How to select b value of Diffusion-weighted MR Imaging for detecting primary rectal cancer

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Introduction

Diffusion-weighted imaging (DWI) can detect the brownian motion of water in vivo and has been used to improve the detection and characterization of ischemic lesions of the brain, and has also been used to characterize hepatic or renal lesions. DWI recently has been used to predict and early monitor the tumor's response to treatment. So, DWI has shown important value of clinical application, and has been used by radiologist more and more. DWI is influenced by Blood perfusion and T2 shine through, but how to select b value to reduce the influence has been not reported. The aim of this study is to investigate how to select the reasonable b values of DWI for displaying rectal cancer.

Materials and Methods

Thirty-two patients with rectal cancer with single-shot EPI diffusion-weighted sequences (b=300, 500, 800, 1000 and 1300 s/ mm^2) at 1.5T MR scanner (GE Healthcare) with an 8-channel body phase-array coil. The imaging parameters are: TE/TR：minimum/6000 msec, FOV：36cm, Matrix：128x128, Slicethick：5mm, Nex：8. ASSET technology was used to reduce the distortion of EPI. The mean ADC values and Signal-to-noise ratio (SNR) of tumors, Contrast-to-noise ratio (CNR) of tumors and normal rectal wall, Signal intensity ratio (SIR) of bladder were calculated and compared. The SPSS11.0 was used for data analysis.

$SNR_{tissue} = S_{tissue}/SD_{noise}$ （S_{tissue}: the intensity of tissue; SD noise: standard deviation of background noise）

$CNR = （S_{tumor} - S_{normal\ wall}）/SD_{noise}$（$S_{tumor}$: the intensity of tumor; $S_{normal\ wall}$: the intensity of normal rectal. SD noise: standard deviation of background noise）

$SIR_{tissue} = S_{tissue}/S_{noise}$（$S_{tissue}$: the intensity of tissue; S_{noise}: the intensity of background noise）

Results

The CNR of tumors and normal rectal wall decreases following the ascending of b values, and the CNR in the DWI of rectal cancer with b=300, 500, 1000 s/ mm^2 was significantly higher than that in DWI with b=1300 s/ mm^2 and T2 weighted imaging ($F = 42.492$, $p < 0.001$). The SIR of bladder and background noise in DWI (b=300, 500, 800, 1000 and 1300 s/ mm^2) were lower than that in T2 weighted imaging（$F = 144.786$，$p < 0.05$）. When b values reached 800 s/ mm^2 the SIR declined to 2.437± 0.844. The mean ADC values of tumor were decreases following the ascending of b values.

Discussion and Conclusion

The CNR of tumors and normal rectal wall decreases following the descending of b values, and the CNR in the DWI of rectal cancer with b=1300 s/mm^2 was too low to distinguish tumor and normal bowel wall, therefore, the b value higher than 1300 s/ mm^2 is not suitable to DWI of rectal cancer. On DWI with small b values, the signal reduction of the tissues was markedly influenced by blood perfusion, however, the mean ADC values of tumor decrease following the ascending of b values. Thereby, to increase b values can erase the effect of blood perfusion. ADC value measured in DWI with high b values was close to real D value. When b values reached 800 s/ mm^2 the SIR of bladder and background noise declined to 2.437± 0.844, the SIR in the DWI significantly lower than that in T2 weighted imaging. Therefore, the effect of T2 shine through is too little when b values was higher than 800 s/ mm^2. Therefore the results indicate b 1000 s/ mm^2 is reasonable to DWI of rectal cancer. Both the effect of blood perfusion and T2 shine through can not markedly influence the diffusion-weighted imaging of rectal cancer .

Key words

rectum, neoplasm, magnetic resonance imaging, diffusion–weighted imaging, b value

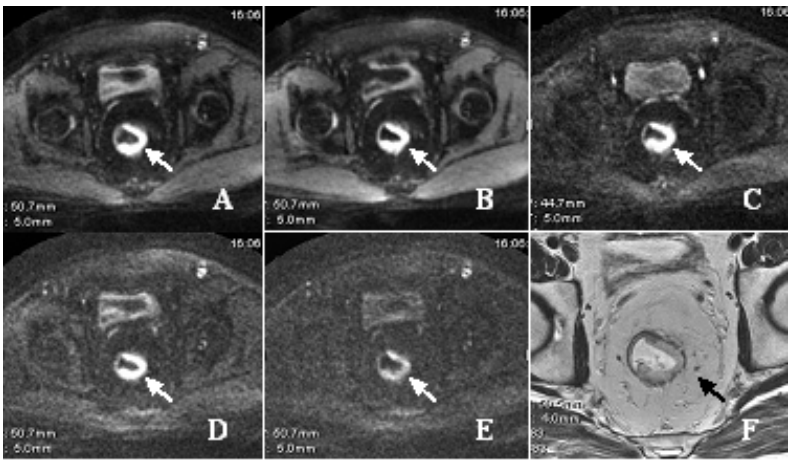

Fig.1 one patient with rectal cancer; the figure A~E are DWI, A：b=300 s/mm^2; B：b=500 s/mm^2; C：b=800 s/mm^2; D：b=1000 s/mm^2; E：b=1300 s/mm^2; F：T2-weighted transaxial FSE (fast spin-echo) image; the figure A~E show The CNR and SNR of rectal tumor (arrow) and normal rectal wall decrease following the ascending of b values. When b value reached 1300 s/mm^2, the intensity of tumor markedly decreased.