

3T MRI-guided Transperineal Targeted Prostate Biopsy: Clinical Feasibility, Safety, and Early Results

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Introduction

Standard of care for tissue diagnosis of prostate cancer today is transrectal ultrasound (TRUS)-guided sampling biopsy of the prostate gland. However, patients with clinical suspicion of cancer and repeatedly negative biopsies and patients who can not have a transrectal approach may benefit from MRI-targeted biopsy using transperineal approach [1,2]. Although initial experience has been with low field MRI, performing these biopsies in a high field 3T MRI may have advantages: to be able to biopsy specific targets in the prostate that are most suspicious for cancer, utilizing fast and high-resolution, high signal to noise scanning capabilities. Now that wide-bore high field scanners are available, interventional procedures are possible using these systems. We aim to report the feasibility, safety and early results of MRI-guided transperineal prostate biopsy in the lithotomy position in a 70cm bore 3T scanner (Siemens MAGNETOM Verio).

Materials and Methods

Patient population: Between January and November of 2010, nine patients (age range: 50-73 y.o.; weight range: 147-211 lbs.) were enrolled in a prospective clinical trial approved by our institutional review board (IRB). Our study was Health Insurance Portability and Accountability Act of 1996 (HIPAA) compliant. All patients had elevated serum prostate specific antigen (PSA) and a dominant index lesion (most suspicious for cancer) on recent diagnostic 3T prostate MRI. Index lesions were depicted as a focus of decreased T2 signal on T2-weighted imaging (T2WI), restricted diffusion on diffusion weighted imaging (DWI), and early phase fast enhancement with fast wash-out on dynamic contrast enhanced (DCE) sequences. Clinical indications included: inability to obtain transrectal ultrasound (TRUS) guided biopsy due to total colectomy (n=1) or inflamed ileal J-pouch (n=1), multiple prior negative TRUS-guided biopsies (n=5), prior prostate brachytherapy and MRI focus suspicious for recurrence (n=1), and MRI focus suspicious for higher grade tumor than suggested at prior TRUS-guided biopsy (n=1).

Procedures: Written informed consent was obtained. A prostate intervention table (designed and fabricated by the authors) with leg holders was placed onto the MRI scanner table (Fig. 1a). The patient was positioned in the lithotomy position on this table. The scrotum was taped away from the perineum and surface coil (3T Body Matrix Coil, Siemens) was placed over the lower pelvis anteriorly. First the table was moved into the scanner's imaging center spot and then all the way to the backside of the gantry (Fig. 1b). Here, the perineum was prepped in the usual sterile fashion and a sterile needle guidance template was placed up against the perineum. Table was then moved back into the gantry to have the prostate gland at the imaging center spot; it did not have to be moved again.

Combining the anteriorly placed Body Matrix Coil (6-channel) with posteriorly located Spine Matrix Coil elements (6-channel) incorporated in the table top, 3D FLASH (TR/TE: 12/1.97 ms; matrix: 256×256×20; flip angle: 45°; slice thickness: 2 mm; acquisition time: 2 min) was performed through the template and used to calibrate and map the needle holes on the template to their imaging coordinates. Then, 2D turbo spin echo (TSE) T2WI (TR/TE: 5250/100 ms; flip angle: 150°; matrix: 320×320; slice thickness: 3 mm; acquisition time: 4 min) was performed through the prostate gland. These images were transferred to the image fusion, target selection, and needle placement planning software (3D Slicer) where T2 signal abnormality based index lesion in the prostate was marked as target. A comparative target was also chosen from the contralateral normal prostate tissue. At this point, preprocedural DWI apparent diffusion coefficient (ADC) map and pharmacokinetic analysis map of DCE imaging were fused with intraprocedural T2WI using deformable registration. These provided two additional targets from the index lesion: restricted diffusion target and abnormal enhancement target. After selection of targets, software computed access to these targets by prescribing location of needle hole on the template and needle depth. Utilizing this information, needles were placed and location confirmed using axial and coronal real-time 2D FISP (TR/TE: 402/1.45 ms; flip angle: 48°; matrix: 128×128; slice thickness: 6 mm). Using MRI-compatible 18-gauge spring-loaded side-cutting needle device (EZ-EM), two core samples were obtained from each target and sent for pathological analysis in formalin.

