

PET/MR in Breast Cancer



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Breast cancer is an international public health concern in which an optimal treatment plan requires a precise staging. Both MRI and PET imaging techniques have made significant progress in the last decades with constant improvements that made both modalities clinically relevant in several stages of breast cancer management and follow-up. On one hand, specific breast MRI permits high diagnostic accuracy for local tumor staging, and whole-body MRI can also be of great use in distant staging, eventually accompanied by organ-specific MRI sequences. Moreover, many different MRI sequences can be performed, including functional MRI, letting us foresee important improvements in breast cancer characterization in the future. On the contrary, ¹⁸F-FDG-PET has a high diagnostic performance for the detection of distant metastases, and several other tracers currently under development may profoundly affect breast cancer management in the future with better determination of different types of breast cancers allowing personalized treatments. As a consequence PET/MR is a promising emerging technology, and it is foreseeable that in cases where both PET and MRI data are needed, a hybrid acquisition is justified when available. However, at this stage of deployment of such hybrid scanners in a clinical setting, more data are needed to demonstrate their added value beyond just patient comfort of having to undergo a single examination instead of two, and the higher confidence of diagnostic interpretation of these co-registered images. Optimized imaging protocols are still being developed and are prone to provide more efficient hybrid protocols with a potential improvement in diagnostic accuracy. More convincing studies with larger number of patients as well as cost-effectiveness studies are needed.

This article provides insights into the current state-of-the-art of PET/MR in patients with breast cancer and gives an outlook on future developments of both imaging techniques and potential applications in the future.

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Introduction

Breast cancer is the leading cancer and the leading cause of cancer mortality in women in the world. In the United States, one woman out of eight will develop breast cancer in

her lifetime.¹ At diagnosis, 4%-6% of patients with breast cancer already have distant metastasis. While the 5-year relative survival for diagnosis at early stage is very high, it drops to 21% if metastatic disease is diagnosed (stage IV).²

International guidelines for clinical management of patients with breast cancer are revised regularly, but imaging techniques that are available can vary significantly from one country to another, and the rapid technological evolution of imaging techniques leads to constant adaptations of clinical practices and requires iterative clinical validation studies. It can therefore be difficult to ensure that the most appropriate and cost-effective technique is being applied to the specific categories of patients in different phases of their disease. PET/MR is a promising hybrid imaging technique that has been

