



Breast 2

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## **Imaging Biomarkers of Response Prediction (I): Insights from Quantitative Characteristics (Radiomics)**

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Breast cancer remains one of the most prevalent malignancies worldwide, and accurate prediction of treatment response is crucial for optimizing patient management.

Radiomics, the quantitative extraction of imaging features from standard breast imaging modalities such as MRI, mammography, and ultrasound, has emerged as a promising tool to develop imaging biomarkers that predict therapeutic outcomes in breast cancer.

From a radiology viewpoint, traditional breast imaging relies primarily on qualitative assessments interpreted visually by radiologists. While valuable, these features capture only a fraction of tumor biology. Radiomics enhances this paradigm by quantitatively characterizing tumor heterogeneity, texture, shape, and kinetic features. These quantitative biomarkers serve as surrogates for underlying genetic, molecular, and microenvironmental variations influencing tumor behavior and treatment sensitivity.

Breast MRI is considered the most suitable modality for radiomic analysis given its high soft tissue contrast and functional sequences like dynamic contrast-enhanced imaging. Radiomics features derived from MRI—such as texture heterogeneity and enhancement kinetics—have demonstrated predictive power for pathological complete response to neoadjuvant chemotherapy (NAC). Studies show that patients whose tumors exhibit more homogeneous texture and favorable enhancement patterns tend to respond better, enabling earlier identification of responders. This aids oncologists in tailoring NAC regimens or modifying treatment strategies to improve outcomes.

Similarly, radiomic signatures from mammography and ultrasound images also contribute to response prediction. For example, textural heterogeneity or abnormality scores derived from artificial intelligence (AI) on mammograms correlates with aggressive tumor phenotypes and poorer response rates. Radiomics applied to elastography ultrasound images provides quantitative stiffness parameters that have been linked to treatment response. Integrating multiple imaging modalities through radiomics further improves predictive accuracy.

In conclusion, radiomics provides a powerful quantitative framework for developing imaging biomarkers that predict breast cancer treatment response. From a radiological perspective, incorporating radiomic analysis into breast imaging exams deepens our understanding of tumor heterogeneity, improving diagnostic accuracy and enabling more personalized therapeutic approaches. Ongoing technological advances and collaborative research efforts will facilitate translation of breast radiomics into clinical practice, ultimately enhancing patient care.

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