
Differentiating Benign and Malignant Breast Lesions with Ultrafast MRI



Breast lesions present a challenge for accurate diagnosis, as it may be difficult to effectively differentiate benign from malignant types. Dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) is widely recognised for its high sensitivity in evaluating these lesions. However, full DCE-MRI protocols can be time-consuming, leading to the development of alternative methods like ultrafast DCE MRI (UF-DCE MRI). This article explores the potential of UF-DCE MRI in breast lesion diagnosis, its diagnostic performance, and how it compares to other imaging protocols.

Understanding UF-DCE MRI and Its Diagnostic Potential

UF-DCE MRI is a technique that captures kinetic information from breast tissues within the first minute post-contrast injection, offering very high temporal resolution (often less than 7 seconds). Unlike traditional DCE-MRI, which may lack time efficiency, UF-DCE MRI uses advanced imaging methods such as view-sharing, parallel imaging, and compressed sensing. The rapid contrast wash-in curves are analysed, providing kinetic parameters like maximum slope (MS) and time to enhancement (TTE), which reflect pathophysiological processes in breast cancer, such as vascular shunting and rapid contrast leakage. As a result, malignant lesions typically enhance more rapidly than benign ones, aiding in their differentiation.

The diagnostic accuracy of UF-DCE MRI in distinguishing between benign and malignant breast lesions has been assessed through a meta-analysis of 16 studies involving 2,090 lesions. The findings indicate a pooled sensitivity of 83% and a specificity of 77%, with a diagnostic odds ratio (DOR) of 18.9 and an area under the curve (AUC) of 0.876. These results suggest that UF-DCE MRI has high accuracy and diagnostic power. Comparisons with conventional DCE-MRI show that although UF-DCE MRI has slightly lower sensitivity, its overall performance is on par, particularly as a stand-alone technique. This opens possibilities for reducing scan times without compromising diagnostic efficacy.

Comparison of Key Kinetic Parameters: Maximum Slope (MS) and Time to Enhancement (TTE)

Two principal kinetic parameters derived from UF-DCE MRI—MS and TTE—are pivotal in the technique's diagnostic process. MS is determined by assessing the steepest enhancement curve within the first minute and calculating the rate of change in contrast enhancement over time. In contrast, TTE is based on the time interval between when the lesion and the aorta begin to enhance. Both parameters reflect rapid contrast uptake in malignant tissues, which differs significantly from benign lesions.

The meta-analysis revealed that MS and TTE have similar diagnostic performances. Individually, MS demonstrated a pooled sensitivity of 80% and specificity of 77%, while TTE showed a sensitivity of 71% and specificity of 80%. The slight difference in sensitivity and specificity was not statistically significant, indicating that both parameters provide comparable diagnostic information. This suggests that while both MS and TTE are effective for characterising breast lesions, they may be interchangeable in practice.

Potential Applications and Integration of UF-DCE MRI

UF-DCE MRI's high diagnostic accuracy and efficiency in obtaining kinetic data present opportunities for its use beyond lesion classification. It can potentially improve lesion conspicuity, differentiate invasive carcinoma from ductal carcinoma in situ (DCIS), predict tumour prognostic markers, and assess pathological response after neoadjuvant treatment. There is also a prospect for integrating UF-DCE MRI with abbreviated breast MRI (AB-MRI) protocols to optimise both diagnostic accuracy and scan time, leveraging the kinetic information without the need for delayed scans. Such hybrid approaches could streamline breast MRI protocols and make them more accessible for clinical use, especially in high-risk screening scenarios.

However, the heterogeneity of results across various studies, influenced by factors like patient demographics, technical parameters, and MRI systems used, highlights the need for standardised UF-DCE MRI protocols. Furthermore, artificial intelligence (AI) applications could enhance UF-DCE MRI's diagnostic power by refining kinetic parameter analysis and lesion characterisation, suggesting a promising area for future research.

UF-DCE MRI demonstrates a high level of accuracy in differentiating benign from malignant breast lesions, offering diagnostic performance comparable to that of conventional DCE-MRI. Both MS and TTE parameters are effective in lesion characterisation, with no significant difference in their diagnostic efficacy. UF-DCE MRI has potential applications in various aspects of breast cancer diagnosis and treatment planning, and its integration into clinical protocols could optimise scan times and patient outcomes. Future research is encouraged to standardise UF-DCE MRI techniques and explore AI-driven advancements for enhanced breast lesion diagnosis.

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