DWI of Breast at 3T: Effects of Fibroglandular Tissue Composition and Background Parenchymal Enhancement in Patients with Malignant and Benign Lesions

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Introduction

Noninvasive MR biomarkers are advantageous in the diagnosis, grading, and treatment monitoring of breast cancer. Mammographic breast density increases the risk of breast cancer (1). Similar to breast density, the amount of fibroglandular tissue (FGT) and background parenchymal enhancement (BPE) on breast MRI are features of normal breast tissue (2) of which increased BPE has been shown to increase the risk of developing breast cancer (2, 3). A recent study (4) did not demonstrate a difference in BPE between control and breast cancer patients and did not demonstrate a correlation between apparent diffusion coefficient (ADC) values in FGT and aggressiveness of breast cancer. Therefore, this study evaluated the effect of FGT and BPE on apparent diffusion coefficient (ADC) measurements in breast cancer patients with malignant and benign (controls) findings.

Methods

Patients: This IRB approved HIPAA compliant retrospective study with waiver of informed consent included 185 patients with BIRADS 4 and 5, who underwent 3T bilateral breast MRI January 2011- January 2013. All were recently diagnosed with breast cancer or have a family history of breast cancer. Patients underwent biopsy after MRI with DWI. Lesions were excluded if smaller than 8 mm and MRI exams with poor fat suppression, motion and susceptibility artifacts were excluded.

MRI: Performed at 3T (Discovery MR750, GE Healthcare) with a 16-channel breast coil (Sentinelle Vanguard, Sentinelle Medical) and included fat-suppressed T2-weighted imaging, DWI and post-contrast T1-weighted imaging. DWI sequence included a 2D DW single-shot dual spin echo EPI; axial imaging plane; TR/TE: 6000/56.4-120.7 ms; 90° flip angle; NEX 3; matrix 128x128; field of view 28-38 cm; slice thickness 4-5 mm; slice gap 0-1 mm; number of slices 17-23; fat suppression enhanced; parallel imaging ASSET; b values:0, 600 s/mm2; acquisition time is about 2 min.

Image Analysis: ADC maps were calculated with GE's Functool. An experienced radiologist placed regions of interest (ROIs) on FGT using ADC maps to calculate FGT-ADC. The T1 post-contrast image at the first time point along with the DWI image at b=0 were used to assess the BPE and FGT for placing ROIs. All ADC values are represented in units of mm2/s. For each patient with a lesion, ADC was measured in normal FGT of contralateral breast. In patients with bilateral lesions, the ADC measurement of FGT was done by placing an ROI in normal tissue at least 2cm away from the lesion. Breasts were dichotomized by fibroglandular composition (fatty/scattered versus heterogeneous/extreme) and by BPE levels (minimal/mild versus moderate/marked). FGT-ADC values were compared using the two-sample t-test.

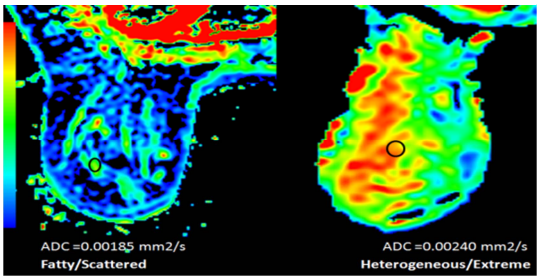
Results

209 breasts from 185 patients (mean age, 49 years; range, 23–81 years) were included into the final analysis with 71 malignant and 138 benign lesions. Breasts were classified per BIRADS with respect to FGT (fatty, scattered, heterogeneous and extreme) and BPE (minimal, mild, moderate, marked). Two fatty breasts were combined with scattered. In 209 breasts, mean FGT-ADC were significantly different based on the fibroglandular tissue composition (p=0.0007), with no difference with BPE (p=0.7). Figure 1 shows the representative ADC maps for breasts with different FGT composition. Mean FGT-ADC in patients with malignant lesions is significantly higher in heterogeneous/extreme compared to the fatty/scattered group (p=0.0073). Additionally, compared to patients with malignant lesions, in patients with benign lesions, the difference in FGT-ADC between these groups is smaller (p=0.015). Based on the BPE, 209 breasts were classified as minimum (n=74), mild (n=37), moderate (n=71), and marked (n=27). No significant difference was observed in ADC values of normal tissue between minimal/mild (n=111) versus moderate/marked (n=98) BPE groups (p=0.69). Within patients with benign lesions or malignant lesions, minimal/mild versus moderate/marked BPE groups did not affect the FGT-ADC value (p=0.03).

Table 1. Influence of Breast Density on ADC values (Mean and SD) in Normal FGT of Patients with Malignant and Benign Lesions

Breast Density	Pathology	n	Mean (mm2/s)	SD (mm2/s)
Fatty/Scattered	Malignant	15	0.001748	0.000385
	Benign	20	0.001676	0.000447
Heterogeneous	Malignant	41	0.002056	0.000307
	Benign	77	0.001922	0.000302
Extreme	Malignant	14	0.002041	0.000259
	Benign	35	0.002032	0.000266

Figure 1. ADC map of breasts with different FGT composition



Conclusions

FGT-ADC values derived from DWI were significantly higher in dense breasts and are positively correlated with breast disease aggressiveness. FGT-ADC values are independent of background parenchymal enhancement. It may be interesting to investigate the perfusion fraction from DWI to correlate with BPE.

References:

1) Saftlas AF et al., 67(11), 2833 (1991). 2) King V et al., Radiology 260, 50 (2011). 3) King V et al., Eur Radiol 22, 2641 (2012). 4) Cho GY et al., PISMRM (2012).