to NRPs.

METHOD AND MATERIALS

The nationwide Medicare Part B fee-for-service databases for 2004-2016 were searched. All noninvasive noncardiac US CPT codes were selected. The databases indicate procedure volume which were used to calculate utilization rates per 1000 Medicare beneficiaries. Medicare place-of-service codes showed where the exams were interpreted and specialty codes indicated the specialty of the interpreting physicians. Sample statistics are not required in full populations like this.

RESULTS

POC US performed by NRPs peaked in 2010 at 211 studies per 1000 Medicare beneficiaries and has since declined to 192 studies in 2016 (-9%). POC US by NRPs is predominantly performed in private offices where peak utilization was seen in 2010 at 159 studies per 1000, declining to 140 in 2016 (-12%). The 2004-2016 interval changes in the remaining places-of service where NRP POC US is performed are as follows: (1) EDs: 1 to 3 (+136%); (2) hospital inpatients: 21 to 14 (-31%); hospital outpatient departments (HOPDs): 21 to 26 (+23%). The top NRP specialties in noncardiac POC US in 2016 and their rates were: vascular surgeons 38, cardiologists 37, other surgeons 31, primary care physicians 20. US use by radiologists peaked in 2011 at 238 studies and has since fluctuated between 234-238 without a significant trend. Over the period of the study, US use by radiologists has grown in the following places-of-service: (1) ED: 10 to 23 (+133%); (2) HOPD: 83 to 101 (+21%); (3) private offices: 39 to 56 (+44%). Inpatient US by radiologists has declined recently.

CONCLUSION

Despite the increased advocacy of POC US in recent years, NRPs have demonstrated a 9% decline in its utilization since 2010, particularly with decreasing use in private offices. There is no evidence of a recent shift away from radiologists. Radiologists demonstrated growth in use of POC US in EDs, HOPDs and private offices.

CLINICAL RELEVANCE/APPLICATION

There is no significant growth in use of point of care ultrasound by nonradiologist physicians.

SSQ20-07 Primary Percutaneous Placement of Low-Profile versus Traditional Pigtail and Standard Balloon-Retention Gastrostomy Catheters in Adults: A Retrospective Review

Thursday, Nov. 29 11:30AM - 11:40AM Room: S403A

Awards
Student Travel Stipend Award

Participants
Iftikhar Burney, MD, Houston, TX (Presenter) Nothing to Disclose
Zeyad A. Metwalli, MD, Bellaire, TX (Abstract Co-Author) Nothing to Disclose
David Sada, MD, Houston, TX (Abstract Co-Author) Nothing to Disclose
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PURPOSE

De novo percutaneous placement of low-profile or button-type gastrostomy catheters (LP) is infrequently reported in adults. This study compares the safety and clinical outcomes of primary percutaneous placement of LP catheters and traditional (pigtail and balloon-retention) gastrostomy catheters (TG) at a single institution.

METHOD AND MATERIALS

This was an institutional review board-approved retrospective, single-institution review comparing initial LP and TG catheter placements in a 24-month time period. The age, gender, indication, catheter type, catheter French size, and method of anesthesia of 139 consecutive initial gastrostomy placement procedures were recorded. Total catheter days without intervention, major and minor complications, reasons for re-intervention, and procedure fluoroscopy times were compared.

RESULTS

During the 24 month study period, 61 LP and 78 TG catheters were placed. Technical success for both methods was 100%. Mean total catheter days prior to intervention was 137 days in the LP group and 128 days in the TG group ($p = 0.70$). Minor complications including cellulitis, peri-catheter leakage and early catheter occlusion occurred in 4.9% (3/61) in the LP group and 9% (7/78) in the TG group ($p = 0.51$). Major complications including early catheter dislodgement and bleeding requiring transfusion (in one patient) occurred in 4.9% (3/61) in the LP group and 7.7% (6/78) in the TG group ($p = 0.73$). Procedure fluoroscopy time was lower in the LP group (2.56 minutes) compared to the TG group (4.21 minutes) ($p < 0.005$).

CONCLUSION

Primary placement of low-profile or button-type gastrostomy catheters is technically feasible with a low complication rate similar to that of traditional gastrostomy catheters.

CLINICAL RELEVANCE/APPLICATION

De novo placement of low-profile gastrostomy catheters is technically feasible with a comparable safety profile to traditional

pigtail and balloon-retention gastrostomy catheters.

SSQ20-08 Comparison of Treatment Outcomes in Thermal Ablation for T1a Renal Cell Carcinoma: Does Treatment Modality Matter?

Thursday, Nov. 29 11:40AM - 11:50AM Room: S403A

Awards
Student Travel Stipend Award

Participants
Wenhui Zhou, BS , Boston, MA (Presenter) Nothing to Disclose
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PURPOSE

To compare the clinical outcomes of radiofrequency ablation (RFA), cryoablation (CA) and microwave ablation (MWA) for treatment o fT1a renal cell carcinoma (RCC).

METHOD AND MATERIALS

A retrospective analyis was performed of 320 patients (mean age = 71 ys., range = 22-90 yrs.) between October 2006 and December 2017. Mena R.E.N.A.L., P.A.D.U.A. and centrality index scores were 6., 8.1, and 2.9, respectively. Treatment response, residual disease and survival outcome were compared among the three groups. Local recurrence-free, metastatic-free,and overall surival rates were tabulated using Kaplan-Meier methods and compared with log-rank tests.

RESULTS

365 T1a biopsy-proven RCC measuring 1.2 to 4. cm were treated with CT-guided MWA (n= 40, 11%), RFA (n=291, 80%), or CA (n=34, 9%). There were no significant differences in patient demographics or tumor characteristics betwen the three cohorts. Technical success rate, complication rate and rsidual disease rate were similar among the three groups (p=0.91, p=0.14, p=0.46, respectively). At two-years follow-up, analysis of the local disease free-, metastatic free-, andoverall survial rate showed that MWA is non-inferior to RFA and CA (p=0,60, p=0.93, p=0.75, respectively).

CONCLUSION

CT-guided percutaneous MWA is an effective thermal ablation option for treatmen of T1a renal cell carcinoma.

CLINICAL RELEVANCE/APPLICATION

Microwave ablation has comparable therapeutic efficacay and oncologic outcomes when compared to RFA and CA.

SSQ20-09 Role of Dynamic Contrast-Enhanced MRI (DCE-MRI) in Treatment Response Evaluation of Metastatic Bone Disease

Thursday, Nov. 29 11:50AM - 12:00PM Room: S403A

Participants
Roberto Scipione, MD , Rome, Italy (Presenter) Nothing to Disclose
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Andrea Leonardi, MD , Roma, Italy (Abstract Co-Author) Nothing to Disclose
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PURPOSE

To correlate perfusional features in skeletal metastases treated with MR-guided Focused Ultrasound (MRgFUS) with clinical outcomes assessed by visual analogue scale (VAS).

METHOD AND MATERIALS

53 patients with symptomatic skeletal metastases, suitable for MRgFUS, were enrolled. Dynamic Contrast-Enhanced MR exam (3T Discovery 750 scanner, GE; Gd-BOPTA, Bracco) was performed before and 3 months after the ablative procedure. As perfusional parameters, DCE transfer rate (Ktrans) and extravascular volume fraction (ve) were calculated by dedicated analysis software. Clinical outcomes were evaluated over the following three months using VAS scale.

RESULTS

42 of 53 treated subjects (79.2%) demonstrated a clinical complete response (CR), with a VAS score mean reduction of 4,5 (48,2%. p<0,001), whereas five patients showed a partial clinical response (PR) with residual pain, according to VAS scale. Perfusional analysis demonstrated in CR population significant decrease of Gadolinium extraction (mean Ktrans reduction 2,18/min, ΔKt=52,72%. p<0,01) and ve increase (5,6%. p<0,01). Partial Responders showed no substantial modification in Ktrans value (ΔKt=+0,044/min, +11,39%. p>0,05) or increase in extravascular volume (1.3%. p<0,01). Spearman test revealed a significant relationship between Ktrans quantitative parameters and pain relief evaluated by VAS scale (p<0,001) in both CR and PR patients.

CONCLUSION

K trans value reduction positively correlates to clinical outcomes, probably for a decreased neoplastic cells' metabolism after ultrasound ablation procedure.

CLINICAL RELEVANCE/APPLICATION

DCE-MRI has an important role in treatment response evaluation. Perfusional parameters may be routinely included in the imaging evaluation of patients affected by metastatic bone disease.

SSQ21

Vascular Interventional (Liver Cancer Interventionist)

Thursday, Nov. 29 10:30AM - 12:00PM Room: S403B

GI IR VA

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

FDA Discussions may include off-label uses.

Participants
Xiaoming Yang, MD, PhD, Mercer Island, WA (*Moderator*) Nothing to Disclose

Sub-Events

SSQ21-01 Tunable Ultrasound Vascular Therapy for Hepatocellular Carcinoma

Thursday, Nov. 29 10:30AM - 10:40AM Room: S403B

Participants
Laith R. Sultan, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose
Julia D'Souza, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Susan M. Schultz, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
Mustafa Mohammed, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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Andrew K. Wood, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

Tumor perfusion has varying effects on cancer therapy depending on the nature of the treatment used. While drug delivery and radiation therapy require increased tumoral perfusion for a better response, non invasive ischemic therapy and hyperthermia models require reduced blood flow. The purpose of this study is to investigate the dose-dependent effects of novel antivascular ultrasound therapy (AVUS) on hepatocellular carcinoma (HCC) tumoral blood flow.

METHOD AND MATERIALS

HCC was induced in 15 Wistar rats by ingestion of diethylnitrosamine (DEN) for 12 weeks. Rats received AVUS treatment at low and high doses. Low dose group (n=6) received 1 watt/cm2 ultrasound for 1 min with 0.2 mL microbubbles injected IV. High dose group (n=9) received 2 watts/cm2 for 2 min with 0.7 mL microbubbles IV. Tumoral perfusion was measured before and after AVUS with contrast-enhanced ultrasound (CE-US) and power Doppler (PD-US). Quantitative measures: perfusion index (PI) and peak enhancement (PE) were obtained from each AVUS dose. Histology samples were evaluated for percent area of hemorrhage and findings of tissue injury and repair including inflammation, necrosis, and fibrosis. Histology results were compared with pre- and post-AVUS ultrasound imaging findings.

RESULTS

With high dose AVUS, PE and PI of CE-US decreased from baseline by an average of 29.3% and 28.8%, respectively. Histology showed extensive tissue injury (hemorrhage, necrosis, fibrosis) in 58% of tumor cross-sectional area. Conversely, low dose therapy led to an increase in PE and PI of CE-US by an average of 39.3% and 67.8%, respectively. Histology showed smaller areas of microhemorrhage versus large pools of hemorrhage (only 17% area). PD-US changes were similar to CE-US.

CONCLUSION

Low-dose therapy increased tumoral perfusion, which may improve drug delivery or radiation therapy. Conversely, high-dose therapy decreased tumoral perfusion, an effect that could be used for noninvasive ischemic therapy. This tunable modulation of blood flow in tumors could provide multiple roles for AVUS in cancer therapy.

CLINICAL RELEVANCE/APPLICATION

Increasing availability of ultrasound in developing world could enable AVUS as an inexpensive & less resource-intensive tool for HCC therapy. Titrating the dose of AVUS could allow selective use to enahnce radiation therapy, drug delivery, or for ischemic therapy.

SSQ21-02 Radiofrequency Ablation Using a Separable Clustered Electrode for Treatment of HCCs: Randomized Controlled Trial of a Dual Switching Monopolar Mode versus a Single Switching Monopolar Mode

Thursday, Nov. 29 10:40AM - 10:50AM Room: S403B

Awards
Student Travel Stipend Award

Participants
Jae Won Choi, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose
Jeong Min Lee, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Grant, Bayer AG Grant, General Electric Company Grant, Koninklijke Philips NV Grant, STARmed Co, Ltd Grant, RF Medical Co, Ltd Grant, Samsung Electronics Co, Ltd Grant, Guerbet SA

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PURPOSE

To prospectively compare the efficacy, safety and mid-term outcomes of dual-switching monopolar (DSM) radiofrequency ablation (RFA) with those of conventional single-switching monopolar (SSM) RFA in the treatment of hepatocellular carcinoma (HCC)

METHOD AND MATERIALS

This prospective study was performed with approval of the institutional review board, and written informed consent was obtained for all enrolled patients. From January 2015 to May 2016, 80 patients with 94 HCC nodules were enrolled and randomly treated with either DSM-RFA or SSM-RFA, using a separable clustered electrode and a three-channel dual-generator unit. Technical parameters, procedure-related complications, and technical efficacy were assessed at the post-procedural imaging studies. For a mean follow-up of 23.9 months ± 9.2, the patients were observed for local tumor recurrence as well as overall disease progression. Survival analysis was performed with the Kaplan-Meier method, and differences between the survival curves were evaluated with the log-rank test.

RESULTS

Significantly higher ablation energy per given time was delivered in the DSM-RFA group than in the SSM-RFA group (1.61 ± 0.28 kcal/min vs. 1.17 ± 0.28 kcal/min, respectively; P < .0001). Major complications were observed in two (4.9%) of 41 patients in the DSM-RFA group and in one (2.6%) of 39 patients in the SSM-RFA group (P=1.0000). A patient in the DSM-RFA group experienced intercostal arterial bleeding that required embolization. Pleural effusion developed in one patient in each group. Rates of local tumor recurrence in HCC nodules treated with DSM-RFA and SSM-RFA were 8.5% and 4.7%, respectively, at 2 years (P = .3160). The 2-year local recurrence-free survival rates in the DSM-RFA group and the SSM-RFA group were 90% and 94.4%, respectively (P = .3312). The 2-year event-free survival rates in the DSM-RFA group and the SSM-RFA group were 54.9% and 75.7%, respectively (P = .2649).

CONCLUSION

Although dual-switching monopolar radiofrequency ablation using a separable clustered electrode delivers higher ablation energy per given time than the SSM-RFA, it failed to show superior effectiveness to the SSM-RFA in the treatment of HCCs.

CLINICAL RELEVANCE/APPLICATION

Dual-switching monopolar radiofrequency ablation may be considered as a technically more efficient alternative with non-inferior clinical effectiveness to the SSM-RFA.

SSQ21-03 Utility of Change in Volumetric ADC and Enhancement Post TACE in Predicting Histologic Grade of HCC, with Pathologic Correlation

Thursday, Nov. 29 10:50AM - 11:00AM Room: S403B

Participants
Sanaz Ameli, MD, Baltimore, MD (*Presenter*) Nothing to Disclose
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Ihab R. Kamel, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG

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PURPOSE

To investigate the role of change in ADC and enhancement after trans- arterial chemoembolization (TACE) in predicting histological grade of hepatocellular carcinoma (HCC).

METHOD AND MATERIALS

This HIPPA compliant retrospective study was approved by our institutional review board. The study population included 104 HCC patients (128 index lesions) with MR imaging within 6 months before and 6 months after TACE who presented at our institution between 2001 and 2015. All cases had pathologic report of the HCC tumor by biopsy or liver transplantation. Volumetric measurements of venous enhancement (VE) and apparent diffusion coefficient (ADC) were performed on baseline and post TACE MRI. Based on pathology report, the tumors were histologically classified into two groups: Low grade HCC (n=42) and intermediate/high grade HCC (n=86). In case of tumors with mixed differentiation, the worst differentiation grade was considered. The mean ADC (mm2/s) and enhancement (%) of two groups were compared at two-time points. P value<0.05 was considered statistically significant.

RESULTS

Mean ADC increased by (363.88±529.07 x 10 -6 mm2/s) in low grade vs. (136.20±503.73 x 10 -6 mm2/s) in high grade HCC post TACE. ADC change in low grade tumors was higher than in intermediate/high grade tumors (P=0.02). Setting the cutoff of 148.4 x

10 -6 mm2/s or more in ADC change had a sensitivity and specificity of 62% and 55%, respectively in differentiating between the 2 groups. Enhancement decreased by (46 ± 34%) in low grade vs. (28± 36%) in high grade tumors post TACE. Enhancement change was significantly higher in low grade HCC as compared to intermediate/high grade tumors (P=0.011). Setting the cutoff of 39% or more decrease in enhancement had sensitivity and specificity of 65% and 55%, respectively in differentiating between the 2 groups.

CONCLUSION

Low grade tumors demonstrate a greater change in ADC and enhancement post TACE as compared to intermediate/ high grade tumors.

CLINICAL RELEVANCE/APPLICATION

The change in ADC and enhancement in HCC after TACE could potentially be utilized to predict tumor differentiation and can help the clinicians to plan future treatment in these patients.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ihab R. Kamel, MD, PhD - 2015 Honored Educator

SSQ21-04 Quantitative Arterial Flow Measurement with 4D DSA

Thursday, Nov. 29 11:00AM - 11:10AM Room: S403B

Participants
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PURPOSE

To evaluate the quantitative accuracy and precision of flow measurements derived from 4D digital subtraction angiography (4D DSA) and to evaluate 4D DSA flow values in a model of hepatic transarterial embolization (TAE).

METHOD AND MATERIALS

4D DSA generates a time-resolved 3D angiogram using a conventional C-arm acquisition consisting of a mask rotation followed by a contrast-enhanced rotation. Methods of quantifying flow in vessel segments of the 4D data are under development. In this work, flow was derived from a Fourier phase analysis of the pulsatile contrast waveform that arises when a constant-rate intra-arterial iodine injection mixes with pulsatile blood flow. 4D DSA flow was compared to reference standard flow measured by an ultrasonic flow probe (Transonic) in a vascular phantom study (range of flow rates 5-20 mL/s). In a porcine model, 4D DSA flow was evaluated before and after selective left or right hepatic TAE with 100-300 m microspheres. Iodinated contrast medium was injected at 2 mL/s during 4D DSA imaging.

RESULTS

4D DSA flow was linearly proportional to reference standard flow in the vessel phantom (R2 = 0.96) with a slope of 1.33 +/- 0.06 and an intercept of -0.2 +/- 0.77 mL/s. The slope was consistent with a flow state between the extremal cases of plug flow and parabolic flow, and the intercept was consistent with zero bias. The standard deviation in the 4D-DSA flow measurement averaged 1.2 mL/s in the phantom. In the porcine study (4 subjects), the mean reductions in 4D DSA flow following embolization were -0.2, -1.3, -2.2, and -1.0 mL/s ($p <= 0.04$). In repeat measurements performed in the same in vivo flow state, the average change in 4D DSA flow was 0.7 mL/s.

CONCLUSION

4D DSA can provide quantitative measurements of pulsatile flow through a vessel. These measurements are sensitive to changes in flow that occur during hepatic transarterial embolization.

CLINICAL RELEVANCE/APPLICATION

4D DSA flow measurements may be used to quantify treatment-related changes in arterial blood flow in the interventional suite, yielding a new, quantitative endpoint for procedures.

SSQ21-06 Radiofrequency Ablation of Primary Parathyroid Adenoma: Preliminary Results for Patients Ineligible for Surgery

Thursday, Nov. 29 11:20AM - 11:30AM Room: S403B

Participants
Eun Ju Ha, Suwon, Korea, Republic Of (*Presenter*) Nothing to Disclose
Jung Hwan Baek, Seoul, Korea, Republic Of (*Abstract Co-Author*) Consultant, STARmed; Consultant, RF Medical

PURPOSE

The purpose of this study was to retrospectively evaluate the outcomes of ultrasonography (US)-guided radiofrequency ablation (RFA) of parathyroid adenoma in patients who were ineligible for surgery

METHOD AND MATERIALS

Between October 2010 and June 2016, six parathyroid adenomas (mean diameter, 2.0 cm; range, 1.2-3.8 cm) in six patients with primary hyperparathyroidism were treated with US-guided RFA by two radiologists in two hospitals. The inclusion criteria for this study were (1) primary hyperparathyroidism, (2) pathologically confirmed parathyroid adenoma on US-guided fine-needle aspiration, and (3) refusal- or ineligibility- for surgery. RFA was performed using a RF generator and 19-gauge internally cooled electrode. The hydrodissection technique using the 5% dextrose water was applied in all patients. The medical records were reviewed and analysed, focusing on the procedural profiles of RFA, symptoms and complications during and after RFA, and changes in hormone levels on follow-up US.

RESULTS

Before RFA, the mean nodule volume was 1.0 ± 0.5 mL. The mean parathyroid hormone (PTH) level was 210.4 ± 283.9 pg/mL and calcium level was 10.4 ± 0.9 mg/dL. At 1- and 6- month follow-up after RFA, a significant reduction in the mean volume (78.4 ± 3.7% and 89.1 ± 8.4 %, respectively) was noted and five ablation zones (5/6, 83.3%) near completely disappeared (<=0.1mL). The mean PTH level was decreased to the normal range (50.9 ± 6.5 pg/mL) at 1-month follow-up and were progressively decreased at 6-month follow-up in 5 patients (40.1 ± 7.3 pg/mL). The PTH level in one patient was re-increased from 48 pg/mL to the 241 pg/mL at 6-month follow-up. The mean calcium level was decreased to 9.3 ± 0.8 mg/dL at 6-month follow-up. There was no immediate complication during- and after- the procedure.

CONCLUSION

RFA might represent an effective and a safe alternative for managing parathyroid adenomas, especialy in patients ineligible for surgery

CLINICAL RELEVANCE/APPLICATION

RFA might be an alternative treatment option for managing parathyroid adenomas in patients with primary hyperparathyroidism.

SSQ21-07 Conventional versus Drug-Eluting Beads Chemoembolization for Infiltrative Hepatocellular Carcinoma: Comparison of Efficacy and Safety

Thursday, Nov. 29 11:30AM - 11:40AM Room: S403B

Participants
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PURPOSE

To compare the early tumor response and the toxicity in patients with infiltrative hepatocellular carcinoma (iHCC) treated with conventional or drug-eluting beads transarterial chemoembolization (TACE).

METHOD AND MATERIALS

A total of 89 iHCC patients who were treated with either cTACE(n=33) or DEB-TACE(n=56) were included in this retrospective study between April 2016 and September 2017. Tumor response was measured one month after the procedure using Modified Response Evaluation Criteria in Solid Tumors (mRECIST). Toxicity was graded by Common Terminology Criteria for Adverse Events v5.0 (CTCAE v5.0). The difference of tumor response and toxicity were compared between cTACE group and DEB-TACE group using Chi-square test or Fisher's exact test (if appropriate).

RESULTS

There was no difference in objective response rate between cTACE group and DEB-TACE group (12.1% vs. 10.7%, P=0.839). However, disease control rate is significantly higher in DEB-TACE group than cTACE group (85.7% vs. 66.7%, P=0.034). In some advanced disease, such as bilobar lesions, ECOG 1-2, and presence of portal venous tumor thrombus, DEB-TACE showed higher disease control than which cTACE showed (all P<0.05). For side-effect analysis, abdominal pain (P=0.034) and fever (P=0.009) are more frequent in cTACE group, and there was no difference in serious liver toxicity between two groups.

CONCLUSION

DEB-TACE offers more benefits of efficacy and tolerability in iHCC than cTACE, particularly for patients with more advanced disease.

CLINICAL RELEVANCE/APPLICATION

For iHCC patients, especially with ECOG 1-2, bilobular or portal venous tumor thrombus, DEB-TACE is recommended due to the low toxicity and well tolerability.

SSQ21-08 A Matched Study Comparing Right Portal Vein Embolization with and Without Segment 4 Portal Vein Embolization for Right Hepatic Trisectionectomy

Thursday, Nov. 29 11:40AM - 11:50AM Room: S403B

Participants
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PURPOSE

Portal vein embolization (PVE) is widely used before major hepatectomy. However, the necessity of segment 4 (S4) portal veins embolization in addition to embolization of the right portal vein before right hepatic trisectionectomy is controversial. Thus, we examined the effect of S4 PVE on hypertrophy of segments 2 and 3 (S2+3) in a matched retrospective cohort study.

METHOD AND MATERIALS

We retrospectively reviewed patients with biliary carcinoma who underwent preoperative PVE using gelatin sponge and coils between January 2010 and November 2017. Totally, 28 patients underwent right and S4 portal veins embolization (RPVE+4) for right hepatic trisectionectomy, and 100 patients underwent right PVE (RPVE) for right hepatectomy. We measured the liver volumes by CT using the workstation before and after embolization, and 22 patients from each group respectively were matched for the ratio of S2+3 volume to total liver volume (%S2+3 volume) before embolization. Volume changes in S2+3 after embolization were compared among the two groups.

RESULTS

There was no statistically significant difference between the two groups in the time between PVE and volumetric CT (mean, RPVE+4, 26.5days vs RPVE, 23.4days; P = .349). The absolute S2+3 volume increase was significantly more in RPVE+4 group than RPVE (RPVE+4, 129.5±79.5ml vs RPVE, 70.5±29.9ml; P = .002). The %S2+3 volume increased in both groups: from 23.7±4.5% before PVE to 33.0±4.7% after PVE in RPVE+4, and from 23.6±4.4% to 29.6±4.6% in RPVE. The increase of the %S2+3 volume (9.3±3.2% vs 5.9%±1.3; P < .001) and the increase rate of the %S2+3 volume (41.7±22.1% vs 26.3±8.6%; P = .004) were significantly higher in the RPVE+4 group. In multiple regression analysis, the absolute S2+3 volume increase (P = .002) and the increase rate of the %S2+3 volume (P = .003) were also significantly higher in the RPVE+4 group.

