Assessment of Prostate Cancer Aggressiveness using Diffusion weighted Imaging

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Introduction: Critical factors in evaluating prognosis of prostate cancer are tumor location, extent, volume, and Gleason score (made up of the primary and secondary Gleason grades) (1). Gleason grading based on needle biopsy is prone to sampling error. An accurate, non-invasive method to predict Gleason score could significantly impact risk assessment and assist in treatment selection in patients with prostate cancer. Previous studies have investigated correlation between Gleason scores and MRI (2) and 3D MR spectroscopic imaging (3D MRSI) data (3). MRI and 3D MRSI measurements showed correlation with Gleason scores, despite some overlap among MR findings for different scores. One study correlated diffusion-weighted imaging (DWI) findings with prostate cancer risk level (defined by patient age, clinical tumor stage, PSA, and Gleason score) but found no significant correlation unless the perfusion component of the signal was excluded (by using b-values > 0) (4). The purpose of this study was to perform a lesion-based analysis using whole-mount step-section pathology after radical prostatectomy as the standard of reference to investigate whether the apparent diffusion coefficient (ADC) values calculated from DW images of prostate cancer lesions correlate with lesion Gleason scores.

Method: This retrospective study included 26 prostate cancer patients with no prior treatment who underwent preoperative endorectal MRI/DWI. The clinical characteristics of the patient population were: age 42-72 years (median 61 yrs.), PSA level at diagnosis 0.58-9.6 ng/mL (median 5.7 ng/mL), surgical Gleason score 6-9 (median 7). Thirty-two lesions had pathological volume ≥ 0.1 cm^3 and were evaluated. At surgical pathology, tumor volumes ranged from 0.12 to 12.79 cm^3 (median 0.49 cm^3); Gleason scores were: 3+3: 14/32 (44%); 3+4: 11/32 (34%); 4+3 or greater: 7/32 (22%).

Acquisition: MR examinations were performed on 1.5T GE whole-body MRI units. DW images were obtained using single-shot spin-echo EPI. Imaging parameters were: TR/TE = 4000/99.8 ms, FOV = 14×14 cm^2, 72×72 matrix, 3-mm slice thickness, 0 gap, 4-8 NEX. The b-values were 0 and 800 s/mm^2.

Histopathologic Analysis: The specimen was step-sectioned after prostate resection. The cancer foci were outlined in ink on whole-mount step-section pathologic slices of the prostate. On the basis of anatomical landmarks, the whole-mount step-section pathologic slices were paired with the most closely corresponding T2-weighted images. The region on the T2-weighted image corresponding to the pathologic lesion was identified by a radiologist and a pathologist who reviewed the data together.

Image Analysis: ADC maps were generated from the original DW images after convolution with a Gaussian blur function (FWHM=2 mm). ADC maps were aligned with the corresponding T2w image using affine transformation.

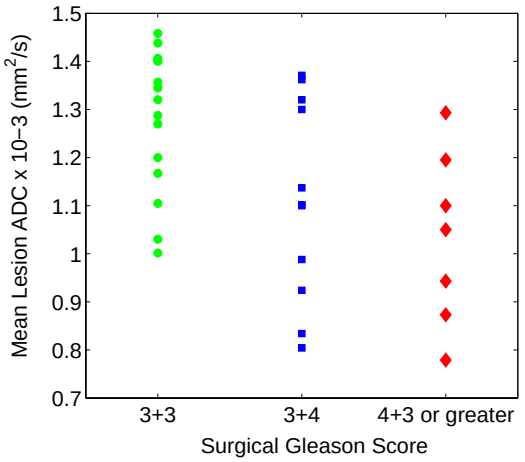

Fig. 1: Group ADC mean (± std. dev):
3+3: 1.27±0.15 x10^{-3} mm^2/s
3+4: 1.10±0.21 x10^{-3} mm^2/s
4+3 or greater: 1.03±0.18 x10^{-3} mm^2/s

Results and Discussion: Table 1 summarizes our findings. The P value for discriminating between Gleason scores in lesions on the basis of mean lesion ADC value was significant for Gleason scores 3+3 vs. 3+4 (P value=0.04), and 3+3 vs. 4+3 or greater (P value < 0.005), but there was no significant difference between Gleason scores 3+4 vs. 4+3 or greater (P value=0.42). Tumor volume, location, and extent were not incorporated in the analysis, which could explain the degree of overlap in mean lesion ADC values among lesion Gleason scores.

References: [1] Hricak H, et al. Radiology 2007; 243:28-53. [2] Wang L, ISMRM, 2007; p. 791. [3] Zakian KL, et al. Radiology 2005; 234:804-814. [4] deSouza N, et al. ISMRM, 2007; p. 3659.

Pathological Gleason Score	Pathological Gleason Score		
	3+3	**3 + 4**	**4+3 or greater**
3+3	N/A	0.04	< 0.005
3 + 4	0.04	N/A	0.42
4+3 or greater	< 0.005	0.42	N/A