
Everything You Need to Know about Prostate MRI

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The diagnosis of prostate cancer is straightforward. However characterizing it—what kind of prostate cancer—is crucial to disease management. The PSA blood test is a validated screening tool, but can neither prove the presence of cancer in the prostate nor accurately determine how much or how aggressive it is. New tests, such as Opko 4K can better determine who is likely to have significant cancer, which may help identify which men need a biopsy, and which men do not. However, random biopsy remains the standard of prostate cancer diagnosis, despite the limitations of potentially missing the worst part of the disease and not being able to determine if it has spread outside of the prostate. Prostate MRI holds the promise of improving not only the characterization of prostate cancer, but improving biopsy diagnosis.

Editor's note: This article is an excerpt from the upcoming book "The Five Shades of Blue" authored by Dr. Mark Scholz, and various other authors.

Magnetic resonance imaging, or MRI, uses powerful magnetic fields to generate images of the human body. Nearly any tissue can be characterized by MRI. It uses no ionizing radiation (unlike X-rays, CT scans, or nuclear medicine) and is completely safe except for patients who have certain types of metal implanted in their bodies. The main drawback to MRI compared to CT scans is that it takes longer (on the order of 30 minutes to an hour) and generally only evaluates the pelvis, unlike PET or nuclear medicine bone scans, although there is research in the use of MRI to screen the entire body for cancer, just like a PET scan.

Mp-MRI of the prostate uses different parameters to characterize cancer, thus the term "multiparametric MRI" or "mp-MRI." Standard tissue contrast images are generated on T1 and T2-weighted imag-

ing. These images cannot discriminate cancer from benign changes, but have the highest spatial resolution and are the best for delineating the prostate capsule. Therefore, they are used to determine if prostate cancer is confined to the prostate or not. Diffusion-weighted imaging (DWI), along with the accompanying apparent diffusion coefficient (ADC) map, measure Brownian free water motion, and therefore the degree of cellular density and disorder. This has been shown to be the best measure of the aggressiveness of prostate cancer, but it is much lower in resolution compared with T2-weighted imaging. Although it correlates well with grade of cancer, it is not as accurate to estimate the stage of cancer compared to T2-weighted imaging. Blood flow is disordered in most tumors and some other conditions. Dynamic contrast enhanced (DCE) perfusion imaging uses continuously acquired images of the prostate during intravenous



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injection of a contrast dye containing gadolinium—a rare earth element—to map blood flow. Although it is not as accurate as T2-weighted images or DWI in the detection of significant cancer, it is a valuable adjunct in problem cases, and is invaluable for characterizing the prostate after therapy (including hormonal and radiation treatment). Spectroscopic imaging can measure the concentrations of specific chemicals in the category of “metabolites” and can be especially useful in problem cases. However, the procedure takes the longest, requires the use of an endorectal coil (a small probe in the rectum), and may result in additional costs.

Prostate MRI can be tweaked to address specific clinical scenarios in the face of an elevated PSA and negative biopsies, or for active surveillance, where the main question is whether the prostate harbors any significant cancer. A limited scan of just the prostate, without an endorectal coil, can take just half an hour (or less, depending on the facility). For radiation planning, one may want to add in the rest of the pelvis and maybe the abdomen to the scope of the scan. Surgical planning may require the use of an endorectal coil to better visualize the lining of the prostate which helps the surgeon determine whether it is safe to spare one or both nerve bundles that run alongside the prostate.

There is some preparation for prostate MRI. Patients with a history of kidney or heart disease, diabetes, high blood pres-

sure, or some other medical conditions will need a blood test of kidney function before they can receive contrast. All patients are screened for any possible metal in the body, including any prior surgeries. Some patients may wish to request a mild sedative from their referring physician to take prior to the scan to help with claustrophobia or to help tolerate the endorectal coil. Finally, it is crucial that all patients empty the rectum prior to scanning. This is imperative for an endorectal coil, but just as important for other scans, because gas or stool in the rectum distorts the magnetic field and can compromise image quality.

MRI for Targeted Biopsy Planning

One of the most important contributions of prostate MRI is that unlike other tests to determine whether cancer is clinically significant, such as PCA3, PHI, or Oncotype DX, prostate MRI can additionally determine the cancer’s location. Prostate MRI provides a 3-dimensional image of the prostate to give physicians a sense of where the suspicious areas are, how suspicious they are, and the extent of the suspicious area. This means that, rather than systematically sampling evenly-spaced areas in the prostate hoping to find cancer, the most suspicious area can be pinpointed. **MRI targeted biopsy has been shown to improve the likelihood of finding significant cancer when it exists and provides increased confidence that no significant cancer will be overlooked for men on active surveillance.**



Help us spread the word about mp-MRI for prostate cancer. Visit www.pcri.org to donate to our MRI awareness campaign!

