The value of synthetic MRI for early prediction of NAC response in breast cancer: a complement to apparent diffusion coefficient in radiomics

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Declaration of Financial Interests or Relationships

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I have no financial interest or relationships to disclose with regard to the subject matter of this presentation:

Motivation

- Contrast-free sequences is receiving increasing attention.

- As a novel technology, radiomics analysis of *sythetic MRI (SyMRI)* in breast treatment has not been widely explored.

Introduction

• Neoajuvant chemotherapy (NAC) has been widely used in locally advanced breast cancer in last decades. Achieving pathologic complete response (pCR) after NAC represents a more favorable long-term outcome and sometimes surgical avoidance.

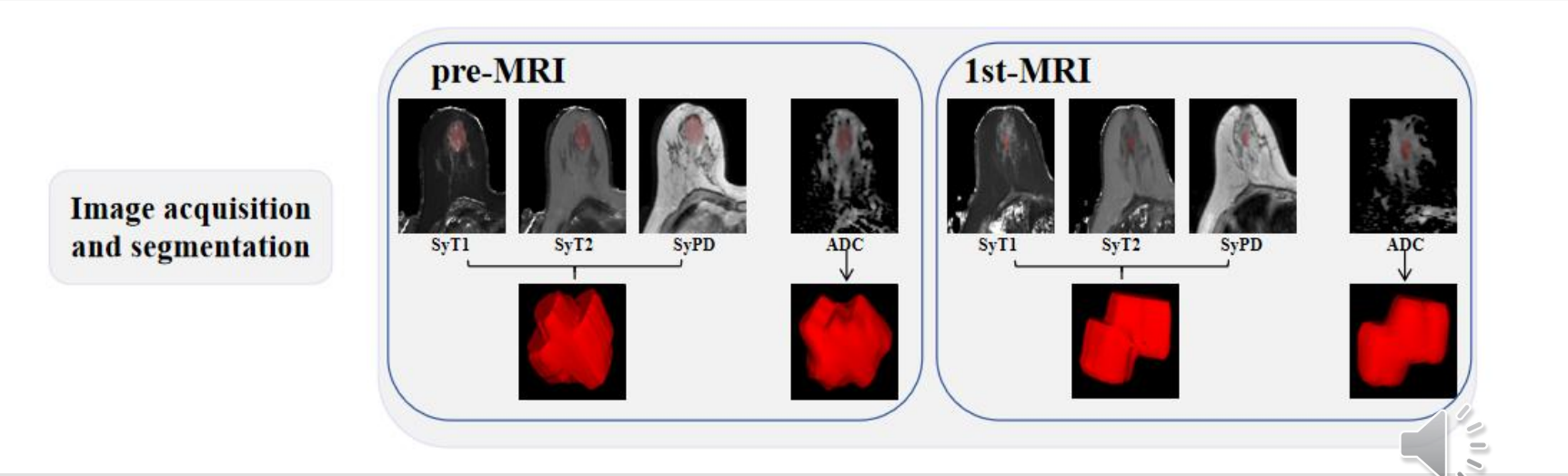
• Previous work has shown that the quantitative parameters of SyMRI can predict pCR before and after NAC treatment, also can be a supplement to changes in tumor size and ADC value. However, the value of SyMRI radiomics analysis for its rich post-processing sequences has not been widely explored.

Goals

This study aims to analyse the radiomics features extracted from SyMRI and its complementary value to conventional ADC sequence, which will contribute to the application of contrast-free sequences in radiomics.