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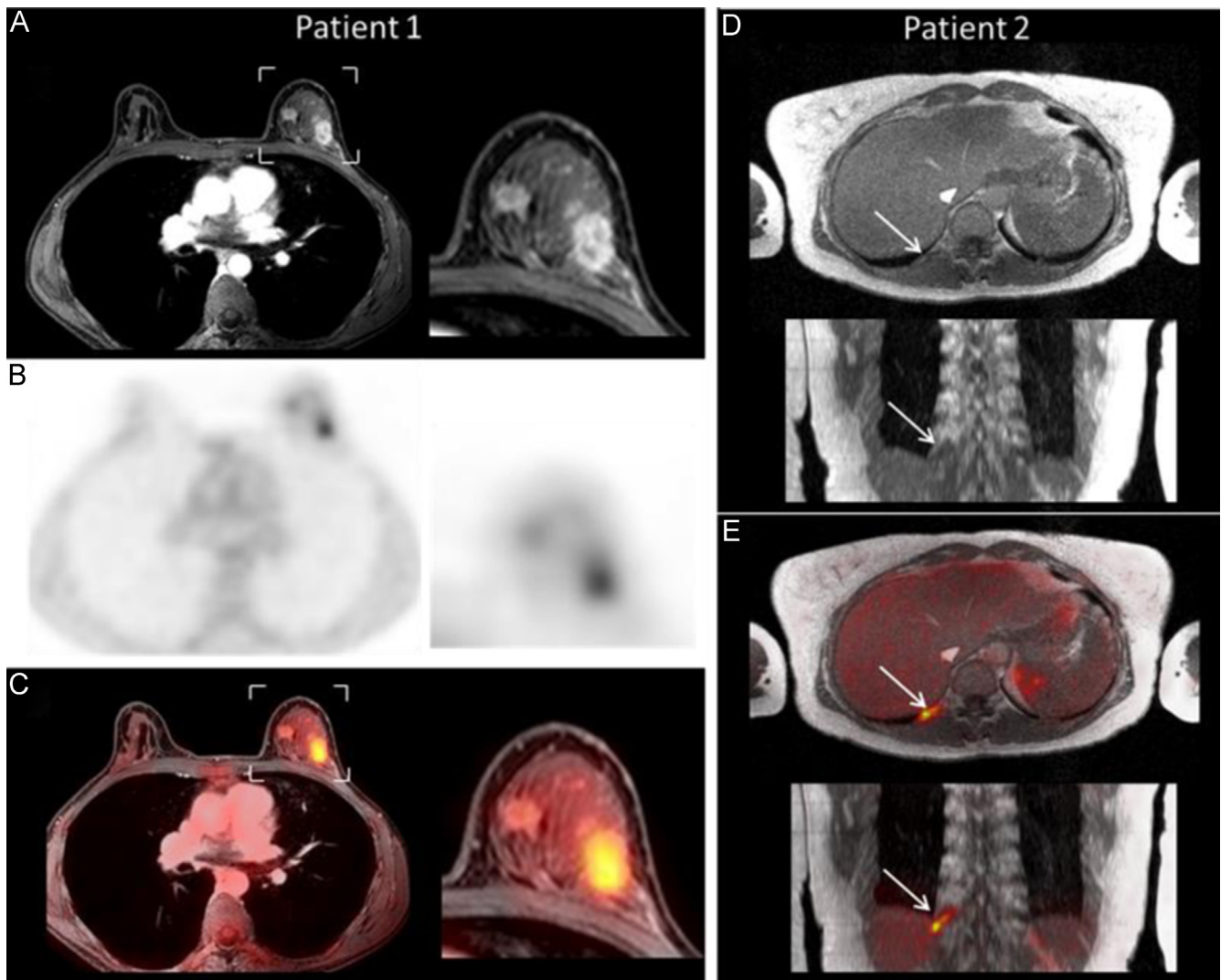


Figure 1 Examples of hybrid PET/MR studies conducted on a Philips Ingenuity TF PET/MR using a dedicated seven channels breast coil for local and distant metastatic assessment of breast cancer: (patient one) 35-year-old woman with grade 2 invasive ductal carcinoma (IDC): PET showed uptake in two sites (B), one corresponding to the known IDC, the second, less obvious on PET, being highly suspicious on DIXON-water images 90 seconds after using gadolinium (A) and on fusion of Dixon and PET images (C). This second lesion was confirmed to be an IDC on biopsy; (patient two) 46-year-old woman with left breast IDC: suspicious osseous ^{18}F -FDG uptake (D and E: white arrows), clearly visible on PET images (E), and retrospectively identified on whole-body in-phase Dixon MRI (D). The diagnosis of bone metastasis was confirmed with a biopsy.

introduced recently. It still requires more clinical studies with large cohorts of patients in order to better define its added value and real clinical effect in patient management and outcome. In this review of our preliminary clinical experience as well as early results published in the literature, we summarize the current established role of MRI and PET/CT imaging modalities in assessment and follow-up of malignant breast lesions and we discuss the potential role of hybrid PET/MR in the management of patients with breast cancer both for the assessment of regional breast lesions as well as distant metastases (Fig. 1). We also give an outlook on future improvements in breast cancer PET/MR imaging and discuss its potential role in the future.

Part I. Current Status of Imaging of Breast Lesions in MRI

Breast MRI has been increasingly adopted in clinical practice. It offers excellent sensitivity and negative predictive value, with relatively lower specificity and positive predictive value (PPV). In a meta-analysis including 69 studies, 9,298 women, and 9,884 breast lesions, pooled sensitivity for MRI was 90% (95% CI: 88%-92%) and specificity 75% (95% CI: 70%-79%).³

Technical Recommendations

Although breast MRI techniques are rapidly evolving, there are some general considerations that are accepted worldwide

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