Diffusion Tensor Imaging of the Prostate: Low Anisotropies in Central Gland and Peripheral Zone in Men with Adenocarcinoma

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Introduction: Diffusion tensor imaging (DTI) studies of the prostate in healthy young volunteers has been performed without the use of endorectal coil technology using single-shot echo planar imaging (EPI) methods (1). The fractional anisotropy (FA) values reported were on the order of 0.3 to 0.5 (1), suggesting that DTI may be a useful probe for assessing microstructural aspects of prostate tissue. In the present study, we employed endorectal coil technology with a line scan diffusion imaging (LSDI) sequence (2) and multiple signal-averages to generate DTI data sets in men with biopsy proven prostate cancer. In contrast to the previous study performed with EPI (1), FA values in the central gland (CG) and peripheral zone (PZ) measured with LSDI were on the order of 0.16 and 0.11, respectively. The low FA values make for fairly weak eigenvector maps with fairly vague structural information in the gland.

Methods: Five men with biopsy proven adenocarcinoma of the prostate (age range 58 to 74) undergoing staging MR exams with an endorectal coil and a 1.5 T scanner (General Electric Medical Systems, Milwaukee, WI) consented to have an additional DTI scan in accord with hospital institutional review board regulations. A single 5 mm thick axial slice was imaged with a LSDI sequence (2) using 6 non-collinear diffusion sensitization directions with a b-factor of 750 s/mm^2 and two baseline images with a b-factor of 5 s/mm^2. A TR/TE of 2000/65 ms/ms was employed with a 64 x 128 (column x frequency encode) matrix with a 22 cm FOV for nominal voxel volumes of 0.03 ml. To insure an adequate signal-to-noise ratio (SNR) for robust FA measurement, 12 signal averages were employed so that the total scan time was approximately 10 minutes. Standard DTI analyses were performed to generate maps of the diffusion coefficient D, FA, and the primary eigenvectors. Regions of interest in PZ and CG were identified and regional D and FA values recorded.

Results and Discussion: Interindividual mean ± standard deviation D values in CG and PZ were 1.13 ± 0.25 μm^2/ms and 1.27 ± 0.22 μm^2/ms, respectively. The interindividual mean ± SD FA values in CG and PZ were 0.16 ± 0.09 and 0.11 ± 0.04, respectively. The figure shows a D map, an FA map and a primary eigenvector map from one of the subjects. The latter shows a small degree of structure within the peripheral zone in which the directional preference of water appears to be perpendicular to the edges of the gland. Overall, however, rather low FA values were measured despite the reasonably SNR values (> 25) in the baseline images.
The FA values we obtained are much smaller than those reported by Sinha and Sinha (1). This can possibly be attributed to the older age range and presence of disease in our subjects. It is also possible, however, that FA values reported in (1) are artifactually high due to low SNR as the studies were performed without the use of an endorectal coil and were performed with single-shot EPI methodology. It is well-known that noisy data can lead to overestimates of FA (3,4). The low FA values we have encountered in the prostate implies that obtaining microstructural tissue information from this gland will be challenging and perhaps better performed at higher field strengths.

References

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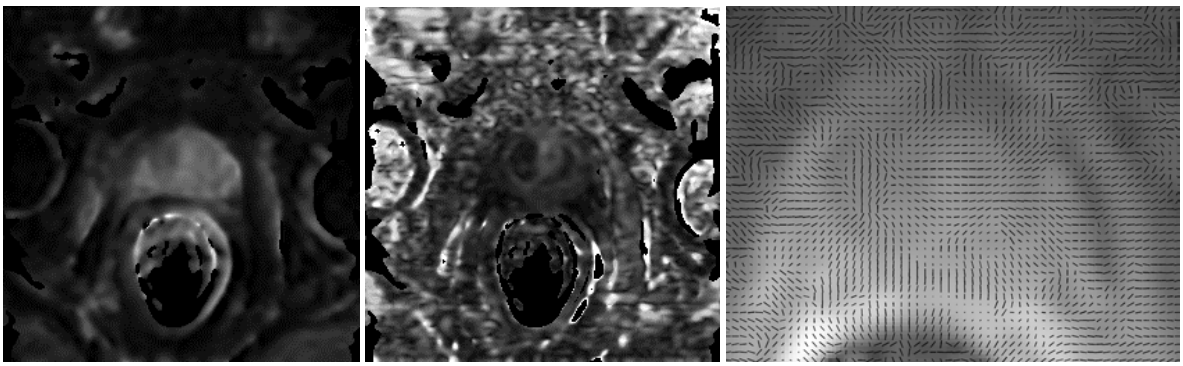

Figure 1. Left, a D map of the prostate. At center, an FA map. On the right, a primary eigenvector map (expanded view).