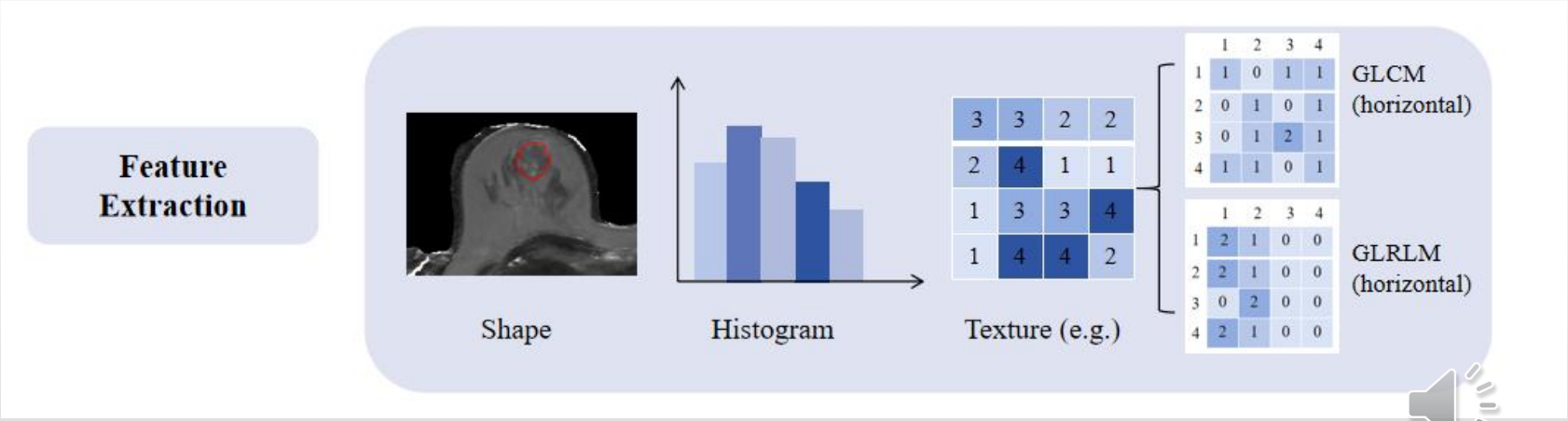
Materials and Methods

- All patients underwent breast MRI with SyMRI and ADC before (pre-) and after the first cycle (1st-) of NAC.



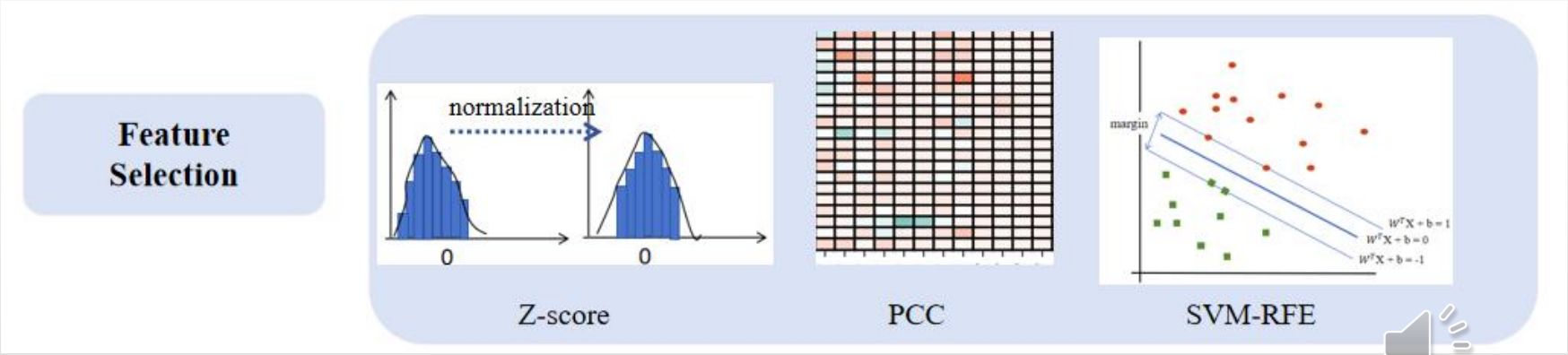
Materials and Methods

- Based on the whole tumor volume, pre- and 1st- radiomics features were extracted from each SyMRI quantitative map (SyT1/SyT2/SyPD) and ADC map, and their changes (delta-radiomics features) were calculated.



