A Novel Machine Learning Method to Predict Breast Cancer Patient Response to Neoadjuvant Chemotherapy from MRIs

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Background: Neoadjuvant chemotherapy (NAC) is often used as treatment for mid to late stage breast cancer prior to surgery. However, it is currently not possible to determine accurately or reliably whether a patient will respond to NAC, resulting in entire regimens of toxic chemotherapy being administered to patients unnecessarily. Pathologic complete response (pCR) and progression free survival (PFS) are used to evaluate patient response to NAC and accurate predictions of these measures has the potential for mid-treatment modification of NAC and improved prognosis. Purpose: This research aims to develop convolutional neural networks (CNNs) to predict pCR to NAC and PFS from axillary lymph node (aLN) MRIs. Methods: Dual input, 11-layer CNNs utilizing a combination of post contrast DCE-MRI scans from timepoints before and during treatment were coded and performance compared. To our knowledge, this is the first use of CNNs to predict patient response through multiple timepoints. Results: The model trained on the first and second timepoints performed best with an accuracy of 84.18% and AUC of 0.71, and these timepoints also yielded the highest performance when predicting PFS with an accuracy of 79.17% and AUC of 0.79. Conclusions: We found early changes in NAC response were the most predictive of pCR and PFS. These findings encourage the implementation of AI to use early imaging markers of aLN MRIs to predict response to NAC and PFS to enable mid-treatment modification of NAC and improve prognosis.