Tractography of the neurovascular bundles of the prostate with zoom DTI technique: preliminary report

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Target audience: Sparing the neurovascular bundles (NVB) of the prostate is vital to preserve erectile function and guarantee good postoperative continence for the prostate cancer (PCa) patients who undergo radical prostatectomy. As recently introduced robotic surgery has enhanced the ability for nerve sparing, the importance of the preoperative evaluation for the NVB is increasing especially in PCa patients undergoing robot-assisted laparoscopic radical prostatectomy. Although, several studies have reported the application of diffusion tensor imaging (DTI) and fiber tractography to the peripheral nerves in the extremities, few studies have applied this technique for visualization of the NVB of the prostate[1, 2]. Although DTI with a smaller FOV is desirable for visualizing tiny NVB around the prostate, a conventional excitation technique limits the minimum size of FOV for DTI to approximately 250mm. Thus, it is expected that DWI using a selective radiofrequency excitations technique (zoom DTI) can reduce FOV of DTI and improve accuracy of fiber tracking around the prostate. The purpose of this preliminary study was to evaluate the ability of DTI using selective radiofrequency excitations technique with limited FOV of 120mm for the demonstration of the NVB using fiber tractography technique as compared with conventional DTI using larger FOV of 256mm.

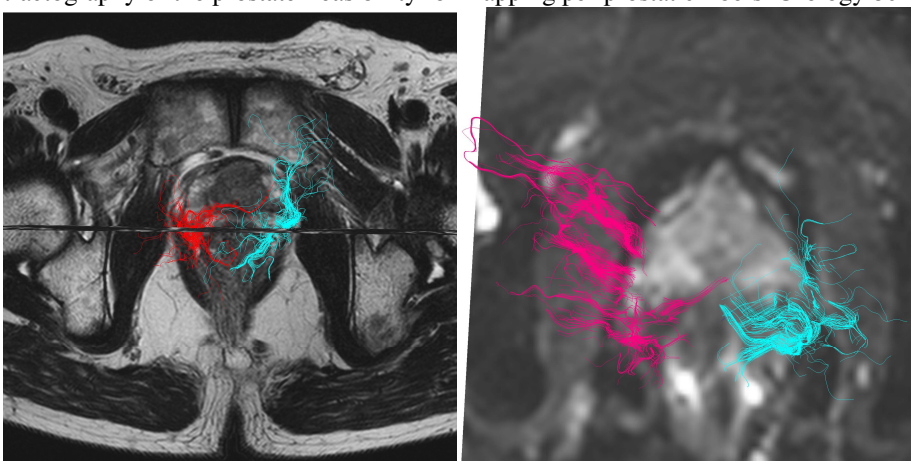
Methods: 16 patients (67±6 years) with biopsy-proven PCa underwent preoperative MR protocol including DTI at 3T using a multichannel phased array coil. DTI was acquired with a conventional single-shot echo planar imaging for 10 patients, and with a selective radiofrequency excitations technique (zoom DTI) for six patients. The scanning parameter for zoom DTI were as follows: TR 5,648 ms; TE 52.7 ms; FOV 120 mm, matrix 64×63, NEX 4, section thickness 3 mm, and acquisition time: 10.0 min, while for conventional DTI: TR 10,000 ms; TE 71.4 ms; FOV 256 mm, matrix 112×112, NEX 3, section thickness 2.5 mm, and acquisition time: 6.8 min. B-values of 0 and 600 s/mm^2, 6 diffusion gradient orientations, and pixel bandwidth of 2,878, Hz were applied for both of DTIs. Three-dimensional fiber tracking for the periprostatic tissue was performed using MEDNRIA (Asclepios Research Project) using following parameters: FA threshold of 0.1; minimum fiber length of 10 mm; smoothness of 20. The degree of image distortion, aliasing artifact, and homogeneity of fat saturation for each DTI were visually assessed with 5-point scale and compared with Mann-Whitney analysis. Region of interest (ROI) were drawn on b=0 images for the region of bilateral NVB and mean number of fibers detected were compared with unpaired t-test. P-values less than 0.05 were considered significant for all statistical analyses.

Results: Degree of aliasing artifact with zoom DTI were less prominent than conventional DTI (1±0 vs. 2±0.8, $p<0.05$), whereas there was no significant difference in degree of distortion (P=0.5). Zoom DTI provided more homogenous fat saturation than conventional DTI (5±0 vs. 4±0.6, $p<0.01$). Number of detected fibers on tractography with zoom DTI were greater than those with conventional DTI (1558±687, vs. 639±260, $p<0.05$), while there was no statistically significant difference in average length of fiber between zoom DTI and conventional DTI.

Discussion: Zoom DTI can provide better images with less aliasing artifact and more homogenous fat saturation than conventional DTI. As no aliasing artifact was observed among the cases with zoom DTI, DTI with a small FOV of 120mm are successfully obtained using a body phased-array coil.

Conclusion: Tractography with zoom DTI technique of the prostate is feasible and would elucidate the periprostatic fiber tract detail, although further study is required to correlate DTI findings to gold standard anatomic specimens.

References: 1) Kim CK, et al.: Diffusion tensor imaging of normal prostate at 3 T: effect of number of diffusion-encoding directions on quantitation and image quality. Br J Radiol 85: e279-283, (2012). 2) Finley DS, et al.: Diffusion tensor magnetic resonance tractography of the prostate: feasibility for mapping periprostatic fibers. Urology 80: 219-223, (2012)



Figures.
Tractography with conventional DTI (left) showed fewer fibers than with zoom DTI (right). A couple of fiber bundles were clearly demonstrated on tractography with zoom DTI