DWI of rectal cancer at 3T

X. Zhang[1,2], X. Ma[2], H. Zhang[1], D. Yu[2], and C. Li[2]

[1]Weill Medical College of Cornell University, New York, NY, United States, [2]Qilu Hospital of Shandong University, Jinan, Shandong, China, People's Republic of

Objectives: Diffusion-weighted MR Imaging (DWI) helps diagnose tumors because normal tissue and benign tumors tend to have more molecular structure restricting random motion of free water. In this study we investigate the utility of DWI in discriminating rectal cancer from other lesions by measuring the apparent diffusion coefficients (ADC) of benign and malignant rectal diseases.

Materials and Methods: DWI were obtained in 57 patients (male 35, female 22, age 21-85) with suspected rectal disease on a 3T MR scanner (GE Signa Excite) using an 8-channel phased-array surface coil and an echo planar imaging (EPI) pulse sequence. The parameters were TR = 1600 ms, TE = 55.2, 64.5, 72.5, 78.2, 83 ms, NEX = 3, FOV = 38 cm, matrix = 128×128, 6-11 slices depending on the size of rectal lesions, slice thickness = 7 mm with an interval of 1 mm. The scan duration was 17-35 s. The DWI was repeated 5 times with b values set at 200, 400, 600, 800 and 1000 s/mm^2. The ADC and the signal intensity of different rectal diseases were measured with ROI of 50 mm^2 and compared to the ADC and signal intensity of normal gluteal muscle with the same size ROI. Statistical analyses were performed using SPSS version 11.5 software (SPSS, Inc., 1989–2001).

Results: Histological examination of resected specimen or fine-needle biopsy confirmed 38 primary rectal cancers, 6 local recurrences, 2 adenomas, 2 stromal cell tumors, 1 dermoid cyst, 1 endometrioma, 7 periannal abscesses/fistulas. At b value = 400 s/ mm^2, rectal lesions had maximum contrast compared to background tissues (Fig1). The ADCs also decreased and became stable with the increase of b value (Fig2).

At any given b value, the 2 stromal cell tumors had the lowest ADCs among all the rectal diseases, with the most significant difference at b ≥ 800 s/mm^2 (Table 1). The ADCs of rectal cancer including primary and local recurrence showed no difference when compared with other benign lesions ($p > 0.05$). However, the ADCs for T4 stage tumor were lower than the ADCs of other stages. There were no significant differences between cancers with and without lymph node metastasis and distant metastasis.

Conclusions: These data in 57 patients show that DWI in rectal tumor imaging at 3T is promising for discriminating rectal malignancy from benign adenomas and for distinguishing stromal cell tumor from other tumors. Rectal cancer is optimally depicted on DWI images when b value = 400s/mm^2 although the ADC value is measured more accurately when b value = 1000 s/mm^2. ADC of stromal cell tumor is significantly lower than that of other diseases perhaps due to its unique cellular architecture. With deep infiltration of the tumors into the rectal wall at T4 stage, the ADCs are lower presumably due to more compact distribution of tumor cells and limited water molecular movement.

Table 1 The ADCs of different rectal disease measured at different b values

	n	b value($\times 10^{-3}$mm^2/s)				
		200	400	600	800	1000
Primary cancer	38	2.5±0.6	1.8±0.6	1.5±0.4	1.3±0.3	1.2±0.3
Local recurrence	6	2.5±0.6	2.0±0.7	1.8±0.3	1.4±0.2	1.3±0.3
Perianal abscess	7	2.5±1.1	2.0±0.8	1.6±0.6	1.5±0.6	1.2±0.1
Adenoma	2	2.2±0.3	2.0±0.2	1.5±1.0	1.2±0.6	1.2±0.4
stromal cell tumor	2	1.0±1.1	0.8±1.1	0.7±0.8	0.5±0.7	0.4±0.6
F statistic		2.03	1.499	1.996	2.864	3.848
P value		0.108	0.219	0.113	0.034	0.010

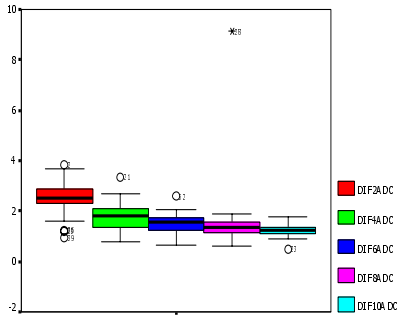
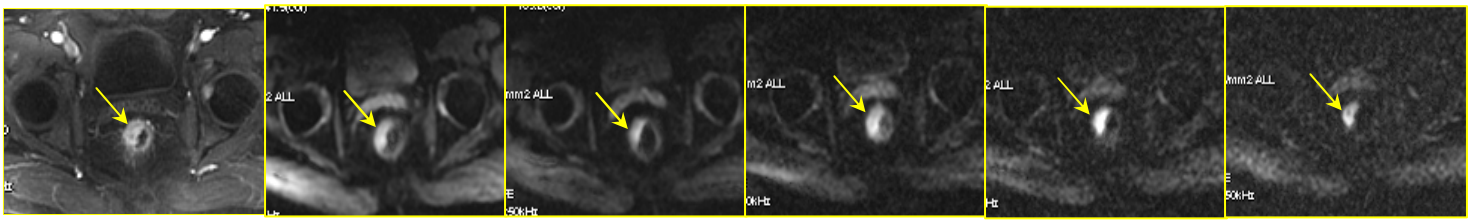


Fig2. The ADCs of rectal cancer measured at different b values.



Arterial phase b=200s/mm^2 b=400s/mm^2 b=600s/mm^2 b=800s/mm^2 b=1000s/mm^2

Fig 1 DWI pictures of rectal cancer with different b values showed the expected signal intensity decrease of normal gluteal muscle and rectal lesions with the increase of b value and interestingly improved cancer to background contrast at higher b values. An optimal trade off between optimizing contrast and maximizing SNR occurs at b value = 400 s/mm^2.

References 1.Taouli B, Radiology. 2003,226:71-78. 2.Ichikawa T, AJR. 1998,170:397-402. 3.Byun WM, AJNR,2002,23:906-912. 4.Shimony IS, Radiology,1999,212:770-784. 5.Chiu FY, J Comput Assist Tomogr. 2005, 29:176-80. 6.Namimoto T, Radiology. 1997,2004:739-44. 7.Ichiro Yamada, Radiology 1999; 210:617–623. 8.Yamashita Y, J Magn Reson Imaging, 1998,8:367-374. 9.Chan JH, Abdom Imaging. 2001,26:161-165. 10.Hein PA, Eur J Radiol, 2003, 45(3):214-22. 11.Kremser C, Strahlenther Onkol, 2003,179(9):641-649.