Diffusion weighted MRI (DWI) is emerging as a valuable technique for a variety of clinical breast imaging applications. Whereas contrast-enhanced MRI demonstrates tissue vascularity, DWI reflects the microscopic cellular environment and is sensitive to characteristics such as cell density, membrane integrity, and microstructure. Breast cancers typically exhibit restricted diffusion, with higher DWI signal intensity and lower apparent diffusion coefficient (ADC) values than normal breast fibroglandular tissue, attributed to increased cellularity and decreased extracellular space. Based on this characteristic, DWI has shown promise for improving the detection and characterization of breast cancer. There is growing evidence that DWI may help reduce the number of false positives associated with conventional dynamic contrast-enhanced MRI, provide early indication of response to neoadjuvant chemotherapy (reflecting alterations in cell membrane integrity and tumor cellularity), and may also offer a viable alternative non-contrast method of breast MR screening without the costs and toxicity associated with DCE MRI.

DWI is a short scan available on most commercial MR scanners and does not require any exogenous contrast. As such, a growing number of imaging centers are incorporating DWI into the clinical breast MR examination. However, there is wide variation in DWI acquisition and analysis approaches, including the choice of b-values. As a result, there is considerable variability in the reported ADC values for similar breast pathologies in the literature. This lack of standardization makes it difficult to define generalizable guidelines for breast DWI and to reliably assess the clinical usefulness of the technique. Prior to widespread adoption of DWI for breast tumor assessment, promising single center findings must be validated in multicenter trials across a variety of platforms using standardized acquisition and analysis approaches.

Towards this goal, two national multicenter trials of breast DWI were recently conducted by the American College of Radiology Imaging Network (ACRIN). ACRIN 6702 was performed at 10 academic institutions from 3/2014 to 4/2015 and investigated the value of DWI for differentiating benign and malignant MRI-detected breast lesions. The study confirmed that use of an ADC threshold could increase the positive predictive value of breast MRI without reducing sensitivity, and may be most useful in BI-RADS 4 masses. ACRIN 6698 was performed at 10 institutions from 8/2012 to 1/2015 and investigated the value of DWI for detecting early response in patients undergoing neoadjuvant chemotherapy. The study showed mid-treatment change in tumor ADC was predictive of pathologic response, and the predictive value of ADC varied across biologic subtypes. Despite confirming potential clinical utility, both trials identified that further technical developments are needed to address image quality issues of low resolution, spatial distortion, and artifacts that currently limit wide clinical implementation. Many of these image quality issues are being addressed by MRI system manufacturers and will hopefully lead to greater accuracy and reproducibility of breast DWI.

Keywords: Diffusion weighted MRI (DWI), Breast, Diagnostics, Treatment response, Multicenter trials
The value of T2-weighted imaging in breast MRI

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The differentiation of benign and malignant lesions in dynamic contrast-enhanced MR Mammography (MRM) is based almost entirely upon the lesions’ enhancement behavior and morphology. Unlike MRI strategies in other parts of the body, for dynamic MRM, T2-weighted pulse sequences have not been attributed a major role. In most institutes, T2-weighted sequences with or without fat suppression are popularly used just to facilitate the detection of cysts. The situation has changed in recent years, especially after the new version of the BI-RADS release. The signal intensity of the lesion and the surrounding breast tissue in T2-weighted images was reported to be a very useful diagnostic adjunct to the dynamic MRM protocol. Based on a retrospective study of 1010 consecutive patients (mean age, 55.0 years ± 11.6 [SD]; range, 16–87 years) with 1129 contrast-enhancing lesions, edema signs, a MR feature in T2WI, were reported that there was a correlation between the incidence of edema signs and tumor grading in the invasive carcinomas. Surrounding changes of the lesions detected by T2-weighted might be a useful adjunct in predicting tumor prognosis. Some new researches on new T2WI technology, for example, 3D T2-weighted Imaging and Double Echo Steady State T2-mapping will also be briefly introduced.

Keywords: Breast MR; T2WI; breast edema; breast cancer
Role of Diffusion-weighted Imaging in Breast Cancer Screening

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Diffusion-weighted imaging is a noncontrast MR imaging technique that provides information on tissue cellularity and microstructure and has the potential to aid in the detection, diagnosis, and evaluation of treatment response for breast cancer. With a short scan time, DWI may be performed as an adjunct to DCE-MRI to improve diagnostic accuracy or as an alternative to gadolinium-enhanced MR evaluation in patients at risk for nephrogenic systemic fibrosis. Moreover, there is also promise in using DWI as a noncontrast alternative screening modality in women at intermediate or high risk of breast cancer. On DWI, malignant tumors are more cellular than normal breast tissue, they often appear hyperintense to surrounding tissues on DWI. In a study of 118 mammographically and clinically occult breast lesions, Partridge et al. found that 89% of malignancies were hyperintense on DWI, with lower ADC values for malignant compared with benign lesions. Balzer et al. also reported comparable sensitivity and specificity between DCE-MRI and unenhanced sequence (T2WI and DWI) for breast cancer detection. McDonald et al. reported that DWI can identify mammographically occult cancers in elevated-risk women with dense breasts, with a sensitivity of 45%, specificity of 91%, PPV of 62%, and NPV of 83%. In the reader study by Yabuuchi et al., DWI was more accurate than mammography, with an AUC of 0.73 compared with 0.64 for mammography. Such data show potential for using DWI as an adjunct to mammography without the costs and toxicity associated with DCE-MRI. However, DWI cannot detect all lesions identified by DCE-MRI. In a blinded reader study of 42 lesions, 42% of malignant breast lesions were not visible on DWI. Tozaki and Fukuma also reported that 32% of nonmass DCIS could not be detected on DWI. Recent technical advances in DWI have resulted in improved image quality. In particular, DWI using readout-segmented echoplanar imaging (rs-EPI) has better spatial resolution and less distortion than does conventional single-shot EPI. Furthermore, fusion imaging using high b-value DWI and T1WI could allow both anatomic and functional evaluation. We performed several studies about the role of fusion DWI using unenhanced T1WI. In a study of 129 lesions detected at 3T MRI, detection rates of index malignant lesions were similar for enhanced or unenhanced MRI. Interobserver agreement for final assessments was reliable across five readers and diagnostic accuracy for predicting malignancy was similar. In a study of 343 patients with a personal history of breast cancer, the diagnostic performance of fusion DWI was equivalent to that of conventional protocol with sensitivities of 89–100%, specificities of 93–95%. Such data show potential for using DWI as an adjunct to mammography without the costs and toxicity associated with DCE-MRI. However, further study is needed to determine whether sensitivity can be improved with higher field strengths to increase SNR or spatial resolution.

Reference


Keywords: Breast, Diffusion-weighted imaging, Screening