Application of zoomed EPI and pTX for breast diffusion weighted imaging.

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Introduction:

Within recent years, diffusion weighted imaging (DWI) of the breast has become a frequently used technique for the assessment and treatment response monitoring of breast cancer. Typically, echo planar imaging (EPI) based methods are used which are prone to characteristic artifacts, such as susceptibility artifacts, image blurring and spatial distortion due to gradient nonlinearity and eddy currents. Thus, there can be a significant spatial mismatch in lesion appearance and position between morphologic sequences (T1, T2) and EPI which can have a significant impact on the diagnostic accuracy. Furthermore, because of the strong demand on the gradient system limits, the spatial resolution of DW-EPI in clinical breast MRI is only moderate, with in-plane resolution around 1.8x1.8mm^2 or even coarser. One promising method to overcome the spatial distortion is to use readout segmented, multi-shot EPI[1-3] at the expense of significant increased acquisition time. This study demonstrates the use of an alternative approach, 2D-selective RF excitation[4] on a 2-channel parallel transmit system (pTX)[5] to a) mitigate these distortions by shortening the phase encode burden and the echo train length and b) allow the user to restrict the acquisition volume to the breast alone (zoomed EPI).

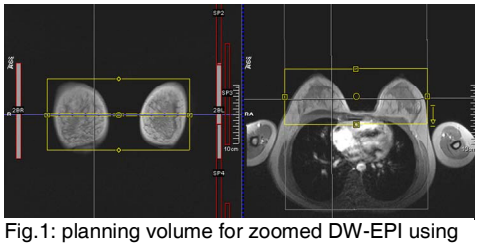

Fig.1: planning volume for zoomed DW-EPI using 2D-RF excitation

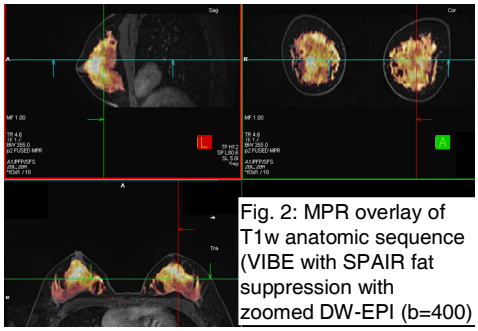

Fig. 2: MPR overlay of T1w anatomic sequence (VIBE with SPAIR fat suppression with zoomed DW-EPI (b=400)

Methods:

3 healthy subjects were scanned on a 3-T MAGNETOM Skyra (Siemens Healthcare, Erlangen, Germany) with a prototype 2-channel pTX system using a 4-channel combined (biopsy and diagnostic) breast coil. For both protocols, 24 axial slices were acquired with three b-values (50, 400, 800) in 3-scan trace mode with GRAPPA factor of 2. TR/TE was 4400/54 ms for the non-selective sequence vs 4800/73 ms for the selective version. The resulting in-plane resolution was 1.8x1.8mm vs 1.3x1.3mm in plane for the zoomed EPI where the FOV was reduced from 332 to 260mm as well as the matrix slightly increased (192x78 to 200x78). Both protocols were set up for comparable acquisition time (3:53 and 3:39 min for zoomed EPI, respectively).

Results

The prescribed volume for the zoomed EPI is shown in Fig. 1 along with the stop bands of the 2D-RF pulse. In Figure 2 an overlay of a T1-weighted fat-suppressed GRE (VIBE) with a DW (b-400) dataset is displayed in multi-planar reconstruction to demonstrate very good co-registration and resolution.

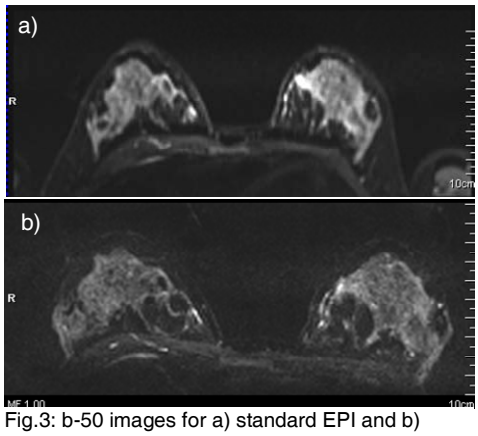

Fig.3: b-50 images for a) standard EPI and b) zoomed DW-EPI using 2D-RF excitation

Figure 3a-b (from a different volunteer) compares standard DW-EPI (a) with the described zoomed EPI protocol in the original imaging plane. While there is a clear improvement with respect to resolution and distortion the reduced SNR is obvious as well.

Discussion:

Zoomed EPI in DWI shows potential to mitigate spatial distortions commonly observed in standard EPI. In the protocol shown here, the SNR penalty is due to two reasons: 1) increased TE because of the 2D-selective RF pulse but also 2) because it was invested in higher resolution. Clinically, the higher spatial resolution may allow for the DWI evaluation of enhancing foci and small non-mass enhancement on MRI. Further investigations are planned to balance SNR and spatial resolution, as well as a quantitative comparison including measured ADC, and reduction of artifacts.

Conclusion:

Our data suggest that the use of zoomed EPI in breast DWI can result in reduced distortions and enables higher resolution when supported by sufficient SNR but detailed comparisons are needed to prove this conclusively.

References:

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