A Deep Learning Artificial Intelligence Algorithm Helps Pathologists Improve Diagnostic Accuracy and Efficiency in the Detection of Lymph Node Metastases in Breast Cancer Patients.

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Background:
The detection of metastases to lymph nodes constitutes an essential task in breast cancer staging because it affects therapy choice, survival, and insurance claims, and the positivity of pathologists at this task is suboptimal. This highlights the need for AI techniques to assist pathologists in detecting tumor metastases to lymph nodes, which could potentially improve their diagnostic accuracy and reduce time spent on this task.

Design:
An AI algorithm was trained using multiple instance learning, a weakly supervised deep learning approach whereby the digitized glass slide images (shown on whole slide image or WSI) is paired with its corresponding pathology report. More than 90,000 breast verified lymph node WSI from more than 6,000 patients were used to train this algorithm, which is designed to highlight areas suspicious for lymph node metastases in digital WSI lymph node images. These algorithms were asked to review a challenging dataset comprising 90 breast verified lymph node WSI of which the 15,000 digitized images were digitized images for challenging cases. Sixty-six slides were breast images. The pathologists read the dataset twice, both digitally without AI assistance and with AI assistance, and they were asked to rate their slide head diagnosis and time spent during their read.

Results:
The average sensitivity of the pathologists during the assisted phase was 75%. The average sensitivity during the assisted phase was found to be significant compared to the unassisted phase. Compared to the reading time in seconds, the accuracy was much higher during the unassisted phase, compared to 25 seconds per slide during the assisted phase. The average reading time was reduced to 157 seconds per slide on the unassisted phase. Whether the pathologists were assisted by AI. These shorter reading times applied to both benign and malignant WSI regardless of metastasis size.

AI Displays Suspicious Areas

Fig. 1. AI displays suspicious areas on whole slide images. (Left) A whole slide image of a lymph node with metastatic disease. (Right) The same slide with AI assistance. The suspicious areas are highlighted by the algorithm. (Right) A whole slide image of a lymph node without metastatic disease. (Right) The same slide with AI assistance. The suspicious areas are highlighted by the algorithm.

A Pathologists ROC Curve

B Diagnostic Sensitivity

C Average Time Required Per Slide

Fig. 2. A. Receiver operating characteristic curve for the pathologists in the presence of the tool. The area under the curve was 0.95 for the tool version and 0.90 for the tool version without AI assistance. The pathology tool assisted AI has the emission to score the WSI for which it was trained.

12% Increase in Pathologists’ Sensitivity

55% Reduction in Slide Reading Times

Conclusion:
This study highlights how AI can help pathologists improve their diagnostic performance, as measured by sensitivity improvements, to detect metastases of any size. In addition, AI helped pathologists reduce their reading times by more than half.

Bibliography: