Screening and Detection Advances in Magnetic Resonance Image–Guided Prostate Biopsy

Samuel K. Stephenson, MS, Edward K. Chang, BS,
Leonard S. Marks, MD*

KEYWORDS

• Prostate cancer • Magnetic resonance imaging • Fusion biopsy • Targeted prostate biopsy
• Prostate-specific antigen • Ultrasonography • Transrectal ultrasonography

KEY POINTS

- Reliable imaging of prostate cancer within the organ has been elusive; however, over the past few years, use of multiparametric magnetic resonance imaging (MRI) has begun to allow visualization of many organ-confined prostate cancers. The new imaging modality and its offshoot, targeted biopsy, offer the promise of a major transformation in management of this disease.
- By aiming a biopsy needle at MRI regions of interest, a physician can now obtain tissue directly from suspicious lesions (ie, targeted prostate biopsy), rather than by blindly sampling the organ.
- Use of MRI images to guide prostate biopsy is accomplished by image fusion and may be performed in 1 of 3 ways: by direct in-bore MRI-MRI fusion; by cognitive fusion, using ultrasonography (US) guidance to sample suspicious areas on MRI; and by MRI-US fusion, using a device made for the purpose.
- MRI-US fusion devices, such as the Artemis (Eigen-Hitachi, Grass Valley, CA) or UroNav (Invivo-Philips, Gainesville, FL), allow the urologist to use sophisticated MRI images to guide prostate biopsy in an outpatient clinic setting; the procedure is contextually similar to that performed by most urologists for the past several decades.
- Targeted prostate biopsy, via MRI-US fusion, (1) allows diagnosis of serious tumors not found with conventional biopsy; (2) helps to avoid detection of insignificant tumors; (3) provides a method for repeat biopsy of specific tumor-bearing sites for men in active surveillance; and (4) creates an opportunity for study of focal therapy.

Disclosures: The project described was supported by Award Number R01CA158627 from the National Cancer Institute. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health. Additional support was provided by UCLA Clinical and Translational Sciences Institute Grant No. UL1TR000124, the Beckman Coulter Foundation, the Jean Perkins Foundation, the Steven C. Gordon Family Foundation, and the Nancy E. Barry and Letitia P. Rees Foundation.
Department of Urology, David Geffen School of Medicine at UCLA, 10945 LeConte Avenue, PVUB Suite 3361, Los Angeles, CA 90095, USA
* Corresponding author.
E-mail address: lmarks@mednet.ucla.edu

Urol Clin N Am 41 (2014) 315–326
http://dx.doi.org/10.1016/j.ucl.2014.01.007

urologic.theclinics.com

INTRODUCTION

For nearly a century, digital rectal examination was the only tool available to aid in tissue sampling for diagnosis of prostate cancer (CaP).[1] With the advent of ultrasonography (US) in the 1980s, physicians had a new modality for directing biopsy needles in real time. Originally developed by Stamey, the US-guided, transrectal sextant method became widely adopted.[2] Since that time, additional samples are taken (usually totaling 12) and local anesthesia has been added, but otherwise the random, systematic procedure of the 1980s has remained largely unchanged. Saturation biopsy has been advocated but may increase detection of insignificant cancers, and it typically requires general anesthesia.

Thus, CaP is the only important solid malignancy diagnosed by blind biopsy of the organ (ie, without tumor visualization). Some 50% of cancers detected by this method may not be of clinical significance.[3] In addition, systematic biopsies are poor at sampling lesions in the anterior, midline, and apex of the prostate. This situation can lead to underdiagnosis of important lesions in these regions. Further, almost one-third of currently detected cancers are reclassified from original biopsy Gleason score to a higher score on final pathology.[4]

Groundwork for a change in this schema was established with the observation that some CaP lesions could be visualized with magnetic resonance imaging (MRI).[5] As MRI usage became widely disseminated, and as the technology improved, the value of MRI to diagnose (and stage) CaP became increasingly apparent. The advent of MRI coincided with decreasing volume of CaP at diagnosis.[6] In an earlier time, when CaP usually presented as a palpable mass, US imaging could detect many lesions. Because of early prostate-specific antigen (PSA) screening, most newly diagnosed CaP is nonpalpable, and US usually fails to visualize a lesion. Thus, use of MRI to identify suspicious prostate lesions fills an important void, helping to identify regions of interest and enable targeted biopsy.[7]

ADVENT OF MRI FOR DIAGNOSIS OF CAP

Among the first to show that CaP could be imaged by MRI was Hricak, in 1983.[5] Subsequent advances in magnet strength and the availability of multiparametric studies have made MRI the imaging modality of choice for diagnosis of CaP (**Fig. 1**). The established parameters of multiparametric MRI (mp-MRI) are T2-weighted images (T2WI), dynamic contrast enhancement (DCE), and diffusion-weighted imaging (DWI). As the limitations of PSA testing to diagnose CaP have become increasingly apparent, the importance of a visual representation of the tumor has become compelling. Accurate imaging of CaP and the offshoot, targeted biopsy, contain the seeds for a major change in management of the disease.

CURRENT USE OF MRI FOR DIAGNOSIS OF CAP

Either pelvic phased array or endorectal coils (ERC) may be used when performing mp-MRI of the prostate. ERC may improve definition of the prostate capsule, but does not seem critical for characterization of intraprostatic lesions. Thus,

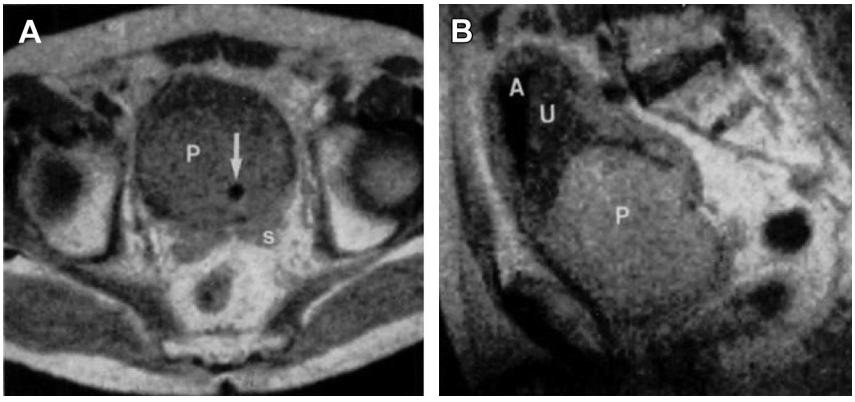

Fig. 1. Prostate MRI c. 1983.[5] These were among the first published MRI images, obtained with a 0.35-T coil. In the transverse scan (*A*), the prostate (P) is enlarged and the Foley catheter (*arrow*) in the prostatic urethra is displaced posteriorly to the left by adenomatous tissue. Seminal vesicles are seen inferior to the bladder (s). In the sagittal scan (*B*), air (A) and urine (U) level can be seen in the bladder. At the time, magnet strength was not capable of showing zonal anatomy or small cancers. (*From* Hricak H, Williams RD, Spring DB, et al. Anatomy and pathology of the male pelvis by magnetic resonance imaging. AJR Am J Roentgenol 1983;141(6):1107; with permission.)