CONCLUSION

S4 PVE in addition to right PVE significantly improves S2+3 hypertrophy and increases the proportion of the future liver remnant compared with right PVE alone.

CLINICAL RELEVANCE/APPLICATION

S4 PVE added to right PVE is more effective in preparation for right hepatic trisectionectomy and may make the operation safer.

SSQ21-09 Multicentric Assessment of the Hong Kong Liver Cancer Staging System in Chinese Patients following Transarterial Chemoembolization

Thursday, Nov. 29 11:50AM - 12:00PM Room: S403B

Participants
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PURPOSE

Recently, the hepatitis B-based Hong Kong Liver Cancer (HKLC) staging system was reported to guide treatment options. We aimed to validate the performance of the HKLC compared with the Barcelona Clinic Liver Cancer (BCLC) staging system in Chinese hepatocellular carcinoma (HCC) patients treated with conventional transarterial chemoembolization (cTACE) as initial treatment.

METHOD AND MATERIALS

This retrospective study included patients with HCC who underwent cTACE between January 2008 and December 2016 at three Chinese institutions. All of the patients were calculated HCC stage using 5-substage HKLC (HKLC-5), 9-substage HKLC (HKLC-9), and the BCLC system. Based on overall survival (OS), these three staging systems' performance on treatment outcome prediction were compared using C statistic, Akaike information criterion (AIC), area under the receiver operating characteristic curve (AUC), linear trend chi-square, likelihood ratio chi-square, and calibration plots, respectively.

RESULTS

A total of 715 patients were included. The median OS was 10.1 months. Compared with the BCLC system, the HKLC system, especially HKLC-9 showed better performance on survival prediction (HKLC-9: C=0.689, AIC=6646.162; HKLC-5: C=0.683, AIC=6662.663; BCLC: C=0.680, AIC=6654.146), homogeneity (likelihood ratio chi-square: HKLC-9=232.38, HKLC-5=215.87, and BCLC=224.39, p <0.001) and calibration (R2: HKLC-9=0.923, HKLC-5=0.916, and BCLC=0.914). HKLC-9 outperformed on AUC at 6, 12, and 24 months' survival prediction than HKLC-5 and BCLC. BCLC showed better performance on monotonicity (linear trend chi-square: HKLC-9=121.641, HKLC-5=117.389, and BCLC=125.752; p <0.001).

CONCLUSION

Combining survival prediction, discrimination, and calibration, the HKLC, especially HKLC-9 system performed better for Chinese patients treated with cTACE than the BCLC system.

CLINICAL RELEVANCE/APPLICATION

HKLC outperforms BCLC when regarding patients with HCC treated with conventional TACE as initial treatment.

SST01

Breast Imaging (Multimodality Breast Imaging)

Friday, Nov. 30 10:30AM - 12:00PM Room: E353B

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
Debra S. Copit, MD, Wynnewood, PA (*Moderator*) Research funded, Hologic, Inc

Sub-Events

SST01-01 Comparative the Average Glandular Dose between Digital Breast Tomosynthesis (DBT) and Full-Field Digital Mammography (FFDM): Correlation with Breast Thickness and Density

Friday, Nov. 30 10:30AM - 10:40AM Room: E353B

Participants
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PURPOSE

To compare the average glandular dose (AGD) between single-view digital breast tomosynthesis (DBT) and single-view full-field digital mammography (FFDM), and to evaluate the correlation of AGD with breast thickness and density.

METHOD AND MATERIALS

A total of 318 female patients who underwent both DBT and FFDM (DBT and FFDM were performed in the same compression thickness in each breast) were included. 636 DBT images of unilateral breast mediolateral oblique (MLO) view and 636 FFDM images of unilateral breast mediolateral oblique (MLO) view were analyzed. Mammographic breast density was determined according to BI-RADS breast density grading, and breast thickness and AGD per exposure in MLO views retrieved from DICOM headers were recorded. Breast thickness were divided into the following four groups: <= 30cm, 31 ~ 45cm, 46 ~ 60cm and > 60cm. The statistical analyses used variance analysis and Pearson's correlation for parametric tests.

RESULTS

(1) The AGD of DBT had a weak negative correlation with breast density (correlation coefficient =-0.305, P<0.001), decreased as the breast density increased. The AGD of FFDM did not change significantly with breast density increased (correlation coefficient =-0.027, P=0.501). (2) Breast thickness was significantly associated with AGDs, and both AGDs of FFDM and DBT increased with increased breast thickness (correlation coefficient =0.771 and 0.935, respectively, all P<0.001). (3) When breast density was >75% and breast thickness was >60cm, the AGD of DBT was lower than that of FFDM, and the difference was statistical significant (P = 0.031).

CONCLUSION

The AGD of DBT increased with breast thickness increased and decreased with breast density. For thick and dense breast, the radiation dose of DBT was lower than that of FFDM.

CLINICAL RELEVANCE/APPLICATION

In this study, we evaluated the AGD of MLO FFDM and DBT according to breast density and thickness.

SST01-02 Accuracy of Molecular Breast Imaging in Patients with Suspicious Calcifications

Friday, Nov. 30 10:40AM - 10:50AM Room: E353B

Participants
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PURPOSE

Molecular breast imaging (MBI), which shows uptake of Tc-99m sestamibi in metabolically-active tissue, has been proposed as a tool for determining whether biopsy of mammographically-detected lesions is necessary. Here, our goal was to evaluate the diagnostic accuracy of MBI in patients with suspicious calcifications on mammography.

METHOD AND MATERIALS

Women scheduled to undergo stereotactic biopsy of calcifications detected on 2D mammography were prospectively enrolled to undergo MBI prior to biopsy. MBI was performed with injection of Tc-99m sestamibi and a dedicated gamma camera. A breast radiologist interpreted MBI in conjunction with mammography.

RESULTS

In 71 women studied, 76 discrete areas of calcifications were identified for biopsy, of which pre-biopsy MBI was positive in 17/76 (22%). Of 76 calcification lesions, 24 (32%) were malignant, including 20 DCIS and 4 invasive ductal cancer; MBI was positive in 10/20 (50%) DCIS and 2/4 (50%) invasive cancers. In 21 cancers with calcification morphology of amorphous, coarse heterogeneous, or fine pleomorphic (BI-RADS 4B), MBI was positive in 12/21 (57%), while in three cancers with fine linear or fine linear branching calcifications (BI-RADS 4C), MBI was negative in all 3 (p=0.06). Calcification distribution was more varied for the MBI-positive cancers (0 regional, 7 grouped, 1 linear, 4 segmental) than for the MBI-negative cancers (1 regional, 10 grouped, 1 linear, 0 segmental) (p=0.14). The median pathologic size for MBI-positive cancers was 1.5 cm (range=0.5-3.2 cm) compared to 0.9 cm (range=0.1-2.0 cm) for MBI-negative cancers (p=0.09). Beyond calcification lesions, detection of non-mass focal areas of uptake on MBI led to additional biopsies of 6 sites, of which 2 were malignant (DCIS). The overall positive and negative predictive values of MBI were 61% (14/23) and 81% (48/59), respectively.

CONCLUSION

MBI has insufficient negative predictive value to be used for identifying calcifications in which biopsy could be avoided. However, MBI can reveal additional sites of mammographically-occult disease.

CLINICAL RELEVANCE/APPLICATION

Negative findings on MBI should not be used to avoid biopsy of suspicious calcifications on mammography.

SST01-03 Staging Early Breast Cancer with Simultaneous PET/ MRI: Impact on Management

Friday, Nov. 30 10:50AM - 11:00AM Room: E353B

Participants
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PURPOSE

Breast cancer is a biologically heterogenous disease with certain clinical subtypes having a greater propensity to develop metastasis even at an early stage. In its present state, NCCN recommends 18-F FDG PET CT in patients above clinical stage III disease. There have been reports on PET CT in altering clinical stage in early breast cancer. DCE (Dynamic Contrast-Enhanced) MRI has been shown to detect additional disease in the ipsilateral & contralateral breast. Simultaneous PET/MRI combines 18F-FDG PET & MRI of the whole body & DCE-MRI of the breast in a single examination. This retrospective study evaluates the impact of simultaneous 18F-FDG PET/MRI in pretreatment staging of early breast cancer (Stage I-IIIA).

METHOD AND MATERIALS

The study was approved by institutional ethics committee. 101 patients with histologically proven breast cancer (clinical stage I, IIA, IIB, IIIA) who underwent simultaneous PET/MRI (including DCE MRI breast) were included. Breast lesions, nodes & metastases were evaluated on PET, MRI & PET-MRI for lesion count & diagnostic confidence (DC).

RESULTS

101 index breast lesions were identified on MRI, PET/MRI (Mean DC 4.96) & 99 on PET (Mean DC >=4). MRI detected multifocality in 15 (14.8%), multicentricity in 10 (9.90%) & contralateral unsuspected cancer in 2 patients. PET detected axillary nodal metastases in 12/18 (DC>=4), MRI in 15/18 (DC>=4) and PET/MRI in 15/18 patients. Distant metastases were found in 18 /101 (18 %) on PET (Mean DC score 4.1), MRI (Mean DC score=3.7) & PET/MRI (Mean DC score =4.7) with bone (n =11), lymph nodes (mediastinal; n=2), liver (n=4), brain (n=1) & lung (n=5). The mean metastatic lesion size on MRI was 1.52 ± 0.25 cm (Range: 0.5-5.7cm). PET MRI changed the overall stage in 66 patients (65%, upstaging: 62, downstaging:4) & overall change in management in 29 % of early stage breast cancer patients including 18 patients who were upstaged to stage IV.

CONCLUSION

Simultaneous18F-FDG PET/MRI has the potential to impact the initial staging in early breast cancer for an overall improved patient management.

CLINICAL RELEVANCE/APPLICATION

Simultaneous PET/MRI has the potential to alter the stage and hence the clinical management in patients with early breast cancer thus reducing the morbidity and cost due to inappropriate therapies.

SST01-04 The Gambler's Fallacy in Screening Mammography

Friday, Nov. 30 11:00AM - 11:10AM Room: E353B

Participants
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PURPOSE

It has been documented in multiple settings that the sequence of decisions already made affects future decision-making. One component of this phenomenon is known as the gambler's fallacy: the tendency to underestimate the likelihood of 'streaks' (successive identical decisions) occurring by chance. The purpose of this study was to determine if the gambler's fallacy affects radiologists interpreting screening mammography.

METHOD AND MATERIALS

This was a retrospective, HIPPA compliant IRB approved study. Patients who underwent routine screening mammography in 2014 at our institution were included, with 8,543 total exams, which was sufficient to detect a 1% change in recall rate based on an 80% power calculation with a two-sided 0.05 significance level, for our recall rate of 7%. Data were collected from log books containing the BI-RADS assessments of routine screening mammograms, the order in which the examinations were interpreted, and the number of preceding BI-RADS 0 and BI-RADS 1 or 2 assessments for each exam. If recalled (BI-RADS-0), subsequent diagnostic exam BI-RADS assessment also was recorded. Analysis was performed using Fishers exact test to evaluate whether an increasing number of preceding decisions to not recall (BI-RADS-1 or 2) resulted in an increased number of recalls that did not lead to a cancer diagnosis. False positive was defined as a BI-RADS 0 assessment at screening, followed by a BI-RADS 1, 2 or 3 at diagnostic breast imaging. A true positive was defined as a BI-RADS 0 assessment at screening, followed by a BI-RADS 4 or 5 assessment at diagnostic breast imaging.

RESULTS

Data on 8,543 routine screening exams was collected for the year 2014. An average of 20.9 exams were batch read in each session. 700 exams (8%) were assessed as BI-RADS 0. Of those, 231 (33%) were assigned either BIRADS-4 or 5 at the time of diagnostic imaging. True and false positives were compared, stratified by the number of preceding BI-RADS 1 or 2 assessments in that batch-read session. Exams with a higher number of preceding negative assessments did not have a higher false positive rate.

CONCLUSION

At our academic institution, we did not observe a statistically significant effect of the gambler's fallacy in one year's worth of screening mammography.

CLINICAL RELEVANCE/APPLICATION

We did not detect an effect of the gambler's fallacy in one year's worth of screening mammography at an academic institution.

SST01-05 Outcomes of Ductal Carcinoma in Situ According to Detection Modality: A Multicenter Study Comparing Recurrences Between Mammography and Breast US

Friday, Nov. 30 11:10AM - 11:20AM Room: E353B

Participants
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PURPOSE

To determine whether if disease recurrence and intrinsic characteristics of ductal carcinoma in situ (DCIS) is associated to the imaging method of detection in asymptomatic women who are diagnosed with DCIS.

METHOD AND MATERIALS

This retrospective, multicenter study was conducted at 8 institutions including 844 women who were treated for asymptomatic, pure DCIS who had preoperative mammography and breast ultrasonography (US) available for review. Mean follow up interval after treatment of the 844 women was 91.2 months (standard deviation: 533.3, range: 6.4-180.9 months). Medical records and breast images were reviewed by 8 breast-imaging dedicated radiologists for clinicopathologic information and image analysis. Kaplan-Meier analysis and univariable/multivariable Cox proportion hazard model was used to analyze the recurrence-free survival rates and factors associated with recurrence after DCIS treatment.

RESULTS

Of the 844 women who were treated for DCIS, 25 (3.0%) had developed recurrences. Patients with US-detected DCIS had significantly lower 5- and 10-year recurrence-free survival rates compared to patients with mammography-detected ones (P=0.011). US-detected DCIS had significantly lower 5- and 10-year recurrence-free survival rates compared to mammography-detected ones in patients <50years or with mammographically-dense breasts (P=0.002, and 0.002, respectively). Multivariable analysis showed that US for detection modality (HR: 4.451, 95% CI: 1.530, 12.950, P=0.006) and HER2 positivity (HR: 4.036, 95% CI: 1.438, 11.330, P=0.008) showed significant association to recurrences.

CONCLUSION

US for detection modality and HER2 positivity were factors significantly associated to recurrences in patients treated for asymptomatic DCIS.

CLINICAL RELEVANCE/APPLICATION

Supplementary screening US may enable detection of clinically important DCIS, especially in younger women or mammographically-dense breasts in which mammography has suboptimal performances in detection of DCIS or small invasive cancers.

SST01-06 Do Triple Negative Breast Cancers Have Characteristic Imaging Features According to Androgen Receptor and Vimentin Status?

Friday, Nov. 30 11:20AM - 11:30AM Room: E353B

Participants
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PURPOSE

Lehmann et al (Journal of Clinical Investigation, 2011) previously identified six molecular subtypes of triple negative breast cancer (TNBC) through analysis of gene expression profiles; the luminal androgen receptor (LAR) subtype has been shown to have a higher percentage of regional spread to lymph nodes and the mesenchymal (M) subtype, a lower percentage. The purpose of this study is to determine if TNBCs have characteristic imaging features based on androgen receptor (AR) and vimentin (VM) status, which are surrogate immunohistochemical markers for the LAR and M subtypes of TNBC, respectively.

METHOD AND MATERIALS

This study is part of a clinical trial of stage I-III TNBC patients, which is being conducted at a single quaternary care center. A total of 144 patients, who were randomized to the intervention arm of being informed of the results of their molecular characterization including androgen receptor and vimentin status prior to receiving neoadjuvant chemotherapy, were included in this interim imaging analysis. Androgen-receptor-positive tumors (AR+) were defined as having >=15% staining. Vimentin-positive (VM+) tumors were defined as having >=50% staining. Two experienced, fellowship-trained breast radiologists used BIRADS (Breast Imaging Reporting and Data System) lexicon to review and reach consensus on all imaging studies (i.e., mammogram, ultrasound, and breast magnetic resonance imaging) while blinded to the immunohistochemical results. Fisher's exact test was used to assess the association of AR or VM status with imaging features. P values less than 0.05 was considered statistically significant.

RESULTS

Androgen-receptor-positive TNBC was significantly associated with scattered and heterogeneous breast composition on mammography (p=0.04), presenting as a mass with calcifications on mammography (p=0.04), having an irregular shape on ultrasound (p=0.005), and having an irregular margin on MRI (p=0.04). However, vimentin expression in TNBC was not significantly associated with any specific imaging features.

CONCLUSION

TNBCs have characteristic imaging features based on androgen receptor status but not based on vimentin status.

CLINICAL RELEVANCE/APPLICATION

Multimodality breast imaging may help identify LAR TNBC, which has been shown to be a subtype with a higher rate of regional nodal disease and with decreased response to neoadjuvant chemotherapy.

SST01-07 Usefulness of Surveillance MR for Early and Late Recurrent Breast Cancer in Women after Breast-Conservation Therapy

Friday, Nov. 30 11:30AM - 11:40AM Room: E353B

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PURPOSE

To investigate the diagnostic performance of mammography, ultrasonography, and breast magnetic resonance imaging (MRI) for early and late recurrences in patients who underwent breast-conservation therapy (BCT) for breast cancer.

METHOD AND MATERIALS

This retrospective study was approved by our institutional review board. Between January 2014 and February 2018, 1312 women with 1951 surveillance breast MR examinations after BCT were studied. We assessed the cancer detection rate of each surveillance MR, mammography and ultrasound.

RESULTS

Of 1951 cases of surveillance postoperative MRI, 59 cases were confirmed as cancer recurrence through biopsy. Nineteen cases of recurrences within 12 months post-BCT were defined as early recurrences while other 40 cases of recurring after 13 months post-BCT were defined as late recurrences. There were no statistically significant differences in patients' demographics between two groups with $p > 0.05$; age at cancer diagnosis, age at recurrence, symptoms, laterality of recurred cancer and intense surveillance. Among 19 patients with early recurrence, 7 cases were detected on mammography (36.8%), 10 on ultrasound (52.6%), and 17 on MRI (89.5%). Of 40 patients with late recurrence, 24 were detected on mammography (60%), 29 on ultrasound (72.5%) and 39 on MRI (97.5%). In both groups, MRI showed significantly higher cancer detection rate than mammography or ultrasound ($p < 0.01$).

CONCLUSION

In breast cancer patients with BCT, regardless of early or late, postoperative MR surveillance showed a significantly higher detection rate for cancer recurrence than mammography or ultrasound.

CLINICAL RELEVANCE/APPLICATION

Postoperative surveillance MR is useful tool for screening early or late cancer recurrence in breast cancer patients with breast conserving therapy.

SST01-08 The Role of Digital Breast Tomosynthesis (DBT) versrus Automated Breast Ultrasound (ABUS) in the Detection and Characterization of the Different Breast Lesions

Friday, Nov. 30 11:40AM - 11:50AM Room: E353B

Participants
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PURPOSE

DBT and ABUS are advanced applications of digital mammography and breast ultrasound respectively. We aimed to evaluate the role of DBT versus ABUS in the detection and characterization of breast lesions

METHOD AND MATERIALS

Institutional review board approval was obtained for this prospective study that included 80 patients with 87 breast lesions. Methods of evaluation were digital breast tomosynthesis and automated breast ultrasound. For mammogram acquisition the system acquires a traditional digital mammogram and a tomosynthesis scanning in the same compression in the MLO and CC views. 3D ABUS were done for anteroposterior; lateral and medial acquisitions. Included breast lesions were analyzed regarding size, shape, margin, extension, calcifications and multiplicity. Operative data was the gold standard reference

RESULTS

ABUS showed more accurate measurements of the size of the breast lesions as DBT overestimated 18.8% of masses, on the other hand ABUS over estimated 25% of masses. No size under estimation by both modalities. ABUS was superior to DBT in estimation of the shape of the lesions 87% versus 69.6% for DBT, but both displayed similar values in the evaluation of the margins (65.2%).Tomosynthesis was far better in the detection of calcification in 40 lesions; while automated ultrasound was able to detect calcifications in only 11 lesions of them. Multiplicity was better demonstrated by ABUS that showed an accuracy of 100% compared to 80% by DBT. We found out that the sensitivity of tomosynthesis in detection and characterization of breast masses was 100 %, the specificity was 81.25%, the positive predictive value was 87.5% and the negative predictive value was 100%. On the other hand the sensitivity of automated ultrasound was 100%, the specificity was 75%, the positive predictive value was 84% and the negative predictive value was 100%.

CONCLUSION

DBT and ABUS, both showed near estimation in the detection and characterization of breast lesions. DBT is the modality for calcifications and ABUS is more accurate in the detection of multiplicity.

CLINICAL RELEVANCE/APPLICATION

DBT is considered as an adjunct to digital mammogram to increase the conspicuity of the different breast lesions. ABUS is a revolution in the ultrasound scanning of the breast that can be used as a non-invasive, fast and easy tool of breast imaging in early detection (i.e. screening) and differentiation of breast lesions.

SST01-09 First Description of Molecular Imaging Heterogeneity Profiles for Breast Tumors and Its Clinical Utility

Friday, Nov. 30 11:50AM - 12:00PM Room: E353B

Participants
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PURPOSE

The concept of tumor heterogeneity, also called in Radiology as Tumor Texture, is based on the different areas of tumor uptake, which correspond to different levels of expression, cellularity, hypoxia or other parameters interested in being measured. We want to know if the description of the tumor heterogeneity uses in Radiology has its relation with PET parameters and if any biological characteristics of the breast tumors have a structure-function correlation.

METHOD AND MATERIALS

We have analyzed 1000 consecutive patients with breast cancer in a dedicated breast PET (dbPET). Different parameters have been defined that allow us to find a pattern of Texture and Heterogeneity (TeHe), for this, and following the rules of the radiological descriptions we defined a series of structural templates that cover practically all tumors, a mathematical formula has been defined for this correlation, and a assisted software for tumor shape description has been used to perform 3D categories.

RESULTS

7 different patterns divided into 5 groups for TeHe are described, and classified as: 1: Homogeneous-diffuse, 2: Lobular, 3: Annular and Spindle, 4: Eccentric and Focused; and 5: Speckled. A numerical value has been assigned between 1 and 5 for this classification with 1 being the most homogeneous and 5 being the most heterogeneous. This value is achieved through a mathematical relationship: medSUV/maxSUV: values close to 1 denote a high homogeneity and those close to 0 indicate a high heterogeneity. Process is complicated when tumor geometry becomes part of this heterogeneity. In those cases, some geometric patterns may explain similar values. We have analyzed the clinical utility of this classification and we have found two major uses: i) in the description of the efficiency of neoadjuvant therapy, where changes in TeHe pattern define responders of non-responders and ii) we have found, for the FIRST TIME, a correlation between TeHe patterns and the molecular subtype, crucial fact in the future of imaging based breast cancer diagnosis.

CONCLUSION

Studies of tumor heterogeneity based on metabolism show us different patterns that correlate with molecular subtypes and predict response to treatments.

CLINICAL RELEVANCE/APPLICATION

Tumor Texture and Heterogeneity are becoming, like in conventional radiology, in a new tool for prediction of response to the treatment and in molecular subtype characterization.

SST02

Chest (Thoracic Malignancy)

Friday, Nov. 30 10:30AM - 12:00PM Room: E350

CH CT MR NM

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

FDA Discussions may include off-label uses.

Participants
Girish S. Shroff, MD, Houston, TX (*Moderator*) Nothing to Disclose
Andrew J. Plodkowski, MD, Brookside, NJ (*Moderator*) Nothing to Disclose

Sub-Events

SST02-01 Radiologist Variability in the Determination of the T-Size Descriptor Cutpoints in the Eighth Edition of the TNM Classification of Lung Cancer (TNM8)

Friday, Nov. 30 10:30AM - 10:40AM Room: E350

Participants
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PURPOSE

Based on pathological size TNM8 introduced additional T-descriptor size cutpoints at 1cm intervals impacting stage groups. Our aim was to determine whether radiological staging by different radiologists consistently classifies lesion size within this more detailed staging.

METHOD AND MATERIALS

4 thoracic radiologists (4-17yr experience) staged 180 consecutive new lung cancers, recording multiple parameters blinded to the study aim. Readers were provided with axial 2.5mm, 1mm, coronal and sagittal 3mm images and asked to stage the primary as per clinical practice. Readers recorded the solid component for subsolid lesions. 2 observers covertly recorded the image series used for review and measurement. Inter-rater consistency of primary lesion size and T-size determination was evaluated. The impact of reader recorded lesion characteristics on consistency was assessed.

RESULTS

Readers recorded lesions as solid in 78-87% of cases, part-solid in 11-17% and pure ground glass in 1-2% with a moderate mean inter-rater kappa (0.71). 176 lesions were considered measurable by at least 3 readers (median 38mm, 7-113mm), 95% evaluated by all 4 readers. Readers varied widely in measurement plane (2.5mm:20-90%, 1mm:2-54%, coronal:7-24%, sagittal:0-26%) and mean number of planes reviewed (1.1-3.0). For lesions the mean range of measurement about the consensus median size was 31% (3-175%). Increased reader range of measurement about the median size was associated with part solid (mean 43% v 29% solid, $p<0.01$ Mann Whitney U) and cavitary lesions (32 v 19%, $p<0.05$). Atelectasis and spiculation were not significant. Using median size to determine T-descriptors, only 42% of cases had 100% reader concordance (74% concordance for at least 67% of readers). Complete concordance was significantly lower for groups T1c-T3 (20-35%) and higher in the remaining groups (42-67%). Mean inter-rater T assignment kappa was 0.57 (moderate), but higher with weighted kappa (0.80, good).

CONCLUSION

There is considerable variation in tumor size determination by thoracic radiologists, influenced by lesion perceived morphology, and measurement choices that result in lower inter-reader concordance for the narrower range TNM8 T-size criteria.

