Diagnostic Performance of 1.5 Tesla Endorectal MR Imaging and MR Spectroscopic Imaging for the Detection of Locally Recurrent Prostate Cancer after External Beam Radiation Therapy

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INTRODUCTION: recurrent disease after external beam radiotherapy is suspected after biochemical failure (rising PSA) and may be local, systemic, or both. Transrectal ultrasound guided biopsy is the standard of care for the detection of local recurrence, but is invasive and may miss tumors since only a small fraction of the gland is sampled. Although endorectal T2-weighted MR imaging has emerged as an exciting new modality for the detection and characterization of prostate cancer, it is limited by post-treatment loss of zonal anatomy and diffuse low T2 signal, which hinder tumor detection [1].

PURPOSE: to determine if MR spectroscopic imaging improves detection of locally recurrent prostate cancer after definitive external beam radiation therapy when compared to T2-weighted MR imaging alone.

SUBJECTS: we retrospectively identified 64 men who underwent endorectal MR imaging and MR spectroscopic imaging and transrectal ultrasound-guided biopsy between February 1999 and February 2008 for suspected local recurrence of prostate cancer after external beam radiotherapy because of biochemical failure.

IMAGING TECHNIQUE: Studies were performed on a 1.5-Tesla MR scanner using the body coil for excitation and a pelvic phased array coil in combination with an endorectal coil for signal reception. MR sequences included thin-section high nominal spatial resolution axial and coronal T2-weighted FSE images of the prostate and seminal vesicles. 3D MR spectroscopic imaging data were acquired using water and lipid suppressed double-spin echo point-resolved spectroscopy sequence technique.

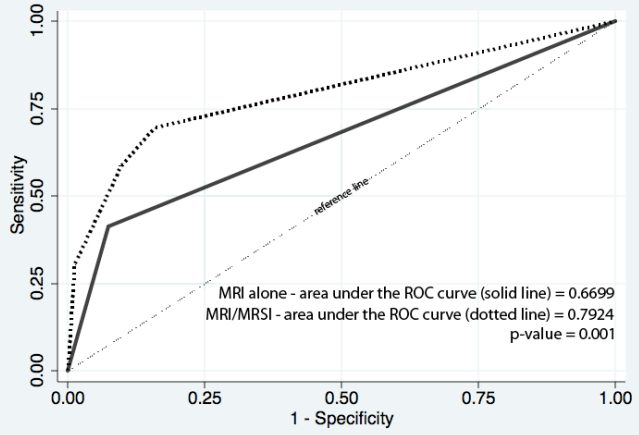
IMAGING INTERPRETATION: a radiologist and a spectroscopist independently rated recurrent tumor as present or absent in the left and right sides of the prostate on T2-weighted MR imaging and MR spectroscopic imaging, respectively. Our decision to localize imaging abnormalities to the side of the prostate instead of to the sextant was based on previously reported results demonstrating the limitation of the prostatic sextant as a unit of analysis [2]. This inaccuracy is likely to some extent attributable to errors in registration between imaging slices and biopsy specimens. Because of radiation-induced shrinkage and distortion of prostatic tissue, sextant localization is further impaired, both by TRUS and MR imaging, and such errors are likely to be even greater.

STANDARD OF REFERENCE: The presence or absence of recurrent tumor at transrectal ultrasound guided sextant biopsy was used as the standard of reference. Evidence of post-treatment effect only was considered a negative result.

STATISTICAL ANALYSIS: to take into account the clustering effect, we used the generalized estimating equations to estimate the predictive probabilities of T2-weighted MR imaging and combined T2-weighted MR imaging plus MR spectroscopic imaging. The performance of each technique was calculated using receiver operating characteristic curve analysis. We used cluster resampled bootstraping to compare the differences between the areas under the receiver operating characteristic curves (A_Z) and construct 95% confidence intervals. For all statistical analyses, a probability value of less than 0.05 was considered to indicate a significant outcome.

RESULTS: there was a statistically significant difference between the A_Z for T2-weighted MR imaging (0.67; 95%CI=0.60-0.74%) and for the integrated approach (0.79, 95%CI=0.72-0.87) (figure 1). MR spectroscopic imaging had more true positive results when compared to T2-weighted MR imaging alone (58.7% versus 41.3%, respectively), without an important change in the number of false positive results (9.8% versus 7.3%, respectively). Fourteen hemi-prostates were incorrectly classified as negative by both techniques and the diagnosis of recurrent disease was missed in 8 patients.

Figure 1: Receiver operating characteristic (ROC) curves for detection of locally recurrent prostate cancer after external beam radiotherapy (with or without androgen deprivation therapy) with T2-weighted MR imaging (MRI) and combined T2-weighted MR imaging and MR spectroscopic imaging (MRI/MRSI).



CONCLUSION: the addition of MR spectroscopic imaging to T2-weighted MR imaging significantly improves the detection of locally recurrent prostate cancer after external beam radiotherapy. The resulting information may assist the clinician to advise patients about subsequent evaluation, selecting those for whom targeted hemi-prostate biopsy is appropriate to confirm disease. Although targeted therapies may be offered to patients in whom very minimal recurrent disease is diagnosed, hemi-prostate imaging evaluation is sufficiently accurate to obviate the need for sextant localization, since the most commonly recommended salvage treatments (prostatectomy and LDR brachytherapy) treat the entire gland.

REFERENCES

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