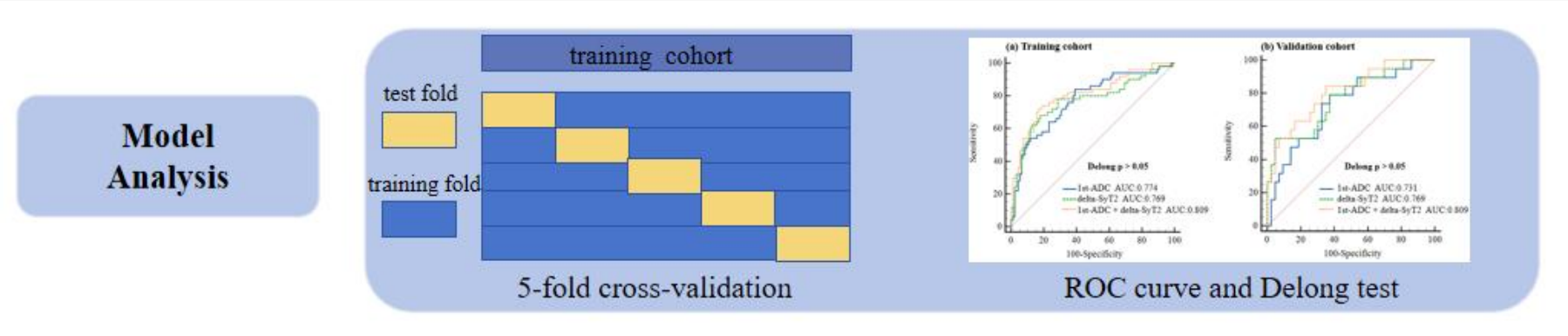
Materials and Methods

- After the data standardization, support vector machine-recursive feature elimination (SVM-RFE) was used to select features and build models.
- We set the value of 0.7 as the boundary, models with the AUC value higher than 0.7 in both the training and validation cohort were considered to have relatively good performance. Seperate radiomics models which met the above condition were combined in pairs or multiple combinations to generate fusion models.



Materials and Methods

- The model performance was assessed by receiver operating characteristic (ROC) analysis and compared by DeLong test.



Results

- Delta-radiomics models based on SyMRI sequences outperformed the baseline and first cycle of NAC radiomics models.
- The 1st-ADC radiomics model had a higher AUC of 0.774/0.731 (training/validation) compared with the corresponding pre- and delta- models.

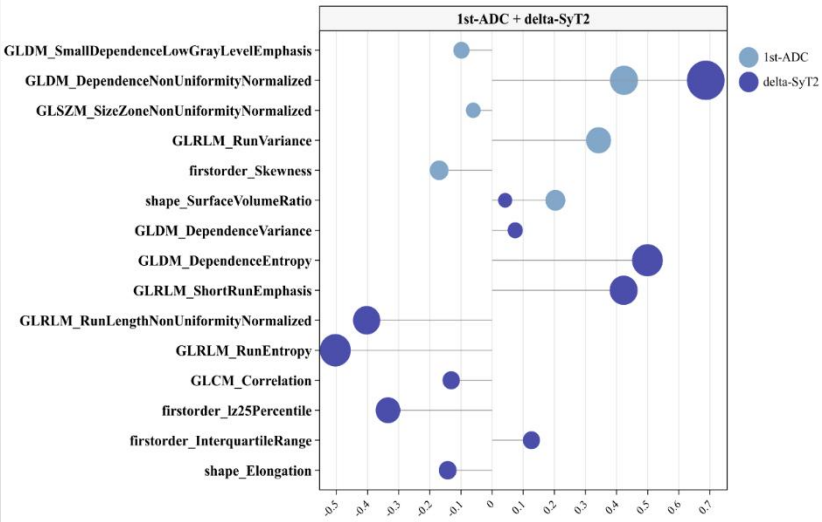
pre-radiomics models	SyT1 (training/validation)	SyT2 (training/validation)	SyPD (training/validation)	ADC (training/validation)
No.of selected features	3	7	7	6
AUC	0.549/0.584	0.657/0.657	0.659/0.551	0.690/0.673
95% CI of AUC	0.449-0.648/ 0.435-0.733	0.561-0.753/ 0.522-0.793	0.565-0.754/ 0.387-0.715	0.600-0.781/ 0.530-0.817
Sensitivity (%)	90.0/22.0	54.0/100.0	30.0/84.2	66.0/84.2
Specificity (%)	25.3/89.5	79.0/39.5	95.8/37.2	64.2/46.5
Accuracy (%)	47.6/50.0	70.3/58.1	73.1/51.6	64.8/58.1
PPV (%)	38.8/37.0	57.5/42.2	79.0/37.2	49.3/41.0
NPV (%)	82.8/87.5	76.5/100.0	72.2/84.2	78.2/87.0

