Elementary Clinical Estimation of DWI and ADC Value in Differentiating Benign and Malignant Breast Lesions

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Introduction

A recent study [1] on breast diffusion weighted imaging (DWI) revealed that the apparent diffusion coefficients (ADC) of benign and malignant lesions were different, which indicated a potential of DWI for distinguishing between benign and malignant breast lesions. But the ability of DWI to detect and discriminate benign and malignant breast lesions was not evaluated. In this study, DWI and contrast-enhanced MRI were performed in 55 patients. The signal intensity of the lesions on DWI was investigated and ADC value was calculated in all cases. In addition, a separating point of ADC for discriminating benign and malignant lesions was put forward and sensitivity, specificity, PPV, NPV, and overall accuracy were retrospectively analyzed on the basis of this separating point.

Methods

Twelve health volunteers and 55 patients were studied with MRI. Fifty-eight lesions were pathologically proved, including 31 benign lesions (18 fibroadenomas, 6 adenosises, 1 intraductal papilloma, 4 fibrocystic changes, 1 galactocele, 1 trauma) and 27 malignant lesions (23 infiltrating carcinomas, 2 DCIS, 2 medullary carcinomas). A 1.5 T MR system (GE) with GPFlex surface coil was employed. DWI was obtained using a spin echo, single-shot EPI sequence (effective TE 99 ms, TR 10000 ms, slice thickness 5 mm, FOV 24×24 cm, matrix size 128×128, 1 NEX). Scan time for one DWI sequence was 40 sec. The sensitizing gradients were applied sequentially in x-, y- and z-directions (z is in the direction of the main magnetic field) using diffusion weighting factors (b-values) of 0, 250, 500, 750, and 1000 s/mm^2 (0 and 1000 s/mm^2 in some the cases). The ADC values were determined in all three orthogonal directions (ADC-x, ADC-y and ADC-z). An average ADC could then be calculated from the three ADC-values. In order to locate the lesions accurately, standard T_2-weightening sequence with fat saturation and Gd-DTPA enhanced efgre 3D were used. Statistical analysis was performed by ANOVA and SNK of SAS.

Results

96%(24/25) of benign lesions (6 adnosises were not included) and 96.3% (26/27) of malignant lesions were visible as high signal intensity on DWI (Fig. 1). One small adenoma and one DCIS (patchy form enhancement) were missed on DWI. Calculated ADC (in units of 10^{-3} mm^2/sec) of malignant lesions (0.9608±0.2043) was statistically different from that of benign lesions (1.5858±0.3234) (6 adenosises and 4 fibrocystic changes were not included) and that of normal fibroglandular tissue (1.7617±0.4031) (F=34.78, P=0.0001). There was no significant difference between the ADC of benign lesions and that of normal fibroglandular tissue (P>0.05). Mean ADC of 4 cystic lesions was 2.4371±0.2188. Overlap still existed between the ADC of malignant and benign lesions. In order to obtain a high sensitivity in diagnosing the malignant lesions, one-side upper limit of 95% permissible interval of ADC (mean+1.645SD=1.2969) was adopted as the point to separate the malignant from benign lesions. As a result, a lesion was classified as benign if its ADC was more than 1.2969 and malignant if it was less than or equal to 1.2969. According to the classification of ADC used here, the following diagnostic indices emerge: sensitivity, 92%(24/26); specificity, 85%(17/20); PPV, 88.9%(24/27); NPV, 89.5%(17/19); and overall accuracy, 89%(41/46)(Table 1).

Table 1. The distribution of ADC in Breast Cancers, Benign Solid Lesions and Fibrocystic Changes

ADC	Malignant lesions (n=26)	Benign solid lesions (n=20)	Fibrocystic changes (n=4)
≤1.2969	24	3	0
>1.2969	2	17	4

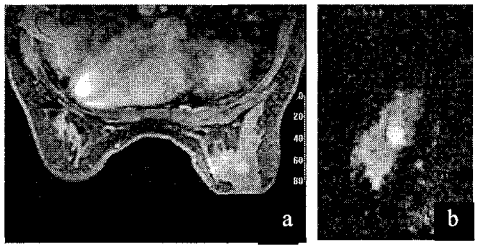

FIG.1. A medullary carcinoma in a 38-year-old patient. (a) contrast-enhanced MR. Axial plane. An enhanced nodule was clearly seen. (b) The nodule showed a high signal on DWI (Sagittal plane, b=1000), ADC=0.7373×10^{-3} mm^2/sec

Discussion

Although 96% of the breast lesions were detected on DWI in this data, contrast-enhanced MRI should be used to locate the lesions due to the poor spacial resolution of DWI. The ADC ranges of malignant lesions, benign lesions, and normal fibroglandular tissue in this study were different from that in Lucas-Quesada's results[1]. In order to evaluate the possible effect of different coils, a phantom was scanned with GPFlex surface coil, head coil and breast surface coil and ADC results with different coils were identical (P>0.05). Moreover, GPFlex surface coil got a better signal to noise ratio than breast surface coil.

In summary, our clinical and statistical analysis results showed that DWI is an useful method in discriminating benign and malignant breast lesions. Calculated ADC ranges and the separating point of benign and malignant lesions may provide an elementary reference for differential diagnosis.

References

1.Lucas-Quesada, F.L., Sinha, S., DeBruhl, N.D., Sinha, U.S., Bassett,L.W., Radiology(supp), 209,468,1998