Diffusion-weighted imaging: a valuable aid for the determination of the margin of breast carcinoma

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Background

Breast cancer is one of the most common female malignancies in the world. The limitations of mammography, ultrasound and routine MRI do not allow reliable identification of primary breast carcinoma and its boundary, especially in biological perspective. Our aim was to define a threshold value of apparent diffusion coefficient (ADC) with which malignant breast lesions can be distinguished from benign lesions, and more importantly, to explore a new non-invasive method for the precise detection of tumor margin in biological perspective by echo planar diffusion weighted imaging (EPI-DWI).

Materials and Methods

57 cases of breast positive or dubious lesions were scanned by routine MRI and EPI-DWI from June 2006 to January 2007 and all the cases were confirmed by pathologic examination. The values of ADC were compared between malignant lesions and benign lesions. The sensitivity and specificity of EPI-DWI and the threshold value of ADC were evaluated by Receiver Operating Characteristic curve (ROC). The adjacent tissue of malignant lesion was layered from the anatomic margin of lesion outwards with a layer thickness of 5 mm, from the innermost layer 1 to the outermost layer 4. In sagittal ADC map, the ADC values of malignant lesion and breast tissues surrounding the lesion in different directions (front, back, upper, lower) were compared and the ADC values among different layers were also compared.

Results

Pathological results showed that among the 57 lesions, 22 were benign and 35 were malignant. The mean ADC value of each type of lesion was as follows: malignant lesions, $(1.04\pm0.23)\times10^{-3}mm^2/s$ (b=500) and $(1.01\pm0.20)\times10^{-3}mm^2/s$ (b=1000); benign lesions, $(1.79\pm0.29)\times10^{-3}mm^2/s$ (b=500) and $(1.73\pm0.34)\times10^{-3}mm^2/s$ (b=1000). The ADC value of malignant lesions was statistically lower than that of benign lesions, either b=500 or b=1000 (both $P<0.05$). In ROC curve, when b=500, the threshold value between malignant and benign lesions was $1.240\pm0.25\times10^{-3}mm^2/s$ with 93% sensitivity and 100% specificity; while b=1000, it was $1.203\pm0.25\times10^{-3}mm^2/s$ with 96% sensitivity and 97% specificity. The ADC value of malignant lesions was statistically lower than that of breast tissues surrounding the lesions in all four directions from layer 1 to layer 4 (all $P<0.05$); while there was no statistical difference in ADC values among the four directions. For the breast tissues around the malignant lesions, the ADC values increased gradually from layer 1 to the layer 4 and there was a significant difference between the ADC values of layer 1 and layer 2 ($P<0.05$); while from layer 2 outwards, there was no statistical differences among different layers. Further study showed that the ADC values from layer 2 to 4 were not statistically different from that of the normal breast tissue on the other side ($P>0.05$).

Conclusion

Our preliminary study showed that EPI-DWI with ADC measurement is an accurate tool in differentiating malignant breast lesions from benign lesions. Furthermore, this approach could provide objective and quantitative information about the identification of breast carcinoma margin in biological perspective. 10 mm outwards from the anatomical margin of breast carcinoma could be viewed as its biological margin. These results make EPI-DWI a promising diagnostic method in the field of conservative breast surgery.