S-01

Clinical Practice and Experience Sharing of Breast Ultrasound with AI (Artificial Intelligence) Assistance

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The integration of artificial intelligence (AI) into breast ultrasound has revolutionized clinical practice, enhancing diagnostic accuracy and efficiency. Breast ultrasound, a vital tool in breast cancer detection and management, traditionally relies heavily on the operator's expertise. However, AI assistance breast ultrasonography may augment the capabilities of this imaging modality and ultrasonography performing.

At Taichung Veterans General Hospital (TVGH), we have incorporated TaiHao Medical Inc.'s BU-CAD and BR-FHUS Smart Systems into our clinical workflow. These AI-powered systems provide real-time analysis and support, improving the detection and characterization of breast lesions. The BR-FHUS system excels in computer-aided breast navigation and detection, highlighting suspicious areas for further evaluation, while the BU-CAD system offers advanced functionalities for functional and morphological assessment of breast tissue, assisted breast ultrasonography report formation.

Our experience at TVGH has shown that the integration of these AI systems have also proven to be efficiency in the education and training of PGY (Post Graduate Year) and junior resident surgeon. The AI systems provide immediate feedback and guided learning opportunities, accelerating the development of their diagnostic skills and confidence in performing breast ultrasounds.

In conclusion, the use of AI-assisted breast ultrasound systems at TVGH has greatly benefited both clinical practice and medical education. The experience gained from implementing TaiHao Medical Inc.'s technologies underscores the potential of AI to transform breast imaging, offering improved outcomes for patients and enhanced learning experiences for future radiologists.

S-02

AI Application in Breast Ultrasound

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Ultrasound is the most challenging breast image method for AI development and applications, yet the most promising with its non-invasiveness and wide applications in screening, diagnosis, and disease monitoring. As the accuracy of traditional hand-held ultrasound (HHUS) is deeply affected by operator experience, machine model, and numerous patient factors, AI model development may require high quality database collected according to the intended application. With technologies such as deep learning (DL) and convolutional neuron network (CNN), AI models have been designed for lesion detection, segmentation and classification with accuracy ranging from 76% to 99.1%.

Currently, there are three commercially available AI tools for HHUS approved by FDA, including S-Detect, Koios Decision Support, and BU-CAD. All of them provide lesion classifications corresponding to BI-RADS, and BU-CAD (TaiHao Medical, Inc., Taiwan) is the only one with detection functionality, which provides automated regions of interest (ROIs) of a lesion, while the other two require the operator to mark the center of the lesion of interest. Overall, current application of AI for breast ultrasound includes 1) Interpretation of beast lesions on ultrasound, 2) Triage of patients with palpable masses in lower-resource settings, 3) Teaching tool for less experienced ultrasound operators, and 4) Evaluation and prediction of disease status is individuals diagnosed with breast cancer.

Other potential applications of AI algorithms may be promising in prediction of axillary lymph node metastasis, prediction of neoadjuvant chemotherapy response, prediction of molecular subtype of breast cancer, prediction of breast cancer prognosis, prediction of surgical upstaging risk of ductal carcinoma in situ (DCIS), and guidance for breast-conserving surgery. However, challenges of AI application in breast ultrasound do not limit to training database or lesion types, but also cost and reimbursement of AI, post-implementation evaluations, and liability issues.

S-03

Backscatter Ultrasound Imaging and Its Applications to OSA Diagnosis and Treatment

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In this talk, I'll report two studies investigating the potential standardized Backscatter Ultrasound Imaging (BUI) as a noninvasive and cost-effective method for assessing OSA severity and predicting treatment outcomes.

The first study focused on correlating BUI measurements of the tongue with OSA severity as measured by the apnea-hypopnea index (AHI). We found a significant association between backscattered statistical values and AHI, suggesting that BUI could be a valuable tool for identifying individuals with OSA.

The second study explored the predictive value of BUI for response to hypoglossal nerve stimulation (HNS), a trending treatment for OSA. The results showed that BUI measurements of tissue composition were highly predictive of HNS response, with patients exhibiting less fat deposition being more likely to benefit from the treatment.

Overall, these studies demonstrate the potential of BUI as a valuable clinical tool for assessing OSA severity, guiding treatment decisions, and predicting treatment outcomes. By providing a noninvasive and cost-effective method for evaluating upper airway anatomy, BUI can help improve the diagnosis and management of OSA.

S-04

Ultrasound Backscattering Analysis and AI Applications for Liver Disease Diagnosis

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Non-alcoholic fatty liver disease (NAFLD) is a broad term encompassing a range of liver conditions not caused by excessive alcohol use. It starts with hepatic steatosis, a condition characterized by the accumulation of excess fat in the liver cells, which can progress to more severe liver damage if not addressed. NAFLD can evolve into non-alcoholic steatohepatitis (NASH), where liver inflammation and cell damage accompany fat accumulation. As NASH progresses, it can lead to liver fibrosis, the scarring of liver tissue that disrupts liver function. Early diagnosis and intervention are crucial in preventing NAFLD from escalating to liver fibrosis and cirrhosis, highlighting the need for sensitive diagnostic tools and awareness of the disease's progression. Ultrasound is essential for initial screening and monitoring of NAFLD, but its limitations highlight the need for ongoing research and development of more precise imaging modalities to improve diagnostic accuracy, especially in the critical transition from NASH to fibrosis. In this presentation, we introduce updated ultrasound techniques based on backscattering analysis, omics, and deep learning approaches for characterizing hepatic steatosis, liver fibrosis, and NASH.

S-05

Deep Learning Technology for Improving the Ultrasound Imaging Quality and its Medical Applications

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Ultrafast ultrasound imaging based on plane wave (PW) compounding has been proposed for use in various clinical and preclinical applications, including shear wave imaging and super resolution blood flow imaging. Because the image quality afforded by plane wave imaging is highly dependent on the number of PW angles used for compounding, a tradeoff between image quality and frame rate occurs. In the present study, a convolutional neural network (CNN) beamformer based on a combination of the GoogLeNet and U-Net architectures was developed to replace the conventional delay-and-sum (DAS) algorithm to obtain high-quality images at a high frame rate. RF channel data are used as the inputs for the CNN beamformers. The outputs are in-phase and quadrature data. Simulations and phantom experiments revealed that the images predicted by the CNN beamformers had higher resolution and contrast than those predicted by conventional single-angle PW imaging with the DAS approach. In in vivo studies, the contrast-to-noise ratios (CNRs) of carotid artery images predicted by the CNN beamformers using three or five PWs as ground truths were approximately 12 dB in the transverse view, considerably higher than the CNR obtained using the DAS beamformer (3.9 dB). Most tissue speckle information was retained in the in vivo images produced by the CNN beamformers. In conclusion, only a single plane wave at 0° was fired, but the quality of the output image was proximal to that of an image generated using three or five plane wave angles. In other words, the quality–frame rate tradeoff of coherence compounding could be mitigated through the use of the proposed CNN for beamforming.

S-06

The Preset and Future of Specialist Ultrasound

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Due to the significant advancements in computational technology, the application of artificial intelligence (AI) across various industries has started to thrive. The use of AI in medical imaging is also gradually increasing. Ultrasound, due to its non-invasive, real-time, and safe nature, is one of the fastest-growing medical imaging modalities for AI development. With the intervention of AI, ultrasound is increasingly becoming specialized. This presentation will share insights from an industry perspective on the applications of AI in ultrasound, as well as the specialized applications driven by AI intervention.