Correlation between 3T MRI Apparent Diffusion Coefficient Values and Prostate Cancer Gleason Score in Prostatectomy Specimens

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Introduction: Gleason Score (GS) estimations of prostate adenocarcinoma are the most important predictor of tumor aggressiveness, behavior and prognosis. A clinical problem is underestimation of the true Gleason Score by transrectal ultrasound guided prostate biopsies. Apparent Diffusion Coefficient (ADC) values, determined from Diffusion Weighted MR imaging (DWI), correlate well to cellular densities in human cancers: prostate cancer has significantly lower ADC values compared to benign prostate tissue. Different Gleason scores show differences in cellular densities, ADC values on DWI could hypothetically have a correlation with Gleason scores. ADC values show interpatient variations as well as overlap between healthy prostate tissue and prostate cancer within each individual patient as a consequence of differences in tumor growth. Because of this variation it is impossible to define an ADC threshold for tumor discrimination. To correct for this variation a contrast- to- noise ratio (CNR) of mean ADC (mADC) of tumor tissue to mADC of normal tissue was used next to plain ADC values. This study examines a possible correlation between ADC values calculated from DWI at 3T and prostate cancer Gleason score, as indicated for every individual cancer focus on histopathologic slides of the resected prostates as the standard of reference.

Materials and Methods: 3T MR imaging was performed in 30 patients with proven prostate cancer, prior to radical prostatectomy. Diffusion Weighted Images were obtained with a spin echo EPI pulse sequence using TR 2600 ms, TE 91 ms, b-values 0, 50, 500, 800 s/mm², spatial resolution: 1.5 x 1.5 x 3 mm. ADC maps were calculated from DWI and were aligned slice-by-slice to step-section radical prostatectomy specimens. Per slice regions of Interest (ROI) were drawn on ADC maps over tumor and mean ADC values were calculated. Additionally, ROIs were drawn on directly adjacent normal prostatic tissue, of which ADC values were also calculated. Prostatectomy determined GS was correlated to: a) mean tumor ADC values (mADC) b) contrast-to-noise ratio (CNR) values (mADCtumor - mADCnormal) / σ of tumor to directly surrounding normal prostate. Pearson correlation coefficients were calculated.

Results: In total, 130 tumor lesions were annotated. Tumors lesions were stratified into GS 5, 6, 7 (3+4), 7 (4+3), 8, 9. Distribution of tumors was: GS 5 (14 tumor lesions), GS 6 (48), GS 3+4 (26), GS 4+3 (24), GS 6 (8), GS 9 (10). Mean ADC values (x10⁻³ mm²/s) (± SD) of tumors were calculated. GS 5: 1.191 (±0.180), GS 6: 1.312 (±0.199), GS 7(3+4): 0.987 (±0.214), 7 (4+3): 0.825 (±0.195), 8: 0.972 (±1.143), 9: 0.903 (±1.133). CNR values were for GS 5: 1.19 (±0.98), GS 6: 1.55 (±0.77), GS 7 (3+4): 2.99 (±0.69), GS 7 (4+3): 4.06 (±1.02), GS 8: 4.6 (±1.28), GS 9: 4.87 (±1.05). Correlation coefficients were significant between mean tumor ADC values and GS (r = -0.57, p < 0.01) as well as CNR and GS (r = 0.80, p < 0.01).

Discussion and Conclusion: 3T MRI - ADC values of prostate tumors correlate to Gleason Score of the corresponding cancer focus in prostatectomy specimens. This correlation appears to be strongest for Contrast to noise Ratio of mean ADC value of tumor to mean ADC value of normal surrounding prostate tissue. As described above this stronger correlation might be a consequence of correction for ADC variations and background noise. ADC values on 3T diffusion weighted MRI have shown to predict tumor aggressiveness and could be of future use in treatment decisions and in patient follow-up in active surveillance.