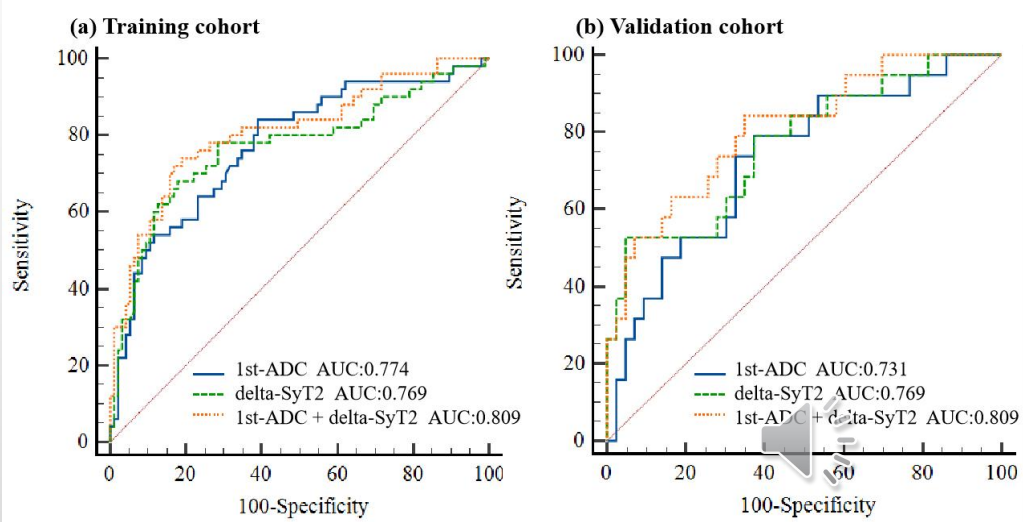
1st-radiomics models	SyT1 (training/validation)	SyT2 (training/validation)	SyPD (training/validation)	ADC (training/validation)
No.of selected features	15	10	14	16
AUC	**0.737/0.715**	0.729/0.608	0.751/0.573	**0.774/0.731**
95% CI of AUC	0.644-0.830/ 0.580-0.851	0.641-0.818/ 0.446-0.771	0.668-0.833/ 0.418-0.728	0.691-0.856/ 0.594-0.868
Sensitivity (%)	70.0/47.4	48.0/73.7	72.0/73.7	84.0/79.0
Specificity (%)	74.7/83.7	88.4/48.8	71.6/48.8	61.1/62.8
Accuracy (%)	73.1/72.6	74.5/56.5	71.7/56.5	69.0/67.7
PPV (%)	59.3/56.3	68.6/38.9	57.1/38.9	53.2/48.4
NPV (%)	82.6/78.3	76.4/80.8	82.9/80.8	87.9/87.1

delta-radiomics models	SyT1 (training/validation)	SyT2 (training/validation)	SyPD (training/validation)	ADC (training/validation)
No.of selected features	8	11	8	15
AUC	**0.755/0.717**	**0.769/0.769**	0.774/0.657	0.746/0.696
95% CI of AUC	0.664-0.847/ 0.566-0.867	0.680-0.858/ 0.636-0.902	0.683-0.866/ 0.508-0.806	0.651-0.842/ 0.5[illegible]-0.849
Sensitivity (%)	64.0/52.6	68.0/52.6	66.0/100.0	60.0/84.2
Specificity (%)	86.3/90.7	82.1/95.4	85.3/30.2	87.4/58.1
Accuracy (%)	78.6/79.0	77.2/82.3	78.6/51.6	77.3/66.1
PPV (%)	71.1/71.4	66.7/83.3	70.2/38.8	71.4/47.1
NPV (%)	82.0/81.3	83.0/82.0	82.7/100.0	80.6/89.3