Patients received local anesthesia together with intravenous procedural sedation during the procedures which lasted 1-2 hours; following two hour postprocedural observation, all patients were discharged home accompanied by their escort.

Results

All nine procedures were technically successful and patients tolerated the procedure well without intra or postprocedural pain. Two patients had asymptomatic self-limited small periprostatic hematoma on imaging. No other complications were encountered.

Of eight available biopsy results, one patient whose prior TRUS biopsy of left gland showed Gleason score 3+3=6 cancer had a dominant index lesion in the anterior central gland suspected to have a higher score. MRI-guided biopsy of the index lesion proved Gleason score 4+3=7 and this changed patient's management from brachytherapy to hormone deprivation and external beam radiation therapy. One patient with inflammation of ileal J-pouch had prostate carcinoma of index lesion. Gleason score 3+3=6, and as a result under appropriate therapy (Fig. 2). On the other hand, biopsy of index lesion showed no malignancy in six patients: one with suspected recurrence after prior brachytherapy, one patient without a rectum status post colectomy, and four patients with prior negative TRUS-guided prostate biopsies. These patients are being followed (mean follow-up: 4 months) without further therapy at this time. All comparative biopsies from contralateral prostate tissue were negative for cancer.

Discussion and Conclusion

Transperineal targeted prostate biopsy in the lithotomy position is feasible and safe in wide-bore 3-Tesla MRI. The procedure is well tolerated, takes advantage of fast high-resolution scanning and registration of preprocedural diagnostic MRI multiparametric data sets to successfully target lesions. This approach can yield clinically useful results in patients with index lesion on MRI.

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References [1] D'Amico AV *et al.*, J Urol, 2000; 164(2):385-387; [2] Blumenfeld P *et al.*, J Magn Reson Imaging 2007;26(3):688-694.

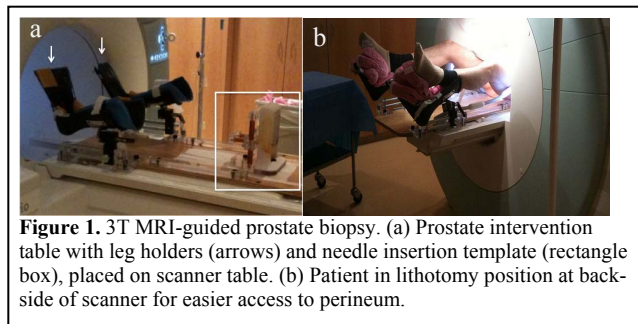


Figure 1. 3T MRI-guided prostate biopsy. (a) Prostate intervention table with leg holders (arrows) and needle insertion template (rectangle box), placed on scanner table. (b) Patient in lithotomy position at back-side of scanner for easier access to perineum.

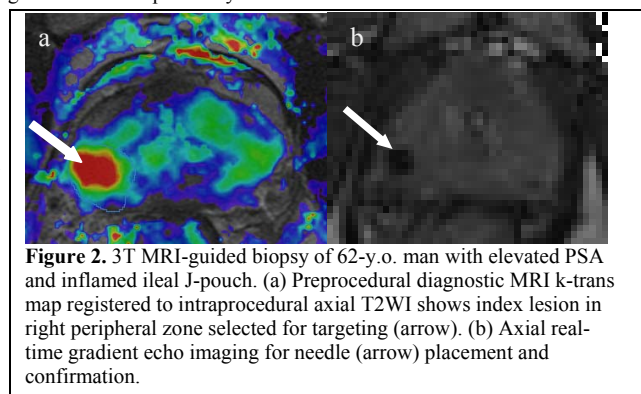


Figure 2. 3T MRI-guided biopsy of 62-y.o. man with elevated PSA and inflamed ileal J-pouch. (a) Preprocedural diagnostic MRI k-trans map registered to intraprocedural axial T2WI shows index lesion in right peripheral zone selected for targeting (arrow). (b) Axial real-time gradient echo imaging for needle (arrow) placement and confirmation.