CLINICAL RELEVANCE/APPLICATION

Pathological size data informed increased numbers of cutpoints in TNM8 to better predict survival but increases radiological stage uncertainty and inter-reader variance in clinical practice.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Ioannis Vlahos, MRCP,FRCR - 2015 Honored Educator

SST02-02 A Novel Algorithm to Approach Multiple Lung Cancers with Multiple Pulmonary Sites of Involvement: Differentiation between Multiple Primary Lung Cancers and Intrapulmonary Metastasis

Friday, Nov. 30 10:40AM - 10:50AM Room: E350

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PURPOSE

To develop an differentiation algorithm in patents with multiple lung cancers, using clinical and imaging variables.

METHOD AND MATERIALS

We retrospectively included 112 lesions in 55 patients (57 pairs) with multiple lung cancers who received at least two separate surgeries between January 2007 and December 2016. Each pair of multiple lung cancers was classified into two categories with histopathologic findings as the standard reference: multiple primary lung cancer (MPLC) and intrapulmonary metastasis (IPM). We established five serial questions for differentiation; 'Is either nodule pure ground-glass nodule on CT?' or 'Are both of the two lesions ground-glass dominant nodules?' (Step1), 'Does either nodule harbor air-bronchogram or irregular shape?' (Step2), 'Do both of the two nodules have the same or different grade of maximal standardized uptake values (SUVmax) on PET/CT?' (Step3), and 'Does either case harbor mediastinal LN or distant metastasis on preoperative work-up?' (Step4). The SUVmax values were classified into grade 1(<2.5), grade 2(2.5-5.0), and grade 3(>5.0). At each decision step, each pair was classified as MPLC or IPM. The sensitivity, specificity, and accuracy of the differentiation algorithm were analyzed.

RESULTS

Among 57 pairs, 36 pairs (63.2%) were classified as MPLCs, and the other 21 pairs (26.8%) as IPMs of standard reference. In step1, 14 pairs were classified as MPLC. In step2, 10 pairs with absence of air-bronchogram or irregular contour on both lesions were classified as IPM. In step3, 8 pairs showing two grades of separate SUV were classified as MPLC. In step4, 3 pairs with mediastinal LN or distant organ metastasis were classified as IPMs and 22 pairs were considered MPLC. The sensitivity for MPLC (specificity for IPM), specificity for MPLC (sensitivity for IPM), and accuracy were 94.4%, 52.4%, and 78.9%, respectively. Accuracy for each step was 100% for step 1, 90% for step 2, 62.5% for step 3 and 68% for step 4, respectively.

CONCLUSION

Approach algorithm using comprehensive information of clinical and imaging variables can allow differentiation between MPLCs and IPMs in a substantial number of cases of multiple lung cancers with multiple pulmonary sites of involvement.

CLINICAL RELEVANCE/APPLICATION

Our approach algorithm using clinical and imaging information can help differentiation between MPLCs and IPMs in multiple lung cancers.

SST02-03 Risk of Occult Mediastinal Disease in Non-Small Cell Lung Cancer Patients with Radiographic N0 Disease according to Tumor Location

Friday, Nov. 30 10:50AM - 11:00AM Room: E350

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PURPOSE

Lung cancer guidelines recommend invasive mediastinal staging for patients with centrally located tumors without evidence of nodal disease on imaging studies. However, there is no uniform definition of central tumor. This study aims to evaluate the risk of occult mediastinal disease in non-small cell lung cancer (NSCLC) patients with radiographic N0 disease according using several different definitions for central tumor.

METHOD AND MATERIALS

Of the patients who underwent curative-intent surgical resection or endobronchial ultrasound-guided transbronchial needle

aspiration between January 2014 and December 2015, 1,337 consecutive patients with radiographic N0 disease were identified. Based on the most proximal part of the tumor in computed tomography (CT) image, tumors were categorized using five different definitions; contact with hilar structure, located within inner one-third or two-thirds of hemithorax according to concentric or sagittal lines.

RESULTS

About 7% (93/1337) of patients had occult N2 disease and they had significantly larger tumor size and more solid tumors in CT image. All but inner two-thirds of hemithorax by sagittal line were associated with N2 disease. However, only inner one-third of hemithorax by concentric line remained significant after adjustment for tumor size and density in CT (adjusted odds ratio [95% confidence interval], 2.29 [1.28-4.11]).

CONCLUSION

We suggest using inner one-third of hemithorax by concentric line as indication of EBUS-TBNA in NSCLC with radiographic N0 disease.

CLINICAL RELEVANCE/APPLICATION

Using inner one-third of hemithorax by concentric line as indication of EBUS-TBNA in NSCLC with radiographic N0 disease.

SST02-04 Comparison of Computed Tomography and Clinical Findings Between Immune-Related Pneumonitis and Pneumonia by Pathogen in Patients Treated with Anti-Programmed Death-1 (PD-1)/Programmed Death Ligand 1 (PD-L1) Therapy

Friday, Nov. 30 11:00AM - 11:10AM Room: E350

Participants
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PURPOSE

Immune-related pneumonitis (IRP) is an uncommon but potentially fatal toxicity of anti-programmed death-1 (PD-1)/programmed death ligand 1 (PD-L1) therapy for intrathoracic malignancy including non-small cell lung cancer. The purpose of study was to compare CT and clinical findings between IRP and pneumonia by pathogen.

METHOD AND MATERIALS

A total of 154 patients who received anti-PD-1/PD-L1 therapy were identified from 2014 to 2017. Among these patients, IRP developed in 9 (5.8%) and pneumonia in 30 (19.5%), which were confirmed through multidisciplinary approach. CT findings (reticulation, consolidation, ground glass opacity [GGO], interlobular septal thickening, micro- [<10mm] and macro-nodules [>=10mm], bronchial wall thickening, bronchiectasis, pleural effusion, and lesion distribution/bilaterality) and clinical features (symptom, smoking history, cancer staging, laboratory findings, underlying disease, prior radiotherapy history) were compared between IRP and pneumonia. Grade and outcome of IRP were also investigated.

RESULTS

In chest CT, diffuse reticulation (44.4% vs.0%, P=0.02), patchy/diffuse GGO (100% vs. 50%, P=0.01), and interlobular septal thickening (66.7% vs. 10%, P=0.002) were significantly more frequent in IRP than in pneumonia, whereas macronodule (0 vs. 36.7%, P=0.033) was significantly more common in pneumonia than IRP. IRP significantly showed peripheral location (77.8% vs. 16.7%, P=0.001) and bilateral distribution (44.4% vs. 3.3%, P=0.007). However, there were no significant differences in clinical findings between IRP and pneumonia. Among the IRP patients, 66.7% (6 of 9) of cases were grade 3, and 66.7% improved with drug holding/steroid therapy. The median onset duration of IRP from the first prescription was 126 days (range, 40-669), the median time for improvement was 43 days (range, 21-45), and the median time to death due to IRP was 18 days (range, 11-55).

CONCLUSION

Several CT findings including diffuse reticulation, patchy/diffuse GGO, and interlobular septal thickening with bilateral and peripheral distribution were more frequent in IRP than pneumonia by pathogen. Clinical findings were overlapped.

CLINICAL RELEVANCE/APPLICATION

It is crucial to suspect IRP as opposed to pneumonia in routine practice. Radiologists should be familiar with those findings of IRP to avoid delayed diagnosis and serious drug related complication.

SST02-06 Growth Rates of Thymic Epithelial Tumor and Thymic Cyst: Is Differentiation Feasible?

Friday, Nov. 30 11:20AM - 11:30AM Room: E350

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PURPOSE

To investigate the growth rate of thymic epithelial tumors (TETs) and thymic cysts to determine whether they can be differentiated, and to identify clinico-radiological predictors of interval growth and their differential implications.

METHOD AND MATERIALS

This retrospective study included 122 patients (male:female=64:58; mean age, 57.2 years) with pathologically proven thymic cysts (n=56) or TETs (n=66) who underwent 2 serial chest CT scans at least 8 weeks apart. Average diameters were measured, and volume-doubling times (VDTs) were calculated. Attenuation was also measured and clinical characteristics were recorded. VDTs were compared between the thymic cysts and TETs using the log-rank test. Predictors of growth were analyzed using the log-rank test and Cox regression analysis.

RESULTS

The frequency of growth did not significantly differ between TETs and thymic cysts (P=0.279). The VDT of the thymic cysts (median, 324 days) was not significantly different from that of the TETs (median, 475 days; P=0.808). Water attenuation (<=20 Hounsfield Unit) predicted growth in thymic cysts (P=0.016; HR, 13.2 [95% CI, 1.6-107.3]) and lesion size (>17.2 mm) predicted growth in TETs (P=0.008 for size and P=0.029 for size*time; HR=e^(-0.001×time+1.654)). Among the growing lesions, positive and negative predictive values of water attenuation for the thymic cysts was 93% and 80%, respectively.

CONCLUSION

The frequencies of interval growth and VDTs were indistinguishable between TETs and thymic cysts. Water attenuation and lesion size predicted growth in thymic cysts and TETs, respectively. Among the growing lesions, the water attenuation was a differential feature of thymic cysts.

CLINICAL RELEVANCE/APPLICATION

Water attenuation (<=20 HU) indicates thymic cysts for the growing thymic lesions. Thus, CT follow-up, instead of surgical resection, can be recommended for the obvious cysts even if they show interval growth.

SST02-07 Cut-Off Value of MR Enhancement for Differentiating Benign Cysts from Solid Anterior Mediastinal Lesion: A Preliminary Observation

Friday, Nov. 30 11:30AM - 11:40AM Room: E350

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PURPOSE

To determine the optimal cut-off value of MR enhancement for the differentiation of benign cysts from solid lesions in the anterior mediastinum.

METHOD AND MATERIALS

The derivation dataset consisted of 19 consecutive patients with pathologically proven benign cysts (n=7) and solid lesions (n=12) in the anterior mediastinum who underwent a diagnostic contrast-enhanced MR from two institutions. We measured maximum diameters, T1 and T2 signal intensities (SI), apparent diffusion coefficients (ADCs) from diffusion-weighted images, and relative enhancement ratios (RERs). T1 and T2 SIs were normalized by SI of cerebrospinal fluid. RERs were obtained from the subtraction of axial pre- and post-contrast T1-weighted fat-suppressed images after the precise non-rigid image registration of the two images using a dedicated WIP software (MRI Arithmetics, Siemens Healthcare, Erlangen, Germany). After comparison of image variables between cysts and solid masses, the cutoff value of the most differential MR variable was determined based on a receiver operating characteristic curve. For validation, two separate datasets were utilized: 1) 15 patients with 8 cysts and 7 solid lesions from another institution (validation dataset 1); 2) 11 patients with MR-proven stable benign cysts more than 2 years (validation dataset 2). Diagnostic accuracies were calculated from validation datasets.

RESULTS

Normalized T2 SI (0.21-0.92 vs. 0.12-0.58; *P*=.013), ADC (1.76-4.09 vs. 0.66-2.93 10-3 mm2/s; *P*=.013), and RER (0.41-24.1% vs. 28.1-771.7%; *P*<.001) significantly differed between cysts and solid masses. RER of 26% or less was determined as the cutoff value for differentiation of cysts from solid masses. In validation dataset 1, the cutoff value showed sensitivity of 87.5% and specificity of 100%, the sensitivity of 90.9% was observed in validation dataset 2.

CONCLUSION

The assessment of RER with the cutoff value of 26% can appropriately differentiate benign cysts from solid anterior mediastinal masses.

CLINICAL RELEVANCE/APPLICATION

The differentiation of benign cysts from solid anterior mediastinal masses can be supported by quantitative measurement of RER, potentially reducing a futile thymectomy.

SST02-08 Primary Tumor Standardized Uptake Value (SUVmax) as Powerful Prognostic Factor for Early

Esophageal Squamous Cell Carcinoma

Friday, Nov. 30 11:40AM - 11:50AM Room: E350

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PURPOSE

We have previously shown that initial PET-SUVmax(Standardized uptake value) of early esophageal cancer helps both discriminating T1a and T1b stage esophageal squamous cell carcinoma(eSCC) from other eSCCs. In this study, we analyze the impact of PET-SUVmax for patient's survival.

METHOD AND MATERIALS

This retrospective study was based on 435 patients with a surgically proven early T- (Tis or T1a [< T1a], T1b and T2) stage eSCC. We performed survival analysis by the Kaplan-Meier method and comparisons of survival using log-rank test.

RESULTS

131 < T1a, 234 T1b, and 70 T2 eSCCs were enrolled. Mean SUVmax value were 2.53 for < T1a eSCCs, 4.02 for T1b eSCCs and 9.69 for T2 eSCCs. With ROC curve analysis, cut off value of SUVmax 3.05 (AUC: 0.757; 95% CI, 0.710-0.803; P < .001) at PET provided sensitivity 74.8% (98/131), specificity 70.1% (213/304), respectively, for differentiating < T1a eSCCs from other cancers. Cut off value of SUVmax 5.65 (AUC: 0.897; 95% CI, 0.857-0.937; P < .001) provided sensitivity 77.1% (54/70), specificity 87.7% (320/365), respectively, for differentiating T1 (< T1b) eSCCs from T2 eSCCs. In multivariate analysis, both SUVmax and pathologic staging including tumor size and node involvement were significant predictors of survival (p < 0.01). Survival analysis and log-rank test showed significant difference for overall survival among groups based on proposed cut-off SUVmax values (p =0.008 for cut off value 3.05, p <0.001 for cut off value 5.65)

CONCLUSION

In early esophageal squamous cell carcinomas, SUVmax gives us powerful predictor of overall survival after resection.

CLINICAL RELEVANCE/APPLICATION

Pretreatment SUVmax of primary esophageal cancer shows powerful predictive values which can be comparable to pathologic T stage.

SST02-09 Surgically Resected T1- and T2-Stage Esophageal Squamous Cell Carcinoma: T and N Staging Performance of EUS- and PET/CT

Friday, Nov. 30 11:50AM - 12:00PM Room: E350

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PURPOSE

To demonstrate the frequency of nodal metastases and to disclose the diagnostic performance of endoscopic ultrasonography (EUS) and PET/CT in T and N staging in surgically resected early-stage esophageal squamous cell carcinomas (eSCCs).

METHOD AND MATERIALS

IRB approved this retrospective study with waiver of informed consent for reviewing medical record. We included 435 patients with an early T-stage (Tis or T1a [< T1a], T1b and T2) eSCC. The rates of metastatic lymphadenopathy were calculated. Then, the performance of EUS and PET/CT in subdividing T and N stages was assessed.

RESULTS

131 < T1a, 234 T1b, and 70 T2 eSCCs were identified. In discriminating < T1a from other cancers, the sensitivity, specificity and accuracy of EUS were 60.3% (79/131), 80.3% (244/304), and 74.3% (323/435), respectively. With ROC curve analysis, cutoff value of SUVmax 3.05 at PET provided sensitivity 73.3% (96/131), specificity 70.4% (214/304), and accuracy 71.3% (310/435) for differentiating < T1a eSCCs from others. Ten (7.6%) of 131 < T1a cancers had nodal metastasis. In discriminating N0 from node-positive disease, sensitivity, specificity and accuracy of EUS were 89.6% (267/298), 41.6% (57/137) and 74.5% (324/435), respectively, whereas those of PET/CT were 88.9% (265/298), 38.7% (53/137), and 73.1% (318/435), respectively.

CONCLUSION

In > 70% of patients with < T1a eSCCs, the tumor stage can be discriminated from higher stage cancers by using EUS or PET/CT, and substantial percentage (7.6%) of < T1a eSCC patients have nodal metastases, but the nodes are missed in more than half of the patients in clinical staging.

CLINICAL RELEVANCE/APPLICATION

Substantial percentage (7.6%) of < T1a eSCC patients have nodal metastases, and nodal metastasis rates increase as T stage increases (T1b [37.6%] and T2 [55.7%]). Moreover, more than half of nodal metastases were missed on PET/CT or EUS. Thus, after endoscopic surgery or even after curative surgical resection of < T1a eSCCs, adjuvant therapy is needed for those having nodal metastasis.

SST03

Gastrointestinal (Advanced MRI Techniques)

Friday, Nov. 30 10:30AM - 12:00PM Room: E352

GI MR

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

FDA Discussions may include off-label uses.

Participants
Hersh Chandarana, MD, New York, NY (*Moderator*) Equipment support, Siemens AG; Software support, Siemens AG; Advisory Board, Siemens AG; Speaker, Bayer AG;
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Frank H. Miller, MD, Chicago, IL (*Moderator*) Research Grant, Siemens AG

Sub-Events

SST03-01 Efficacy of Gadoxetic Acid-Enhanced MRI for Evaluating Biliary Anatomy in Living Donor Liver Transplantation

Friday, Nov. 30 10:30AM - 10:40AM Room: E352

Participants
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PURPOSE

To determine the added value of combined T2-magnetic resonance cholangiography (MRC) and hepatobiliary phase-MRC (T2+HBP-MRC) for evaluating the biliary anatomy in living liver donors by comparing it with T2-MRC alone, and evaluate the clinical usefulness of T2+HBP-MRC for surgical planning

METHOD AND MATERIALS

Our institutional review board approved this study and waived the requirement for informed consent. Between January and December 2016, we included 276 donors who underwent T2 and gadoxetic acid-enhanced MRI before right hemihepatectomy for living donor liver transplantation. Two reviewers evaluated the biliary anatomy classification using T2-MRC in the first session and T2+HBP-MRC in the second session. The sensitivity, specificity and confidence level (5-point scale) of T2-MRC and T2+HBP-MRC for variant biliary anatomy were evaluated using McNemar's test or paired t-test. The agreement rates of each biliary anatomy classification between MRC and operative cholangiography and the underestimated rates of multiple BDO for each MRC were evaluated using McNemar's test.

RESULTS

Of the 276 donors, variant biliary anatomy was observed in 36.2% (100/276). T2+HBP-MRC showed a significantly higher sensitivity for diagnosing variant biliary anatomy than T2-MRC alone (99.0% [99/100] vs. 89.0% [87/100], p = 0.006) with better confidence level (4.9±0.3 vs. 4.6±0.7, p<0.001), and inter-observer agreement (kappa, 0.902 vs. 0.730). A significantly higher agreement of biliary anatomy classification with operative cholangiography (98.6% [272/276] vs. 89.9% [248/276], p<0.001) and a significantly decreased the underestimation rate of multiple BDO (5.8% [16/276] vs. 9.4% [26/276], p=0.002) were obtained by T2+HBP-MRC than T2-MRC alone.

CONCLUSION

T2+HBP-MRC can be more useful than T2-MRC alone by improving diagnostic performance of variant biliary anatomy and giving information to make accurate surgical plans.

CLINICAL RELEVANCE/APPLICATION

T2+HBP-MRC can be clinically more useful than T2-MRC alone for evaluating biliary anatomy in living donor liver transplantation.

SST03-02 In Vivo Imaging of Hepatocellular Carcinoma Using Hyperpolarized Water

Friday, Nov. 30 10:40AM - 10:50AM Room: E352

Participants
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PURPOSE

Besides the risk of allergic reactions and a nephrogenic systemic fibrosis, research showed remnants of Gadolinium based MR contrast agents (GBCA) in the brain - with unknown long-term effects. Purpose is to examine dynamic nuclear polarization (DNP) of water as a method to generate MR contrast and to prove it can be used for imaging of hepatocellular cancer (HCC) in vivo.

METHOD AND MATERIALS

Liquid-state Overhauser DNP hyperpolarizes water molecules by temporarily coupling their nuclear spin to the electron spin of irradiated radicals under resonance conditions. Microwave irradiation takes place in a resonator chamber containing immobilized TEMPO radicals, passed by a NaCl solution at a flow rate of 800µl/min within the bore of a 1.5T scanner. After catheterization of iliac vessels hyperpolarized water was administered directly at the celiac trunk of transgenic TGFa/c-myc mice that develop HCC. The aorta, its hepatic branches and the liver were visualized at 2 fps with dynamic GRE sequences (TR 6.4ms, TE 2.8ms, FoV 58x78x5mm, Matrix 128x77px) for 10 sec. Temporal DNP signal intensities, SNR and CNR values were measured in the aorta, hepatic artery, HCC and liver parenchyma. Anatomic sections und IHC staining confirmed the lesions as HCCs.

RESULTS

Magnitude imaging featured mainly a negative signal due to short relaxation time and fast signal decay during repetitive GRE pulses. In phase imaging signal intensities increased by factor 2.1 in the aorta, 1.6 in the hepatic artery and 1.2 in HCC and liver parenchyma. These changes were subsequently visible at the following periods after application: sec. 1-4 in the aorta, sec. 3-7 in the hepatic artery, sec. 4-8 in HCC and only slowly in the liver parenchyma, illustrating the HCC's typical early arterial enhancement. SNR increased up to 1.7 times and CNR up to 10.8 times. After stopping microwave power no contrast resides.

CONCLUSION

The in-bore DNP setup continuously creates hyperpolarized water, featuring high T1 signal enhancements in MR imaging and a short relaxation time. The strong contrast enhancement made a dynamic visualization of the supplying vessels and the typical contrast dynamics of HCCs possible - even using a standard clinical 1.5T scanner.

CLINICAL RELEVANCE/APPLICATION

Hyperpolarized water might be a promising future alternative to GBCA in MR angiographies and liver imaging without risking the potential adverse effects or intracorporal remnants.

SST03-03 Modified Breath-Hold Compressed-Sensing 3D Magnetic Resonance Cholangiopancreatograph: Clinical Feasibility in Biliary and Pancreatic Disorders

Friday, Nov. 30 10:50AM - 11:00AM Room: E352

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PURPOSE

To prospectively evaluate the clinical feasibility of a modified 3D breath-hold (BH) compressed-sensing (CS) MRCP prototype protocol with small field-of-view (FOV) and high spatial resolution (modified BH-CS-MRCP), and to compare its performance with respect to the original BH-CS-MRCP and navigator-triggered (NT)-CS-MRCP.

METHOD AND MATERIALS

In this prospective IRB approved study, a total of 82 patients (46 male, median age, 55 years, range, 16-79 years) underwent 3D CS-MRCP on a 3T MR scanner. Three protocols (modified BH-CS-MRCP, original BH-CS-MRCP and NT-CS-MRCP) were performed in random order. Acquisition time of each protocol was recorded. Image quality, background suppression, duct visibility and diagnostic confidence with duct anatomic variations and duct-related pathologies were rated on a 5-point scale by two blinded radiologists independently. The diagnostic performance of each protocol was calculated using receiver operating characteristic curves.

RESULTS

Acquisition time was 17 seconds for both BH-CS-MRCP protocols, and 127.5±36.9 seconds for NT-CS-MRCP. In 75 cooperative patients, the incidence of major artifacts was low for all protocols (5.3%-8.0%). Background suppression was similar with the two BH-CS-MRCP protocols, both inferior to the NT-CS-MRCP protocol. Modified BH-CS-MRCP and NT-CS-MRCP depicted pancreatic duct and second-level branches of biliary duct better than original BH-CS-MRCP (all $p<0.01$). The diagnostic performance for detecting bile duct abnormalities was similar for all protocols(all $p>0.05$), whereas for detecting pancreatic duct abnormalities, modified BH-CS-MRCP and NT-CS-MRCP had significantly better performance(both $p<0.01$). In 7 non-cooperative patients, NT-CS-MRCP had superior image quality than both BH protocols (both $p<0.01$).

CONCLUSION

Modified BH-CS-MRCP is clinically feasible for pancreatic and biliary disorders. NT-CS-MRCP is useful in non-cooperative patients.

CLINICAL RELEVANCE/APPLICATION

The general image quality with CS-MRCP was reported to be similar or even superior compared to the conventional navigator-triggered (NT) protocol. However, according to previous reports, the visibility of the pancreatic duct with the original BH-CS-MRCPwas lower, and the diagnostic yield was lower. We found that the modified BH-CS-MRCP is feasible in clinical patients, with image quality and diagnostic performance equally good or better than NT-CS-MRCP.

SST03-04 Assessment of Liver Stiffness with Free-Breathing MR Elastography in Patients and Volunteers

Friday, Nov. 30 11:00AM - 11:10AM Room: E352

Participants
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PURPOSE

Liver MR elastography (MRE), as a quantitative imaging biomarker for hepatic fibrosis, is often performed during breath hold at end-expiration to avoid the changes due to respiratory motion. However, some patients have limited ability to perform adequate breath holds (e.g., pediatric and sedated patients). Our study purpose is to evaluate the technical feasibility and measurement variation of a rapid, free-breathing MRE technology for assessing liver stiffness (LS) with a comparison of standard breath-held MRE.

METHOD AND MATERIALS

We have recruited 32 patients with chronic liver diseases, and 8 controls. A standard breath-held multi-slice 2D GRE-MRE was performed to calculate the baseline liver stiffness (LSB). A view-sharing based reconstruction strategy for a free-breathing single-shot multi-slice 2D EPI-MRE was performed to calculate median liver stiffness (LSM) within anatomically co-registered ROIs, and its temporal variation ΔLS (defined in FigB). We performed Bland-Altman and intraclass correlation (ICC) analyses to analyze variance statistics and method accuracy, and Spearman correlation analyses to evaluate the relationships between LSB, LSM and ΔLS in non-cirrhotic (LSB<5kPa) and cirrhotic (LSB>=5kPa) livers respectively, with a 0.05 significance level.

