Is Perfect the Enemy of Good? Weighing the Evidence for Biparametric MRI in Prostate Cancer

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Abstract: The role of multiparametric MRI in diagnosis, staging and treatment planning for prostate cancer is well established. However there remain several challenges to widespread adoption. One such challenge is the duration and cost the examination. Abbreviated exams omitting contrast enhanced sequences may help address this challenge. In this review, we will discuss the rationale for biparametric MRI (bpMRI) for detection and characterization of clinically significant prostate cancer prior to biopsy and synthesize the published literature. We will weigh up the advantages and disadvantages to this approach and lay out a conceptual cost/benefit analysis regarding adoption of bpMRI.

Introduction

Prostate magnetic resonance imaging (MRI) has been utilized in assessment of prostate cancers for decades, initially efforts were focused on staging known cancers and now on detection and characterization.[1] This led to a significant expansion in the use of MRI in prostate cancer.[2] [3] [4] The role of MRI in detection is to identify the clinically significant lesions, which are defined as Gleason Grade (GG) group ≥ 2, while leaving GG 1 or indolent lesions undetected. These major advances are possible based upon the acquisition of a set of MR sequences (so-called multi-parametric or mpMRI). The four sequences combine two with morphologic information (typically T1 (pre-contrast) and T2 weighted sequences) and two functional sequences namely-Diffusion-weighted imaging (DWI)—and its counterpart, the apparent diffusion coefficient (ADC) map—plus pre- and post-T1W images with dynamic I.V. gadolinium contrast enhanced (DCE) imaging. The combination of these sequences provides information about different aspects of both tumor morphology and biology such as cellular density (seen on DWI) and altered vascularization (seen on DCE). It is now universally accepted radiological practice to interpret and report Prostate multiparametric MRI using Prostate Imaging Reporting & Data System (PI-RADS) v2.1 which incorporates the components of multiparametric MRI to a numerical score signifying the likelihood of clinically significant cancer.[5]

The term "biparametric" (bp) has been used to refer to prostate MRIs which employ T2WI and DWI sequences and omit the use of IV contrast. Thus, bpMRI excludes the IV injection and acquisition of the post-contrast images. It thereby reduces the exam time and cost of the contrast agent. The other advantages include increase patient acceptance due to the

avoidance of the IV administration and the avoidance of the Gadolinium itself. Intravenous contrast administration also requires other associated resources such as preoperative lab testing (specifically measurement of Glomerular Filtration Rate (GFR)), pharmacy costs for storage, dosing and dispensing the contrast agents as well as the need for trained staff to place, monitor and remove IV cannulas. Lastly, although gadolinium is generally regarded as a very safe contrast agent with minimal toxicity or side effects, there have been concerns regarding nephrogenic systemic fibrosis (NSF), now mitigated and more recently concerns regarding deposition of gadolinium in the brain also with mitigation strategies.[6] [7] [8] [9]

Given these factors, there is significant interest in abbreviated non-contrast MRI protocols. In particular, the issues listed above have led many to question whether after the elimination of gadolinium-based contrast enhanced sequences can still provide the required information for prostate cancer detection. Over the past decade, numerous studies have shown evidence to support the value of bpMRI in the assessment of both biopsy-naive men and men with a prior negative prostate biopsy for potential cancerous prostate lesions.[10] [11] In this review, we will describe the basis for bpMRI protocols, the evidence for and against this approach, plausible applications and the implications of bpMRI from a dissemination perspective.

Multiparametric MRI

There is now a wealth of prospective data supporting the ability of multiparametric MRI to identify clinically significant cancer[12] [13] [14] and MRI-based diagnostic pathways are widely acknowledged as superior to historical approaches which typically refer men with a PSA above reference ranges for a sextant or systematic biopsy. [13] [15] [16] [12] [17] [18]

Multiparametric MRI refers to MRIs which incorporate high resolution T2 & T1 weighted MRI (T2W) sequences with functional sequences (DWI & DCE). The T2W sequences provide morphologic details about the gland sub-structure internally- including zonal anatomy, the location of the prostate pseudo capsule, and peri-prostatic structures. T1W sequences are especially useful for detection of post biopsy hemorrhage within the prostate gland or the seminal vesicles.

