

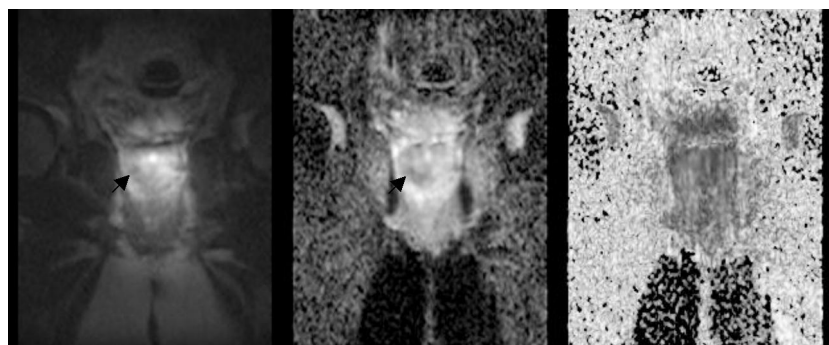
Diffusion Tensor Imaging for Prostate Cancer Detection: Preliminary Results from a Biopsy-Based Assessment

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Introduction: We hypothesized that as cancer cells invade the ductal anatomy of the prostate, the water diffusion coefficient (D) and fractional anisotropy (FA) may be altered. This hypothesis was tested by performing diffusion tensor imaging (DTI) and comparing D and FA between regions of "normal" peripheral zone (PZ) and regions of prostate cancer (PC) as determined by biopsy and conventional T2-weighted imaging.

Methods: Eight men referred for prostate imaging at our hospital were scanned at 1.5T (GE Signa) with a line scan diffusion imaging (LSDI) [1] sequence in addition to standard T2-weighted imaging with a combined endo-rectal and pelvic coil array. Diffusion weighted images ($b = 750 \text{ s/mm}^2$) were acquired with six diffusion sensitization gradients along with two baseline images ($b = 5 \text{ s/mm}^2$). Five coronal slices were acquired in 6.2 minutes with voxel size of $1.7 \times 1.7 \times 6 \text{ mm}^3$ and TR/TE values of 5000/65 ms/ms. All 8 men underwent biopsy, 6 before and 2 after their MR imaging session. A radiologist familiar with each case specified a region of interest (ROI) in the PZ where a decrease in T2-weighted image intensity was in accordance with a positive biopsy result. Decreased T2-weighted image intensity is a clinically established indicator of the presence of PC, which most often originates in the PZ [2]. The radiologist also specified a "normal" ROI within the PZ where there was no loss of T2 intensity and no positive biopsy result reported. These ROIs were assumed to be cancer-free. Trace diffusion and FA images were reconstructed from the data, and comparisons were made between the cancerous and cancer-free regions.



Coronal T2-weighted image (left) with regions of decreased signal (arrows) in accordance with a positive biopsy result. Water diffusion image (center) showing corresponding decrease in the same regions. Fractional anisotropy (right) shows no correlation.

Results and Discussion: Two of the eight patients were cancer-free, as indicated by biopsy and T2-weighted imaging studies. In these patients the D, FA and T2-weighted imaging appeared homogenous throughout the PZ. Among the remaining 6 patients, there were 10 distinct regions of T2-weighted focal abnormality corresponding to positive biopsy results. The mean intra-patient drop in T2 image intensity between cancerous and normal regions was 35% (15% sd). In 9 of the 10 regions, D showed a decrease, while in the remaining case D showed no change. The mean value of D was $1.28 \mu\text{m}^2/\text{ms}$ (0.15 sd) in normal regions, $0.98 \mu\text{m}^2/\text{ms}$ (0.25 sd) in cancerous regions. The mean intra-patient drop in D between cancerous and normal

regions was 24% (14% sd). A simple t-test indicated that the drop in the value of D was statistically significant ($p < .05$). The FA maps did not correlate with T2-weighted intensity and biopsy, with 5 showing an increase, 2 showing a decrease, and 3 showing little change. The mean value of FA was 0.15 (0.06 sd) in normal regions, 0.20 (0.08 sd) in cancerous regions. The mean intra-patient rise in FA between cancerous and normal regions was 28% (39% sd). These changes in FA were not statistically significant; the slight increase may be attributable to reduced signal to noise ratios in the lesion areas.

Conclusion: Ours results are in agreement with the small number of recent reports [3,4,5] suggesting that diffusion imaging of the prostate may be useful in the diagnosis of prostate cancer. Specifically, the early assessment presented here suggests that the water diffusion coefficient drops in the presence of prostate cancer.

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