Assessment of Aggressiveness of Prostate Cancer: Correlation of MR Signal Intensity with Gleason Grade Based on Step-Section Pathologic Analysis after Radical Prostatectomy

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Introduction/Background

Prostate cancer is a frequently multifocal and histologically heterogeneous disease. Its biologic aggressiveness varies greatly but is a key predictor of outcome. The Gleason grading system, the gold standard for measuring prostate cancer aggressiveness, remains one of the strongest prognostic indicators. It has been shown that imaging, such as MR spectroscopy, may provide diagnostic information regarding tumor aggressiveness. It has also been shown that quantitative measurement of signal intensity on T2-weighted MR imaging can help differentiate benign disease from prostate cancer. However, to our knowledge, no prior study has been performed to correlate signal intensity of prostate cancer on T2-weighted MR images to tumor Gleason grade on whole mount step-section pathology after radical prostatectomy.

Purpose

To determine whether signal intensity on axial T2-weighted magnetic resonance images correlates with aggressiveness of prostate cancer.

Materials and Methods

Between January 2001 and July 2004, 74 patients meeting the following criteria were included in the study: no other treatment before surgery; with at least one prostate lesion on step-section pathology of uniform Gleason grade 3 or 4, or any lesion containing Gleason 5 components; lesion size ≥ 0.2 cm^2 in bi-dimensional diameter product; and no corresponding T1 hyperintensity indicating postbiopsy changes. The median time from MRI to surgery was 29 days (range: 1 day to 164 days). Endorectal MRI was performed on a 1.5-T scanner with a pelvic-phased array coil in combination with an endorectal coil. T2-weighted fast spin-echo images of the prostate and seminal vesicles were obtained in three planes (TR 3650-6917 msec, effective TE 78-135 msec, echo train length 8-16, slice thickness 3 mm, FOV 14-16 cm, matrix 256 x 192, number of acquisitions 3). Endorectal coil profiles were obtained from a phantom study to identify signal intensity iso-surface (Fig. 1). The images were also postprocessed with a commercial software after acquisition to correct for the reception profile of the endorectal and external pelvic phased-array coils.

MR images were retrospectively analyzed in the presence of pathological maps. Largest possible round or elliptical regions of interest (ROI) were placed on the tumors on axial T2-weighted images. Mean signal intensities and standard deviations were automatically calculated on workstation. For normalization, ROI measurement of non-tumor prostatic tissue and the internal obturator muscle were placed along the signal intensity iso-surface of the tumor on uncorrected images; and on contralateral non-tumor prostatic tissue and on internal obturator muscle close to the tumor on corrected images. Correlations between Gleason grade and tumor-to-muscle and non-tumor prostate-to-muscle signal intensity ratios (SIRs) were assessed using Kendall's Tau- b. Tumor-to-muscle SIRs in peripheral zone (PZ) and transition zone (TZ) lesions of the same Gleason grade were also compared.

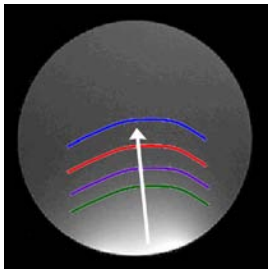
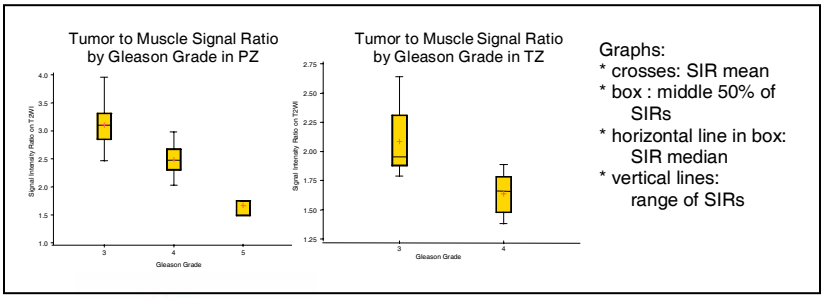


Fig 1. Endorectal coil profile was obtained from a phantom study to identify signal intensity iso-surface (arrow). This approach allows generating signal intensity ratios without image intensity correction, when ROIs are placed along the intensity iso-surfaces.

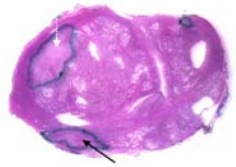
Results

Ninety-one lesions in 74 patients were analyzed (17 patients had two qualifying lesions). Fifty-nine (65%) of the lesions were in the PZ and 32 (35%) were in the TZ. The majority of the lesions (79/91, or 87%) were Gleason grade 3, 8 (9%) were Gleason 4, and 4 (4%) had Gleason 5 components. There was a significant correlation between Gleason grade and tumor-to-muscle SIR for both PZ and TZ tumors on both corrected and uncorrected images ($p < 0.05$) (Graphs). A lower tumor-to-muscle SIR was associated with a higher Gleason grade. As control, non-tumor prostate-to-muscle SIR did not correlate with Gleason grade ($p = 0.83$ and 0.57). Tumor-to-muscle SIRs were lower in the TZ than in the PZ (Graphs, Fig. 2).



Conclusion

Prostate tumors of higher Gleason grade demonstrate a lower tumor-to-muscle signal intensity ratio on T2-weighted MRI. Signal intensity ratio evaluation on T2-weighted MRI therefore may facilitate noninvasive assessment of prostate cancer aggressiveness.



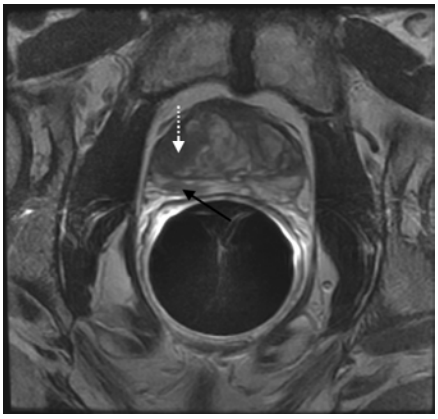


Fig 2. *Above*, whole mount step-section pathology shows a TZ Gleason 3 lesion (white arrow), and a PZ Gleason 3 lesion (black arrow). *Right*, Corresponding corrected T2-weighted MRI shows the tumor-to-muscle signal ratio is 3.99 in PZ and 1.77 in TZ.

References:
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