Apparent diffusion coefficient values during magnetic resonance -guided biopsy of the prostate: correlation with histological results

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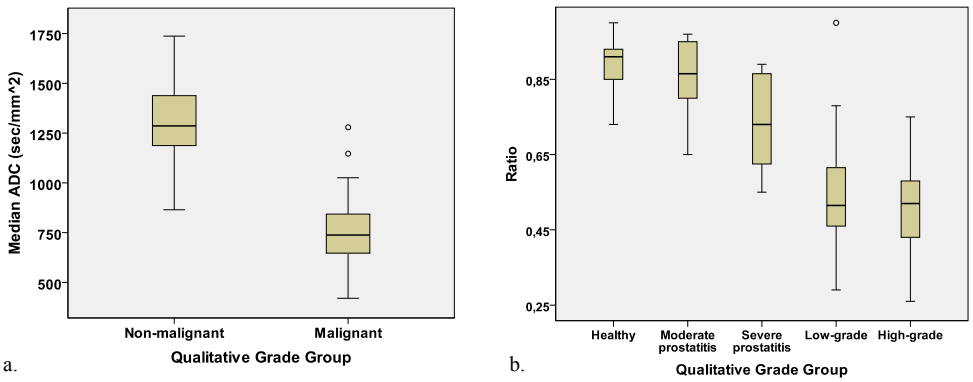
Introduction: Recently, diffusion-weighted imaging (DWI) and dynamic contrast-enhanced MR imaging (DCE-MRI) are introduced as additional imaging methods to improve the specificity[1,2]. Langer et al. found significant differences in ADC values between normal peripheral zone tissue and cancerous tissue. In this study whole mount section histopathology was used as standard of reference. However, the correlation between imaging and histopathology is influenced by shrinkage and deformation of the resected prostate. Furthermore, there was a time lap between imaging and radical prostatectomy in which the histopathology may have changed. To overcome these problems we investigated the correlation between DWI and histopathology obtained during the same MRI guided biopsy session.

Materials and methods: Retrospectively 47 patients (median age, 65 years; median prostate-specific antigen level, 11 ng/mL) who received MR-guided biopsy and DWI during the same session were included. Patients who underwent MR-guided biopsy after prostatectomy (recurrent suspicious regions), radiation therapy or without a histopathological report were excluded. Also patients with biopsies in the anterior fibromuscular stroma (AFS) and hyper- or atrophic tissue were excluded. During the biopsy procedure T2-w turbo spin-echo images in the axial direction (TR/TE, 3620/104 milliseconds; flip angle, 120 degrees; slice thickness, 4 mm; in-plane resolution, 0.8 x 0.8 mm; number of slices, 15) and axial DWI were acquired with a single-shot echo-planar imaging sequence with diffusion modules and fat suppression pulses. Water diffusion in 3 directions was measured using b-values of 0, 100, 500, and 800 s/mm^2 (TR/TE, 2000/67 milliseconds; slice thickness, 4 mm; in-plane resolution, 1.8 x 1.8 mm; number of slices, 16). Apparent diffusion coefficient (ADC) maps were automatically calculated by the scanner software. After acquiring a biopsy, fast T2-w true fast imaging with steady precession (TRUE-FISP) images (TR/TE, 4.48/2.24 milliseconds; slice thickness, 3 mm; in-plane resolution, 1.1 x 1.1 mm; number of slices, 5) in axial and sagittal direction were obtained with the needle *in situ* to verify needle positioning towards the desired CSR. After the MR-guided biopsy procedure the samples were sent to the department of pathology.
Calculated ADC-maps were merged with the control T2-w TRUE-FISP image with the needle left in situ. Eight pixels with the lowest ADC-values were selected (in 3 image directions) at the same location as the needle (ROI_{CSR}). To correct for diffusion differences between individual patients 'healthy regions' were annotated as ROIs (24 pixels) in the contra lateral segment in mirror position to the CSR (ROI_{Norm_Mirror}) and the ratio between ROI_{CSR} and ROI_{Norm_Mirror} was calculated. Prostate motion, that may have occurred between the initial DWI and the control TRUE-FISP image, was manually corrected. Of each ROI the median, standard deviation (SD) and the ratio between ROI_{CSR} and ROI_{Norm_Mirror} of the ADC-values (in x 10^{-3} s/mm^2) were calculated. Five qualitative grading (QG) groups were defined: 1) normal – biopsies with healthy prostate tissue; 2) moderate prostatitis – biopsies with moderate symptoms of inflammation; 3) severe prostatitis – biopsies with severe symptoms of inflammation; 4) low-grade - biopsies with Gleason score 5 and 6; 5) high-grade - biopsies with Gleason score 7, 8 and 9. Two-tailed t-tests were performed to determine differences between groups. Significant differences were considered at $p < .05$.

Results: From the total population, (47 patient, 63 biopsy specimens) 37 patients (40 biopsies) were diagnosed with prostate cancer where Gleason score ranged from 5 to 9. In 17 men, 23 tumor-negative biopsies were found, of which 9 biopsies were normal prostate tissue, 6 biopsies were determined with moderate prostatitis 8 with severe prostatitis. The mADC ($0.74 \pm 0.10 \times 10^{-3}$ mm^2/sec) found in the biopsy specimen with prostate cancer was significantly lower ($p < 0.001$) than the non-malignant biopsy specimen with mADC of $1.29 \pm 0.16 \times 10^{-3}$ mm^2/sec (figure 1a). There was no significant difference between high- and low- grade cancer (p=0.43). Furthermore, there was a significant difference between prostatitis and cancer ($p<0.001$) as well as between healthy specimen and prostatitis (p=.03).

Discussion: According to the results found in this study we can conclude that the mean ADC-values of men with malignant and non-malignant prostate cancer were significant different ($p < 0.001$). Furthermore, significant differences were seen between prostatitis and cancer as well as between healthy specimen and prostatitis. However, there was no significant difference between high- and low- grade cancer. More biopsy specimen should be evaluated to determine whether there is a significant difference between high- and low- grade cancer.



a. b.

Figure 1: In (a) boxplots of the median ADC values for non-malignant and malignant groups are shown. In (b) boxplots of the ratios (ROI_{CSR} / ROI_{Norm_Mirror}) for the different QG are shown.

References

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