PROSTATE CANCER : ARE THERE DIFFERENCES BETWEEN NATIVE DIFFUSION-WEIGHTED IMAGES AND THE APPARENT DIFFUSION COEFFICIENT MAP IN TUMOR DETECTION AND CHARACTERIZATION?

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Introduction: While recent studies have supported the utility of diffusion-weighted imaging (DWI) in the detection of prostate cancer (PCa), these studies have employed varying methodology for the acquisition, processing, and interpretation of DWI. For instance, these studies have differed in whether the interpreting radiologists reviewed both the native diffusion-weighted images (nDWI) and apparent diffusion coefficient (ADC) maps in a joint fashion [1], only nDWI [2], or only the ADC map [3-5]. Although differences in the relative utility of nDWI and the ADC map have been reported for other organs such as the lung [6] and liver [7], such a comparison has not to our knowledge previously been performed in the prostate. Therefore, the purpose of this study was to compare the visibility of PCa on nDWI and the ADC map as well as to assess the histologic and MRI features of PCa that influence the visibility of tumor foci on these respective image sets.

Methods: 21 patients with PCa (from an ongoing study) underwent prostate MRI on a 1.5T scanner before prostatectomy that included axial T1WI, axial T2WI, and axial DWI (b=0-500-1000). Two pathologists reviewed the prostatectomy slices and localized 63 foci of peripheral zone (PZ) PCa. A single radiologist reviewed the MR images based upon the prostatectomy data. For each tumor focus, the radiologist recorded the visibility of the tumor on nDWI-b500, nDWI-b1000, and the ADC map, with the percentage of tumors visible on each of these image sets compared using a McNemar test. The particular nDWI image set with the greatest tumor visibility was then selected for further comparison with the ADC map. For each visible tumor focus, an ROI was placed on the tumor on T2WI, nDWI, and the ADC map. In addition, for each patient, a region of histologically confirmed benign PZ was selected for measurement of both the nDWI signal intensity (SI) as well as the ADC value. The relative contrast between PCa and benign PZ for each tumor focus was calculated for both nDWI and the ADC map as the ratio between the difference and the sum of the measured values for benign PZ and PCa on these respective image sets. For tumors visible on the ADC map, the tumor Gleason score, tumor size, ADC, visibility on T2WI, and relative T2 SI with respect to muscle were then compared between those that were or were not also visible on nDWI using a combination of the Mann-Whitney U test, unpaired Student's T-test, and Fisher's exact test.

Table 1-Comparison of Tumor Visibility Between Image Sets*		
Image set	N	% tumor foci visible
nDWI-b500	14/63	22.2%
nDWI-b1000	27/63	42.9%
ADC map	42/63	66.7%

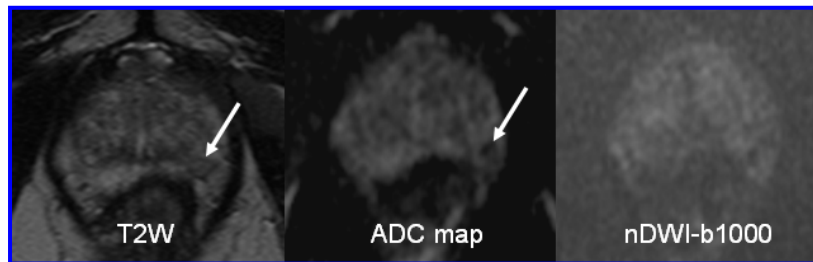*Significant differences in visibility between each pair of image sets (p-values ranging from <0.0001 to 0.0041)

Figure 1: Right midgland tumor is visible on T2WI and ADC map, but not on nDWI-b1000.

Table 2-Comparison of Tumors Visible and Not Visible on nDWI-b1000 (Among Tumors Visible on ADC Map)			
Property	Visible On nDWI-b1000	Not Visible on nDWI-b1000	P
Gleason Score	6.73	6.45	0.1184
Tumor size (mm)	12	9	0.1055
ADC (x10^{-3} mm^2/s)	0.99	1.04	0.4122
T2 visible	100% (22/22)	90% (18/20)	0.2206
T2 SI relative to muscle	4.22	4.00	0.6564

Results: Significantly more tumor foci were visible on nDWI-b1000 than on nDWI-b500 (p=0.0023), and significantly more tumor foci were visible on the ADC map than on either nDWI-b1000 (p=0.0041) or nDWI-b500 (p<0.0001) (Table 1). There was significantly greater relative contrast between tumor and benign PZ on the ADC map than on nDWI-b1000 (relative contrast of 0.288 and 0.100 respectively, p<0.0001). Among 42 tumors visible on the ADC map, 22 tumors that were also visible on nDWI-b1000 were compared with 20 tumors that were not also visible on nDWI-b1000 (Table 2): a trend toward a higher Gleason score (p=0.1184) and tumor size (p=0.1055) among tumors that were visible on both nDWI-b1000 and the ADC map as compared with those tumors visible only on the ADC map did not reach statistical significance; there were no differences between these two groups in terms of tumor ADC (p=0.4122), tumor visibility on T2WI (p=0.2206), or tumor T2 SI relative to muscle (p=0.6564). Statistical analysis was not performed for 5 tumor foci that were visible on nDWI-b1000 but not on the ADC map.

Conclusions: This preliminary data suggests that PCa has greater visibility and relative contrast compared with benign PZ on the ADC map than on nDWI. Further evaluation with more patients may indicate whether there is significance to the trend we observed toward greater Gleason score and size for those tumors visible on both nDWI and the ADC map as compared to those visible on the ADC map alone. Additional features of tumor foci on T2WI did not influence their visibility on DWI in this sample. These preliminary results support the importance of review of the ADC map in addition to nDWI when performing DWI of the prostate given possible greater tumor visibility on the ADC map.

References: [1] Miao H, et al. EJR 2007;61:293-302. [2] Tamada T, et al. Radiology 2008;248:531-539. [3] Haider MA, et al. AJR 2007;189:323-328. [4] Lim HK, et al. Radiology 2009;250:145-151. [5] Morgan VA, et al. Acta Radiologica 2007;48:695-703. [6] Uto T, et al. Radiology 2009;252:247-254. [7] Vandecaveye V, et al. European Radiology 2009;19:2456-2466.