The peripheral zone is the site of origin of 75% prostate cancer.[19] The normal peripheral zone appears of high signal intensity on T2W and tumors within the peripheral gland appear as round or ill-defined hypointense (low signal) focal lesions. In addition to low T2 signal intensity, peripheral zone tumors typically exhibit restricted diffusion.[20] The transition zone, is the site of origin of benign prostatic hyperplasia (BPH) and the remaining 25% of cancers. The MR findings seen in BPH are multifocal heterogeneous mixtures of glandular nodules (T2 hyperintense) and intervening stromal tissue (T2 hypointense). Cancers in the TZ, in contrast tend to demonstrate uniformly low T2 signal and a variety of shapes such as lenticular non-circumscribed shape and can have blurred internal signal described as “erased charcoal.” [21] [22] Therefore, stromal BPH can occasionally mimic

or obscure clinically significant cancer in the TZ **as these nodules are often highly vascularized**. The central zone (CZ) and the anterior fibromuscular stroma (AFMS) comprise the smallest portion of prostatic tissue and less than 5% of cancers originate there—**however given lack of early enhancement in these two regions, the potential for contrast enhanced sequences to identify tumor in these two sites is one potential benefit of DCE sequences.[5]**

Both DWI and DCE sequences provide tissue characterization- namely cellularity and vascularity respectively. DWI provides information on diffusion of water molecules in tissue. In areas of cancer where the cells are tightly packed or dense they restrict the water motion leading high signal on DWI and corresponding low ADC.[23] [24] [25] DWI can qualitatively identify focal areas of restriction and the actual quantification using the ADC value. Because loss of proliferative controls are a hallmark of aggressive tumors, areas of restricted diffusion tend to harbor more aggressive tumors.[13] Low ADC values on MRI (indicating restricted diffusion) indicate higher grade tumors. [14] [15] [26] ADC metrics have been found to be inversely related to the Gleason grade, an established measure of prostate tumor aggressiveness.[27] [28] [29]

The DWI is one of the most important contributors to the overall PI-RADS assessment and must be combined with data from the T2W and DCE images.[20] [5] Just as diffusion weighted sequences provide information about disordered cellular proliferation, contrast enhanced sequences reveal tumor neovascularization, a process largely mediated by increased androgen receptor expression seen in higher grade tumors.[30] **Therefore, even**

taking into account the normal-age related changes of prostatic hyperplasia, prostate cancer will often demonstrate focal and early enhancement compared to normal gland tissue.

It is now accepted radiological practice to interpret and report prostate MRI using PI-RADS v2.1. This international standard provides an assessment of suspicious lesions from 1-5 with higher numbers indicating a higher probability of cancer.[20] T2 weighted images are the key sequences for evaluation of the transition zone, whereas diffusion weighted sequences are key for evaluation of the peripheral zone. The role of contrast enhancement is limited to the evaluation of PI-RADS 3 (defined as: "the presence of clinically significant cancer is equivocal") lesions in the peripheral zone and has no formal role in TZ lesions. Specifically, a PZ lesion which would otherwise be scored 3 in the peripheral zone based on diffusion weighted sequences, but which exhibits early or focal contrast enhancement would be scored 4 (defined as: "clinically significant prostate cancer is likely").

Barriers to MRI Dissemination

Despite efforts to standardize prostate MRI, level-1 evidence of its role prior to biopsy, and guidelines supporting its use,[31] [32] is still only used in a minority of men.[33] There are many reasons for this in 2021, a major one being access to MR scanners. Due to the high costs of the MR scanners and their operation, many healthcare systems across the world have limited access. MRI utilization is carefully controlled and monitored, along with insurance coverage. The limits vary and there are local and geographical differences

in the prioritization of clinical needs. There are also variations in the experience of radiologists and lack of acceptance by referring physicians (Urologists, Radiation Oncologists and other specialists).

While actual hospital MRI costs are difficult to accurately obtain and report, it is clear that MR exams are charged at a premium in order to recoup the capital investment and relatively high operational costs, given the technical training and skills required to both perform and interpret the exam. These relatively fixed costs are resistant to change and will reflect the level of acceptance by the insurance or third-party payors. Most MR exam times are restricted to 30-40minutes per patient and any opportunity to reduce or speed up the exam time can be very welcome.

The DCE sequence requires IV contrast and the exam or "table-time" as well as costs associated with contrast can be modulated. In comparison to typical MR acquisition times of around 30 minutes for an mpMRI, abbreviated protocols can allow for a reduction **in acquisition time** to under 10 minutes.[11] **It should be noted that there is variability due to specific protocols utilized and specific time savings related to elimination of contrast sequences alone may less than the 20 minutes implied by this study**. **In the study cited above, the authors utilized only axial T2W sequences and axial DWI. A 3 plane T2W and T1W sequence with a large field of view (to calculate volume, rule out hemorrhage and assess for nodal and bony metastases) would not achieve such a dramatic time savings. Because there are differences in the specific bpMRI protocols, the amount of time and resources saved with this approach can vary.**

The second category of potential costs savings—reduction in pharmacy costs, and associated resources required for contrast administration is also complex. While eliminating contrast sequences may plausibly reduce costs related ordering, storing and administering contrast agents, there are other mitigation strategies. For example, there was a 2017 recommendation from the American College of Radiology which suggested that evaluation of pre-procedural glomerular filtration rate (GFR) be made optional prior to administration of macrocyclic contrast agents.[34] This has the potential for significant costs savings in prostate imaging without needing to eliminate these sequences.[35] Additionally, nearly all MRI facilities utilize Gadolinium contrast, so many of the costs associated for storage and administration of contrast are fixed.

