BRS-TUA

Breast Tuesday Poster Discussions

Tuesday, Dec. 3 12:15PM - 12:45PM Room: BR Community, Learning Center

BR

AMA PRA Category 1 Credit ™: .50

Participants

Jung Min Chang, MD, Seoul, Korea, Republic Of (*Moderator*) Nothing to Disclose

Sub-Events

BR233-SD-TUA1 Overweighting of Individual Outcomes is the Main Source of Base Rate Neglect in Mammography

Station #1

Participants
Fallon Branch, MS, Augusta, GA (*Presenter*) Nothing to Disclose
Jay Hegde, PhD,MS, Augusta, GA (*Abstract Co-Author*) Nothing to Disclose

PURPOSE

To quantitatively characterize the roles of various contributing factors to base rate neglect (or base rate fallacy) in mammography, wherein radiologists fail to adequately take into account the prevalence of a given outcome (e.g., breast cancer) in the relevant patient population.

METHOD AND MATERIALS

Fourteen practicing radiologists volunteered for this study. Subjects were simultaneously given three pieces of information: (1) The base rate of breast cancer in the given cohort of patients, (2) The hit rate and false alarm rate of a machine learning system for breast cancer detection, and (3) The binary decision of the system (+ve or -ve for cancer) for a given mammogram from the present patient cohort. Using only this information, subjects had to estimate, using an on-screen slider, the percent chance that the mammogram in question is actually positive breast cancer. We systematically varied the above three pieces of information and measured its effect on the subjects' reports.

RESULTS

The estimated probability of cancer was significantly anti-correlated with the theoretically expected probabilities (r = -0.39; df = 3148; t = -23.41, $p << 0.05$; see figure), indicating that base rate neglect had a significant biasing effect in this case. A general linear model of the data revealed that item #3 above (i.e., binary decision) made a large, statistically significant contribution to the outcome (t = 20.87; p < 2e-16). The false alarm rate had a modest effect (t = -2.28; p = 0.02). Base rate (item #1 above) did not have a significant effect (t = -0.33; p = 0.74).

CONCLUSION

Information about the cancer status in individual case, 'individuating information', had a disproportionately large effect, and the base rate had a statistically insignificant effect on the subjects' estimates of the probability of cancer. This is consistent with the results of previous studies of the sources of the base rate fallacy in other, non-clinical contexts.

CLINICAL RELEVANCE/APPLICATION

This study suggests, albeit does not prove, that base rate neglect in mammography arises primarily because radiologists attach too much importance to individuating information, i.e., the cancer status of individual mammograms.

BR234-SD-TUA2 The Usefulness of Bayesian Network in Assessment of Triple-Negative Breast Cancer Risk

Station #2

Participants
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PURPOSE

To determine whether a Bayesian network model learned from epidemiologic, clinical, and pharmacokinetic quantitative dynamic contrast-enhanced (qDCE) MRI parameters can aid in preoperative classification of triple-negative breast cancer (TNBC)

METHOD AND MATERIALS

The institutional review board exempted this retrospective study from requiring informed consent. 197 women (mean age ± standard deviation, 50.43±10.25 years) with breast cancer confirmed by surgical pathology were included from April 2016 to August

2017. All patients underwent DCE MRI within one week before surgery. The pattern of the time of intensity curve and pharmacokinetic parameters were derived from DCE-MRI for each lesion. The epidemiologic and clinical parameters were also collected. By using 5-fold cross validation, a Bayesian network model was trained and tested to estimate TNBC risk based on epidemiologic, clinical, and qDCE MRI pharmacokinetic parameters. Probability estimates were used to build receiver operating characteristics (ROC) curves, and the performance of the Bayesian network was evaluated by using area under the ROC curves (Az), positive predictive value (PPV), and accuracy.

RESULTS

The established Bayesian network consisted of 21 features that were conditionally dependent on each other. Posttest probability table of the deterministic node showed that patients with age 0.186 tend more likely to have TNBC, while patients with age < 35 years and a mass-like lesion, or patients with age between 35 and 50 with non-mass-like lesion are almost impossible to have TNBC. The Bayesian network model showed good performance in terms of Az (0.731, 95% CI: 0.635-0.828), PPV (0.397, 95% CI: 0.257-0.538), and accuracy (0.834, 95% CI: 0.738-0.930) when the threshold level of posttest probability was set as 0.163 (95% CI: 0.114-0.211).

CONCLUSION

Bayesian network model with integration of epidemiologic, clinical, and qDCE MRI pharmacokinetic parameters can be used to predict the risk of TNBC in women with breast cancer.