RESULTS

FigA shows two example LSB and LSM images of a healthy liver and a cirrhotic liver, respectively. FigB shows an example of dynamic liver stiffness measurement in free-breathing MRE. Bland-Altman analysis shows mean difference of -0.18kPa between LSB and LSM with ICC of 0.96. FigC illustrates that LSM excellently agrees with LSB in all subjects (R^2=0.87, $p<0.0001^*$), highly accurate in 33 non-cirrhotic livers (LSM=1.03×LSB, $p<0.0001^*$), moderately underestimates LSB in 7 cirrhotic livers (LSM=0.79×LSB, $p<0.0001^*$). Measurement variation (FigC, shown as bubble size) increases with disease severity(R^2=0.40, $p<0.0001$).

CONCLUSION

Our preliminary results suggest that free-breathing MRE provides highly accurate liver stiffness value, especially for non-cirrhotic livers.

CLINICAL RELEVANCE/APPLICATION

The free-breathing MRE excellently agreeing to conventional breath-held liver stiffness will be beneficial for pediatric and sedated patients.

Honored Educators

Presenters or authors on this event have been recognized as RSNA Honored Educators for participating in multiple qualifying educational activities. Honored Educators are invested in furthering the profession of radiology by delivering high-quality educational content in their field of study. Learn how you can become an honored educator by visiting the website at: https://www.rsna.org/Honored-Educator-Award/ Richard L. Ehman, MD - 2016 Honored EducatorSudhakar K. Venkatesh, MD, FRCR - 2017 Honored Educator

SST03-05 Inter- and Intra-Reader Agreement of Different Parameters of Gadoxetic Acid Enhanced Hepatobiliary Phase Imaging in Patients with Chronic Liver Diseases: A Comparison Study

Friday, Nov. 30 11:10AM - 11:20AM Room: E352

Participants
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PURPOSE

To examine inter- and intra-observer reliability between different hepatobiliary phase (HBP) image scores on gadoxetic-acid (GA)-enhanced MRI and their correlation with clinical parameters and liver function in patients with diffuse chronic liver disease.

METHOD AND MATERIALS

This retrospective IRB-approved study included 353 patients (224 male, 129 female, mean age 53.4 ±13.8 years) with chronic liver disease who had undergone GA-enhanced MRI of the liver between 2010-2015. Relative liver enhancement (RLE), contrast uptake index (CUI), hepatic uptake index (HUI), and liver to spleen contrast ratio (LSC) were calculated by two radiologist independently using unenhanced and GA-enhanced HPB images (obtained 20 minutes after GA administration); 50 image sets were reviewed twice to assess intra-observer reliability. Albumin-bilirubin (ALBI) grade, Child-Pugh score and Model of End Stage Liver Disease (MELD) were calculated as markers of disease severity. Associations between HPB and disease severity markers were assessed (Spearman ´s correlation). Reader reliability was evaluated using intraclass correlation coefficient (ICC).

RESULTS

There was a significant correlation ($p<0.001$ for all) between five pairs of MR-derived parameters: RLE-CEI (R=0.947,), RLE-LSC (R=0.813,) RLE-HUI (R=0.767), CEI-LSC (R=0.818) and HUI-LSI (R=0.943). Depending on the MR parameter, MR-disease severity correlation coefficients ranged from 0.482-0.525 for ALBI-score, 0.371-0.430 for MELD, and 0.490-0.333 for Child-Pugh. Intra-observer ICCs ranged from 0.979 (0.963-0.989) for RLE to 0.816 (0.670-0.898) for LSI indicating excellent agreement. Inter-observer ICCs ranged from 0.979 (0.962.0.988) for RLE to 0.792 (0.629-833) for HUI.

CONCLUSION

Strong correlations were observed between different MR-derived HBP-based parameters with each other and between these parameters and disease severity markers. MR-derived parameters showed excellent inter- and intra-observer agreement.

CLINICAL RELEVANCE/APPLICATION

Qualitative MR-derived HBP imaging parameters have high observer releiability and show promise for evaluation of chronic liver disease severity.

SST03-06 Abbreviated Gadoxetic Acid-Enhanced MRI (AGAM) Including Second Shot Arterial Phase (SSAP) for Liver Metastasis Workup

Friday, Nov. 30 11:20AM - 11:30AM Room: E352

Participants
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PURPOSE

To evaluate feasibility of AGAM protocol including SSAP for liver metastasis workup

METHOD AND MATERIALS

This retrospective study was approved by our IRB and the requirement for informed consent was waived. 108 patients with hepatic metastasis who underwent gadoxetic acid-enhanced MRI using a modified injection protocol were included. Modified injection protocol included routine dynamic imaging after a first injection of 6-mL and SSAP after a second injection of 4-mL. Primary cancer sites consisted of colorectum (n=59), stomach (n=16), biliary trees (n=16), pancreas (n=7), and others (n=7).The image set 1 consisted of T2WI, chemical shift image, DWI, and T1-weighted dynamic image including hepatobiliary phase (HBP) [full original protocol]. The image set 2 consisted of T2WI, DWI, HBP, and SSAP [abbreviated protocol]. Acquisition time was measured in each image set. Visual assessment of vascularity was performed in the original arterial phase (AP), SSAP, and their subtraction images. After excluding patients with >=10 metastatic lesions, 149 lesions in 51 patients were included for detection and characterization analysis. The reference standard was a combination of pathologic result and follow-up image. Two radiologists independently reviewed two image sets regarding the presence and probability of liver metastasis with >6-week time interval. The diagnostic performance of each image set for each reader was compared by using a jackknife alternative free-response receiver operating characteristic (JAFROC) analysis. The sensitivity and positive predictive value (PPV) were also calculated.

RESULTS

Acquisition time was significantly shorter in img set 2 than in img set 1 (1118.3±128.3 vs. 372.8±30.5 sec, $p<0.0001$). Regarding the visual assessment of vascularity, 98.8% (85/86) hypervascular metastases (hyperintense on the original AP) showed hyperintensity on the SSAP and/or SS subtraction images. For both readers, average JAFROC figure-of-merit was not significantly different between img set 1 and 2 (0.998 vs. 0.997, $p=0.210$), and sensitivity and PPV did not show significant difference.

CONCLUSION

AGAM protocol including SSAP can provide faster image acquisition with preserving visual vascularity and diagnostic performance for liver metastasis workup.

CLINICAL RELEVANCE/APPLICATION

For liver metastasis workup, AGAM protocol can serve as a faster and more convenient alternative without compromising the diagnostic performance.

SST03-07 Magnetization Transfer Imaging Adds Information to Conventional MRIs to Differentiate Inflammatory and Fibrotic Intestinal Strictures in Crohn's Disease

Friday, Nov. 30 11:30AM - 11:40AM Room: E352

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PURPOSE

Identifying inflammation- or fibrosis-predominant strictures in patients with Crohn's disease (CD) is crucial for developing treatment strategies. We evaluated the value of magnetization transfer (MT) with conventional MRI in characterizing CD stricture types using surgical histopathology as a reference standard.

METHOD AND MATERIALS

Forty patients with CD who underwent MRI scanning before surgery were enrolled. MRI parameters included: T2WI hyperintensity, bowel wall thickness, enhancement pattern changes over time, enhancement pattern and gain ratio in dynamic contrast-enhanced image phases, and MT ratios. Group and logistic regression analyses were performed to identify MRI variables for predicting inflammation and fibrosis, respectively.

RESULTS

Significant correlations with histological inflammation scores were shown for wall thickness ($r=0.361$, $P=0.001$) and T2WI hyperintensity ($r=0.396$, $P<0.001$), whereas histological fibrosis scores were significantly correlated with MT ratio ($r=0.681$, $P<0.001$) and wall thickness ($r=0.461$, $P<0.001$). Using T2WI hyperintensity as a predictor, conventional MRI could differentiate mild and moderate-to-severe inflammation with a sensitivity of 0.871 and a specificity of 0.800. The MT ratio could discriminate mild and moderate-to-severe fibrosis with a sensitivity and a specificity of 0.913 and 0.923, respectively. Combining MT ratios and T2WI hyperintensity, the MRI classification moderately agreed with the pathological stricture classification ($P<0.01$, $K=0.567$). The diagnostic accuracy of T2WI hyperintensity and MT ratio were 84% and 87%, with a moderate agreement between the MRI and the pathological classification ($P<0.01$, $K=0.576$).

CONCLUSION

The MT ratio in addition to conventional MRI improves the differentiation of fibrotic from inflammatory components of a small bowel stricture in patients with CD.

CLINICAL RELEVANCE/APPLICATION

Measuring the degree of bowel inflammation and fibrosis help optimize management strategies.

SST03-08 Transient Severe Motion in Gadoxetate Disodium Enhanced Liver MRI: A Multi-Center and Multi-Reader Trial in 1789 Patients

Friday, Nov. 30 11:40AM - 11:50AM Room: E352

Participants
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PURPOSE

To determine the frequency of transient severe motion occurring in dynamic gadoxetate disodium enhanced liver MRI in a large multi-center setting.

METHOD AND MATERIALS

Institutional review board approval with a waiver for informed consent was obtained from all participating institutions from two different countries for this retrospective study. 1789 gadoxetate disodium enhanced liver MR examinations (1069 male and 720 female patients) acquired after intravenous administration of 5-20 ml gadoxetate disodium were included. 7156 dynamic data sets (pre-contrast, arterial phase, portal venous phase, late venous phase; each acquired during a single breath-hold) were reviewed by 10 radiologists with a minimum of 5 years after board certification. To determine interrater agreement and reliability all radiologists were obliged to review 40 selected additional data sets as a pre-requisite. Image evaluation was performed on a 5-point scale (1, no respiratory motion artifacts; 5, extensive respiratory motion artifacts, non-diagnostic study). Transient severe motion (TSM) was defined as a pre-contrast score of <=2, arterial score of >=4 and a portal and late venous score of <=3. Statistical tests included intraclass correlation coefficient (ICC), Kendall coefficient of concordance (W), normality test, and paired t-test.

RESULTS

ICC for interrater agreement and reliability were 0.983 (CI 0.973 - 0.990) and 0.985 (CI 0.978 - 0.991), respectively (both p<0.001), indicating excellent agreement and reliability. 874 (48.6%), 453 (25.2%), 346 (19.2%), 91 (5.1%), and 25 (1.4%) of all arterial phases were rated with a score of 1-5, respectively. Transient severe motion was detected in 51 of 1789 (2.9%) examinations. Mean motion scores for the pre-contrast scan, arterial phase, portal venous phase, late venous phase were 1.37±0.68, 1.85±0.99, 1.51±0.80, 1.38±0.66, respectively. Arterial phase motion scores were rated significantly worse than all other phases (p<0.001, respectively).

CONCLUSION

Although arterial phase imaging is significantly more often affected by motion artifacts than all other phases, the frequency of transient severe motion in gadoxetate enhanced dynamic liver MRI is only 2.9%.

CLINICAL RELEVANCE/APPLICATION

With only 2.9% the rate of transient severe motion in gadoxetate enhanced liver MRI is substantially lower than reported in previous single and dual center studies.

SST03-09 Role of Quantitative Parameters from Dynamic Contrast-Enhanced MRI in Evaluating Regional Lymph Nodes with Short-Axis Diameter Less Than 5 Millimeters in Rectal Cancer

Friday, Nov. 30 11:50AM - 12:00PM Room: E352

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PURPOSE

It is still a challenge for radiologists to evaluate lymph nodes (LNs) metastatic status in rectal cancer with morphology when LNs are too small. However, there are about 50% metastatic LNs in rectal cancer which are less than 5 millimeters in size. The aim of this study was to investigate whether it was feasible to differentiate metastatic from non-metastatic LNs with short-axis diameter less than 5mm in rectal cancer using quantitative parameters derived from dynamic contrast-enhanced (DCE)-MRI.

METHOD AND MATERIALS

Sixty-five LNs with short-axis diameter less than 5mm from 122 patients were evaluated, including malignant LNs (n=27) and benign LNs (n=38). DCE-MR examinations were performed on a 3.0 Tesla MRI system (Magnetom Verio, Siemens, Germany). The following parameters were assessed: volume transfer constant (Ktrans), rate constant (kep), fractional extravascular extracellular space (EES) volume (ve), short-axis diameter (S), long-axis diameter (L) and short-to-long-axis diameter ratio (S/L). Receiver operating characteristic (ROC) curves were applied for analyzing significant parameters.

RESULTS

The metastatic LNs exhibited lower Ktrans than the non-metastatic LNs (P<0.001), but other parameters had no statistical differences in two groups. The AUC of Ktrans was 0.732 with the 95% CI being 0.610-0.854, and the diagnostic cutoff value was 0.088 min-1 (sensitivity, 60.5%; specificity, 81.5%).

CONCLUSION

Ktrans had moderate diagnostic performance in assessing small regional LNs in rectal cancer, making it a supplementary predictor when it is hard to distinguish malignant LNs from benign ones only by morphology.

CLINICAL RELEVANCE/APPLICATION

LN status plays a pivotal role in the treatment strategy of rectal cancer and has an influence on the prognosis of the colorectal cancer patients. Therefore, accurate LN evaluation is a necessary before treatment.

SST04

Genitourinary (Imaging of Pregnancy)

Friday, Nov. 30 10:30AM - 12:00PM Room: E260

GU MR OB 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

SST04-01 Placenta Accreta Spectrum: Diagnosing Myometrial Invasion with Presence of Placental Bulge Sign

Friday, Nov. 30 10:30AM - 10:40AM Room: E260

Participants
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PURPOSE

To evaluate the correlation of "placental bulge sign" with the depth of invasion in patients with placenta accreta spectrum. Placental bulge sign is defined as deviation of uterine serosa from expected plane caused by abnormal outward bulge of placental tissue. Uterine serosa may appear intact but outline shape is distorted.

METHOD AND MATERIALS

In this HIPAA- compliant, IRB-approved, retrospective study, patients undergoing MR Imaging for evaluation of placenta accreta spectrum between March 2015 to 2018 were included. Patients who delivered elsewhere were excluded. Evaluation for placental bulge was performed by 2 independent readers and its presence or absence was recorded. Surgical pathology from cesarean hysterectomy or pathology of the delivered placenta was used as a reference standard. Statistical significance was calculated using Chi square test and inter-reader agreement was evaluated with kappa analysis.

RESULTS

61 patients underwent MRI for invasive placenta over 3 years. 2 patients delivered elsewhere and were excluded. 17 cases were normal placenta. At surgical pathology from cesarean hysterectomy, there were 8 cases of placenta accreta, 29 increta & 4 percreta. Placental bulge was present in 32 of 33 increta & percreta cases (True positive= 96.9%). Placental bulge was absent in 25 of 26 cases of normal placenta or placenta accreta without myometrial invasion(True negative=96.2%). Positive & negative predictive values were 96.9% and 96.2%,respectively. The results were statistically significant($p<0.01$). Estimated Kappa of 0.87 signified excellent inter reader concordance. In 1 false positive, placenta itself was normal but the bulge was present. On surgical pathology, this patient has markedly thinned, fibrotic myometrium without accreta. 1 false negative case was imaged at 16 weeks and may have been too early to diagnose the placental bulge sign.

CONCLUSION

Presence of uterine bulge can be confidently used to diagnose myometrial invasion and signifies at least placenta increta. In conjunction with other findings of invasive placenta, placental bulge was 100% predicitve of myometrial invasion. Using the bulge alone without other signs can be fraught with pitfalls and false positive results.

CLINICAL RELEVANCE/APPLICATION

Till date,no diagnostic finding for placenta increta is recognized. This diagnosis has surgical implications i.e. increased hemorrhage.Adjunct measures to control post-partum bleeding become necessary

SST04-02 ADC and IVIM: The New Perspective to Diagnose Placenta Accreta by MRI

Friday, Nov. 30 10:40AM - 10:50AM Room: E260

Participants

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PURPOSE

To investigate the diagnostic value of single b value (ADC) and multiple b value (IVIM) model for placenta accreta in pregnant women by MRI in functional perspective. We evaluate the differences of tissue characters between placenta accreta and normal placenta quantitatively, aimed to provide the basis for the functional diagnosis of placenta accreta by MRI.

METHOD AND MATERIALS

61 pregnant women were enrolled in our retrospective study. Among them, 24 cases were confirmed for placenta accreta by operation or pathology. The remaining 37 cases were normal placenta. Gestational weeks were 23 weeks to 36 weeks. All patients underwent DWI scanning which including 7 b values (0, 50, 100, 150, 400, 700 , 1000s / mm²) and the 2 b values(0, 800 mm²). The perfusion percentage (f%), diffusion coefficient (D), pseudo-diffusion coefficient (D *) and apparent diffusion coefficient (ADC) were measured by DKI tool and Siemens workstation respectively. The enrolled cases were divided into accreta group and control group. The accreta group were divided into two groups according to implanted part and non-implanted part. And the differences between the groups were tested by the Kruskal-Wallis test.

RESULTS

The average values of f%, D * and D in normal group were (29.66±7.0)%, (11.02±3.5) and (1.45±0.27) respectively, and those in the implanted part of accreta group were (52.18±7.8)% , (12.99±2.99) and (1.41±0.3) respectively. Those in non-implanted part of accreta group were (38.18±7.29)%,(11.04±3.23) and (1.40±0.17) respectively. ADC was (1.87±0.15) mm2 / s in the normal group, (2.32±0.17) mm2 / s in implanted part and (1.99±0.12) mm2 / s in non-implanted part of accreta group. The above comparison groups were statistically significant except for the D value.

CONCLUSION

f% and D * ADC provide information about perfusion and diffusion of placental tissue. Placenta accreta is significantly higher than the normal one. Implanted part is also higher than the non-implanted part in the accreta cases. IVIM and DWI (ADC) can be used as a potentially functional technique for placenta accreta's diagnosis by Magnetic Resonance Imaging.

CLINICAL RELEVANCE/APPLICATION

IVIM and ADC are recommended as new fMRI sequences which provide the perfusion and diffusion imformation to diagnosis the placenta accreta

SST04-03 Predictive Parameters of the Morbidly Adherent Placenta on MRI

Friday, Nov. 30 10:50AM - 11:00AM Room: E260

Participants
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PURPOSE

To assess predictive indicators of morbidly adherent placenta in 2nd and 3rd trimester MRI.

METHOD AND MATERIALS

This is a retrospective study of 2nd and 3rd trimester pregnancies assessed by MR from 2007 to present. Women were included if there was suspicion for placental invasion based on surgical history and suspicion of placenta previa on ultrasound. MR was performed on 1.5 T Signa (GE Healthcare) or Magnetom (Siemens) magnet. Studies were anonymized on OsiriX (Pixmeo SARL). The MRIs were then reviewed by an experienced radiologist, specialized in OBGYN imaging, who was blinded to clinical outcomes. Twenty qualitative and quantitative parameters were assessed and compared to four clinical outcome measurements: need for cesarean hysterectomy, pathology report, impression at time of surgery, and intraoperative blood transfusions. Univariate logistic regression analysis was performed. P-values less than 0.05 were considered significant. Analyses were performed using SAS (SAS Institute Inc).

RESULTS

Of 41 women, 29 required a cesarean hysterectomy, 11 had cesarean delivery, and 1 delivered vaginally. Twenty-five of 41 required blood transfusion. On pathological assessment, 22 had evidence of invasion. Twenty-five of 41 women were deemed clinically invaded by the surgeon during delivery. Eleven out of the twenty MRI parameters assessed demonstrated statistical significance (see table). Of particular note, the greatest linear dimension of invasion, inhomogeneity, fibrin deposition, radiologist impression and assessment of degree of invasion had the greatest predictive value.

CONCLUSION

Multiple MR parameters can predict placental invasion and correlate with the need for cesarean hysterectomy, as well as pathological and surgical impressions of invasion. These defined MRI parameters provide a systematic method for assessing placental invasion. Future work should combine these and clinical variables in a larger series with multiparamteric analysis to design a standardized index.

CLINICAL RELEVANCE/APPLICATION

Quantitative outcomes based assessment of MR parameters can be used to predict placental invasion and reduce diagnostic uncertainty.

SST04-04 Feasibility and Reliability of a Novel Low Cost 3D Ultrasound System in 2nd Trimester Fetal Imaging

Friday, Nov. 30 11:00AM - 11:10AM Room: E260

Awards
Student Travel Stipend Award

Participants
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PURPOSE

The clinical utility of ultrasound (US) is limited by operator dependence and restricted planar image capture. We have developed a novel, low cost technology to enable 3D volumetric image acquisition and automatic orientation using existing 2DUS platforms. We demonstrate its feasibility and reliability in 2nd trimester fetal imaging.

METHOD AND MATERIALS

The research device (orientation sensor, screen capture device, and computer) plus 2DUS machine (GE Voluson E8, 2D C1-5 probe) were used to capture 2 image volumes for each of 10 2nd trimester fetuses. Source images were obtained by a student with minimal US experience by sweeping the US transducer continuously across the region of interest. Acquisition and reconstruction times were automatically recorded. Volumes were reconstructed using a voxel-based algorithm designed by the research team. 3DSlicer was used for image analysis. Blinded measurements of biparietal diameter (BPD), femur, and humerus were made by the student during image review and compared to those reported by expert sonographers during routine anatomy scans performed on the same day. Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC).

RESULTS

Gestational ages ranged from 16 to 23 weeks. BMI ranged from 23.2 to 30.9. Image acquisition (sweep time) and volume reconstruction required mean 29.9s and 72.9s, respectively. Fetal orientation, BPD, femur, and humerus could be identified in multiplanar and volumetric images. ICCs demonstrated strong inter-rater reliability between the student and expert report for each measurement (BPD ICC 0.88 CI95% 0.53-0.97; femur ICC 0.91 CI95% 0.63-0.98; humerus ICC 0.81 CI95% 0.22-0.95).

CONCLUSION

Comprehensive fetal image volumes were rapidly acquired by a novice and reconstructed for interactive visualization without restriction to planar images. Orientation, BPD, femur, and humerus could be identified for each fetus during image review despite no attempt at identification during scan acquisition. Measurements were highly reliable. This low cost technology could advance the clinical utility of US in obstetric imaging, especially in low resource settings.

CLINICAL RELEVANCE/APPLICATION

A novel, low cost device enabled capture of comprehensive, oriented fetal image volumes by a novice and may enhance the clinical utility of US in obstetrics, particularly in low resource settings.

SST04-05 Utility of High Resolution Images in MR Evaluation of Placenta Accreta Spectrum

Friday, Nov. 30 11:10AM - 11:20AM Room: E260

Participants
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PURPOSE

To assess the utility of high resolution (HR) images in management of placenta accreta spectrum (PAS).

METHOD AND MATERIALS

In this HIPAA- compliant, IRB-approved, retrospective study, patients undergoing 3T MR Imaging for evaluation of placenta accreta spectrum between March 2015 to 2018 were included. The images were analyzed by 2 independent readers with 5 and 15 years of experience and expertise in placental imaging. First, the large field of view (FOV) images, which include the entire uterus were analyzed for diagnostic quality and the presence or absence of findings of PAS. Additional pertinent observations included location of invasion, depth of invasion/myometrial thinning, presence of cervical invasion, bladder invasion and intra-placental hemorrhage. Next the HR, small FOV images were reviewed for diagnostic quality. These images were reviewed for any additional findings not previously identified on large FOV images. Intraoperative findings & surgical pathology were used as reference standard. Reader confidence for diagnosis was recorded on both large & small FOV images.

RESULTS

60 patients who underwent 3T MRI for invasive placenta were included in the study. Of these, HR images were found to be non-

diagnostic from respiratory motion artefact in 19 cases(32%). In remaining cases, HR images were not found to add any additional information to effect patient management in 37 cases(58%). In 2 cases, HR images were found to be helpful to exclude focal accreta. In additional 2 cases with placenta increta, HR images were helpful to exclude bladder invasion. However, when adequately performed, reader confidence for diagnosis of all accreta, increta and percreta was increased.

CONCLUSION

HR images are often degraded from artefact, probably related to their acquisition later in the protocol, reflecting increasing patient discomfort. Although HR images improve reader confidence, in most cases, no new findings or additional diagnostic information is acquired. If MRI is positive for invasive placenta, additional HR may rarely be necessary to evaluate for invasion of adjacent organs. In a negative examination, they may be helpful to exclude focal invasion. Live review of acquired images can guide need for HR aquisition.

CLINICAL RELEVANCE/APPLICATION

HR images can be omitted during MR for invasive placenta in many cases, reducing imaging time, associated cost and patient discomfort. Rarely, they are useful to assess focal invasion.

SST04-06 Estimation of Fetal Weight by Measurement of Fetal Thigh Soft-Tissue Thickness (STT) in the Late Third Trimester: Its Correlation with Hadlock's Method and Actual Birth Weight

Friday, Nov. 30 11:20AM - 11:30AM Room: E260

Participants
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PURPOSE

The purpose of this study is To assess the reliability of the linear measurement of mid-thigh soft-tissue thickness (STT). To prospectively evaluate the Formula derived by Scioscia et al using Fetal STT for estimating fetal EFW. To assess its correlation with established method of Hadlock and finally compare the results with actual birth weight post delivery.

METHOD AND MATERIALS

This was a prospective study involving 325 singleton uncomplicated pregnancies presenting to emergency department. 300 of these, who delivered within 48 hours of measurement were considered for the analysis. Scioscia et al developed the equation for Estimated Fetal Weight using multiple stepwise regression analysis (EFW = -1687.47 + (54.1 × femur length) + (76.68 × STT)). This equation was utilised in following three consecutive phases: (1) Evaluation of the novel formula derived by Scioscia et al for EFW using femur length and STT , (2) Comparing the resulting EFW with existing Hadlock's equation and (3) To test the accuracy of the formula by comparison with actual birth weight.