Although calculating the precise cost savings is difficult, and despite the presence of other potential mitigation strategies to reduce the cost of MRI, it is likely that bpMRI protocols do confer some cost savings. By reducing exam time, the number of MRIs per day can be increased. This may increase revenue in fee for service settings, which may decrease the depreciation time over which the equipment is "paid off" thereby spurring increased investment in MRI scanners. This can subsequently offer the chance of lowering the notable differences in health care access among some patients.[36] [33]

Although a less intensive and shorter study duration is likely to save money in most health systems, it is important to acknowledge that the financial benefits of adopting of a bpMRI likely differ for different stakeholders and within different health

systems. For example, radiologists who practice in a fee for service setting may receive credit for fewer MRIs if the total time to read a study is greater (possible with bpMRI) and similarly, a greater number of biopsies performed in the setting of equivocal bpMRI could raise costs for the health system at large while increasing revenue for urologists who are paid on a per-biopsy basis.

Comparative Effectiveness of Multi-Parametric versus Bi-Parametric MRI

Review of current published investigations Comparing Multi- versus Bi-Parametric MRI

One of the first studies to evaluate the relative contribution of DWI and DCE to prostate MRI was performed by Yoshizako et al. and published in 2008.[37] Their team analyzed preoperative MRIs on 35 men treated with radical prostatectomy for prostate cancer. The accuracy of MRI for detecting *transition zone* cancer was compared using T2 only, T2 plus diffusion weighted sequences, T2 plus contrast enhancement and all three sequences. The accuracy of 64.3% increased to 69% percent when adding DCE alone, but to 83.3% when adding DWI. Although both DWI and DCE sequences improved the accuracy of prostate MRI, largest benefit was seen with the addition of diffusion weighted sequences and a relatively smaller benefit was seen with the addition of contrast enhanced sequences.

A similar study comparing the relative contribution of diffusion weighted and contrast enhanced sequences was performed by Kitajima et al, whose 2010 analysis of 53 sequential

men with suspected prostate cancer who received pre-biopsy MRI. The accuracy of MRI for different MRI strategies was compared. [38] They reported that the addition of diffusion weighted sequences and contrast enhanced sequences improve sensitivity, specificity and accuracy compared to T2 weighted sequences alone. Although their ROC analysis showed no significant difference between the AUC T2 weighted plus DWI versus all three sequences (T2 plus DWI plus contrast enhanced sequences), the sensitivity and specificity of the full multiparametric approach including both contrast-enhanced and diffusion weighted sequences was superior to the biparametric approach. Likewise, a retrospective study in radical prostatectomy patients by Taghipour et al found that DCE identified clinically significant PCa in most equivocal PZ lesions, DCE being correct in increasing the assessment category to PI-RADS 4 in 69% of cases that received a PI-RADS 3 score based on DWI alone.[39]

Since that time, a small series mostly retrospective studies have assessed the relative contribution of contrast enhanced sequences. A 2018 meta-analysis by Woo et al, pooled the data from 24 studies comparing these two approaches. The study did not demonstrate a benefit for multi-parametric over biparametric approach, however the studies exhibited a large degree of heterogeneity, were mostly retrospective, and the MR techniques varied in such as use of endorectal coil, Radiologist's experience and DCE temporal resolution as well as the measure of truth or diagnostic accuracy (the studies varied in terms of the reference standards for pathological evidence of prostate cancer with some using TRUS versus transperineal biopsy, saturation versus targeted, and a minority using radical prostatectomy specimens).[40]

Accuracy reported in other studies in the pre-diagnostic setting is similar and generally comparable between the two approaches: Thestrup et al compared the accuracy of biparametric versus multiparametric MRI in a series of men reviewed by two radiologists at a single hospital. The authors compare of results generated using T2 and DWI only versus multiparametric approach including IV contrast. They report sensitivity in the range of 0.94 to 0.96 for biparametric and 0.93 to 1.00 for multiparametric protocols. The two approaches were not significantly different in terms of accuracy. The rate of false negatives was 0.49% for biparametric and 0.0% with mpMRI.[41] A similar two-institution study was reported by Stanzione et al, AUC obtained from the ROC analysis were 0.91 and 0.93 for bpMRI and mpMRI, respectively.[42]

