Deep Learning of Multimodal Ultrasound: Stratifying the Response to Neoadjuvant Chemotherapy in Breast Cancer Before Treatment

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Abstract

Background: Not only should resistance to neoadjuvant chemotherapy (NAC) be considered in patients with breast cancer but also the possibility of achieving a pathologic complete response (PCR) after NAC. Our study aims to develop 2 multimodal ultrasound deep learning (DL) models to noninvasively predict resistance and PCR to NAC before treatment.

Methods: From January 2017 to July 2022, a total of 170 patients with breast cancer were prospectively enrolled. All patients underwent multimodal ultrasound examination (grayscale 2D ultrasound and ultrasound elastography) before NAC. We combined clinicopathological information to develop 2 DL models, DL_Clinical_resistance and DL_Clinical_PCR, for predicting resistance and PCR to NAC, respectively. In addition, these 2 models were combined to stratify the prediction of response to NAC.

Results: In the test cohort, DL_Clinical_resistance had an AUC of 0.911 (95%CI, 0.814-0.979) with a sensitivity of 0.905 (95%CI, 0.765-1.000) and an NPV of 0.882 (95%CI, 0.708-1.000). Meanwhile, DL_Clinical_PCR achieved an AUC of 0.880 (95%CI, 0.751-0.973) and sensitivity and NPV of 0.875 (95%CI, 0.688-1.000) and 0.895 (95%CI, 0.739-1.000), respectively. By combining DL_Clinical_resistance and DL_Clinical_PCR, 37.1% of patients with resistance and 25.7% of patients with PCR were successfully identified by the combined model, suggesting that these patients could benefit by an early change of treatment strategy or by implementing an organ preservation strategy after NAC.

Conclusions: The proposed DL_Clinical_resistance and DL_Clinical_PCR models and combined strategy have the potential to predict resistance and PCR to NAC before treatment and allow stratified prediction of NAC response.