RESULTS

The STT was significantly correlated with both abdominal circumference and birth weight ($r2 = 0.64$ and 0.34, respectively; $P < 0.001$).The correlation matrix of FL and STT with actual birth weight was higher ($r2 = 0.86$ and 0.80, respectively) as compared to their mutual correlation. However,among the studied estimates, the model using STT proposed herein was apparently more accurate compared with the hadlock's method owing to lower standard error and better stronger correlation with actual birth weight. Moreover, the differences between EFW and actual birth weight were more spread out using the estimates of Hadlock et al. than they were using ours.

CONCLUSION

Our findings confirm the potential of linear measurement of mid-thigh STT as a valuable parameter for the sonographic assessment of fetal growth and EFW. Scioscia's equation is apparently at least as reliable as the most widely used formulae for EFW, is easily reproducible and has a better correlation with actual birth weight.

CLINICAL RELEVANCE/APPLICATION

Accuracy of STT in estimating the estimatedd fetal weight (EFW) outperforms the routinely used formulas, so STT shall be measured in all obstetric sonograms in third trimester.

SST04-07 Predictive Accuracy of Trans-Cerebellar Diameter in the Determination of Gestational Age in Third Trimester of Pregnancy

Friday, Nov. 30 11:30AM - 11:40AM Room: E260

Participants
Omolola Akinwunmi, MBBS, Ibadan, Nigeria (*Abstract Co-Author*) Nothing to Disclose
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PURPOSE

To determine the accuracy of trans-cerebellar diameter (TCD) measurement in sonographic assessment of gestational age in third trimester of pregnancy and its correlation with other conventional fetal biometric parameters

METHOD AND MATERIALS

A cross-sectional study was conducted on 500 pregnant women who fulfilled the inclusion criteria and were attending the hospital's antenatal clinic from January to October, 2015. Each participant underwent a transabdominal obstetric ultrasound examination for the measurement of trans-cerebellar diameter and other fetal biometric parameters using an Ultrasonix touch ultrasound machine version 5.6.4 with a 3,5MHz curvilinear probe

RESULTS

The average age of participants was 32 years. The average gestational age was 34 weeks and the mean trans-cerebellar diameter (TCD) estimation was 46.1 ± 6.1mm (corresponding to 34.7 ± 2.6 weeks). We observed a statistically significant correlation between gestational age and TCD at third trimester with correlation co-efficient of 0.97 and R2 of 0.931 ($p < 0.001$). From regression analysis, a strong significant association was observed between fetal TCD at third trimester and actual gestational age. The observed sensitivity of TCD in predicting gestational age was 95.6% with a positive predictive value of 98.3%. TCD was also significantly correlated with other fetal biometeric parameters including bipareital diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) with correlation co-efficient of 0.76, 0.90, 0.79 and 0.75 respectively.

CONCLUSION

The findings of this study have suggested trans-cerebellar diameter as a reliable sonographic tool in the estimation of gestational age in normal third trimester pregnancy.

CLINICAL RELEVANCE/APPLICATION

Tran-cerebellar diameter measurement can be reliably used to estimate gestatinal age for optimal obstetric management especially for pregnant women who are not sure of their last menstrual period, those who have had no antenatal records or those who present with obstetric emergency. It is therefore recommended as part of the baseline sonographic parameter in estimating gestational age

SST05

Musculoskeletal (Spine)

Friday, Nov. 30 10:30AM - 12:00PM Room: E351

MR MK NR

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

FDA Discussions may include off-label uses.

Participants
Corrie M. Yablon, MD, Ann Arbor, MI (*Moderator*) Nothing to Disclose
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Sub-Events

SST05-01 Location of First Radiographic Spinal Fracture as Determinant of Future Vertebral Fracture Risk

Friday, Nov. 30 10:30AM - 10:40AM Room: E351

Participants
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PURPOSE

We aimed to examine if the location of a first radiographic vertebral fracture (VF) determines the risk of future incident radiographic VFs.

METHOD AND MATERIALS

Prevalent radiographic VFs were scored in 3882 subjects aged 55 years or older at baseline and after a mean follow-up of four years, using two methods: SpineAnalyzer® Quantitative Morphology (QMSA) and Algorithm Based Qualitative (ABQ). We defined the location by a) three regions: T4-T8; T9-T12 and L1-L4, b) exact vertebral level from T4 to L4. The association between the location of first prevalent VF and occurrence of future incident VFs was examined using logistic regression models adjusted for age, sex, BMI, and FN- BMD.

RESULTS

At least one incident VF was observed in 3.9 % (QMSA) and 2.0% (ABQ) of the participants. As compared to participants without VFs, individuals with multiple fractures at baseline had three (OR= 2.7; 95%CI 1.7-4.2 for QM) to 12 (OR= 12.4; 95%CI 4.8-31.9 for ABQ) times increased likelihood of suffering incident VFs. A first QMSA VF at T4-T8 was associated with increased risk of incident VF (OR= 7.7; 95%CI 4.3; 13.8), at T9-T12 (OR=2.5; 95% CI 1.0; 6.1) and L1-L4 (OR= 3.5; 95% CI 1.2; 10.5). A first ABQ VF at T4-T8 was associated with increased risk of incident VF (OR= 17.2; 95%CI 4.8; 61.4), at T9-T12 (OR=4.2; 95% CI 1.3; 12.7) but not at L1-L4 (OR= 1.9; 95% CI 0.5; 6.5). Of all vertebral levels, subjects with VFs arising at T8 had (with both methods) the highest risk for incident VFs (OR= 16.0; 95%CI 2.5; 102.2) for ABQ and (OR=11.5; 95%CI 4.5; 29.1) for QMSA, as compared to participants without VFs. Fractures at T6 scored with QMSA (OR=16.8; 95%CI 5.3; 52.6), T7 (OR=5.5; 95%CI 1.9; 15.2), L1 (OR=7.3; 95%CI 2.3; 22.6) and at T12 scored with ABQ (OR=5.6; 95%CI 1.5-20.8) were also associated with incident VFs. No other vertebral body locations were significantly associated with future VFs risk.

CONCLUSION

A first radiographic VF located at the upper thoracic region (T4-T8) and specifically at T8, is strongly and robustly associated with increased risk for future VFs independent of age, sex and BMD according to two different scoring methods.

CLINICAL RELEVANCE/APPLICATION

Since VFs in the upper thoracic spine (T4-T8), and specifically at T8, are strongly associated with increased risk for future VFs, such fractures require special attention for radiologists and warrant referral for monitoring and appropriate treatment.

SST05-02 UTE MR Morphology of Disco Vertebral Junction: Correlation with Disc Grade and T2 Values

Friday, Nov. 30 10:40AM - 10:50AM Room: E351

Awards

Student Travel Stipend Award

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PURPOSE

We have previously reported unique capability of ultrashort echo time (UTE) MRI to image the morphology of the discovertebral junction (DVJ) in human lumbar spines. In this cadaveric study, we sought to determine if DVJ morphology correlates with disc Pfirrmann grades and T2 values.

METHOD AND MATERIALS

Lumbar spines from 37 cadavers (30 males, 60±10.1 yrs, mean±SD) were imaged at 3T using UTE (TR=300 ms, TEs=0.01 and 5.5 ms, FOV=16 cm, matrix=512x512) and spin echo T2 map (TR=2000 ms, 8 TEs=10 to 70 ms) sequences. UTE images were used to define morphology of the DVJ as being normal (distinct linear high signal intensity, Figure 1A, arrows) or abnormal with focal signal loss (Figure 1A, arrowhead) and/or irregularity (Figure 1A, curved arrow). Spin echo data was used to perform Pfirrmann grading of the disc (Figure 1B), and T2 mapping (Figure 1C). T2 values of nucleus pulposus was determined using an atlas-based automated region of interest. Using statistics, we compared proportion of disc grades (Figure 1D) and nucleus T2 values (Figure 1E) when the disc was adjacent to normal DVJs, 1 abnormal DVJ, or 2 opposing abnormal DVJs.

RESULTS

Out of 278 DVJs, 198 were normal, 45 had focal signal loss, and 35 were irregular. There was greater proportion of higher disc grades (Figure 1D; chi-square p=0.00004), as well as lower T2 values (Figure 1E; ANOVA p=0.18), in discs adjacent to 2 opposing abnormal DVJs, compared to discs adjacent to normal DVJs.

CONCLUSION

These results suggest that the prevalence of abnormal DVJs in human lumbar spines are quite high (~25%), and given the association between DVJ and disc degeneration, altered DVJs could be important for the etiology of disc degeneration.

CLINICAL RELEVANCE/APPLICATION

By direct assessment of the DVJ with UTE MRI early detection of beginning disc pathology in a preclinical stage is feasible. DVJ may play a biomechanical/metabolic role in support of healthy discs.

SST05-03 Feasibility of Zero Echo Time Sequence of the Cervical Spine MRI: Emphasis on Evaluation of Osseous Structures and Calcification

Friday, Nov. 30 10:50AM - 11:00AM Room: E351

Participants
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PURPOSE

To determine the availability of zero echo time (ZET) sequence for the evaluation of osseous foraminal stenosis (OFS) and presence of peridiscal osteophyte (PO), discal calcification (DC), and ossification of posterior longitudinal ligament (OPLL) by comparison with CT as reference standard.

METHOD AND MATERIALS

Twenty one patients (mean age, 67.7 years; 10 male, 11 female) who underwent cervical MRI including 3D ZET sequence and concomitant CT within 1 months (mean interval, 3.8 days; range, 0-27 days) were retrospectively enrolled from November 2017 to March 2018. Two independent musculoskeletal radiologists evaluated ZET images and CT in separate sessions for the followings at each level: 1) grading of OFS by a visual 4-point scale from 0-3 (0=none or minimal, 1=mild, 2=moderate, 3=severe) on oblique sagittal images from C2-3 to C7/T1 (total 252 foramina); 2) presence of PO and DC of central zone of central canal from C2-3 to C7/T1 (total 126 disc level); 3) presence of OPLL from C2 to C7 (total 126 vertebral body level). Intermodality agreement between ZET and CT, and intra- and interobserver agreements for ZET were measured with the kappa (κ) statistics.

RESULTS

Intermodality agreements for detecting PO, DC, and OPLL between ZET and CT were almost perfect by 2 readers (κ=0.943-1 by reader 1; κ=0.867-1 by reader 2, respectively). Substantial to almost perfect agreements (κ=0.826 by reader 1, κ=0.787 by reader

2) were found for grading of OFS between ZET and CT. Overall intra- and interobserver agreements were substantial to almost perfect for ZET (κ=0.788-1).

CONCLUSION

The results of our study shows strong intermodality agreement between ZET sequence of MRI and CT in the cervical spine for evaluation of osseous structures and calcification.

CLINICAL RELEVANCE/APPLICATION

ZET sequence of MRI can demonstrate 'CT-like' contrast for the evaluation of cervical spine.

SST05-04 Effect of Physical Activity on Thoracic and Lumbar Disc Degeneration - a MRI Based Analysis of 385 Healthy Controls from the KORA Cohort

Friday, Nov. 30 11:00AM - 11:10AM Room: E351

Participants
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PURPOSE

Depending on the type and extent of physical activity, there isn´t always a health preventing and health promoting impact found. Less information is available on the impact of physical activity on vertebra disc degeneration. Therefore, the purpose was to evaluate the impact of physical activity on intervertebral disc degeneration of the thoracic and lumbar spine.

METHOD AND MATERIALS

A total of 385 patients of the KORA study (Cooperative Health Research in the Augsburg Region) were included in this study. All subjects underwent full body dual-echo Dixon and T2 Haste sequence MR scan performed on a 3T scanner (Magnetom Skyra, Siemens Healthcare). Furthermore, they were tested on the basis of a standardized assessment tool inter alia on anthropometric data such as age, weight and heights as well as on physical activity/work, daily bike rides and daily walks. In order to quantify thoracic and lumbar disc degeneration, assessment was performed by two experienced radiologists according to the Pfirrmann Score (Grade >2 = pathological). Statistical analysis was performed by univariate and multivariate analysis.

RESULTS

Age (BWS-Pfirrmann score:0.15; p<0.001, LWS Pfirrmann score:0.06; p<0.001 and Overall-Pfirrmann score:0.21, p<0.001), BMI (BWS-Pfirrmann score:0.11; p<0.05, LWS Pfirrmann score:0.05; p<0.01 and Overall-Pfirrmann score:0.16, p<0.01) as well as no physical activity (BWS-Pfirrmann score:1.96; p<0.01, LWS Pfirrmann score:0.99; p<0.001 and Overall-Pfirrmann score:2.95, p<0.001) lead to significant thoracic and lumbar disc degeneration when testing for univariate correlation. When testing on interdependency, we showed that age (BWS-Pfirrmann score:0.15; p<0.001, LWS Pfirrmann score:0.06; p<0.001 and Overall-Pfirrman score:0.21, p<0.001) and no physical activity (BWS-Pfirrmann score:1.85; p<0.01, LWS Pfirrmann score:0.97; p<0.001 and Overall-Pfirrmann score: 2.82, p<0.001) still correlate with disc degeneration in multivariate analysis. On the other hand, we found that much physical activity also leads to a thoracic and lumbar disc degeneration.

CONCLUSION

No or less physical activity as well as age and BMI correlate with thoracic and lumbar disc degeneration.

CLINICAL RELEVANCE/APPLICATION

According to the literature, high physical activity increases degeneration. In contrast research for no to little physical activity and degeneration is limited. We were able to show that no or less activity results in a similar outcome.

SST05-05 The Assessment of Disco-Ligamentous Complex Injury on Magnetic Resonance Imaging (MRI) and CT Scan After Acute Cervical Spine Trauma

Friday, Nov. 30 11:10AM - 11:20AM Room: E351

Participants
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PURPOSE

to investigate useful imaging findings to assess disco-ligamentous injury after acute cervical spine trauma

METHOD AND MATERIALS

Between January 2015 and December 2017, 96 patients (11women, 85 men, age range 20-83 years, mean age 58 years) performed cervical spine MRIs and CT scans after acute trauma. We evaluated pre-vertebral hematoma, edema of cervical back muscles, high signal intensity (SI) within the spinal cord (contusion), instability, discontinuity of anterior longitudinal ligament (ALL), abnormal high SI of disc, ossification of ALL or anterior spur formation, and fracture of posterior elements. The presence or absence of disco-

ligamentous complex injury confirmed by surgery were compared with imaging findings.

RESULTS

Disco-ligamentous complex injuries were identified in 58 patients (60%) at surgery. The instability of the bony structure associated with fracture was seen only 27 patients (28%). Prevertebral hematoma (mild;26, moderate;27, severe;34) were presented in 87 (91%), edema of cervical back muscles in 75 (78%), spinal cord contusion in 86 (90%), high SI of disc in 67 (70%), and OALL or spur formation in 44 (46%).The agreement between the imaging assessment of ALL discontinuity and the disco-ligamentous injury identified in surgery was very low (kappa value; 0.25). There was a high correlation between disco-ligamentous complex injuries identified in surgery and cord contusion, abnormal high SI of disc and fractures of posterior elements on the images.

CONCLUSION

The imaging findings of cord contusion, abnormal high SI of disc and fractures of posterior elements might be useful for assessment of disco-ligamentous complex injury while the imaging asessment of ALL discontinuity is less accurate.

CLINICAL RELEVANCE/APPLICATION

If instabilities or fractures are not well seen on the images, it is difficult to directly recognize ALL rupture including disc. Therefore these secdonary imaging findings might be useful to recognize disco-ligamentous complex injury before surgery and scoring subaxial cervical spine injury.

SST05-06 Prediction of Abnormal Bone Density and Osteoporosis from Lumbar Spine MR Using Modified Dixon Quant in 257 Subjects with QCT as Reference

Friday, Nov. 30 11:20AM - 11:30AM Room: E351

Participants
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PURPOSE

To investigate the predictive value of using vertebral bone marrow fat fraction (BMFF) obtained from lumbar spine MRI to assess abnormal bone density and osteoporosis

METHOD AND MATERIALS

257 participants (181 females, and 76 males; age: 48.9+-14.7 years old; BMI: 22.9+-3.04 kg/m2) were recruited for the study with written consent and approved by local institutional review board (IRB). Exclusion criteria: history of known spinal tumor, trauma, dysplasia, spinal surgery and hormone therapy. All subjects underwent lumbar MRI (Ingenia 3.0T, Philips) including modified Dixon(mDixon) Quant for assessment of BMFF at L1, L2 and L3 by manually drawing ROI (region of interest) on the fat fraction map (InterlliSpace TM Portal, Philips). Quantitative computed tomography (QCT) was performed on all subjects for determination of bone mineral density (BMD). Partial correlation analysis between vertebral BMFF and BMD was first performed. Logistic regression analysis using independent training and validation data sets were performed to evaluate the performance of predicting abnormal BMD (osteopenia [80 to 120 mg/cm3] and osteoporosis [<80mg/cm3]) or osteoporosis using BMFF.

RESULTS

All participants were divided into three groups based on their BMD from QCT: normal bone density (>120mg/cm3, 135 subjects), osteopenia (82 subjects) and osteoporosis (40 subjects). Moderate inverse correlation was found between vertebral BMFF and BMD after controlling age, gender and BMI ($r = -0.529$, $p<0.001$). The logistic regressions were trained using 2/3 of the cases and the performance was evaluated using the independent validation set comprised of the rest 1/3 cases. The area under the curve, sensitivity, specificity of predicting abnormal bone density were 0.940, 0.902, and 0.867, respectively and 0.906, 0.929 and 0.764, respectively for predicting osteoporosis. Its positive predictive value was found to be 0.907, making it an excellent screening tool.

CONCLUSION

Our study demonstrates statistically significant moderate correlation between vertebral BMFF and BMD. mDixon Quant as a fast, simple, non-invasive and non-ionizing imaging method to access vertebral BMFF has a high predictive power for identifying abnormal bone density and osteoporosis.

CLINICAL RELEVANCE/APPLICATION

Lumbar spine MRI is one of the most commonly performed study in clinical practice, added value of prediction of abnormal BMD using mDixon Quant would greatly benefit the patients.

SST05-07 Quantitative Assessment of Fat Infiltration in Lumbar Multifidus Muscle using T2-Weighted Multipoint Dixon in Patients with Low Back Pain: Correlation with Herniated Nucleus Pulposus

Friday, Nov. 30 11:30AM - 11:40AM Room: E351

Participants
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PURPOSE

This study is to quantitatively assess fat infiltration in lumbar multifidus muscle using T2-weighted multipoint Dixon (T2 Dixon) and to reveal the relationship with herniated nucleus pulposus (HNP) in patients with low back pain (LBP).

METHOD AND MATERIALS

Among 241 patients who performed MRI of lumbar spines (L-spine) for LBP on 1.5T scanner, 114 patients (age, 42.7±1.4y; 58 females) were enrolled, excluding patients with prior spine surgery, malignancy, compression fracture, spondylolisthesis, spondylitis, and advanced spinal stenosis. The presence and level of HNP were recorded. Two readers independently measured multifidus sectional area from T2 Dixon of axial L3 level and coronal L-spine. Volumetric multifidus measurement was performed using Syngo.via. Fat fraction (Ff) of multifidus was calculated from signal intensity (SI) of in-phase (IP) and out-of-phase (OP) images by using the formula: '(SIIP-SIOP)/2SIIP x 100(%)'.

RESULTS

Inter-reader agreement of Ff for each method and inter-method agreement of Ff were excellent (ICCs: 0.81 to 0.98). 20 patients had no HNP (age, 39.3±15.7y; 9 females; BMI, 22.4±2.4) and 94 patients had HNP (age, 43.7±14.6y; 49 females; BMI, 25.3±3.4). Among positive HNP, 76 patients had HNP less than 3 levels (age, 40.8±13.9y; 38 females; BMI, 25.3±3.4) and 18 patients had multi-level (>=3 levels) HNP (age, 56.0±10.3y; 11 females; BMI, 25.4±3.7). In positive HNP, coronal Ff (20.1±2.8%) and volumetric Ff (19.8±2.6%) were significantly higher than those of negative HNP (18.0±3.8%, 17.6±3.2%; P=.005, .002, respectively). In multi-level HNP, axial-L3 Ff (22.1±2.9%) and coronal Ff (22.2±2.0%) were significantly higher than those of HNP less than 3 levels (19.0±3.3%, 19.6±2.7%; P<.001 for each). Multivariate logistic regression analysis adjusted for age, sex, and BMI showed that BMI is significantly associated with HNP (odds ratio [OR]: 1.376, P=.004), while age and coronal Ff are significantly associated with multi-level HNP (OR: 1.075, 1.524, P=.021, .015, respectively).

CONCLUSION

Coronal Ff from T2 Dixon of L-spine has the best discriminating power to quantify the fatty infiltration of lumbar multifidus in patients of HNP. Increased coronal Ff was significantly associated with multilevel HNP.

CLINICAL RELEVANCE/APPLICATION

The fat fraction of lumbar multifidus using coronal T2 Dixon is recommended method for patient of LBP to discriminate multi-level HNP from one or two level HNP.

SST05-08 Epidural Fibrosis and Nerve Root Changes on Magnetic Resonance Imaging (MRI) After Lumbar Disc Surgery: Correlation with Clinical Symptoms

Friday, Nov. 30 11:40AM - 11:50AM Room: E351

Participants
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PURPOSE

To investigate correlation between epidural fibrosis and nerve root changes on Magnetic resonance image (MRI) and clinical symptoms after lumbar disc surgery

METHOD AND MATERIALS

Between January 2010 and May 2017, 75 patients (32 women, 43 men, age range 30-87 years, mean age 60 years) who performed lumbar disc surgery at unilateral side of only one level examined follow-up lumbar spine MRI due to back pain or variable neurologic symptoms. We investigated size change, abnormally increased signal intensity, distinction in the epidural space, displacement and compression of nerve root and epidural fibrosis at operative site on mainly axial sequences. Also, the presence or absence of arachnoiditis was evaluated. The clinical symptoms were compared with MR imaging findings using statistical analysis.

RESULTS

Symptoms related with lumbar disc surgery were found in 31 patients (41.3%). The size change of nerve root was seen in 43 patients and high SI of nerve root in 44. The displacement of nerve root was presented in 11 patients and there were no patients showing definite nerve root compression. 51 patients showed epidural fibrosis and definite distinction of nerve root in the epidural space was seen in 45 patients. Arachnoiditis was seen in only 22 patients. The size change of nerve root at surgery site was the only significant MR finding correlating with symptom ($p < 0.05$).

CONCLUSION

The size change of nerve root at surgery site was significantly correlated with new or persistent symptoms after lumbar disc surgery.

CLINICAL RELEVANCE/APPLICATION

MR imaging findings of size change and abnormally high SI of nerve root, indistinction of nerve root in the epidural space and epidural fibrosis are common after lumbar disc surgery. However, these findings except size change of nerve root were post-operative changes unrelated to new or persistent symptoms.

SST05-09 Assessment of Osseous Cervical Foraminal Stenosis in Spinal Radiculopathy Using Susceptibility-Weighted MRI

Friday, Nov. 30 11:50AM - 12:00PM Room: E351

Participants
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PURPOSE

The aim of this study was to evaluate the diagnostic performance of susceptibility-weighted MRI for the evaluation of osseous foraminal stenosis of the cervical spine compared to conventional MR sequences, using CT as a reference standard.

METHOD AND MATERIALS

Twenty-one patients with suspected radiculopathy of the cervical spine were prospectively included. As standard of reference, 280 neuroforamen of the cervical spine, including 58 foraminal stenosis, were identified on sagittal CT images. T1, T2 and SW-MRI of the cervical spine were performed. For this study, the presence of foraminal stenosis was assessed on sagittal views on T1, T2 and SW-MR images. Sensitivity / specificity were calculated and differences in detection rate, severity scoring and sagittal diameter of spinal foraminal stenosis between the different sequences were tested. CT was used as reference standard for all analysis.

RESULTS

56 of 58 osseous foraminal stenosis could be correctly identified on SW-MR magnitude images. SW-MR imaging achieved a sensitivity of 96.6% and specificity of 99.5% for the identification of foraminal stenosis of the cervical spine. In comparison, conventional T1 spine MR sequences achieved a sensitivity and specificity of 43.1% and 100% respectively. Conventional T2 spine MR sequences achieved a sensitivity and specificity of 65.5% and 99.1%, respectively. The overall detection rate was significantly (p0.05) higher on SW-MR imaging and there was no significant difference (p>0.05) in severity scoring compared to CT imaging. T1/T2-weighted MR underestimated the degree of foraminal stenosis. Intermodality and interobserver agreement were highest for SW-MR sequences.

CONCLUSION

Susceptibility-weighted MRI enables the reliable detection of osseous foraminal stenosis of the cervical spine in patients with spinal radiculopathy with a higher sensitivity and specificity compared to conventional T1/T2 MR sequences, with CT as a reference standard.

CLINICAL RELEVANCE/APPLICATION

The main limitation of MRI, compared to CT, is limited value for the detection of osteophytic changes as a cause of foraminal stenosis. Standard MR T1 and T2-weighted sequences often do not allow a differentiation these changes. Therefore, CT or conventional radiographs are often required to detect and quantify these changes. SW-MRI may therefore replace additional tests and prevent radiation exposure for patients as well as speed up diagnostic work up.

