DETERMINATION OF THE OPTIMUM B-VALUE FOR DIFFUSION WEIGHTED IMAGE OF THE BREAST

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Background: Diffusion weighted imaging (DWI) of the breast has been reported previously using a b-value of less than 1000s/mm^2 [1,2]. Theoretically, a higher b-value DWI provides better contrast with its reflection of more tissue diffusivity and less T2 shine through effect [3] . The argument against the use of a higher b-value is its reduction in signal-to-noise ratio (SNR)[4]. We analyzed the SNR and contrast to noise ratio(CNR) of breast tumors and normal breast parenchyma using b-values of 1000s/mm^2 and 1500s/mm^2. The purpose of this study was to assess whether DWI at 1500s/mm^2 is more useful in discriminating breast disease than DWI at 1000s/mm^2 at 1.5T. The apparent diffusion coefficient (ADC) values using both high and low b-values were also compared.

Materials and Methods: Institutional review board approval was obtained and the patients consented prior to study. There were 110 patients who had the following pathologic diagnosis: benign 18; malignant 92 including 76 invasive cancers (IC),16 DCIS. The MRI equipment used was a GE Signa CV/i, 1.5T, using an 8-channel breast coil. DWI protocol parameters were: single shot SE-EPI, b-values; 0, 1000 and 1500 s/mm^2, isotropic imaging, no parallel imaging. Region of interest was placed within the tumors as well as in the normal breast parenchyma on DWI at b=0, 1000, and 1500 s/mm^2 to measure signal intensity (SI). The following parameters, ADC values; In(S1-S2)/b-value {S1:SI at b=1000 or 1500 s/mm^2, S2: SI at b=0 s/mm^2}, SNRof breast tumor (SNR); SI of breast tumor/standard deviation (SD) of background, CNR; (SI of tumor-SI of normal breast parenchyma)/SD of background, were determined and compared between b= 1000s/mm^2 and 1500s/mm^2 for benign, IC and DCIS. **Statistics:** ADC values, SNR and CNR were compared between histologic types by Student t test. Wilcoxon signed rank test was used to compare ADC values, SNR and CNR between b=1000s/mm^2 and 1500s/mm^2 for benign, IC and DCIS respectively. P <0.05 was considered significant.

Results: The ADC results at b-values of 1000s/mm^2 and 1500s/mm^2 were 1.1±0.2x10^{-3}mm^2/s and 1.0±0.2×10^{-3}mm^2/s respectively for malignancies.These were significantly lower than those recorded for benign with values of 1.5±0.2x10^{-3}mm^2/s and 1.3±0.3×10^{-3}mm^2/s respectively. For normal breast parenchyma, values of 1.9±0.3x10^{-3}mm^2/s and 1.7±0.3×10^{-3}mm^2/s were recorded. The ADC values of IC were significantly lower than those of DCIS at both b-values (P<0.0001). All CNR were positive values except one fibroadenoma using a b=1500s/mm^2. SNR and CNR with b=1500 s/mm^2 were significantly lower than those with b=1000 s/mm^2 in all histologic types. The CNR changed from b=1000 to 1500s/mm^2 significantly correlated to the mean CNR of b=1000s/mm^2 and 1500 s/mm^2 in both IC and DCIS (ρ=-0.69, -0.55. P<0.03) . The positive CNR change from b=1000 to 1500 s/mm^2 in IC and DCIS showed a smaller mean CNR of b=1000 and 1500 s/mm^2 (a typical example is shown in figure 1).The SNR showed the same statistical significance as did SNR. SNR and CNR of IC were significantly higher than those of DCIS and benign tumors in both b-values (P<0.0005).

Discussion: The diagnostic accuracy of ADC was found to be the same irrespective of whether b was 1500 s/mm^2 or 1000 s/mm^2 for malignant versus benign. Using visual assessment, DWI with b=1000 s/mm^2 may be more appropriate for the detection of any kind of tumors owing to better SNR and CNR. However, the detection of malignant tumors that have low SNR and CNR, i.e.DCIS in fibrocystic disease and dense breast tissue with higher signal intensity on DWI[1)], may be more apparent in DWI where b=1500 s/mm^2 rather than with b=1000s/mm^2 is employed.

Conclusion: Visual inspection of DW images where a b-value of 1500s/mm^2 has been use would appear to provide better discrimination of malignant tumors from their benign counterparts. However, in contrast, DW images where a b-value of 1000s/mm^2 was used may be more appropriate for screening of malignancy and benign.

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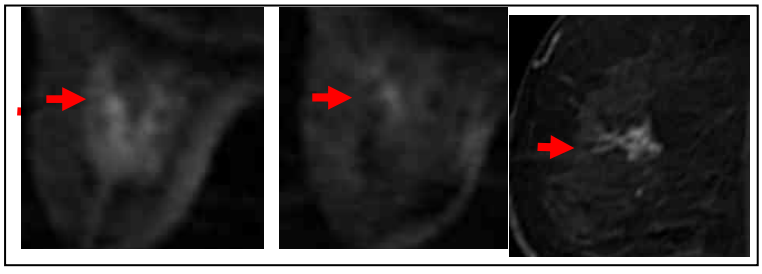

Figure 1. A case of ductal carcinoma in situ. The left image(b-value of 1000s/mm^2) shows a nodular lesion with slightly higher signal intensity than surrounding breast tissue in the upper quadrant. Middle DWimage (b-value of 1500s/mm^2) shows higher contrast against the surrounding breast tissue inturn has a higer CNR than that recorded for b=1000s/mm^2. The contrast enhanced T1 weighted image on the right shows non-mass forming clumped enhancement, which is concordant with the high signal intensity lesion on DWI. The pathologic examination revealed low papillary type DCIS surrounded by fibrocystic disease