Comparative Effectiveness of Targeted Prostate Biopsy Using Magnetic Resonance Imaging Ultrasound Fusion Software and Visual Targeting: a Prospective Study

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Purpose: We compared the diagnostic outcomes of magnetic resonance-ultrasound fusion and visually targeted biopsy for targeting regions of interest on prostate multiparametric magnetic resonance imaging.

Materials and Methods: Patients presenting for prostate biopsy with regions of interest on multiparametric magnetic resonance imaging underwent magnetic resonance imaging targeted biopsy. For each region of interest 2 visually targeted cores were obtained, followed by 2 cores using a magnetic resonance-ultrasound fusion device. Our primary end point was the difference in the detection of high grade (Gleason 7 or greater) and any grade cancer between visually targeted and magnetic resonance-ultrasound fusion, investigated using McNemar's method. Secondary end points were the difference in detection rate by biopsy location using a logistic regression model and the difference in median cancer length using the Wilcoxon signed rank test.

Results: We identified 396 regions of interest in 286 men. The difference in the detection of high grade cancer between magnetic resonance-ultrasound fusion biopsy and visually targeted biopsy was −1.4% (95% CI −6.4 to 3.6, p=0.6) and for any grade cancer the difference was 3.5% (95% CI −1.9 to 8.9, p=0.2). Median cancer length detected by magnetic resonance-ultrasound fusion and visually targeted biopsy was 5.5 vs 5.8 mm, respectively (p=0.8). Magnetic resonance-ultrasound fusion biopsy detected 15% more cancers in the transition zone

Abbreviations and Acronyms

mpMRI = multiparametric magnetic resonance imaging
MR-F = magnetic resonance-ultrasound fusion
MRI = magnetic resonance imaging
PCa = prostate cancer
PSA = prostate specific antigen
ROI = region of interest
TE = echo time
TR = repetition time
TRUS = transrectal ultrasound
VT = visually targeted

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The data used in this study were reviewed by the institutional review board and granted a waiver of authorization determined to be exempt from human subject research consent requirement.

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(p=0.046) and visually targeted biopsy detected 11% more high grade cancer at the prostate base (p=0.005). Only 52% of all high grade cancers were detected by both techniques.

Conclusions: We found no evidence of a significant difference in the detection of high grade or any grade cancer between visually targeted and magnetic resonance-ultrasound fusion biopsy. However, the performance of each technique varied in specific biopsy locations and the outcomes of both techniques were complementary. Combining visually targeted biopsy and magnetic resonance-ultrasound fusion biopsy may optimize the detection of prostate cancer.

Key Words: prostatic neoplasms, magnetic resonance imaging, image-guided biopsy

PROSTATE cancer is a common but clinically heterogeneous disease, with more than 900,000 cases diagnosed globally each year.[1] The current diagnostic standard is systematic TRUS guided prostate biopsy, which is limited due to its random nature and risk of under sampling.[2,3] The diagnostic accuracy of prostate MRI has improved with the addition of functional sequences as part of multiparametric MRI. Increasing evidence now supports the role of mpMRI in identifying high grade prostate tumors.[4,5]

Although recent studies have suggested that the use of MRI targeted biopsy may improve cancer detection,[6–10] the optimal technique to target the suspicious ROIs on mpMRI is still a matter of debate.[11] MRI targeted biopsy techniques (where mpMRI is used to determine the location of suspicious targets) can be classified in 1 of 3 categories of 1) visual targeting, where the operator visually estimates an area on ultrasound that corresponds to the location of the ROI on MRI, 2) MRI-ultrasound fusion biopsy, in which pre-biopsy mpMRI images are superimposed with real-time ultrasonography during prostate biopsy using computer software and 3) direct in-bore, in which the biopsy is performed inside the MRI scanner.

Although MR-F takes advantage of the existing experience of operators using TRUS and enables wide dissemination with physicians, the potential benefits of MR-F must be weighed against a steep learning curve, time investment and costs.[12–14] Two recent trials compared the diagnostic accuracy of MR-F biopsy to VT biopsy, and failed to detect a significant difference in the overall detection of clinically significant PCa.[15,16] Other investigators have found that the use of VT biopsy can also improve sampling efficiency without the costs of the MR-F devices.[17] We compared diagnostic outcomes between MR-F and VT biopsy in terms of PCa detection rates, cancer detection by biopsy location in the prostate and tumor length yield in a prospective study.

MATERIALS AND METHODS

Patient Cohort

After obtaining institutional review board approval, consecutive men who presented for prostate biopsy underwent a prostate mpMRI at our institution. Patients were offered enrollment in this prospective study if 1 or more ROIs were identified on mpMRI (MRI score 3 or greater). All included patients provided informed consent. In total, 296 men comprised the final cohort.

MRI Acquisition and Analysis

MRI studies were performed at our institution at least 3 months after the previous biopsy (in patients who had a previous biopsy) on a 3-T (262, 92%) or 1.5-T (24, 8%) MRI system (GE Healthcare, Wauwatosa, Wisconsin) using a multichannel phased array coil. Several sequences were acquired, including transverse T1-weighted images; transverse, coronal and sagittal T2-weighted images; transverse diffusion weighted sequences and parametric maps of apparent diffusion coefficients. Of the patients 88% also had a dynamic contrast enhanced 3-dimensional T1-weighted spoiled gradient echo sequence after intravenous injection of 0.1 mmol gadopentetate dimeglumine (Magnevist®, Berlex Laboratories) per kilogram of body weight.

Acquisition parameters in msec (range) for T1-weighted images were TR (416 to 816.668), TE (6.176 to 14.532), slice thickness (3 to 5), interslice gap (0 to 2) and field of view (256 × 256 to 512 × 512). Acquisition parameters in msec (range) for T2-weighted images were TR (2,916.67 to 6,766.67), TE (113.28 to 124.608), slice thickness (3 to 4), interslice gap (0) and field of view (256 × 256 to 512 × 512). Acquisition parameters in msec (range) for diffusion weighted images were TR (3,500 to 8,200), TE (61.1 to 101.2), slice thickness (3 to 4), interslice gap (0) and field of view (256 × 256 to 512 × 512). The b values used were 0 and 1,000.

Multiparametric MRI was evaluated per standard clinical care by 1 of 6 members of our institution's genitourinary radiology section, with 6 to 15 years of experience in prostate MRI. ROIs suspicious for prostate cancer detected on mpMRI were graded per standard of care at our institution using a 5-item Likert scale of suspicion as previously described.[18–20] This scale was developed and validated at our institution using whole mount prostatectomy specimens. The recently developed PI-RADS (Prostate Imaging Reporting and Data System) is an expert consensus statement and is still undergoing wide validation. It is not used at our institution at present and, therefore, was not evaluated in this study where standard of care mpMRI interpretation was assessed. All ROIs considered suspicious by the interpreting radiologist (ie subjective probability of cancer 50% or greater [MRI score 3 or greater]), were marked on the T2-weighted