Results

- Combining the delta-SyT2 with the 1st-ADC improved the performance of separate models with a higher but no significant AUC of 0.809/0.809 (training/validation).

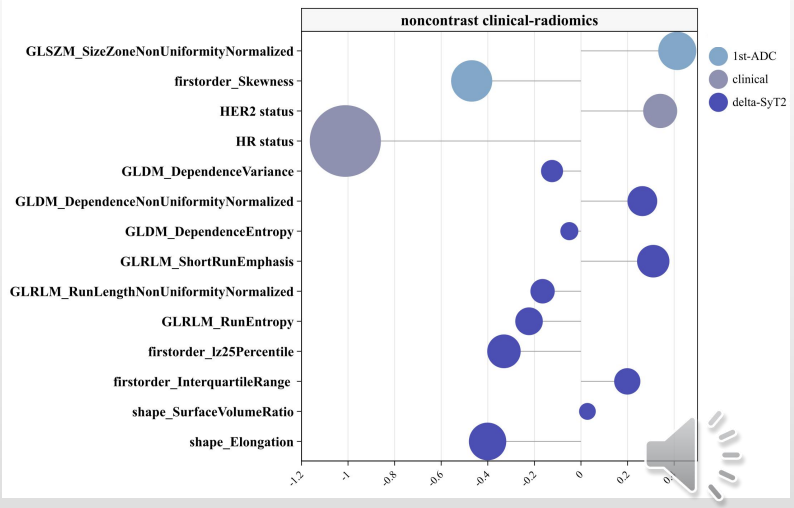




Results

- After adding receptor status to the optimal radiomics model combination, the noncontrast clinical-radiomics model achieved a good discrimination capacity, with an AUC of 0.916/0.914, sensitivity of 0.920/0.842, specificity of 0.821/0.861 and accuracy of 0.855/0.855 in the training and validation cohorts.

fusion radiomics models	noncontrast clinical-radiomics (training/validation)
No.of selected features	14
AUC	0.916/0.914
95% CI of AUC	0.869-0.963/ 0.838-0.991
Sensitivity (%)	92.0/84.2
Specificity (%)	82.1/86.1
Accuracy (%)	85.5/85.5
PPV (%)	73.0/72.7
NPV (%)	95.1/92.5



Discussion

- ADC radiomics model based on the first cycle of NAC get the highest AUC (AUC = 0.774/0.731, training/validation cohort). It is consistent with the results of previous quantitative parameter study.

- Of the three radiomics models generated from SyMRI, delta-radiomics models showed the highest predictive value. It may reflect the sensitivity of SyMRI to post-treatment response. Delta-radiomics features can show the dynamically chages such as morphological characteristics which cannot be detected in single time-point models.

Discussion

- Only one previous study evaluated the diagnostic performance of SyMRI-radiomics in predicting pCR for breast cancer after NAC, they found that radiomics model from T1 maps acquired after 4 cycle of NAC predicted pCR with higher AUCs of 0.78 and 0.72 in the training and testing cohorts, respectively. In our study, models constructed from T2 maps have higher predictice value. This disparity can be attributed to variations in prediction time-point, cancer subtypes included and modeling methods.
- Combined with clinical characteristics, the clinical-radiomics model could provide more accurate information of patients' prognosis.

Impact

•Radiomics model generated from delta-T2 mapping showed stable performance and complementary value to 1st-ADC sequence.

•Once scan-multiparameter and contrast-free SyMRI can obtain the comparative or even elevated value as ADC in early prediction of NAC response in breast cancer.