CLINICAL RELEVANCE/APPLICATION

Bayesian network model can be used to predict the risk of TNBC in women with breast cancer by using epidemiologic, clinical, and qDCE MRI findings..

BR235-SD-TUA3 Independent Validation of Diagnostic Machine Learning Radiomics on a Large Clinical Dataset of Consecutive Breast MRIs

Station #3

Participants
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PURPOSE

To evaluate radiomic machine learning in the task of distinguishing between malignant and benign breast lesions on a consecutive, independent MRI clinical dataset from China.

METHOD AND MATERIALS

Retrospective analysis was conducted of consecutive breast MRI images from 1,483 breast cancer and 496 benign patients who underwent MRI examinations between February 2015 and October 2017. The age range of the cancer and benign patients were 19 to 77 and 16 to 76 years old with an average of 48.1 and 42.1 years, respectively. Database was divided into a training dataset (years 2015 & 2016; 1444 cases) and an independent testing dataset (year 2017; 535 cases) based on MRI examination date. Once a lesion is localized on the radiomics workstation, the computerautomatically segments and extracts radiomic features, which are merged with an SVM (support-vector machine) yielding a lesion signature malignancy score. On the independent, consecutive clinical dataset, the area under the ROC curve served as the primary figure of merit in the classification task for all lesions as well as only mass lesions and only non-mass lesions.

RESULTS

In the task of distinguishing malignant and benign breast lesions on DCE-MRI, the trained radiomic signature yielded an AUC value of 0.89 (se = 0.02) on the independent test dataset. For mass lesions only and non-mass lesions only, the trained signature yielded AUC values of 0.88 (se = 0.02) and 0.90 (se = 0.03), respectively. Compared with the actual clinical management decisions, the predictive model achieved 99.5% sensitivity with 9.6% fewer recommended biopsies.

CONCLUSION

On an independent, consecutive clinical dataset from China, a trainedMRI radiomics signature yielded high performance in distinguishing between malignant and benign breast lesions.

CLINICAL RELEVANCE/APPLICATION

Our computerized radiomic analysis method has potential to aid clinicians in improving breast cancer diagnosis and patient management.

BR265-SD-TUA4 Diffusion Tensor MRI in the Diagnostic Workup of Pregnancy Associated Breast Cancer (PABC): Clinical and Technical Considerations

Station #4

Participants
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PURPOSE

To review the preliminary data of breast DTI studies among pregnant and lactating patients, focusing on the opportunities for additive diagnostic value in screening, diagnosis and management of PABC, as well as the current drawbacks and technical challenges

METHOD AND MATERIALS

All patients were prospectively scanned on 1.5T MRI. Pregnant patients (n=40) were scanned in prone position using unenhanced protocol including DTI and T2-weighted sequences, whereas lactating patients (n=43) were scanned by DTI together with conventional protocol, including dynamic contrast enhanced (DCE). Imaging indications included pre-treatment evaluation of newly diagnosed PABC (n=24) as well as screening of high-risk patients and diagnosis of breast symptoms. DTI was acquired applying 32 diffusion gradients in using b-values of 0, 700 s/mm2 during 09:38min. DTI parametric maps were generated and analyzed at pixel resolution and were compared with reference to conventional imaging and pathology.

RESULTS

All scans of pregnant patients were technically completed and reached diagnostic quality, except one with notable motion artifacts due to positional discomfort. Examinations of lactating subjects were characterized with better signal-noise ration and reduced artifacts. The newly diagnosed PABC lesions were visible on the DTI maps of λ1, λ 2, λ 3, mean diffusivity (MD), and λ 1- λ3, with substantial parametric contrast compared with the apparently normal contralateral fibroglandular tissue ($P<0.001$ for all), except for two sub-centimeter lesions that were below the detection resolution. A representative example of DTI results in pregnant patient is given in Fig1. Comparison of the contrast-noise ratio between DTI and DCE among lactating patients, revealed higher CNR for λ1 and MD. Further comparison with tumor measurements between the two MRI methodologies showed high congruency. Negative findings were found in the screening and symptomatic cohorts.

CONCLUSION

DTI is well tolerated and may serve as a standalone technique in evaluation of pregnant patients, and as a valuable adjunct modality during lactations. Yet, further clinical trials are required to demonstrate the additive value of this approach in achieving earlier diagnosis of PABC.

CLINICAL RELEVANCE/APPLICATION

This work may open the door for new screening and diagnosis strategies during the periods of pregnancy and lactation, in which current practice is limited.