SST06

Nuclear Medicine (Abdomen and Pelvis Nuclear Imaging)

Friday, Nov. 30 10:30AM - 12:00PM Room: E261

CT GI MR NM

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

Participants
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Ephraim E. Parent, MD,PhD, Ponta Vedra Beach, FL (*Moderator*) Research support, Blue Earth Diagnostics Ltd; Research support, Advanced Accelerator Applications SA
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Sub-Events

SST06-01 Liver/Spleen Scintigraphy: An Old Technique with a current Application

Friday, Nov. 30 10:30AM - 10:40AM Room: E261

Participants
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PURPOSE

Cross sectional imaging of the abdomen on occasion can demonstrate incidental pancreatic/peri-pancreatic lesions of unknown etiology. Although these lesions sometimes have the appearance of splenic tissue, situation arise were metastasis and/or primary pancreatic etiology are also on the differential. Scintigraphy with Tc99m Sulfur colloid or heat damaged RBC can be a useful diagnostic tool in identifying the presence of splenic tissue, suggesting a benign etiology for these lesions although the accuracy is uncertain.

METHOD AND MATERIALS

Retrospective review of all non-PET nuclear medicine studies in which a lesion in the upper abdomen were the cause of imaging from 1/2000 to 7/2017. Studies performed for hepatic artery perfusion or liver parenchyma lesion were excluded. Patients charts were reviewed, the date/results of the index study, subsequent imaging, clinical management, along with the last recorded encounter in our electronic medical record to establish benignity in the absence of pathology.

RESULTS

Initial review obtained 623 studies performed, a majority (74%) for hepatic artery perfusion. Liver lesion evaluation was performed in 7% of the cases (hemangioma or FNH). The remainder of the cases were done for evaluating splenic tissue in ITP (~5% of cases), ectopic splenic tissue (~9% after trauma or splenectomy) or to evaluate incidental pancreatic/peri-pancreatic lesions with potential neoplastic etiology (~5% cases, 34 cases total). Of these 34 cases, pathology was obtained in 12/34 patients. Imaging was correct in identifying nonsplenic tissue in 11/12 cases (92%). One case was splenic tissue on path, but was not identified on imaging. For the patients that had imaging indicating splenic tissue without subsequent pathology (12/22), follow up of the patient occurred > 3-years.

CONCLUSION

Pancreatic/peri-pancreatic lesions of unknown etiology can present a diagnostic challenge with causes ranging from benign splenic tissue to a neoplastic process. Scintigraphy offers a unique ability to identify ectopic splenic tissue with a high degree of diagnostic accuracy, >90%, yielding a benign diagnosis and limiting the need of further workup.

CLINICAL RELEVANCE/APPLICATION

Liver/Spleen imaging with Tc99m Sulfur colloid or damaged RBC can accurately identify incidental pancreatic/peri-pancreatic lesions as ectopic splenic tissue not requiring further workup.

SST06-02 The Diagnostic Accuracy of Brain-Lung Uptake and Whole-Body Uptake Derived from Technetium-99m-Labeled Macroaggregated Albumin (MAA) Lung Perfusion Scan for the Diagnosis of Hepatopulmonary Syndrome

Friday, Nov. 30 10:40AM - 10:50AM Room: E261

Participants
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PURPOSE

Technetium-99m-labeled macroaggregated albumin (MAA) lung perfusion scan is considered as a complementary tool for detecting intrapulmonary vascular dilations (IPVD), which is an essential criterion for diagnosing hepatopulmonary syndrome (HPS). The purpose of this study was to compare the diagnostic accuracy of brain-lung uptake and whole-body uptake for detecting IPVD.

METHOD AND MATERIALS

From December 2014 to October 2015, all patients with chronic liver disease and/or portal hypertension, undergoing interventional radiological procedures at our institution were eligible for inclusion in this prospective study. The brain-lung uptake was calculated using the geometric mean (GMT) of technetium counts around the brain and lung in the following formula: (GMTbrain / 0.13) / (GMTbrain / 0.13 + GMTlung). The brain-lung uptake was regarded as positive when the MAA shunt fraction was > 6%. The whole-body uptake was calculated using the GMT of technetium counts around the lung and whole body in the following formula: (1 - GMTlung / GMTwhole-body)

RESULTS

A total of 69 patients were included, IPVD was detected in 32 (46%) patients by contrast-enhanced echocardiography. Of these patients, 26 (38%) patients with elevated AaO2 were diagnosed as HPS. The brain-lung uptake was similar between those with or without IPVD [median, 3.5 (interquartile range (IQR), 2.6-5.8) % vs. 3.1 (IQR, 2.5-4.9) %; P = 0.245]. However, the whole-body uptake was significantly higher in the patients with IPVD than those without IPVD (48.0 ± 6.1 % vs. 40.1 ± 8.1 %; P = 0.001). Multivariable logistic regression showed that whole-body uptake was the only independent predictor that associated with the presence of IPVD [odds ratio (OR), 1.29; 95% CI, 1.07-1.55; P = 0.008]. The AUC values of the whole-body uptake for detecting IPVD were 0.75 (95% CI, 0.60-0.86). The optimal cut-off values of whole-body uptake for detecting IPVD was 42.5%. The sensitivity, specificity, and accuracy for detecting IPVD were 100%, 52%, and 74%, respectively.

CONCLUSION

Whole-body uptake could be a useful alternative to CEE and brain-lung uptake for detecting IPVD, especially in patients with mild or moderate HPS.

CLINICAL RELEVANCE/APPLICATION

Whole-body uptake derived from MAA lung perfusion scan could be a useful alternative to contrast-enhanced echocardiography and brain-lung uptake for detecting intrapulmonary vascular dilations.

SST06-03 Diagnosing Hepatobiliary Disease during Myocardial Perfusion Imaging Using Tc99m Methoxy Isobutyl Isonitrile

Friday, Nov. 30 10:50AM - 11:00AM Room: E261

Participants
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PURPOSE

Tc99m Methoxy Isobutyl Isonitrile (MIBI) has been used for myocardial perfusion imaging (MPI) for the detection of ischemia. This study aimed to investigate the feasibility of effectively evaluating cystic duct patency, during routine visual analysis of the raw MPI and/or with the 3-D reconstructed data.

METHOD AND MATERIALS

A retrospective study of 91 patients undergoing cardiac Sestamibi scan for acute chest pain, and HIDA scan (within no more than 3 months) for suspected gallbladder obstructive disease (GBD). Gallbladder visualization during either the rest or stress portion of the MIBI study was indicative of cystic duct patency. These results were compared to those by the HIDA studies.

RESULTS

Ten patients had the MIBI and HIDA studies 4 days apart, both studies agreed 100% with the diagnosis of cystic duct patency. Sixteen patients had both studies between 4 days and 3 weeks and had an agreement of 87.5% with cystic duct patency. Sixty-one patients had both studies 3 weeks to 3 months apart and had an agreement of 80% with cystic duct patency.

CONCLUSION

The initial results of this study indicate that MPI with Tc99m MIBI is useful in detecting a patent cystic duct and should help in eliminating unnecessary additional Gallbladder testing.

CLINICAL RELEVANCE/APPLICATION

If the interpreting physician was made aware of the benefits of being able to diagnose cystic duct obstruction and gallbladder disease when using the Tc-99m cardiac sestamibi to evaluate myocardial perfusion, it would lead to earlier diagnosis and more efficient patient care; thus, decreasing the amount of imaging that patients need to go through to reach a diagnosis of gallbladder obstruction, which will lead to decreased cost.

SST06-04 Qualitative and Quantitative Analysis of 68ga-DOTA-Peptide Uptake for Identifying Neuroendocrine Tumor in Uncinated Process of Pancreas

Friday, Nov. 30 11:00AM - 11:10AM Room: E261

Participants
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PURPOSE

68Ga-DOTA-peptide is a somatostatin analogue used for imaging neuroendocrine tumors (NET). Various organs demonstrate physiological distribution of which uncinate process of pancreas is a particular concern because uncinate is a common site for NET and great variability of tracer distribution at this location is making the interpretation difficult. Thus aim is to characterize 68Ga-DOTA-peptide distribution in uncinate process and useful hints for distinguishing pathology from physiological distribution.

METHOD AND MATERIALS

83 68Ga-DOTApeptide PET CT scans of 25 patients done between May 2009 and Oct 2014 were reviewed retrospectively. 66 scans from 20 subjects tumor involvement of uncinate process was excluded based on pathological,clinical,radiological evaluation and atleast 1 year follow-up. 17 scans from 5 subjects neuroendocrine tumor involvement of the uncinate process was confirmed by histology and/or multimodality imaging. Statistical analyses univariable Generalized Estimating Equations was carried out for normal uncinate uptake features. Comparison of normal vs tumor uptake was carried out using Mann Whitley test.

RESULTS

There are 3 types of normal distribution in uncinate process diffuse,focal and multifocal. Average SUVmax for normal uncinate process is 5.88 +/-3.34 with highest to be 21.07. The average SUVmax for uncinate neuroendocrine tumor is 76.28 +/- 44.72 with lowest to be 27. Tumor/spleen ratio is significantly higher than uncinate/spleen ratio (8.98 +/- 3.83 with lowest 3.67 vs 0.36 +/- 0.41 with highest 1.44). Strong positive correlation between uptake in normal uncinate process to that in pituitary and spleen (both $P<0.0001$) and the uptake is negatively affected by dose of peptide ($p=0.0002$).

CONCLUSION

Distribution pattern and uptake intensity in uncinate process vary greatly between patients and between scans. Pituitary and spleen uptake serve as references in judging the nature of uptake in uncinate. Low grade NET in uncinate process demonstrate significantly higher than normal uptake and greater than normal uncinate/spleen ratio.

CLINICAL RELEVANCE/APPLICATION

SUVmax and uncinate/spleen ratio is useful for differentiating normal versus tumor. SUVmax of 25 and uncinate/spleen ratio of 1.5 are recommended reasonable cutoff values for this purpose. But tumor involvement in uncinate process should be made by not only by presentation on PET scan but correlating with other imaging findings and/or biopsy result.

SST06-05 Hepatobiliary Scintigraphy versus Ultrasound in the Evaluation of Acute Cholecystitis: An Institutional Review

Friday, Nov. 30 11:10AM - 11:20AM Room: E261

Participants
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PURPOSE

Acute cholecystitis is a common entity. Hepatobiliary radionuclide scintigraphy (HIDA) is considered the gold standard for diagnosing cholecystitis, with sensitivity up to 97%. Ultrasound (US) is the preferred modality in the initial evaluation of acute cholecystitis, due to its availability, low cost, and short examination time, despite being less sensitive than HIDA. At our institution, US is the initial imaging study of choice, and a HIDA is subsequently obtained for equivocal studies. We aim to evaluate the concordance of US and HIDA, and to identify clinical and/or laboratory parameters which may correlate with equivocal US in order to better guide patient management.

METHOD AND MATERIALS

Following institutional IRB approval, MONTAGE was used to search our reporting database between October 2016 and October 2017. HIDA results were categorized as "positive" or "negative". US results were categorized as "negative", "positive", or "equivocal" for the assessment of acute cholecystitis. Clinical and laboratory data were also collected.

RESULTS

A total of 307 patients underwent both US and HIDA (n=307) with 43% (n=132) with an equivocal US. 35% (n=107) of these patients had discordant US and HIDA. Of the cases with an equivocal US, 43% (n=57) underwent cholecystectomy. At pathology,

51% (n=29) had acute cholecystitis with a positive HIDA and 4% (n=2) had acute cholecystitis with a negative HIDA. 14% (n=8) had chronic cholecystitis with a positive HIDA, and 32% (n=18) had chronic cholecystitis with a HIDA negative for acute cholecystitis. In patients with equivocal US, HIDA had a sensitivity of 93.6% and specificity of 69.2%.

CONCLUSION

Over one-third discordance between US and HIDA can have significant clinical implications. Given the high sensitivity of HIDA in patients with equivocal US, initial evaluation with HIDA may be more appropriate in patients in whom US is likely to be equivocal, possibly leading to decreased time to surgery and length of stay.

CLINICAL RELEVANCE/APPLICATION

Our results may elucidate factors influencing HIDA/US concordance, and whether US or HIDA is a more appropriate initial test. Imaging utilization may influence length of stay and time to surgery.

SST06-06 Identification and Characterization of Myocardial Metastases in Neuroendocrine Tumor Patients Using 68Ga-DOTATATE PET-CT

Friday, Nov. 30 11:20AM - 11:30AM Room: E261

Participants
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PURPOSE

Focal 68Ga-DOTATATE PET lesions within the myocardium of neuroendocrine tumor (NET) patients are observed in clinical practice. We determined the frequency and characteristics of lesions that are consistent with cardiac metastasis and assessed the lesion detection rate of conventional imaging.

METHOD AND MATERIALS

629 patients who underwent 68Ga-DOTATATE PET-CT at a supraregional comprehensive cancer center on NET were included from a consecutive registry. Inclusion criteria were: (1) focal 68Ga-DOTATATE tracer uptake within the myocardium in more than two sequential PET exams, and (2) contrast-enhanced CT. To determine the diagnostic accuracy of conventional CT imaging, a case-control cohort with a ratio of 1:3 was used. PET and CT were independently analyzed by two blinded readers. Cohen's k was assessed for interreader agreement. Descriptive statistics were applied for frequencies and characteristics and group comparisons were analyzed using the Fisher's exact test.

RESULTS

The prevalence of myocardial metastases related to the registry was 2.4% with 15/629 NET patients fulfilling the inclusion criteria and a total of 21 focal myocardial 68Ga-DOTATATE tracer uptakes detected. Myocardial lesions were most frequently located in the left ventricle (43%) and the septum (43%). No patient demonstrated a pericardial effusion. Patients with myocardial metastases did not differ in demographics, tumor grading, disease stage or circulating tumor markers compared to the overall registry (all $p>0.05$). The patient characteristics are shown in Table 1. Higher Ki67-Indices were observed ($p=0.049$) for patients with myocardial metastases. Interreader agreement for PET assessment was excellent (Cohen's =1.0). CT reading showed a sensitivity of 19% (95% confidence interval: 6%-43%) at a specificity of 100% (95% confidence interval: 90%-100%). A patient example with a CT-detected cardiac metastasis is provided in Figure 1.

CONCLUSION

68Ga-DOTATATE PET enables detection of myocardial metastatic lesions in NET patients. In contrast, standard morphologic CT imaging provides very limited sensitivity.

CLINICAL RELEVANCE/APPLICATION

68Ga-DOTATATE PET imaging provides added diagnostic value in the initial staging of NET patients with cardiac metastasis and may provide further guidance during patient follow-up.

SST06-07 Evaluation of [18F]-FDG PET/MR Enterography in the Assessment of Ileocolonic Inflammation in Crohn's Disease - Which Surrogate Marker is Better? MaRIA, Clermont, PET, or PET-MR index?

Friday, Nov. 30 11:30AM - 11:40AM Room: E261

Participants
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PURPOSE

To define a PET-MR index as hybrid surrogate marker and evaluate the diagnostic performance of validated MR indices, PET and PET-MR index in detecting ileocolonic inflammation in Crohn's disease (CD) with an integrated whole-body PET/MR .

METHOD AND MATERIALS

53 CD patients with recurrent symptoms underwent ileocolonoscopy with biopsy (reference standard) and PET/MR enterography. 7 ileocolonic segments were divided. The endoscopic activity of inflammation was determined by Simplified Endoscopic Activity Score for CD (SES-CD) and categorized in absent, mild to moderate and severe. Receiver Operating Characteristic (ROC) curves were performed and tested against each other with DeLong' test. Correlations between surrogate markers and SES-CD were tested with Spearmann's rank correlation test.

RESULTS

303 ileocolonic segments were analyzed. A simplified PET-MR index was defined as 0.87*wall thickness + 1.97*edema + 0.83*ulceration + 0.55*SUVmax ratio + 1.14. In detecting active disease (defined as SES-CD >= 2), MaRIA, Clermont score and PET-MR Index as multiparametric indicies performed significantly better than monoparametric SUVmax ratio (areas under ROC: 0.916, 0.914, 0.924 and 0.857, $p < 0.05$). In predicting severe inflammation with ulcerations, among all the surrogate makers (areas under ROC fo MaRIA, Clermont, PET-MR index and PET: 0.962, 0.970, 0.971 and 0.935) only a slightly significant difference could be observed between MaRIA and Clermont score ($p = 0.02$) in their operating characteristics. All surrogate markers correlated moderately with SES-CD both on segmental basis and gobal level ($0.4 < \rho < 0.7$, all $p < 0.001$).

CONCLUSION

As hybrid surrogate marker comprised of MR parameters and PET component, PET-MR index yielded a significantly increased diagnostic performance compared to PET alone. However, neither in predicting active disease nor in detecting severe ulcerative inflammation, PET-MR index could outperform MaRIA or Clermont significantly. Nevertheless, PET-MR index showed the best operating characteristics among all the surrogate markers.

CLINICAL RELEVANCE/APPLICATION

PET/MR enterography provides valuable surrogate markers for assessment of active disease in Crohn´s disease.

SST06-08 Dynamic Study by PET/CT: Phantom Study and Clinical Trial on Sequential 26 Cases of Malignant Lesions of Uterus

Friday, Nov. 30 11:40AM - 11:50AM Room: E261

Participants
Eri O'Uchi, MD, Kamogawa City, Japan (*Presenter*) Nothing to Disclose
Toshihiro O'uchi, MD,PhD, Kamogawa, Japan (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

Dynamic study of PET/CT with 18F-FDG has not been reported up to now. The purpose of this study was to check the reliability of SUVmax on GE IQ PET/CT by phantom study, and to compare tumor 18F-FDG uptake between two phases of 30-second acquisition of dynamic deep-inspiration breath-hold PET/CT (BHPC) before and after 5 to 7 steps of 150-sec free-breathing PET/CT(FBPC).These sequence was named 'Dynamic study by PET/CT'.

METHOD AND MATERIALS

The PET/CT scanner was GE IQ with 26cm BGO crystal and PET images were reconstructed by patented new method of successive approximation (25-times). Before the clinical study, a phantom study was performed using an International Electrotechnical Commission body phantom set corresponding to the NU 2-2001 standard. The phantom set was consisted of a torso cavity and two spheres (inner diameters: 10, 13, 17, 22, 28, and 37 mm). The torso cavity was filled with water, and the 6 spheres were filled with 18F-FDG solutions of the same radioactivity concentration (25 kBq/mL). We studied sequential 26 patients, from 40 to 84 years old, with uterine malignant tumor including 11 cases of corpus carcinomas, 13 cases of cervical carcinomas, and 2 cases of uterus origin malignant lymphomas. On the basis of the phantom study, patients with uterine malignant tumors smaller than 13mm were excluded. Maximum tumor 18F-FDG SUV (SUVmax) was measured in FBPC and the two phases of BHPC.

RESULTS

Our phantom study revealed that BHPC was also reliable when the size of lesion was bigger than 13mm with the accuracy of one SD which was smaller than 2% of SUVmax. This reliability was markedly improved by one tenth in comparison with that of 10 years ago. On clinical study, the mean SUVmax was 18.56 with FBPC, 15.51 with the early phase of BHPC, whereas 18.15 with the delayed phase of BHPC. In dynamic study, 19.2% increase in SUVmax in delayed scan.

CONCLUSION

SUVmax obtained in the early and delayed phase of BHPC which had 15 minutes discrepancy showed a significant difference. BHPC before and after FBPC may contribute to distinguish benign lesions from malignant tumors, and this technique is feasible in the clinical setting with minimum increase in examination time.

CLINICAL RELEVANCE/APPLICATION

The new technique 'Dynamic study of PET/CT' may contribute to distinguish benign lesions from malignant tumors, and this technique is feasible in the clinical setting with minimum increase in examination time.

SST06-09 Multiparametric Evaluation by 18F-Fluorocholine PET-CT and MRI Examinations in Patients with Prostate Cancer

Friday, Nov. 30 11:50AM - 12:00PM Room: E261

Participants
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PURPOSE

To evaluate the relationship between metabolic 18F-fluorocholine (FCH) PET-CT and functional parameters derived by Magnetic Resonance Imaging (MRI) in patients with prostate cancer (PC).

METHOD AND MATERIALS

Patients with proven PC who underwent FCH PET/CT and 1.5 T multiparametric MRI were included. FCH PET/CT consisted in a dual phase: early and late whole-body acquisition. A 12x5' - 3x30' time sampling was reconstructed from the first 150 seconds of the early acquisition. A freehand FCH PET/CT volume-of-interest (VOI) with a threshold of 40% of the maximum signal intensity was drawn on the late acquisition and projected onto the early static frame of 10 min and each frame of the dynamic reconstruction. For the kinetic analysis, an imaging-derived plasma input function was estimated from VOI placed within the largest arterial blood-pool structures available on the early PET image. The pharmacokinetic modeling was the reversible one-tissue compartment model. Kinetic parameter (K1 as influx) and static parameters (early SUVmean, late SUVmean and SUVmean retention index) were extracted. Concerning multiparametric MRI, axial diffusion-weighted imaging was obtained using three b values: 0, 50 and 1300 s/mm2. Dynamic contrast-enhanced studies were obtained with intravenous administration of gadolinium-based contrast agent with a 11x13' dynamic time sampling. Using co-registration of diffusion-weighting MRI with late whole-body FCH PET/CT, a freehand VOI was drawn to obtain the mean Apparent Diffusion Coefficient (ADC). VOI was projected onto the perfusion parametric maps to extract the mean transfer constant (ktrans) and the mean volume of the extracellular space (Ve) using the Tofts pharmakinetic model. Spearman's correlation coefficients were calculated to compare imaging findings.

RESULTS

Thirteen patients were analysed. The median time interval between PET and MRI was 39 days. Concerning correlation analysis between PET and MRI parameters, K1 was significantly correlated with ktrans ($r=0.59$, $p=0.035$) and early SUVmean was significantly correlated with ADC ($r=-0.58$, $p=0.04$).

CONCLUSION

FCH influx using the reversible one-tissue compartment model is significantly correlated with the transfer constant of gadolinium-based contrast agent in prostate cancer.

CLINICAL RELEVANCE/APPLICATION

These results might be useful in the design of future clinical trials involving FCHOLINE-PET/DCE-MR for the assessment of prostate cancer.

SST07

Neuroradiology/Head and Neck (Head and Neck Imaging: Back to the Future)

Friday, Nov. 30 10:30AM - 12:00PM Room: E353A

HN MR NR

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

Participants
Brent D. Griffith, MD, Troy, MI (*Moderator*) Nothing to Disclose
Asim Z. Mian, MD, Cambridge, MA (*Moderator*) Stockholder, Boston Imaging Core Lab, LLC; Consultant, Median Technologies

Sub-Events

SST07-01 Radiogenomic Analysis Identifies Multiple Therapeutically Relevant Subtypes for Head and Neck Squamous Cell Carcinoma

Friday, Nov. 30 10:30AM - 10:40AM Room: E353A

Participants
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PURPOSE

To investigate whether radiogenomics can identify therapeutically relevant molecular phenotypes defined by genomics, epigenomics, and/or transcriptomics for head and neck squamous cell carcinoma (HNSCC).

METHOD AND MATERIALS

We included 113 HNSCC patients from The Cancer Genome Atlas Head-Neck Squamous Cell Carcinoma (TCGA-HNSC) project. Molecular phenotypes investigated were RNA-defined HPV infection, 5 epigenomic subtypes discovered by MethylMix, 4 mRNA subtypes by TCGA group, and 5 common somatic gene mutations. In total, 2,131 quantitative image features were extracted from pre-treatment CT scans. Discriminative features were selected using the Minimum Redundancy Maximum Relevance (mRMR) algorithm. Afterwards, we applied logistic regression model with the least absolute shrinkage and selection operator (LASSO) to build binary classifiers for predicting each molecular subtype. All classifiers were trained using nested stratified 10-fold cross-validation repeated 10 times and the performance metric was the average area under the Receiver Operator Characteristic (ROC) curve (AUC) of the outer loop of the nested cross-validation. Additionally, an HPV prediction model was developed using the entire TCGA-HNSC cohort, and was validated by an independent validation cohort (N = 53).

RESULTS

Our results showed that CT-based features were capable of distinguishing multiple molecular phenotypes in HNSCC. We obtained significant predictive performance for RNA-defined HPV+ vs. HPV- (AUC = 0.82), MethylMix HPV+ vs. other MethylMix subtypes (AUC = 0.85), CIMP-Atypical vs. other MethylMix subtypes (AUC = 0.73), atypical vs. other mRNA subtypes (AUC = 0.83), basal vs. other mRNA subtypes (AUC = 0.75). Furthermore, the HPV prediction model was successfully validated in the validation cohort (AUC = 0.84).

CONCLUSION

Our study demonstrates that CT-based radiogenomic analysis has the potential to predict multiple HNSCC subtypes defined by molecular biological characteristics.

CLINICAL RELEVANCE/APPLICATION

Radiogenomic analysis of CT images can enable automated non-invasive assessment of therapeutically relevant HNSCC molecular subtypes across diverse clinical settings.

SST07-02 Performance Analysis and Optimization of ACR-TIRADS Using a Genetic Algorithm: An Opportunity for Improvement?

Friday, Nov. 30 10:40AM - 10:50AM Room: E353A

Awards
Student Travel Stipend Award

Participants
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PURPOSE

To use the computer science technique of genetic algorithm to create an optimized version of the American College of Radiology Thyroid Imaging and Reporting Data System (ACR TI-RADS), and to compare the performance of the optimized system to the current version.

