

Prediction of Five-Year Breast Cancer Recurrence in Women Treated with Neoadjuvant Chemotherapy



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Introduction

- Neoadjuvant chemotherapy (NAC) is a treatment option for locally advanced breast cancer
- Predicting five-year breast cancer recurrence prior to the start of treatment could impact the treatment selection
- Analyze multiparametric MRI (mpMRI) taken from three types of MRI volumes, as well as clinical data

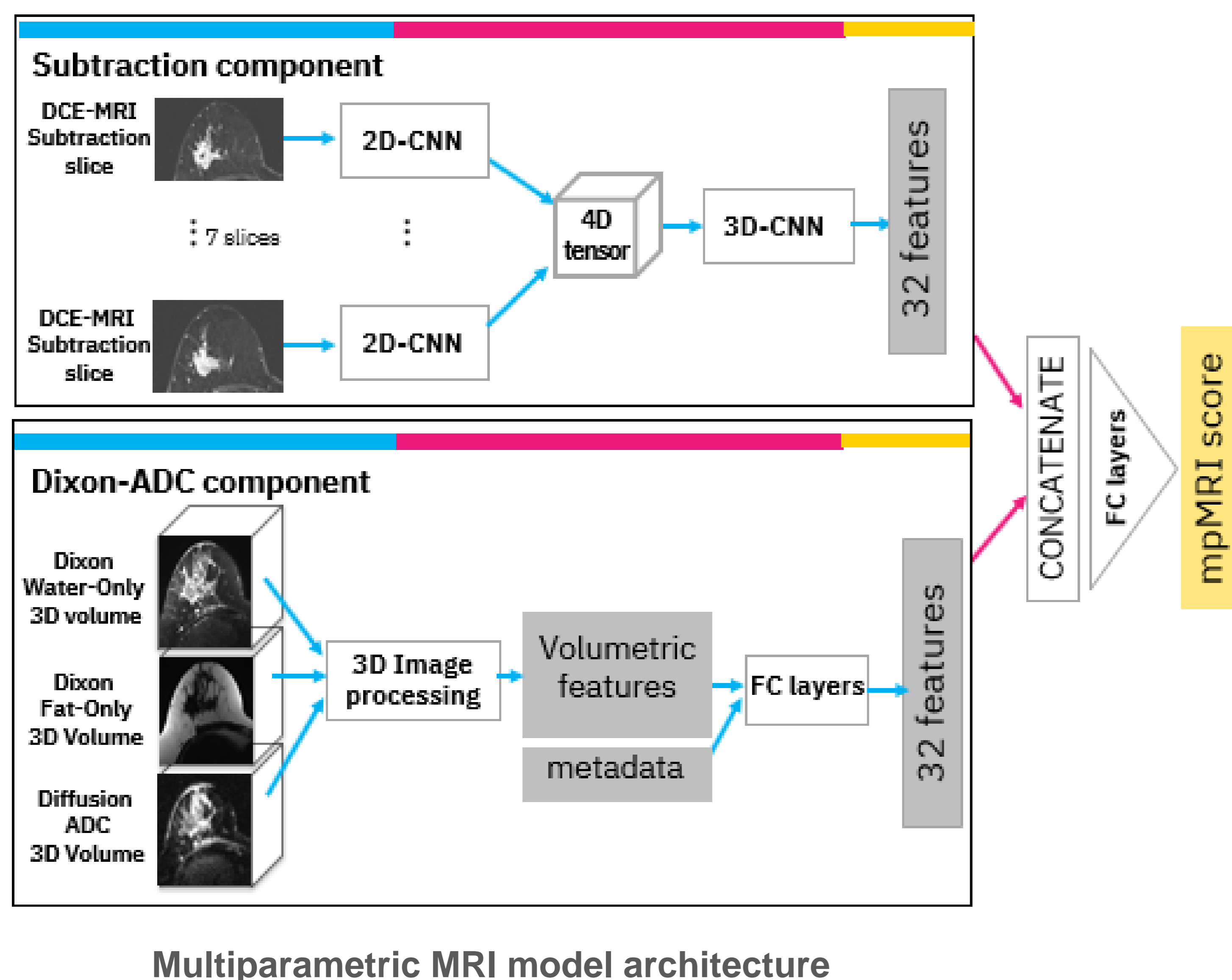


Dataset

- 1738 anonymized patients who received NAC between 2012 – 2018
 - All patients have clinical data
 - 567 patients have multiple MRI types:
 - Subtraction volumes, Dixon volumes, ADC volumes
- 100 patients with clinical and MRI were separated for holdout
- The rest were used for five-fold cross-validation
- The censored patients were used for training but not for validation

Methods

- mpMRI model
 - Subtraction component in which seven adjacent MRI slices form the input to seven 2D-CNNs that have the same weights. The features are aggregated into a 3D-CNN, followed by an average global pooling layer
 - Dixon-ADC component in which three 3D MRI volumes form the input to 3D image processing, which generates volumetric features
 - Features from the two components are passed through an FCNN to create the mpMRI score
- Clinical model
 - Preprocessing via scaler and imputation process
 - Trained using clinical features and the Random Forest classifier
- Ensemble model
 - Combined the clinical and mpMRI models
 - Calibrating using Platt's method and averaging the scores



Results

Evaluation on cross-validation and holdout test

| | | Cross-validation | | Holdout test | |
|---|--|------------------|-------------------|--------------|-------------------|
| | | AUC | Spec at Sens=0.95 | AUC | Spec at Sens=0.95 |
| 1 | Multiparametric MRI | 0.70 | 0.32 | 0.64 | 0.21 |
| 2 | Clinical | 0.71 | 0.26 | 0.71 | 0.20 |
| 3 | Ensemble Multiparametric MRI and Clinical (final model) | 0.75 | 0.47 | 0.73 | 0.41 |

- The mpMRI analysis improved the performance over analyzing each single type of MRI volume
- The final multimodal ensemble model that combined clinical and mpMRI achieved
 - Cross-validation: 0.750 [0.698, 0.796] AUC and 0.466 specificity at 0.95 sensitivity operation point
 - Holdout test: 0.734 [0.680, 0.781] AUC and 0.413 specificity at 0.95 sensitivity operation point

Conclusions

- Demonstrated ability to predict five-year recurrence using multimodal algorithms
 - Each modality alone shows prediction ability, but multimodal model offers better results
 - Used best method per modality and largest training data
- High sensitivity are the operation points of interest in clinical setting
 - The ensemble model significantly improved the specificity at high sensitivity operation points over per-modality specificity
- The results on holdout are similar to those on cross-validation
 - Our models may be generalized well for unseen similar datasets