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Breast 2

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Imaging Biomarkers of Response Prediction (III): Integrative Evaluation with PET-MRI

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PET/MRI is a hybrid imaging modality that integrates molecular imaging information from PET with the high-resolution morphological data of MRI, providing complementary insights within a single examination. 18F-FDG, which reflects the increased glucose consumption of cancer cells, is the most widely used PET tracer for the evaluation of breast cancer. Numerous studies have demonstrated that FDG PET/MRI improves sensitivity and specificity in breast cancer detection, facilitates accurate staging, and provides valuable prognostic information. Importantly, it has shown potential as a biomarker for predicting and monitoring treatment response, particularly in the setting of neoadjuvant chemotherapy. Quantitative metabolic parameters, such as standardized uptake value (SUV), metabolic tumor volume (MTV), and total lesion glycolysis (TLG), have been investigated as predictive biomarkers. Early metabolic changes on FDG PET combined with diffusion and perfusion metrics on MRI can help predict pathologic complete response and distinguish responders from non-responders at an early stage, thereby supporting timely and individualized treatment decisions.

Beyond FDG, novel PET tracers are expanding the scope of molecular imaging in breast cancer. Tracers targeting specific aspects of breast cancer biology, including those for estrogen receptor, HER2, fibroblast activation protein, and gastrin-releasing peptide receptor, provide complementary insights into tumor biology beyond glucose metabolism and may enhance diagnosis and therapy monitoring. Importantly, the relevance of such tracers is amplified in the era of theranostics, where the same molecular targets can be exploited for both imaging and targeted radionuclide therapy. Integrating these tracers into a PET/MRI could provide a comprehensive biomarker panel reflecting tumor biology and treatment susceptibility.

Another important innovation is the development of dedicated breast PET (dbPET), designed to provide higher spatial resolution and optimized breast positioning to overcome the limitations of whole-body PET imaging in the evaluation of small breast lesions. Recent studies have demonstrated that 18F-FDG dbPET is sensitive to early metabolic changes during neoadjuvant chemotherapy and provides complementary information to MRI, useful for treatment response evaluation.

In summary, this lecture will focus on the emerging role of PET/MRI in breast cancer, with particular emphasis on FDG PET/MRI as a predictive biomarker. In addition, it will address the utility of quantitative PET parameters, explore novel tracers beyond FDG, and introduce the clinical relevance of dedicated breast PET.

Keywords: *PET/MRI, Breast cancer, FDG PET, Response prediction, Neoadjuvant chemotherapy, Imaging biomarkers*