METHOD AND MATERIALS

1425 thyroid nodules from 1264 consecutive patients were retrospectively reviewed in this IRB-approved, HIPAA compliant study. Each nodule had either fine needle aspiration (FNA) or surgical histologic correlation. An expert reader assigned ACR TI-RADS features to each nodule. A genetic algorithm then used the TI-RADS assignments and the histologic 'ground truth' as input for a training set of 1325 nodules to create new TI-RADS feature points, numbers optimized using area under the receiver operating characteristic (ROC) curves. The algorithm-derived, optimized TI-RADS risk categories were then calculated and compared to ACR TI-RADS using a test set of 100 nodules not yet used in the algorithm.

RESULTS

The genetic algorithm created a new set of point assignments for 21 different TI-RADS features. The algorithm assigned the same number of points (as ACR TI-RADS) for 13 of the features and ascribed a new point value for 8 features (Figure). Some of the features that had point values that differed from the ACR version included mixed solid and cystic nodules, solid nodules, macrocalcifications, and taller-than-wide shape. Using the test set, sensitivity and specificity for biopsy of malignant nodules were 93% and 47%, respectively, for ACR TI-RADS and 93% and 65%, respectively, for the genetic algorithm optimized TI-RADS.

CONCLUSION

An optimized version of ACR TI-RADS derived from a genetic algorithm has similar point allocation to ACR TI-RADS, which validates many of the ACR's designated point values. The genetic algorithm version has improved specificity while maintaining sensitivity. In addition, newly proposed point values of 0 for some features may simplify the model and eliminate the need to scrutinize potentially confusing features.

CLINICAL RELEVANCE/APPLICATION

Further refinement of ACR TI-RADS points allocation by a genetic algorithm can both improve performance and simplify its clinical application.

SST07-03 MRI Texture Analysis (MTA) in the Optic Nerve During Acute Optic Neuritis (ON): Can Be Considered an Indicator of Optic Nerve Pathology or a Predictor of Visual Recovery?

Friday, Nov. 30 10:50AM - 11:00AM Room: E353A

Participants
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PURPOSE

Retinal nerve fiber layer (RNFL) thickness at Optical Coherence Tomography (OCT) is a biomarker of neuroaxonal loss and a reliable index of visual function in multiple sclerosis (MS). Our aim was to assess the correlation between MTA and RNFL thickness and between MTA and visual outcome (VO).

METHOD AND MATERIALS

We enrolled clinical 27 consecutive patients, who presented to our Emergency Department with a first episode of acute ON (15 female, 12 male; age range: 21-50 years; mean age: 34; 32 eyes: 5 bilateral ON; 10 left ON; 12 right ON) from January 2015 to January 2017. At their arrival all patients underwent a complete ophthalmological evaluation, including assessment of visual acuity and of RNFL thickness at OCT, blood tests to exclude infective or autoimmune ON, and neurological evaluation. Orbit MRI was executed within 7 days from ON onset (mean time: 3.5±3 days) including the following sequence: an axial T1 TSE performed 1 minute after contrast medium injection (gadobutrol, 1ml/10kg), slice thickness:3 mm, gap: 0.5 mm; SPIR fat saturation, FOV 18 cm, from occlusal plane to above orbits. Segmentation of the whole affected optic nerves was executed by the same experienced neuroradiologist through 3D slicer open software version 4.9.0-2017 to get texture analysis. All patients underwent a complete neuro-ophthalmological follow-up at 6 months to assess the VO, classified as: complete recovery, partial recovery, or deficit persistence/relapse.

RESULTS

At Kruskal-Wallis test, we observed a statistically significant correlation between RNFL and the following radiomics features: uniformity (p=.02), energy (p=.01), median (p=.002), 90°percentile (p=.003), 10°percentile (p=.003), gray level variance (p=.005). Analyzing the correlation between radiomics features and VO, we observed a statistically significant correlation only with kurtosis (p=.002).

CONCLUSION

Analysis of the texture in orbit MRI during the acute phase of a first episode of ON may be a potential measure of visual function in ON patients. Kurtosis proved to be correlated with VO.

CLINICAL RELEVANCE/APPLICATION

In patients affected by acute ON, radiomics features can be considered indicators of visual function and kurtosis can be used to predict VO.

SST07-04 3D-FLAIR Sequence with Delayed Acquisition After Intravenous Administration of Gadolinium Can Detect Intralabyrinthine Abnormalities in Patients Referred with Typical Vestibular Neuritis

Friday, Nov. 30 11:00AM - 11:10AM Room: E353A

Participants
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Arnaud Attye, MEd, Grenoble, France (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

The origin of vestibular neuritis (also known as acute vestibular syndrome) remains unkown. The blood labyrinth barrier is similar to the blood-brain barrier yet requiring at least 4 hours after an intravenous administration of contrast media to be evaulated on 3D-FLAIR sequences. We assessed the enhancement of the vestibular nerve and of the semi circular canals on 3D FLAIR sequences in patients with typical acute vestibular syndrome.

METHOD AND MATERIALS

In this multicentric study, 28 patients with an acute vestibular syndrome diagnosed on the basis of typical clinical findings were included. We performed 3D T2 free-precession and 3D-FLAIR sequences 4 hours after contrast media administration. Two radiologists, blinded to the clinical data, independently performed a visual assessment in order to evaluate the perilymph enhancement.

RESULTS

We found a delayed enhancement of the semi circular canals in 24 out of 28 patients (84%). The superior and lateral semi circular canals were involved in 14/24 patients (58%) while the posterior semi circular canal was involved in 4/24 patients (16%). By contrast, an enhancement of the vestibular nerve was never displayed. We found a signal loss on T2 sequences in 11/24 patients (39%). The utricle was involved in 7 patients and the posterior semi circular canal in 4 patients.

CONCLUSION

We demonstrated a significant enhancement of the semi-circular canals on 3D FLAIR sequences performed 4 hours after administration of gadolinium.

CLINICAL RELEVANCE/APPLICATION

Intratympanic therapies such as corticosteroids could be performed depending on the results of imaging in order to reduce chronic dizziness.

SST07-05 Hyperintensity of the Optic Nerve on 3D-FLAIR Imaging is Effective for Identifying Clinically Significant Papilledema in Patients with Idiopathic Intracranial Hypertension

Friday, Nov. 30 11:10AM - 11:20AM Room: E353A

Participants
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PURPOSE

Our group previously demonstrated the role of contrast-enhanced (CE) 3D-Fluid Attenuated Inversion Recovery (FLAIR) imaging in detecting papilledema in idiopathic intracranial hypertension (IIH). The purpose of this study is to determine if a correlation exists between the degree of hyperintensity of the optic nerve (ON) and optic nerve head (ONH) on CE 3D FLAIR imaging and the severity of papilledema on the ophthalmologic Frisén scale.

METHOD AND MATERIALS

In this IRB-approved study, a retrospective chart review was performed of consecutive patients with diagnosed IIH and concurrent magnetic resonance imaging (MRI) with CE 3D FLAIR sequences between 2012 and 2015; MRIs with CE 3D FLAIR sequences from age- and sex-matched control patients were also identified. Two blinded CAQ-neuroradiologists independently reviewed each MRI and graded each ON independently on a scale of 0-3: 0=normal;1=hyperintensity within the nerve without ONH involvement; 2=hyperintensity within the ON and mild inversion of the ONH; and 3=hyperintensity within the ON and significant inversion of the

ONH. To estimate the correlation between MR and Frisén scores, a non-parametric correlation coefficient (Kendall's τ) with the associated 95% BCa-bootstrapped confidence intervals (4,000 iterations) were calculated for both eyes (OS and OD) using R (3.4.3).

RESULTS

49 patients (3 males, 45 females, mean age 29.2 ±10.99) with IIH and 62 controls (5 males, 57 females, mean age 30.89 ±11.74) with normal MRIs were included in this study. For both eyes, there was moderate correlation between the two scales (OD: τ=0.48, 95%CI=(0.32,0.48),OS: τ=0.38, 95%CI= (0.24,0.50)). Inter-reader reliability for MR scores was assessed using weighted Cohen's kappa (OD: κ=0.76 95%CI= (0.55,0.88), OS: κ=0.87 95%CI= (0.78,0.94)).

CONCLUSION

CE 3D FLAIR imaging correlates with the Frisén scale for moderate to severe papilledema and less so for mild papilledema. CE 3D FLAIR sequences also allow for consistent image interpretation with excellent inter-reader reliability. These findings suggest that MRI is effective for identifying clinically significant papilledema, in a setting where prompt diagnosis is crucial and where an ophthalmology evaluation may not be readily available.

CLINICAL RELEVANCE/APPLICATION

CE 3D FLAIR is a feasible imaging technique for the detection of papilledema. Herein, we demonstrate its utility for identifying clinically significant papilledema.

SST07-06 Lacrimal Passage Diseases: Clinical Application of 3.0T MR Dacryocystography of Whole Lacrimal Passages

Friday, Nov. 30 11:20AM - 11:30AM Room: E353A

Participants
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PURPOSE

To analyze the causes of obstruction or stenosis of lacrimal passages, and to investigate the value of 3.0T MR dacryocystography of whole lacrimal passages in clinical application.

METHOD AND MATERIALS

Thirty-eight cases with lacrimal passage diseases underwent MR dacryocystography of whole lacrimal passages. Before the examination, the conjunctival sac was instilled into Sodium Hyaluronate Eye Drops after Racanisodamine Eye Drops was administrated, and 3D-SPC sequence of 2D-TSE sequence were used,which section thickness of 0.2-2.0mm,and Special Purpose Coil was employed. Each part of whole lacrimal passages included lacrimal canaliculitis was demonstrated clearly. The location and cause of obstruction and the degree of stenosis were determined in patients with lacrimal passage diseases.

RESULTS

Of 38 cases of lacrimal passage diseases, chronic inflammation of lacrimal passages(n=28 cases, 35 eyes) were found, included dacryocystitis(n=21 eyes), inflammation of nasolacrimal duct and dacryocyst(n=11 eyes) and lacrimal canaliculitis (n=2 eyes). One cases with lacrimal canaliculus and inner canthus ligament abruption was diagnosed, and congenital variation of defective lacrimal duct(n=6 cases) and stenosing lacrimal sac(n=1 cases) was diaplayed. In addition, inflammation(n=5 cases, 5 eyes) and abscess(n=2 cases) around lacrimal passage were estimated, which closed to lacrimal passages. Paracrymal tumors or tumor- like lesions include steatocystoma (n=3 cases), epidermoid cyst with rupture infection (n=1 case), mucosa-associated lymphoid tissue lymphoma involving nasolacrimal duct(n=1 case) were found. MR dacryocystography of whole lacrimal passages can accurately identified the obstructive location of lacrimal passage, respectively in the lacrimal canaliculus(n=3 cases), in the dacryocyst (n=21 eyes), and in the distal nasolacrimal duct(in=11 eyes).

CONCLUSION

MR dacryocystography of whole lacrimal passages is a absolute noninvasive examination method with higher clinical value in diagnosis of lacrimal passage and its surrounding lesions. It must be recommended as a preferred examination method of lacrimal passage lesions.

CLINICAL RELEVANCE/APPLICATION

MR dacryocystography of whole lacrimal passages can completely replace the commonly used invasive methods such as lacrimal radiography, fluorescein imaging and radionuclide imaging.

SST07-07 MR-Based Quantitative Texture and Shape Analysis: Can It Differentiate Benign and Malignant Solid Epithelial Neoplasms of the Lacrimal Gland?

Friday, Nov. 30 11:30AM - 11:40AM Room: E353A

Participants
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PURPOSE

To assess the performance of MR-based texture and shape features in the differentiation of benign and malignant solid epithelial neoplasms of the lacrimal gland.

METHOD AND MATERIALS

This retrospective study of consecutive patient data was approved by the institutional review board and informed consent was waived. 76 consecutive patients with histopathology-proven epithelial neoplasms of lacrimal gland were enrolled in the study. A total of 924 first-order histogram, grey-level co-occurrence matrix (GLCM) and gray level run-length matrix (GLRLM) textural features, as well as shape features, were extracted from T2-weighted images (T2WI) and fat-suppression post-enhanced T1-weighted images (FS post-enhanced T1WI) of these cases. The least absolute shrinkage and selection operator (LASSO) method and linear discriminant analysis were used to select imaging features and reduce data dimension to discriminate malignant lesions from benign ones. Diagnostic performance was assessed by receiver operating characteristic area under the curve (ROC-AUC) analysis and cross-validated with leave-one-out analysis. Combinations of features were also entered as classification model in logistic regression models and optimal threshold criteria were used to assess its diagnostic sensitivity, specificity and accuracy.

RESULTS

Thirty-five cases of malignant and forty-one cases of benign epithelial neoplasms were enrolled in this study. Four quantitative image features (gray level co-occurrence matrix-inverse difference moment normalized, first-order high-high mean deviation, mean radius and gray level run-length matrix high-high long run emphasis) were selected according to the LASSO logistic regression. AUC-ROC of these four features were 0.880, 0860, 0.882 and 0.857 respectively, with AUC-ROC of 0.930 for combination of all four features. Using optimum-threshold criteria, the combined features identified malignant lacrimal gland epithelial neoplasms from benign group with 92.7% sensitivity, 82.9% specificity and 88.2% accuracy.

CONCLUSION

MRI-based quantitative texture and shape analysis provided improved predictive ability in discriminating malignant epithelial neoplasms from benign ones of lacrimal gland.

CLINICAL RELEVANCE/APPLICATION

The quantitative texture and shape analysis can help lesion characterization of benign and malignant lacrimal gland tumors and allows an appropriate diagnosis and treatment strategy.

SST07-08 Deep Learning Model for Biopsy Recommendations of Thyroid Nodules on Ultrasound: Comparison of a Machine and Radiologists

Friday, Nov. 30 11:40AM - 11:50AM Room: E353A

Participants
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PURPOSE

To develop a deep learning algorithm that uses thyroid ultrasound images to decide whether a thyroid nodule should undergo a biopsy, and to compare the performance of such algorithm to expert and non-expert radiologists based on ACR TI-RADS.

RESULTS

The proposed deep learning algorithm achieved 87% sensitivity, outperforming expert consensus using ACR TI-RADS (81%) as well as five non-expert radiologists. The specificity of the deep learning algorithm was 52% which was higher than expert consensus (51%) and six non-expert radiologists. The mean sensitivity and specificity for non-expert radiologists was 80% and 48%, respectively, both lower than for our deep learning algorithm.

CLINICAL RELEVANCE/APPLICATION

Deep learning may play a significant role in assisting less experienced radiologists in FNA recommendation of thyroid nodules and may improve their sensitivity and specificity.

SST07-09 Reducing Beam Hardening Artifacts in Thyroid CT Images with Model-Based Iterative Reconstruction

Friday, Nov. 30 11:50AM - 12:00PM Room: E353A

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Yanan Zhu, Ankang, China (*Abstract Co-Author*) Nothing to Disclose
Taiping He, Xianyang, China (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To investigate the ability of a new model-based iterative reconstruction algorithm with either spatial and density resolution balance (MBIRSTND) or low-density resolution preference (MBIRNR40) to reduce the beam hardening artifacts in thyroid images, in comparison with the adaptive statistical iterative reconstruction (ASIR) algorithm.

METHOD AND MATERIALS

Twenty patients with thoracic nodules and underwent chest CT scans were retrospectively reviewed. Images at the 0.625mm slice thickness were retrospectively reconstructed with 40%ASIR, MBIRSTND and MBIRNR40 algorithms. Coronal images with the most obvious beam hardening artifacts in the thyroid were selected for comparison. The CT value and standard deviation (SD) value of the left and right thyroid lobes affected by beam hardening artifacts and the surrounding normal tissue were measured and SD values were used to calculate the artifact index (AI) in the thyroid: AI=sqrt(SDthyroid2-SDnormal tissue2). Two radiologists used a 4-point scoring system (with 4 being the best) evaluate the subjective image quality in terms of artifacts in the image and the clarity of displaying thyroids on the coronal images. ANOVA and paired t-test were used to compare the CT value difference between the normal and affected thyroid tissues and AI values of different reconstructions. Subjective score differences were tested using the Wilcoxon symbol scale.

RESULTS

MBIRSTND and MBIRNR40 images significantly reduced the CT value difference between the normal and affected thyroid tissues and the beam hardening artifacts in the left and right thyroid lobes: AI values from 2.27±0.52 and 2.52±0.85 for the left and right lobe with 40%ASIR to 1.64±0.79 and 1.75±0.80 with MBIRNR40, respectively ($P < 0.05$). MBIRSTND and MBIRNR40 had significantly higher subjective scores for thyroid and nodules than 40%ASIR, with MBIRNR40 being the highest ($P < 0.05$).

CONCLUSION

MBIR, especially the one with low-density resolution preference, can significantly reduce the impact of the beam hardening artifacts caused by clavicle on the thyroid and its nodules during CT scans.

CLINICAL RELEVANCE/APPLICATION

Beam hardening artifacts caused by clavicle affect the image quality at the entrance of the thorax and are not conducive to the quality of CT images of the thyroid and other cervical structures. MBIR can reduce this effect.

RSNA 2018 TOMORROW'S RADIOLOGY TODAY
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SST08

Pediatrics (Neuroradiology)

Friday, Nov. 30 10:30AM - 12:00PM Room: E263

MR NR PD

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

FDA Discussions may include off-label uses.

Participants
Stephen F. Kralik, MD, Indianapolis, IN (*Moderator*) Nothing to Disclose

Sub-Events

SST08-01 The Application Study on MRI Segmentation of Brain and T2MAP Sequence in Neonatal Intracranial Hypertension

Friday, Nov. 30 10:30AM - 10:40AM Room: E263

Participants
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PURPOSE

To find the MRI appearance of neonatal intracranial hypertension and study the relationship between intracranial volume (including cerebral white matter, grey matter and cerebrospinal fluid) of neonatal and intracranial hypertension, and consequently offer help for the diagnosis and treatment.

METHOD AND MATERIALS

A total of 51 suspicious intracranial hypertensive patients from the neonatology department in our hospital were included. All patients had undergone MRI examination and all of them had the result of cerebrospinal fluid pressure measured by lumbar puncture. All of the data were collected by Siemens 3.0T PRISMA. The scanning sequences included conventional T1WI, T2WI, T2FLAIR, T1MP2RAGE and T2MAP. The SMP12 software was used to do the volumetric segmentation . As for T2MAP, we counted the T2 value of bilateral frontal lobes, temporal lobes, occipital lobes and basal ganglia regions. Statistical analysis was performed using Pearson correlation analysis and independent sample T-test.

RESULTS

Our study found that there was no significant correlation between the volume of white matter or grey matter and intracranial pressure. The proportion of CSF to intracranial volume was significantly negatively correlated with intracranial pressure at 0.01 level (bilateral). The proportion of CSF to intracranial volume in the intracranial pressure normal group is significantly different from that in intracranial hypertension group. There was a significant difference in basal ganglia T2 value between the two groups. No significant difference in the T2 value of white matter of bilateral temporal lobe, frontal lobe and occipital lobe was found.

CONCLUSION

We found that CSF can provide a certain compensative capacity, while the compensative capacity of brain tissue is relatively weaker. We also found out that T2 value of basal ganglia region significantly increased in intracranial hypertensive patients, suggesting that basal ganglia region may be most common involved in encephaledemia caused by intracranial hypertension. Our study proves that MRI T1MP2RAGE and T2MAP are noninvasive and convenient and can offer a strong help for the diagnosis and treatment of neonatal intracranial hypertension.

CLINICAL RELEVANCE/APPLICATION

Our study proves that MRI T1MP2RAGE and T2MAP are noninvasive and convenient and can offer a strong help for the diagnosis and treatment of neonatal intracranial hypertension.

SST08-03 Clinical Implications of the Punctate White Matter Lesion on Brain MRI in Preterm Infants

Friday, Nov. 30 10:50AM - 11:00AM Room: E263

Participants
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PURPOSE

To investigate the association between punctate white matter lesions (PWML) on term-equivalent age brain MRI and neurodevelopment outcome in preterm infants.

METHOD AND MATERIALS

From March 2013 to March 2017, brain MRI performed around term-equivalent age in preterm infants (gestational age < 32 weeks) were retrospectively reviewed with focused on the presence of isolated PWML without other brain pathology such as cavitary white matter lesion (CWML). An analysis of the MR findings of PWML included evaluation of the number, pattern, laterality, presence of diffusion restriction and signal intensity on SWI, T2WI of PWML. The presence of combined abnormal MR findings including intraventricular hemorrhage (IVH), intraparenchymal hemorrhage (IPH), cerebellar hemorrhage, extra-axial hemorrhage and hydrocephalus were also analyzed. Clinical follow-up was performed and neurodevelopmental outcome was assessed by Bayley Scales of Infant Development scores.

RESULTS

213 infants were included in the study. Among them, 41(19.2%) of 348 have isolated PWML. Of 137 infants with neurodevelopmental outcome, 23(16.7%) infants have isolated PWML. The presence of CWML, grade III/IV IVH, IPH, and hydrocephalus were significantly associated with mental and psychomotor developmental delay (all p-values <.05). There was no significant difference of psychomotor developmental index(PDI) and mental developmental index(MDI) between infants with normal MR findings (n=71) and infants with isolated PWML (n=23) (PDI, 95.1±14.2 vs. 98.0±10.3, P=.372; MDI, 99.4±9.5 vs. 98.9±11.2, P=.604). Mental and psychomotor developmental delay was found in 8.7% and 8.7% of infants who had isolated PWML, respectively, while 4.2% and 18.3% of infants with normal MR findings showed mental and psychomotor developmental delay, without statistically significant difference between two groups (all p-values>.05). Developmental delay in infants with isolated PWML was not statistical association with number, pattern, and signal intensity on SWI, T2WI and DWI, and laterality of PWML lesions.

CONCLUSION

Isolated PWML were detected with high incidence (16.7-19.7%) on term-equivalent age MRI in preterm infants. Isolated PWML have no statistically significant association with neurodevelopmental outcome.

CLINICAL RELEVANCE/APPLICATION

Isolated punctate white matter lesion without other brain pathology in preterm infants around term-equivalent age is not correlated with an adverse neurologic outcome.

SST08-04 Abnormal Spontaneous Low-Frequency Brain Activity in Children with Repaired Tetralogy of Fallot: Resting-State Functional Magnetic Resonance Imaging Study

Friday, Nov. 30 11:00AM - 11:10AM Room: E263

Participants
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PURPOSE

The majority of previous neuroimaging studies have demonstrated both structural and functional abnormalities in children with congenital heart disease (CHD). However, few studies have focused on the regional intensity of spontaneous fluctuations during the resting state and the relationship between the abnormal properties clinical variables and the neurocognitive performances. We use the amplitude of low-frequency fluctuation (ALFF) method to explore the changes in spontaneous low-frequency brain activity in children with repaired Tetralogy of Fallot(TOF) relative to controls.

METHOD AND MATERIALS

In this study, ten repaired Tetralogy of Fallot (TOF) children and thirteen normal controls were recruited. The ALFF method was used to assess the local features of spontaneous brain activity in children with repaired TOF. The ALFF difference between repaired TOF children and normal controls was analyzed and the observed mean ALFF values of the different areas were correlated with clinical neurological assement.

RESULTS

Compared with normal controls, children with repaired TOF showed significantly lower ALFF in bilateral cerebellum, left occipital lobe, and higher ALFF in right parahippocampal cortex, left medial prefrontal cortex (MPFC), left posterior cingulate(PCC). In addition, significant, positive correlations were found between the Wechsler scale scores and the ALFF change coefficients in left occipital lobe (r = .728, P = .017; r = .818, P = .004; r = .719, P = .019; r = -.751, P = .012;), between the Wechsler scale scores and the ALFF change coefficients in left MPFC (r = .636, P = .048), and negative correlations were found between the Wechsler scale scores and the ALFF change coefficients in left cerebellum (r =-.636, P =- .048).

CONCLUSION

The significant regional spontaneous activity deficits was found in repaired TOF children, and the relation between clinical neurological assement and the ALFF change coefficients, which might offer new insights into the neural pathophysiology underlying TOF-related neurodevelopment impairments.

CLINICAL RELEVANCE/APPLICATION

Children withCHD after repaired surgery often along with neurodevelopment impairments ,including cognitive, verbal, behavioral and excution control dysfunction.This study showed correlations between the Wechsler scale scores and the ALFF change coefficients,which might provide powerful new insights into neurodevelopment impairments.

SST08-05 Classification of Seizure Onset Zones in Children with Focal Epilepsy

Friday, Nov. 30 11:10AM - 11:20AM Room: E263

Participants
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PURPOSE

In refractory epilepsy, surgical resection of epileptogenic tissue can significantly improve seizure control. Accurate identification of seizure onset zones is crucial for surgical planning as well as post-operative prognosis. iEEG, the current gold standard for seizure onset zone localization is invasive and can only provide a local assessment. Resting-state fMRI has been used to provide a systematic evaluation of whole brain network architecture. We therefore aimed to identify features of the cerebral network constructed from resting-state fMRI that are useful for seizure onset localization.