BR266-SD-TUA5 Perceived Realism of Generative Adversarial Network-Derived Synthetic Mammograms

Station #5

Participants
Dimitrios Korkinof, London, United Kingdom (*Abstract Co-Author*) Employee, Kheiron Medical Technologies ltd
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Gareth Williams, London, United Kingdom (*Abstract Co-Author*) Employee, Kheiron Medical Technologies Ltd
Edith Karpati, Budapest, Hungary (*Abstract Co-Author*) Employee, Kheiron Medical Technologies
Ben Glocker, PhD, London, United Kingdom (*Abstract Co-Author*) Research Consultant, Kheiron Medical Technologies Ltd
Tobias Rijken, London, United Kingdom (*Presenter*) Stockholder, Kheiron Medical Technologies Ltd

PURPOSE

Quality assessment of generative adversarial network (GAN)-derived images, both during training to detect model collapse and more importantly afterwards for model performance evaluation and comparison purposes, is notoriously difficult to do. Several metrics (inception, Frechet inception and sliced Wassestein's) have been proposed, but none provide an objective assessment of perceived realism. We designed a simple randomised comparison study to determine whether high resolution GAN-derived medical images could be distinguished from real ones as a proxy measure for perceived realism.

METHOD AND MATERIALS

Mammographic MLO-views were selected from a pool of 1000 real and 1000 high resolution GAN-derived images. Randomly assigned GAN-derived/real image pairs were displayed in a custom tablet app, with image pinch and zoom capability, and assigned to the left and right of the screen on a 'coin-toss' upon presentation. Attendees at a large radiology conference were asked to assess 10 randomly-paired cases with no time limit, and select which of the two presented images were real. No two image pairs were ever identical, and once presented an image was removed from the pool for that participant's session.

RESULTS

117 participants took part: 55 were radiologists (82% board certified, 60% specialised in breast radiology). The remaining 62 were non-radiologists. Chi-square goodness-of-fit test with the null hypothesis being that our observations were drawn from a binomial distribution with success probability $n= 0.5$ gave a p-value of 0.999, which indicates failure to reject the null hypothesis at any significance level for all participant groups. Radiologists had a slightly wider distribution spread, but no significant increase in performance compared to non-radiologists.

CONCLUSION

The spectrum of correct identification rate for real images from the GAN-derived/real image pairs approximated to a normal distribution for all sub-groups (all participants, radiologists and non-radiologists) indicating that participants were effectively random in their choice. This suggests that GAN-derived synthetic mammography images are perceived to be as realistic as, and therefore indistinguishable from, real mammography images.

CLINICAL RELEVANCE/APPLICATION

GAN-derived medical images are indistinguishable from real ones. Further research is required to assess whether these can be used to augment training/validation datasets for machine learning tasks.

BR267-SD-TUA6 Weakly-Supervised Deep-Learning Modeling on Sub-Volumes for Pre-Assessment of Digital Breast Tomosynthesis

Station #6

Participants
Emine Doganay, PhD, Pittsburgh, PA (*Presenter*) Nothing to Disclose
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PURPOSE

Digital breast tomosynthesis (DBT) is a quasi-3D imaging modality which can increase cancer detection and reduce false recalls. It, however, entails a much larger volume of imaging data to read, decreasing the time-efficiency of radiologists. In this study, we leverage a weakly supervised approach to build deep learning models to improve radiologists' reading, where the model performs a pre-reading to DBTs to identify potential examinations that are more likely to have malignancy or be breast cancer free.

METHOD AND MATERIALS

This retrospective study includes 546 patients (205 malignant and 341 benign cases, all confirmed by pathology), each having a DBT acquired between 2017-2018 at the same institution. Considering the 3D nature of DBT and the varying length of slice numbers (ranging 31 to 111) per breast across the patients, we proposed a sub-volume (i.e., 11 consecutive slices)-based scheme for 3D-based classification. A total of 1005 and 1753 sub-volumes were generated from the malignant and benign cases, respectively, for multi-sub-volume-based analysis. No lesion segmentation/labeling was performed in any slices; instead, only a weak label of 'malignancy' or 'benign' was given to each sub-volume. We constructed 3D convolutional neural network models using the shallow VGG-19 to perform three binary-classification tasks: (1) malignant vs. all benign, (2) malignant vs. BI-RADS 2&3 benign (109 cases), and (3) malignant vs. BI-RADS 4a&4b&4c benign (168 cases). Patient-wise 10-fold validation was performed, using AUC and sensitivity/specificity to measure model performance.