In one of the largest retrospective studies to date, Kuhl et al, reported their experience with a prospective series of 542 men who were recruited for prostate MRI following negative TRUS biopsies. Men received full multiparametric MRI studies and the radiologists reviewed all images from an biparametric protocol prior to the full multiparametric series. Men received an MRI guided biopsy and the biopsy results for the targeted lesions were compared between the bi-parametric versus mpMRI. For the diagnosis of significant prostate cancer using the abbreviated versus full protocols, the authors report sensitivities of 93.9% (95% Confidence Interval (CI) 88.7 to 97.2) and 94.9% (95% CI 88.8 to 97.2), respectively, and specificities of 87.6% (95% CI 83.9 to 90.7) and 84.8% (95% CI 80.1 to 88.2). The accuracy of the two tests was comparable. [11]

In the Biparametric MRI for Detection of Prostate Cancer (BIDOC) Study, Boesen et al, reported the results of a prospective single arm study which assigned biopsy-naïve men with concern for prostate cancer (based on abnormal DRE or PSA >4ng/dl) to receive bpMRI plus a systematic TRUS biopsy. They report an excellent negative predictive value of negative bpMRI findings in ruling out significant prostate cancer of 97% (95% CI, 95%-99%) supports the use of bpMRI as an initial screening test in this population.[43] Similarly, in the IMPROD study, Merisaari et al report the accuracy of bpMRI in a cohort of men who received radical prostatectomy.[44] While there is necessarily bias related to the fact that this study only included men who indeed had clinically significant cancer (based on the fact that they received radical prostatectomy), the authors report that specificity of bpMRI findings of nearly 100% once they included a margin of 10-12mm around the region of interest on bpMRI.

Most recently Alabousi et al, performed a similar analysis pooling data from an overlapping series of studies. This meta-analysis published in 2019 also found no difference between the two approaches but commented on the large degree of heterogeneity in the literature. [45]

Prospective Studies Comparing Multi versus Biparametric MRI

Imaging based comparative effectiveness trials are challenging as they present difficulties with both blinding and allocation concealment. [46] [47] Thus prospective trials are not straightforward. To date, multi- versus bi-parametric MRI studies have not been evaluated in the context of a dedicated prospective clinical trial. With that said, reanalysis of trial

data from diagnostic studies has been performed to assess the relatively accuracy of bi-versus multi-parametric MRI.

A series of retrospective analyses of prospective studies from the National Cancer Institute were performed to assess the performance of MRI-based prostate cancer detection strategies. Rais-Bahrami et al, (NCI) reviewed results from 149 men with no prior prostate cancer diagnosis enrolled in a prospective trial, with mpMRI, followed by targeted biopsy of lesions and standard 12-core biopsy. They did a sub-analysis of men with MR suspicious lesions on both T2W and DWI MRI (defined as bpMRI positive) and found that bpMRI positive lesions yielded an AUC of 0.8 with higher accuracy obtained in combination with PSA. [48]

A separate validation study of 59 men at the NCI with no prior biopsy and referral for elevated PSA > 4ng/mL compared the diagnostic accuracy of combining biparametric "screen positive" lesions (visible lesion on DWI and T2W sequences) with PSA density for predicting presence of significant disease. They report a sensitivity of 79.4% and 76.0% respectively for detecting Gleason score 7 or higher lesions.[49] **It should be noted that these results were obtained with relatively high-precision diagnosis by MRI guided prostate biopsy and experienced radiologists.**

Similarly, a sub-analysis of the PROMIS trial data was used to compare bi- versus multiparametric MRI. The prospective PROMIS trial was a diagnostic study that enrolled 576 men at 11 UK centres who received both transperineal mapping biopsies alongside

standard TRUS ultrasound guided 12 core biopsy.[12] In the sub-analysis Boisaily et al, compared the diagnostic accuracy of MRI with and without contrast enhanced sequences. Radiologists reported lesions on a 1-5 scale using first T2 alone, then T2 plus diffusion weighted images then contrast enhanced images. They report no statistically significant difference in diagnostic accuracy between the strategies of T2 + DWI versus T2 + DWI + DCE. With that said, the DCE sequences did lead to scoring changes in a sizeable minority of equivocal lesions—of 158 lesions scored 3/5 on biparametric MRI, 32 were downgraded after addition of contrast sequences and 31 were upgraded to 4/5 or 5/5 with the addition of contrast. [50]