METHOD AND MATERIALS

Patients were retrospectively identified with: 1. Focal epilepsy; 2. Resting-state fMRI; 3. A single seizure onset zone identified in a multidisciplinary epilepsy conference. Brain network nodes were defined by cortical parcellation, resulting in networks containing 148 anatomic regions. We then sub-divided each region into network nodes of size 350 mm2. Edges (connections) between each pair of nodes were defined as the mutual information between BOLD time courses. Intra-region connections were summarized by the 75% quantiles of edges within a region. A machine learning algorithm, Multi-layer Perceptron, was then used to predict seizure onset lobes of each individual based on their intra-region connectivity. Classification accuracy was assessed with the leave-one-out algorithm. Each anatomic region was analyzed according to its discrimination power with respect to seizure onset localization.

RESULTS

Fifteen patients met criteria (age: 4-18 years), of which seizure onsets were identified as 5 right frontal, 3 left frontal, 3 right temporal and 4 left temporal lobes. Leave-one-out classification accuracy was 14/15 (93%). The anatomic regions with the maximum discrimination power are distributed throughout the brain consistent with the idea that focal epilepsy is associated with global network abnormalities (Figure 1).

CONCLUSION

Intra-region connectivity obtained from resting-state fMRI had a strong association to clinical diagnosis of seizure onset zone.

CLINICAL RELEVANCE/APPLICATION

Whole brain network approaches can detect features of the epileptogenic network; more complete mapping of this network could improve surgical outcomes.

SST08-06 Comparison of CT and 'Black Bone' MRI for Detection of Skull Fractures in Children with Suspected Abusive Head Trauma

Friday, Nov. 30 11:20AM - 11:30AM Room: E263

Participants
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PURPOSE

The purpose of this research was to determine the accuracy of "black bone" MRI for detection of skull fractures in children with potential abusive head trauma.

METHOD AND MATERIALS

A prospective study was performed in 35 pediatric patients who were evaluated for potential abusive head trauma. All patients had both a noncontrast Head CT (HCT) with multiplanar reformats and/or 3D volumetric reformatted images and "Black Bone" MRI of the brain with multiplanar reformatted images and 3D volumetric images. "Black Bone" MRI was performed using an ultrashort TE pointwise encoding time reduction with radial acquisition (PETRA) sequence at 1.5 T or 3T. "Black Bone" MRI datasets were post-

processed and 3D images created using Fovia's High Definition Volume Rendering software. A board certified pediatric neuroradiologist independently reviewed the HCTs and MRIs blinded to the findings from the other modality. The interpretation of the "Black Bone" MRI was compared to gold standard HCT diagnosis for skull fracture. The sensitivity, specificity, and accuracy for "Black Bone" MRI was calculated.

RESULTS

Median patient age was 4 months (range 1.2-18 months). The incidence of skull fracture was 20%. MRI demonstrated 86% sensitivity, 100% specificity, 97% accuracy, positive predictive value 100%, negative predictive value 97% for identifying skull fracture.

CONCLUSION

A "Black Bone" MRI sequence provides high sensitivity and specificity for detection of skull fractures in pediatric patients with abusive head trauma.

CLINICAL RELEVANCE/APPLICATION

"Black Bone" MRI detection of skull fractures may result in decreased utilization of CT and reduce exposure to ionizing radiation.

SST08-08 A Deep Learning System for Predicting Pediatric Brain Age Using Multi-Parametric MRI

Friday, Nov. 30 11:40AM - 11:50AM Room: E263

Participants
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PURPOSE

The dynamically evolving architecture of the developing brain in early childhood through adolescence poses diagnostic challenges for pediatric brain MRI. We propose to develop and validate an accurate deep learning model predictive of pediatric age using MRI in a multi-institutional cohort.

METHOD AND MATERIALS

In this retrospective study, we examined a dataset of 1034 pediatric brain MRIs reviewed by expert pediatric neuroradiologists and determined diagnostically normal and within the normal range of neural development. For external validation cohort, we studied 111 pediatric patients from an independent institution, which were also confirmed to be normal based on signal intensity, morphology, and absence of pathologic lesions. Patient ages ranged from 0.1 to 200 months. For biological age prediction, we developed a deep learning model (PageNet) that incorporates 2D and 3D convolutional networks using multi-parametric T1-weighted, T2-weighted, and diffusion-weighted imaging (DWI) MRI sequences. We tested our model using 5-fold cross-validation on our internal cohort and, separately, on the independent external validation cohort. Pearson's r correlation between predicted and actual age and mean-average-error (MAE) were used to evaluate model predictive performance.

RESULTS

Using multi-parametric MRI, PageNet accurately predicted pediatric age (r =0.95) in our internal cohort with a MAE of 15.8 months. Similar strong predictive performance was demonstrated on external cohort validation (r = 0.92; MAE = 20 months). Model performance using single MRI sequences was r = 0.93 for T1-weighted, r = 0.93 for T2-weighted, and r = 0.94 for DWI.

CONCLUSION

Deep learning can accurately map brain development captured by MRI to pediatric chronological age. This may serve as a useful clinical tool in assessing age-appropriate brain development and identifying developmental deviations.

CLINICAL RELEVANCE/APPLICATION

A reliable tool predictive of brain maturation can aid clinical assessment of healthy brain development and help gauge deviations of development and associated disorders in children.

SST08-09 Thrombectomy in Childhood Strokes

Friday, Nov. 30 11:50AM - 12:00PM Room: E263

Participants
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PURPOSE

As ischemic stroke is a rare but potentially severe event in children we aimed to evaluate endovascular treatment by mechanical thrombectomy for acute ischemic stroke in a pediatric patient population.

METHOD AND MATERIALS

In this retrospective trial, approved by the local institutional review board, we analyzed all patients < 18 years who were admitted to three large tertiary care centers for thrombectomy of thromboembolic intracranial vessel occlusion (Carotid-T, MCA- main stem M1 to M2- segment) within the last 5 years. Criteria to perform thrombectomy we similar compared to adult patients with acute ischemic stroke: symptoms (NIH score), time frame (onset of symptoms <6h) and imaging criteria (no infarct signs on native CT scan, mismatch in CT perfusion study and M1 vessel occlusion on CT angiography guided the decision for invasive treatment. Endovascular thrombectomy was performed using stent-retrievers alone, or in combination with thrombus aspiration. Clinical and Imaging data were extracted from electronic patient records and the picture archiving and communication system.

RESULTS

Thrombectomy was performed in a total of 12 children with a median age of 14 years (Interquartile Range IQR 7.8 to 16 years). Children presented with a median ASPECT Score of 8.0 (IQR 7.0 to 8.8) and a median pediatric NIHSS of 12.5 (IQR 8.0 to 21.5). Endovascular thrombectomy was successful in all children with acute ischemic stroke, with a TICI 2b stage in n=6 and TICI III in n=6 patients. Median pediatric NIHSS 7 days post thrombectomy was 3.5 (IQR 1 to 8), Modified Ranking Scale Score at 3 months was 1.0 (IRQ 0 to 2.0). No major complications such as arterial dissection, vessel rupture or bleeding were observed.

CONCLUSION

Our data adds to the growing evidence that thrombectomy is effective and safe not only in adults but also in children. Hence, it can be a valuable therapeutic option in childhood stroke.

CLINICAL RELEVANCE/APPLICATION

Our study adds that thrombectomy should be evaluated as a valuable option in pediatric patients presenting with acute ischemic stroke.

SST09

Physics (Nuclear Medicine, Quantitative Image Analysis in Imaging and Radiation Therapy)

Friday, Nov. 30 10:30AM - 12:00PM Room: E264

BQ CT MI NM PH

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

FDA Discussions may include off-label uses.

Participants
Chin-Tu Chen, PhD, Chicago, IL (*Moderator*) Board Member, BioMed Global; Board Member, EVO Worldwide, Inc; Board Member, AEPX; Board Member, EnDepth Vision Systems, LLC; Research Grant, DxRay, Inc; Advisor, RefleXion Medical Inc; Shareholder, EDDA Technology, Inc
Robert Miyaoka, PhD, Seattle, WA (*Moderator*) Research Consultant, MIM Software Inc; Research Grant, Koninklijke Philips NV; Research Grant, General Electric Company

Sub-Events

SST09-01 Performance Evaluation of inSPira HD: A High Resolution SPECT System for Neuroimaging

Friday, Nov. 30 10:30AM - 10:40AM Room: E264

Participants
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Joseph Ringelstein, Hines, IL (*Abstract Co-Author*) Nothing to Disclose
Sumeet Virmani, MD, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose

CONCLUSION

The measured performances demonstrated that the inSPira HD SPECT scanner has high sensitivity, high resolution, and acceptable image quality and, hence, is well suited for high resolution static and dynamic SPECT neuroimaging studies.

Background

High-resolution SPECT imaging is of great interest for studying neurological pathologies. The objective of this study is to characterize the performances of high resolution inSPira HD SPECT scanner for neuroimaging applications.

Evaluation

inSPira HD is a dedicated high resolution SPECT scanner based on a rotating dual clamshell design that acquires data in dual-spiral geometry. The performance characteristics were evaluated in terms of spatial resolution, sensitivity, uniformity, and contrast. The spatial resolution was measured from images of a line source. System volume sensitivity (SVS) was calculated using large flood phantom filled with Tc-99m. ACR Small SPECT Phantom was used to evaluate the image quality in terms of uniformity and contrast. Brain phantom and patients images were acquired to access the system more realistically.

Discussion

Spatial resolution in terms of FWHM was 4.1 mm, 4.2 mm, and 4.3 mm for X, Y, and, Z plane respectively. SVS was 9914.6 cts/sec/uci/ml. Integral uniformity for UFOV and CFOV were 4.8 % and 2.1 % respectively. Percent contrast for the five visible spheres with attenuation correction was 26%, 58%, 76%, 93%, and 99%. Brain phantom and patients images show fine details of brain regions.

SST09-02 A Novel Approach for Dosimetry of 90Y Radioembolization Based on Quantitative 99mTc-MAA SPECT/CT Imaging

Friday, Nov. 30 10:40AM - 10:50AM Room: E264

Participants
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PURPOSE

Radioembolization (RE) with 90Y-microspheres is a well-established treatment modality for treating liver malignancies. At a time of

increasing evidence for dose-effect relationships in RE with 90Y microspheres, the general consensus is that there is an urgent need for accurate dosimetry in patients undergoing RE treatment. This work aimed at estimating absorbed doses to lesions and normal liver in a novel anthropomorphic set-up.

CONCLUSION

In RE treatment planning the dose-kernel method proved to be more accurate with respect to deposition method based on full 3D dose distributions.

CLINICAL RELEVANCE/APPLICATION

Treatment planning in molecular radiotherapy is mandatory to obtain the most appropriate and effective treatment of patient. It is mandatory to validate dose quantification obtained by SPECT/CT imaging.

SST09-03 An Investigation Study of Deep Learning Convolutional Neural Network for Whole-Body PET Denoising

Friday, Nov. 30 10:50AM - 11:00AM Room: E264

Participants
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PURPOSE

The goal of this study is to investigate the quantitative impact of deep residual convolutional neural network (DCNN) configurations for PET image denoising.

METHOD AND MATERIALS

We first compared deep residual networks constructed with different numbers of layers (5 vs 8 vs 10 layers). For the 8 layers network, we also compared two versions such that one has half the number of filters of the other. We trained our networks using 64 clinical datasets representing a range of acquisition and reconstruction protocols. We evaluated the performance of different networks on 4 different human 18F-FDG studies acquired for 4 minutes per bed position. Synthetic lung and liver lesions were generated using GATE simulation and inserted into the listmode data. The listmode data were further rebinned into 2-minute and 3-minute lists in order to test the robustness of networks against different noise levels. All images were reconstructed using OSEM with 3 iterations, 10 ordered subsets and applied with a Gaussian filter (GF) at 6 mm FWHM. Quantifications were assessed by measuring the lesion contrast recovery versus variability of the background liver uptake.

RESULTS

The 10 layers and 8 layers networks with the full number of filters resulted in comparable quantitative and qualitative performance. However, the 10 layers network used 2-fold the training time than the 8 layers network did. Reducing the layers to 5 resulted in reduced lesion contrast recovery and robustness to the noise levels in the input images. Reducing the number of filters in the 8 layers network also reduced quantitative performance compared to the full 8 layers network.

CONCLUSION

The network architecture plays an important role in the denoising performance of a DCNN network. While fewer layers fail to capture the full complexity of the noise distributions, too many layers result in over-parameterization and difficulties in training without substantial performance gain.

CLINICAL RELEVANCE/APPLICATION

A properly chosen denoising neural network architecture can significantly improve noise levels over alternative architectures and help improve clinical decisions made based on resulting images.

SST09-04 Large Scale Assessment of Detectability and Estimability Indices from ACR CT Accreditation Database: Report of an ACR-RSNA Collaboration

Friday, Nov. 30 11:00AM - 11:10AM Room: E264

Participants
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PURPOSE

To assess the variability in a subset of image quality attributes of clinical CT systems using advanced task-based metrics, detectability and estimability, across the US through a collaboration between the ACR and the RSNA (QIBA).

METHOD AND MATERIALS

The ACR CT accreditation program requires institutions to submit images using the Gammex 464 phantom. Through a collaboration between the RSNA QIBA and ACR, a set of 804 randomly-selected de-identified phantom data sets were analyzed using an automated image quality estimator. These data were not filtered with regard to ACR phantom pass/fail outcome. Basic image quality metrics, including HU numbers, CNR, and noise magnitude, were automatically extracted, as well as task-specific resolution (TTF) and noise power spectra. Two advanced task-based metrics that incorporate all the aforementioned metrics were also computed: detectability index (d') and estimability index (e') for CT volumetry, both with demonstrated correlation with human and machine performance. Results from each image set were binned into specific protocols. The data were analyzed in terms of variability across protocols.

RESULTS

For task-specific resolution, despite the wide spread of the frequencies for 0.5 TTF (f50) within each protocol, the median value was largely consistent across protocols (0.40-0.41 1/mm). Noise magnitude and CNR values, related to radiation dose, were highly dependent on the protocol. The d' median values and distribution changed considerably with the task definition. Similar trends were also observed for e'. The d' and e' median values for polyethylene were 142.3, 168.1, 85.8, and 129.1; and 0.026, 0.035, 0.017, and 0.024 for adult abdomen, adult head, pediatric abdomen, and pediatric head, respectively.

CONCLUSION

Assessment of detectability and estimatiblity indices from the ACR CT accreditation database was feasible. Phantom images can be used as a surrogate to ascertain variability across clinical operations. Such data could eventually be used in the development of future conformance assessment procedures.

CLINICAL RELEVANCE/APPLICATION

Analysis of reference phantom datasets across systems and institutions through the ACR Accreditation process enables granular assessment of multi-parameter variability across our national healthcare system enabling the development of key performance indicators, qualification of quantitative performance, and potential nation-wide image quality registries.

SST09-05 A Comprehensive Platform for Automated Analysis and Reporting of QC of Medical Imaging Modalities

Friday, Nov. 30 11:10AM - 11:20AM Room: E264

Participants
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CONCLUSION

This QC platform provides a tested, comprehensive solution for analysis and reporting of QC for most medical imaging modalities.

Background

Periodic testing of image quality is part of Quality Control (QC) of medical imaging devices. Implementation of QC testing is modality and model specific. If vendor-supplied QC is available, the details are not disclosed and exporting QC results is rarely possible. Those results are needed to spot drifts in system performance and to inform all users about the time and outcome of the latest QC. To aid implementation of a department-wide multi-modality QC program, the Society for Medical Physics of the Netherlands (NVKF) devised a community-driven, open source platform for automated analysis of medical images for quality control. The platform comprises a PACS, analysis modules, a database, and web based front-ends for administration and reporting. Analysis modules are available for most modalities, including MR, CT, MG, US, DX, RF and NM. In a normal workflow a user performs a QC test and sends the images to the QC PACS. Based on DICOM metadata, the platform runs the appropriate analysis modules and stores the results in the database. The web-based interface allows immediate access to the QC results.

Evaluation

This platform has been used since 2013 in several Dutch hospitals, successfully analyzing tens of thousands of datasets. Easy access to recent reports and trend plots of QC metrics were found beneficial for successful implementation of a QC program. Due to the open-source nature of the project, analysis modules are reviewed and imporved continually.

Discussion

This platform is a community driven, open source project, with only open source third party software requirements. Its goal is a comprehensive solution for analysis and reporting of QC for all medical imaging modalities. Analysis modules were initially developed for specific models of modalities. Easy exchange of analysis modules and configurations between institutes resulted in a push from the user community towards generalizations to other models and brands. After extensive testing, the platform was publicly released.

SST09-06 An Embedded Pre-Screening Electrochemical Profile in Label-Free and Image-Free Quantified Tissue Behavioral Analysis

Friday, Nov. 30 11:20AM - 11:30AM Room: E264

Participants
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PURPOSE

To address the overcharging challenge of improving the efficiency of cancer screening programs, a label-free and image-free pre-screening tool to detect a frequency-dependent electrochemical profile (or features) of body tissues is developed and tested.

METHOD AND MATERIALS

The study reports the integration of a unique pre-screening tool to non-invasively detect and analyse electrochemical tissue attributes. This pre-screening tool consists of a unique probe configuration including 8-sub-regional probes that are symmetrical distributed in a mirror reflection. The tool uses a 4-active-probe sensing (4-AP sensing) technique through which electrochemical profile of body tissues are measured with high-contrast bioelectrical properties. Therefore, information regarding the extraction of local tissue distinguishability and quantify of tissue behaviour in the frequency domain during asymmetric pathways in the electrochemical profile can be readily assessed without the use of other invasive techniques. The pre-screening tool is also unique in that it utilizes the delivery and sensing channels in a single-probe electrochemical analytical measurement attached directly to external layers of the body (e.g., breast) skin thereby preventing irreproducibility of results.

RESULTS

The performance of the pre-screening tool has been verified by analysis of electrochemical profile using several breast tissue and phantom studies with different simulated tissue density levels at different sub-regions. The results indicated that the tool enabled to sensitively detect, quantify and distinguish the simulated breast tissue and local asymmetrical distribution. The testing results are also quite reproducible and can be offer as a personalized measurement analysis.

CONCLUSION

This research for the first time demonstrates a unique electrochemical sensing device coupled with a quantified behavioural analysis of breast tissue in an innovative pre-screening tool for label-free analysis of breast tissue bioelectrical features. In future human studies, it has potential to build a new low-cost and easy-to-use tool for pre-screening several types of cancers (i.e., breast cancer) to increase cancer detection yield and reduce false positive recalls in current screening methods.

CLINICAL RELEVANCE/APPLICATION

this is a pre-screening tool can be used to increase cancer detection yeild and reduce false-positive recalls (over-diagnosis) in current mammography screening

SST09-07 Development and Initial Evaluation of a DaTscan Digital Reference Object

Friday, Nov. 30 11:30AM - 11:40AM Room: E264

Participants
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PURPOSE

The goal of this work was to design and evaluate 123I-Ioflupane DaTscan digital reference objects (DROs) and to create realistic projection datasets from a DRO to allow testing of DaTscan image reconstruction methods.

METHOD AND MATERIALS

The initial striatal brain DRO was created from an MRI image of an age-appropriate patient. The MRI was segmented to delineate structures of interest. Each structure was assigned a value according to expected Ioflupane uptake: CSF : background : right putamen : left putamen : caudate => 0.33 : 1: 5.5 : 3.25 : 5.5. This corresponds to a specific binding ratio (SBR) of 4.5 for the caudate and right putamen and an SBR of 2.25 for the left putamen. The initial, noise-free DRO was then smoothed using 6 mm and 10 mm Gaussian filters. The three versions were analyzed by four analysis packages. Next Monte Carlo simulation was used to model SPECT acquisition of the 123I-Ioflupane DRO. The simulation included multiple energy emissions and collimator/detector response modeling. After creation of a high count projection sinogram, Poisson-resampling was used to generate sinograms of different noise levels. Projection sinograms were reconstructed on a vendor workstation. Images were then analyzed using DaTquant™ software.

RESULTS

An Ioflupane DRO developed for assessing DaTscan analysis software was tested. The SBR for the striatum varied from 2.53-3.19 (right, healthy) to 1.81-2.05 (left, diseased putamen) for the non-blurred DRO for the different analysis packages. The caudate SBRs varied from 2.4-3.6 (right) to 2.33-3.05 (left). The putamen SBRs varied from 2.56-2.7 (right) to 1.7-2.14 (left, diseased). There was similar variability for the blurred DRO images. The SBRs for the Monte Carlo simulated DRO projection images reconstructed on a vendor workstation were similar to SBRs from experimentally collected phantom data.

CONCLUSION

DROs with known 123I-Ioflupane activity distributions have been created from a patient MRI. Results reveal the variability in the

calculated SBR for different analysis software. Monte Carlo simulation data sets have been created with full models of collimator detector response for testing DaTscan analysis packages and image reconstruction methodologies.

CLINICAL RELEVANCE/APPLICATION

DROs can be used to test/compare vendor analysis packages. Further, Monte Carlo simulations of DROs can be used to test/validate enhanced image reconstruction methods for 123I-Ioflupane brain imaging.

SST09-08 Quantitative Iodine Maps from Spectral Detector Computed Tomography in Daily Practice: A Real World Study in 60 Patients

Friday, Nov. 30 11:40AM - 11:50AM Room: E264

Participants
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PURPOSE

Iodine maps are available from spectral detector computed tomography (SDCT). They visualize the distribution of iodinated contrast media and allow for its quantification. While the accuracy of such maps has been investigated ex vivo in phantoms under optimized conditions, this study aimed to evaluate their accuracy in routine examinations.

METHOD AND MATERIALS

We designed a reference object consisting of 5 tubes filled with potassium iodide solutions of different concentrations (0.0, 0.8, 1.6, 3.2, 4.8 mg/ml). In 60 patients (31 male, mean age 65.2±11.4 years) who underwent routine SDCT of the abdomen, the reference object was positioned within the scan region at random positions/orientations. Iodine maps (IM) were reconstructed using the vendor provided algorithm. Two circular regions of interest were drawn in each tube, mean and standard deviation within each ROI were determined and averaged. Difference between IM and known iodine concentration was calculated. We performed a confounder analysis for BMI and radiation dose. In addition, we developed a software that allows for automatic measurement of the anterior-posterior and left-right diameter of each patient and further, computes a three-compartment model of the examined tissue (fat, bone, lean); all parameters were considered as possible confounders in statistic assessment.

RESULTS

Overall, iodine maps had a high accuracy as indicated by an offset of -0.01±0.12 mg/ml despite their random placement. The offset was found greater in low concentrations (relative offset in 0.8 and 4.8 mg/ml tubes: +6.5% and +1%, respectively). While smaller BMI tended to overestimate iodine content, greater BMI tended to underestimate iodine concentrations. Besides BMI, volume of bone was found to be a strong confounder regarding iodine quantification accuracy.

CONCLUSION

Iodine quantification using iodine maps from SDCT is technically feasible in routine examinations. When considering estimated concentrations for clinical decision making, increased caution is recommended in low concentrations, in skinny and obese patients and in images with presence of large amount of bone.

CLINICAL RELEVANCE/APPLICATION

Iodine quantification in daily practice is feasible with high accuracy using iodine maps from SDCT.

SST09-09 Quantifying Liver Iron Content Using Photon-Counting Detector Based Computed Tomography

Friday, Nov. 30 11:50AM - 12:00PM Room: E264

Participants
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PURPOSE

In a phantom. to quantify liver iron content using multi-energy photon-counting detector (PCD) CT and an image-based material decomposition technique.

METHOD AND MATERIALS

A wet liver analog was synthesized using dry liver extract (1:7 dilution of dry liver in water) to yield a base CT number enhancement of 50 HU at 140 kV, similar as that of normal human liver. Iron concentrations (iron III nitrate) were prepared at 1.8, 2.8 and 5.6 mg/mL with either wet liver or water as a solvent. Cylindrical vials containing approximately 10 mL of pure liver, iron-liver and iron-water solutions were placed inside a 20 cm multi-energy CT phantom (Gammex, Sun Nuclear, WI), and scanned using a whole-body PCD-CT system (Siemens CounT, Forchheim, Germany) at 120 kV, 178 mAs (CTDIvol = 13 mGy) and energy thresholds of 25, 63 keV. Multi-energy PCD-CT images were reconstructed at [25, 120] keV, [63, 120] keV and [25, 63] keV energy ranges using a quantitative smooth kernel (D30). Quantitative iron maps were obtained using an in-house material decomposition

technique with the [25, 120] keV and [63-120] keV images assuming 3 base materials: liver, water and iron. The image domain material decomposition (MD) algorithm is based on spectral prior image constrained compressed sensing (MD-SPICCS) which combines material decomposition and denoising into a unified framework. The mean density (mg/mL) of iron content was estimated from the iron maps generated using MD-SPICCS. A linear regression analysis was performed to compare measured iron concentrations in liver background with known true concentrations.

RESULTS

MD-SPICCS was able to successfully detect and quantify iron from liver background in the phantom images. Liver background from the iron-liver mixtures was assigned to the liver map, while water background from the iron-water mixtures was assigned to water map. Linear regression showed excellent correlation between measured and true iron concentrations in the iron-liver mixtures (slope = 1.1, R2 = 0.9997, RMSE =0.6 mg/mL).

CONCLUSION

We have demonstrated accurate iron quantification in a liver phantom scanned using the PCD-CT system and an image-based material decomposition technique. Measured iron concentrations showed excellent correlation with the ground truth.

CLINICAL RELEVANCE/APPLICATION

Diagnosing hemochromatosis characterized by liver iron overload using imaging methods requires accurate iron quantification to facilitate and monitor therapy.