RESULTS

Average AUC was 0.72 (range 0.70-0.74) when using all benign cases in task 1. For the sub-group analysis, we observe an increased AUC of 0.74 (range 0.72-0.77) in task 2 and a decreased AUC of 0.60 (range 0.50-0.69) in task 3. In particular, a high specificity (0.89) is observed for task 1 and high sensitivity (0.91) is observed for task 2. The ROC curves are given in the attached figure.

CONCLUSION

Without the need of lesion segmentation and labeling, our deep learning method can effectively identify potential concerning DBT scans of reader's interests (more likely to have malignancy or be normal).

CLINICAL RELEVANCE/APPLICATION

Volumetric deep learning models can be a helpful tool to pre-read DBT scans for radiologists, with the promise to optimize reading priority, shorten reading time, and reduce unnecessary biopsy.

BR203-ED-TUA8 Breast Radiotherapy: What the Breast Radiologist Should Know

Station #8

Participants
Matthew Parsons, MD, Salt Lake City, UT (*Presenter*) Nothing to Disclose
Kristine Kokeny, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose
Nicole S. Winkler, MD, Cottonwood Heights, UT (*Abstract Co-Author*) Nothing to Disclose

TEACHING POINTS

The purpose of this exhibit is to: 1. Familiarize radiologists with current breast radiotherapy approaches in the setting of breast conserving therapy 2. Explain the rationale behind radiation treatment approaches including data from selected landmark trials 3. Review indications and techniques for post mastectomy radiation and how imaging impacts decision making 4. Review common radiation related side effects and the natural history of the radiated breast both clinically and on imaging 5. Address frequently asked patient questions with regard to breast radiation

TABLE OF CONTENTS/OUTLINE

-Basics of breast radiotherapy -Radiation oncology workflow and general treatment timeline -Radiation in the setting of breast conserving therapy -Whole vs. partial breast irradiation -Nodal management -Omission of radiation in selected patients -Radiation for DCIS -Post mastectomy radiation -Toxicity of breast radiation

BR204-ED-TUA9 How Artificial Intelligence May Help Improve Accuracy and Reading Times in the Interpretation of Digital Breast Tomosynthesis Screening Studies

Station #9

Participants
Emily F. Conant, MD, Philadelphia, PA (*Presenter*) Grant, Hologic, Inc; Consultant, Hologic, Inc; Grant, iCAD, Inc; Consultant, Advisory Panel, iCAD, Inc; Speaker, iiCME
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TEACHING POINTS

Artificial Intelligence (AI) may help radiologists improve the accuracy of digital breast tomosynthesis (DBT) interpretations while also decreasing reading times when AI data is presented concurrently compared to reading DBT without AI. The AI data is presented at the lesion-level as outlines on DBT slices. AI confidence of malignancy scores are also provided at the lesion-level and case-level.Although AI may have high standalone performance, it will miss some cancers, so readers should not overly rely on AI when suspicious lesions are not outlined by AI. Conversely, AI may outline some non-malignant lesions, and readers must balance the lesion score with their characterization of such lesions to determine the appropriate action.

TABLE OF CONTENTS/OUTLINE

This exhibit demonstrates concurrent use of a deep learning-based AI system for DBT that detects soft tissue and calcific lesions in DBT slices and provides lesion outlines and calibrated confidence scores at the lesion-level and case-level.Example cases are from a reader study with 24 radiologists each reading 65 cancer and 195 non-cancer cases both with and without AI showing significant improvements, on average, in AUC, sensitivity, specificity, recall rate and reading time. Cases include examples where AI either increased or decreased sensitivity and/or specificity and reading time.

BR205-ED-TUA10 Abbreviated Breast MRI: Past, Present, and Future

Station #10

Participants
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Nicoli T. Yoshimi, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose
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TEACHING POINTS

The purpose of this exhibit is: - To present the current status and the future applicability of abbreviated MRI. - To discuss the different abbreviated MRI protocols. - To demonstrate how the use of abbreviated MRI can reduce examination time, reading time and costs. - To show the limitations of abbreviated MRI. - To compare the differences in performance between abbreviated and full protocol MRI.

TABLE OF CONTENTS/OUTLINE

- Introduction and history of the development of abbreviated MRI. - The importance of reducing MRI costs for health systems. - The impact in clinical practice of reducing examination time and reading time. - A systematic approach to the use of abbreviated MRI on screening. - Technique of the various abbreviated MRI protocols. - Differences in sensitivity and specificity of MRI between abbreviated and full protocols. - Limitations of abbreviated MRI. - Future directions: what is on the horizon for abbreviated MRI. - Summary and conclusion.