**DW-MP-SWIFT for High Spatial Resolution Diffusion Weighted Breast MRI**

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**TARGET AUDIENCE** Breast radiologists, MRI technologists, and researchers interested in breast imaging.

**PURPOSE** Develop and test a robust (motion and eddy current resistant) high spatial resolution diffusion-weighted MRI sequence for breast imaging, DW-MP-SWIFT.

**INTRODUCTION** Diffusion-weighted breast MRI has emerged from a research topic to a promising clinical method, especially due to the potential for increased specificity for pathology without exogenous contrast injection\(^5\). However, diffusion-weighted breast MRI has many technical issues including limited spatial resolution and geometric distortion, making small lesion identification and co-registration a challenge\(^1\).

**METHODS** Fig. 1 shows the diffusion-weighted magnetization prepared SWIFT\(^{-3}\) sequence (DW-MP-SWIFT). A 62.5 kHz SWIFT acquisition, HS2 pulse, rf fraction 0.25, TR 4.4 ms was performed for both 16k and 64k views (total acquisition time 2.5 min and 10 min, respectively) for each b-value. The shorter acquisitions were reconstructed to 1.5 mm resolution isotropic 3d images and the longer to 0.75 mm resolution isotropic images. Diffusion preparation was interleaved every 64 views and fat suppression\(^4\) every 16 views in order to correspond to in vivo experiments. The gradient duration \(\delta\) was chosen to be 20 ms and the spacing \(\Delta\), 40 ms, giving a maximum b-value of –3000 at 5 gauss/cm for the oblique (all three gradients on) magic angle direction. Gradients are actually cosine shaped. All acquisitions used gap cycling\(^2\) and the sequence, macros, and reconstruction correspond to CMRRpack v 0.45b [http://www.cmrr.umn.edu/swift/] on our Agilent/Siemens 85 cm bore 4 T scanner.

**RESULTS** Phantom results are shown in Fig. 2. Some of the raw image intensity difference (especially the tube at 8 o'clock position) is due to \(T_1\). Raw images are scaled to highest intensity; otherwise, higher b-value images would not be visible. Images and ADC maps from subject 3 are shown in Fig. 3.

**DISCUSSION** The SWIFT sequence combines excitation (frequency-swept RF pulse), spatial encoding (readout gradient), and acquisition into one multiplexed time interval\(^2\). SWIFT excites signal at high bandwidth and receives after a very short dead time (4 \(\mu\)s) and so is highly robust against off-resonance effects and eddy currents. Elimination of eddy current correction produced no degradation in image quality or artifacts. Because of the rapid multiplexing in SWIFT, there is no time within a given TR to insert additional pulses or gradients, and therefore additional weighting must be done by preparing the longitudinal magnetization. Because of the rapid switching times, we primarily utilize local transmit and receive coils with SWIFT, so that most SWIFT imaging occurs with substantial B\(_1\) inhomogeneity. Previously we have demonstrated the use of adiabatic pulses for CHES\(s\) fat suppression\(^3\) in our 4-channel transceive 4 T breast coil to overcome B\(_1\) inhomogeneity. For diffusion preparation we chose to use a spin echo with flip back consisting of a split BIR4 (B\(_1\) insensitive plane rotation) adiabatic pulse\(^6\) with cosine shaped gradients between the pulse segments. Our intent is to maintain insensitivity to B\(_1\) and B\(_0\) in all preparations and combine this with the B\(_0\) insensitivity of SWIFT readout. In post processing, common mode changes in the flip angle due to B\(_1\) variations are removed, leading to B\(_1\) and B\(_0\) robust ADC maps.

**CONCLUSION** High spatial resolution diffusion imaging has been an unmet need in Breast MRI. We have shown initial phantom and normal subject results for B\(_1\) and B\(_0\) robust high spatial resolution diffusion weighted breast imaging with DW-MP-SWIFT.

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**REFERENCES**