“If you want to make a substantial contribution to medicine for this decade and maybe for the century, address yourself to the problem of imaging cancer within the prostate gland.”

*-Patrick Walsh, 2008
American Urological
Society Whitmore Lecture,
Chicago, IL*

Continued on pg. 16

Everything You Need to Know about Prostate MRI, Continued from Pg. 9

Types of Targeted Biopsy

There are three main kinds of targeted biopsy. The oldest, and simplest, but with the greatest risk of mis-targeting, is known as “cognitive fusion.” This method consists of reviewing the MRI to get a sense of where the cancer is, and then using landmarks in the prostate to find the same area with ultrasound. The advantage is that no specialized software or hardware is needed, so there is no additional expense. However, it is the most demanding of the “operator,” or physician performing the biopsy. He or she must be familiar with prostate anatomy and landmarks on both MRI and ultrasound, and be able to mentally compensate for differences in orientation and compression. Additionally, some landmarks, and many tumors, are invisible on ultrasound, so small tumors far away from the rectum can be difficult to target with this method. One scientific study found that for tumors invisible on ultrasound, nearly a quarter of targeted biopsies were off by more than 3 mm.

The most common form of targeted biopsy, which is rapidly gaining popularity, is software and hardware image fusion targeted biopsy. There are at least 6 separate systems available for image fusion targeted biopsy, each with its own respective strengths and challenges. Because this is an area undergoing rapid development, by the time one of the systems is validated, it is close to being outdated with the rapid deployment of upgrades in software and hardware. Therefore, the “best” system is generally the one that the operator feels most comfortable with. These systems have the benefit that a complex algorithm can fuse the location and shape of the prostate on ultrasound with that from MRI, and compensate for changes in orientation and compression. However, it relies on some statistical assumptions of how the prostate changes from the MRI to the ultrasound based on the position of the patient and the ultrasound probe. It also relies on the expertise of both the radiologist to identify and outline the correct target, and the ultrasound operator to segment the prostate and target the same area. When the system fails, he or she can always fall back to “cognitive fusion,” but the cases where this is necessary are often the hardest cases to target.

The least common method, the most expensive, and most technically demanding, is also possibly the most accurate. “In-bore” MRI-guided biopsy, where a patient lies face-down in the MRI scanner with a needle guide that can guide the biopsy device to the exact place found on the diagnostic scan. This is the only method when a repeat MRI can be done with the biopsy needle in place, confirming that the area is biopsied. However, it is more expensive, takes longer, and can be more uncomfortable. Also, the systematic biopsies are generally not done with this technique. Finally, no head-to-head comparisons yet exist to prove that this is more accurate than image fusion or even cognitive fusion targeted biopsy.

The best targeted biopsy technique varies based on the clinical scenario. For a large tumor in the posterior prostate, near the rectum, any of the techniques would likely work well, so cognitive or image fusion biopsy probably makes the most sense. For a small tumor in the anterior of an enlarged prostate, the in-bore technique probably holds the greatest likelihood to characterize the tumor accurately.

Targeted Biopsy for Patient Management

Targeted biopsy can be used in three common scenarios. The two best established areas are for men with rising PSA and prior negative systematic biopsies, and for men on active surveillance. Targeted biopsy is a newer and increasingly popular choice for men who have never had a biopsy, but want to make sure that the most suspicious area is biopsied the first time. In some countries, such as Great Britain, this last method is becoming routine, where only targets are biopsied – no systematic biopsies are done in most cases.

For men with rising PSA and prior negative systematic biopsies, targeted biopsy, in all of its varieties, has shown added value, finding cancer in somewhat more than half of all such men, although the rate of finding cancer depends on clinical factors such as

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number of prior biopsies, PSA or PSA density, and factors such as ethnicity, age, and diet. This is the best proven use of targeted biopsy for management of an elevated PSA.

For men on active surveillance, prostate MRI provides two advantages: It can find suspicious areas that might have been missed by systematic biopsies, and it provides a baseline for follow-up. Although current active surveillance strategies do not use MRI to determine whether repeat biopsies can be avoided, this concept is gaining traction. New data suggests that in a subset of men, this may be possible.

Additionally, the overall assessment of suspicion—based on the standardized Prostate Imaging Reporting and Data Systems, or “PI-RADS,” and other measures of prostate MRI—correlates with the likelihood that significant cancer may have been missed. This helps to stratify which patients may need targeted biopsy.

Final Thoughts

The use of MRI to screen for which men do or do not need biopsy is controversial. MRI can miss over 10% of significant cancers, although it may be that many of these are small and would typically be found during an annual screening before they would have a chance to spread. The decision to perform MRI in advance of the first systematic biopsy, and whether to perform random systematic biopsies in addition to targets, is unclear and should be part of a discussion with ones physician. ■