Fused MRI/US Biopsy for Detecting Prostate Cancer

Written by Maria Vinall

Multiparametric (MP) magnetic resonance imaging (MRI) enhances the detection of prostate cancer, patient selection for prostate biopsy, and definition of biopsy targets. It has a high sensitivity for detecting high-grade tumors, although low-grade tumors are often not detected. The use of prebiopsy MRI and MRI-targeted biopsy for negative biopsies and active surveillance is increasingly accepted by urologists, and its value in biopsy-naïve patients is being evaluated, stated Andrew Rosenkrantz, MD, New York University Langone Medical Center, New York, New York, USA.

One MRI-targeted approach fuses MRI and ultrasound (US) images of the prostrate in real time using specialized software. In the fusion biopsy (FB), US guidance of the needle to the MRI lesion is achieved via a mechanical semirobotic arm or freehand scanning with electromagnetic navigation, depending on which approved fusion system is used. The FB approach is becoming increasingly used within the field, stated Dr Rosenkrantz. Nonetheless, the visual estimation method and the direct in-bore method are also used, and evidence supports the benefit of all of these methods over standard systematic biopsy (SSB); few data compare the 3 targeting methods with one another.

Urologists familiar with US most commonly perform FB in their clinic, which is conducted after a radiologist performs and interprets an MP-MRI and a biopsy planning session is completed. The planning session includes segmentation of the prostate boundary by the radiologist or technologist, annotation of the MRI targets, and loading of the MRI-based biopsy plan into the fusion US system.

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The ability of FB to better detect and classify prostate cancer was shown in a study of 195 men with negative transrectal US biopsies [Vourganti S et al. *J Urol*. 2012]. The study found that 39% of patients had a higher Gleason score (GS) as defined by FB than by SSB, and that 12 of 21 cases of GS ≥ 8 cancer were detected by FB but not by SSB. Another study, conducted by Dr Rosenkrantz and his colleagues, compared FB against SSB and visual-targeted biopsy (VTB) in 125 patients [Wysock JS et al. *Eur Urol*. 2014]. In this head-to-head comparison, 2 different surgeons performed FB and VTB to reduce possible bias by the urologist.

Tumor detection was slightly better with FB than with VTB (32% vs 27%, respectively; $P = .137$), as was high-grade tumor detection (20% vs 15%; $P = .052$). The lack of statistical significance may be related to the small sample size, acknowledged Dr Rosenkrantz. Notably, FB performed significantly better than VTB for detecting any histologic abnormality, such as tumor, atypia, and high-grade prostatic intraepithelial neoplasia (77 vs 60 targets, respectively; $P = .010$). Multivariate analysis revealed that FB may have a particular advantage in small lesions.

In > 600 patients in whom FB and SSB have been compared at Dr Rosenkrantz's institution, the detection of low-grade tumors was lower with FB than using systematic biopsy at each level of magnetic resonance imaging suspicion score (mSS) from 2 to 5. By contrast, there was a strong association between detection rates of tumors with a GS > 6 and the mSS, with FB detecting significantly more such tumors than systematic biopsy at mSS 4 and 5. According to Dr Rosenkrantz, this supports the use of FB to optimize risk prognosis in prostate cancer patients.

Prostate Imaging Reporting and Data Systems (PI-RADS) classification may be a useful scheme to indicate the level of suspicion on MRI and guide patient selection to optimize the use of FB. For the PI-RADS 1 or 2 category, a significant cancer is unlikely and deferral of biopsy may be considered, while targeted biopsy is usually performed for a PI-RADS 4 or 5. However, for a PI-RADS 3, the risk profile of the patient will likely drive the decision about a targeted biopsy, because the data are not yet clear for this score. In FB, 1 or 2 MRI targets are usually biopsied.

Table 1. Comparison of Fusion Methods

Mechanical Articulated Arm	Electromagnetic Tracking	Software Image Registration
New hardware: mechanical arm	New hardware: electromagnetic tracker	Software only (may need new computer)
Real-time target tracking	Real-time target tracking	"Step-and-shoot" updating
Patient motion requires reregistration	Patient motion requires registration	Automatically compensates for motion
Arm partially restricts motion	Susceptible to electromagnetic interference	Steep angles limit registration
Setup requires attaching arm	Setup requires electromagnetic registration	Only software registration
May require manual contouring of prostate	May require manual contouring of prostate	Must confirm software registration

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Data from comparison of 2 fused MRI/US systems (direct in-bore MRI-guided biopsy and MRI/US fusion targeting), presented by David J. A. Margolis, MD, David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, California, USA, have shown that both systems provide improved targeting over systematic biopsies with low complication rates.

In-bore MRI-guided biopsy can target all locations in about 15 minutes per target and generally requires sedation. Confirmation of targeting is achieved with imaging. MRI/US fusion targeting uses local anesthesia. Image fusion is accurate to within 3 mm and takes < 30 minutes for 12 core plus targets. Both systems require dedicated hardware and software. Three fusion methods are compared in Table 1.

With the mechanical articulated arm method, the prostate is segmented in 1 or 2 planes and then segmentation is refined. A region of interest for each target is selected on each slice and suspicion levels are chosen. Each target is presented with or without guides in a 3D presentation over which a systematic biopsy template can be overlaid. Location of prior positive biopsies can be fused with future biopsy sessions.

With electromagnetic tracking, prostate autosegmentation is supplemented by user refinement. A 6-up view provides coronal maximum intensity projection (MIP), a time-intensity curve, an axial T2 MRI, dynamic contrast-enhanced MRI, apparent diffusion coefficient map, and a diffusion-weighted image. Prostate segmentation on T2 can be overlaid on axial T2 and/or coronal MIP. An initial slice is chosen to start the 3D segmentation of a target with additional slices added to create a single solid region of interest. The selection of the region of interest in the dynamic contrast-enhanced image reveals the time-intensity curve. At this point, the PI-RADS suspicion level can be assigned and an automatic report generated.

A software-based MRI/US fusion targeted biopsy system can detect more clinically significant cancers (median 33.3% vs 23.6%) than would have been missed by using only standard biopsy using fewer cores (median 9.2 vs 37.1 per patient) [Valerio M et al. *Eur Urol.* 2014].

It is difficult to determine which system is best because they are all continually undergoing enhancements and direct comparisons should be version specific. When choosing which system to purchase, clinicians will need to consider which one is compatible with the equipment used by most urologists. The choice of fusion package and accompanying software may also influence MRI parameters. It is important to know which one you will be getting before starting hands-on training.

Improvements are being made for all components of MRI targeting biopsy, including scan techniques, automatic segmentation, and deformable coregistration, all of which improve accuracy. Training is required for radiologists and clinicians. Importantly, 3D processing is reimbursed but image fusing targeting is not.