Machine Learning Assisted Magnetic Resonance Imaging for the Prediction of Lymph Node Metastasis in Breast Cancer: A Systematic Review and Meta-Analysis

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Background

Breast cancer, particularly when it involves lymph node metastasis, substantially affects patient outcomes and treatment strategies, a domain where Magnetic Resonance Imaging (MRI) is essential yet often hindered by subjective interpretations. Integrating machine learning (ML) with MRI is promising for enhancing diagnostic precision, especially in predicting lymph node metastasis. This study assesses the efficacy of ML-enhanced MRI in predicting lymph node metastasis in breast cancer patients.

Methods

A systematic search up to June 2023 in PubMed, Scopus, and Web of Science identified studies applying ML algorithms to MRI data for breast cancer lymph node metastasis prediction. Statistical analysis using R software (version 4.0.3) with the 'mada' package pooled key diagnostic measures (sensitivity, specificity, false-positive rate, diagnostic odds ratio, and Likelihood Ratios) with 95% Confidence Intervals for precise evaluation.

Results

The analysis incorporated 9 studies encompassing 1395 patients, with 553 confirmed metastasis cases. The sensitivity of ML-assisted MRI for predicting lymph node metastasis was 85.2% (95% CI: 78.1-90.3%, I2=76.8%), while specificity was 81.2% (95% CI: 78.5-83.7%, I2=0%), indicating effective identification of patients without metastasis. The false-positive rate was relatively modest at 18.8% (95% CI: 16.3-21.5%), limiting the likelihood of incorrect metastasis identification. The diagnostic odds ratio was 24.97 (95% CI: 14.94-41.71), illustrating a robust distinction capability. The positive Likelihood Ratio (LR+) was 4.54 (95% CI: 3.87-5.32), suggesting a high probability of accurate positive diagnosis, and the negative Likelihood Ratio (LR-) was 0.18 (95% CI: 0.12-0.28), indicating a low chance of false negatives.

Conclusion

The study indicates that AI has substantial potential in accurately detecting distal radius and wrist fractures from plain X-ray images. The observed high diagnostic accuracy and the significant odds ratio suggest that AI could be a highly effective supplement to traditional radiological methods. Its application may enhance the consistency and precision of diagnoses. However, the noted heterogeneity in the results highlights the need for further research to standardize AI applications and ensure their reliable integration into various clinical settings.

Contact

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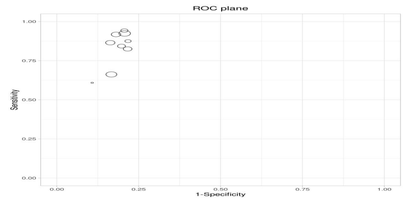
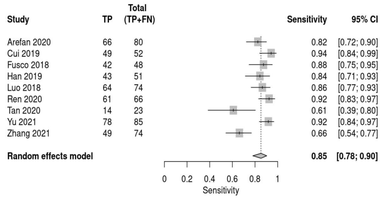
Conflict of interest

No conflict of interest to declare.

ROC Curve



Sensitivity



Specificity