A comparison of different methods using DWI for breast lesion classification

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Introduction

Several approaches to utilize diffusion-weighted (DW) imaging of the breast have been recently reported for treatment response monitoring [1,2] or lesion classification [3-6]. The purpose of this study was to evaluate the performance of three different approaches for lesion classification: 1) DW-EPI with inversion recovery pulse (EPI-IR) to reduce signal contributions from fat, DW-EPI using a chemical shift fat saturation pulse (EPI FatSat) and EPI-IR following the administration of a T1-shortening contrast agent (EPI-IR post CA).

Methods

All experiments were performed on a 1.5T Siemens Magnetom Avanto using a Siemens breast array coil. The inversion recovery DW-EPI was applied prior and subsequent to the administration of Gadovist following the T1-weighted dynamic scan protocol, while the fat saturated DW-EPI was only applied before the dynamic scan.
All DWI measurements were acquired in two averages of 26 slices with 4 mm slice thickness and b-values of 50, 400 and 800 using 3-scan trace calculation. With an inversion time of 190ms, the EPI-IR measurements took 2:55 minutes while the fat-saturated scans could be performed in only 1:31 minute. ADC maps were calculated automatically using the scanner software. In total, 25 patients were examined with 29 lesions that were histologically proven to be 17 malignant and 12 benign. All lesions larger than 5mm in diameter that were detected in contrast-enhanced subtractions were evaluated for visibility in DWI (using the b=800 images). Subsequently regions-of-interest were drawn on the DWI and copied to the ADC maps.

Results and Discussion

Figure 1 displays the range of ADC values for benign (black) and malignant lesions (red) for all experiments with their respective standard deviation and median (inner dash). Good differentiation of malignant and benign lesions [0.73-1.19x10^{-3} mm^2/s resp. 1.2-2.58x10^{-3} mm^2/s] was achieved using DW-EPI with a chemical shift fat saturation pulse while both other approaches showed small or large overlap between the two groups. We suppose this can be assigned to a) the overall reduced SNR with inversion recovery as opposed to fat saturation and b) T1 reduction after contrast administration which changes the impact of the inversion recovery pulse. Previous publications have reported ADC threshold values for lesion differentiation of 1.1x10^{-3} mm^2/s and 1.3x10^{-3} mm^2/s respectively [6, 4] showing good agreement with our findings. Thus we see potential to routinely apply fat saturated DW-EPI to enhance lesion discrimination in the breast especially given the short acquisition time of 1:31 min.

References

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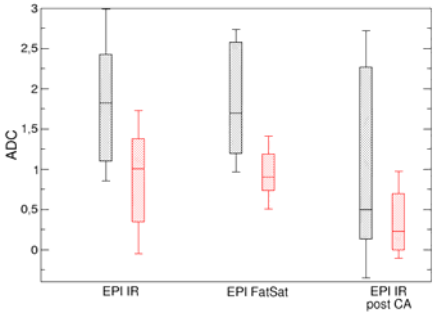

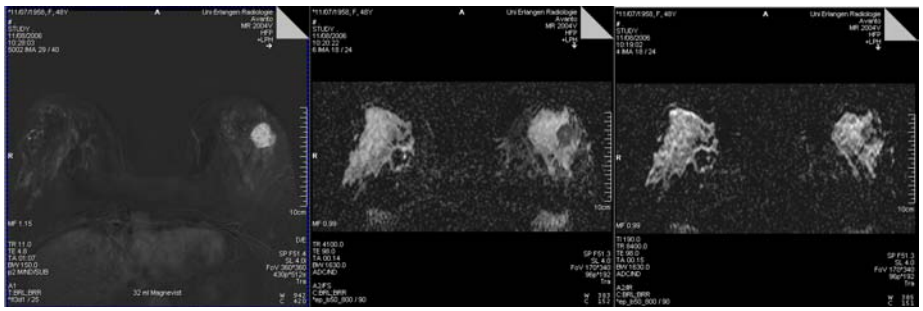

Figure 1: ADC [10^{-3} mm^2/s] values of 12 benign (black) and 17 malignant (red) lesions using diffusion weighted EPI with Inversion Recovery (IR) , fat saturation and IR after administration of Gd-DTPA. The median of each group is indicated by the inner dash.
Figure 2: subtraction image of a contrast enhanced T1w-GRE (left); ADC map from diffusion weighted EPI with fat saturation (middle) and ADC map from diffusion weighted EPI with Inversion Recovery (right). Areas of decreased ADC values appear dark in the left breast (multifocal invasive ductal carcinoma).