Recently, the results of a large Swedish population-based screening trial using MRI were published. This study randomized **1,532 men** with PSA above 3 ng/mL to receive either standard transrectal ultrasound guided 12 or 10 core prostate biopsies, versus a bpMRI with subsequent biopsy for PIRADS 3 or higher lesions. The authors report that the bpMRI based strategy was non-inferior to standard biopsy using a noniferiority margin of 4% ($p < 0.001$ for noninferiority). Furthermore, the bpMRI strategy resulted in a lower percentage of clinically insignificant cancer (4% versus 12% in the TRUS biopsy group).[51]

Drawbacks of a Biparametric MRI Based Approach

Although the ability of bpMRI to identify clinically significant cancer with similar accuracy to multiparametric MRI is demonstrated in the above studies, there are noteworthy limitations. For one, although the usefulness of DCE sequences in the PI-

RADSv2.1 is confined to a relatively "minor" case example of equivocal lesions on T2 and DWI sequences, the number of PI-RADS 3 lesions is still a substantial portion of all pre-diagnosis MRIs. Given an incidence of hundreds of thousands of new cases worldwide, a findings of equivocal lesions in 20-30% of men represents a large group of men. As a result, a bi-parametric MRI setup may trigger a need for an increased amount of documentation and the tightening of follow-up and surveillance programs. By definition, bpMRI does not carry any information from DCE. Any suspicious lesion in the PZ of the gland will be assessed based on information provided by DWI/ADC primarily. Any lesion with a suspicion score of PI-RADS 3 will not have the option to be upgraded to a PI-RADS 4; subsequently, the probability of csPCa in those PI-RADS categories will likely change and an extended diagnostic uncertainty will need to be accounted for by clinicians. Nevertheless, under PI-RADSv2.1 guideline, the interpretation of TZ lesions will be generally unchanged. Commentators have noted that a "safety net" is required for this group which can included close follow-up with repeat MRI or proceeding directly to biopsy. Thus bpMRI alone may raise the number of men receiving negative biopsies or repeat MRI.[52] **Given that MRI-targeted biopsies themselves have a learning curve and some degree of variability, both true-negative and false negative biopsies could conceivably increase in number with bpMRI.**

Secondly, much of the work validating the MRI scoring systems and evaluating the effectiveness of bpMRI has been done in centers of excellence with experienced GU radiologists. Gatti et al, performed a noteworthy analysis of the accuracy of bi- versus multi-parametric MRI which was stratified by radiologist experience. They report that

among radiologists with highest experience (over 1000 cases reported) there was no difference between the multi- and bi-parametric MRI. In contrast, less experienced readers needed the contrast enhanced sequences in order to boost sensitivity and to achieve high AUCs.[53] While much of the initial research developing and validating MRI has been performed in academic centers, the ability to translate this work into large scale practice remains unproven and techniques to ensure quality are vital.[54] If contrast enhanced sequences can shorten the learning curve then this may be a reason to retain these sequences. **Another key factor is that less experienced radiologists using bpMRI may require more time to read and score each study (especially equivocal studies). If this is the case, then for a bpMRI, it is possible that the time-savings in the scanner itself could be outweighed by the extra time required to read and score each study.**

While the studies cited above and others support that bpMRI is not inferior to mpMRI [44] [43] it is likely crucial to ensure there is high quality throughout the diagnostic pathway (from referral to biopsy) including careful evaluation of clinical factors and quality-assurance practices (including close monitoring of the proportion of patients assigned to PIRADS-3). If the elimination of contrast enhanced sequences leads to dramatic increases in the proportion of equivocal MRI reads then the benefit of bpMRI could quickly be lost.

It should be kept in mind that many earlier studies comparing mpMRI and bpMRI were performed prior to contemporary scoring systems (e.g. PI-RADS v2 and PI-RADS v2.1). There is evidence that interrater agreement is higher using more modern

scoring system. Thus readers utilizing PI-RADS v2.1 may obtain even greater concordance of mpMRI and bpMR, as as shown in a recent study by Tamada et al. [55](with the important caveat that PI-RADS v 2.1 does still require DCE sequences for scoring some lesions).

Lastly, there are specific clinical scenarios where contrast enhanced sequences are required. For example, there is consensus on the importance of including contrast-enhanced sequences in follow up after any prostate cancer therapy (e.g. after focal therapy).[56] It may well be that the specific sequences utilized will ultimately be tailored to the clinical scenario at hand with bpMRI utilized in a pre-diagnostic setting and a full MRI utilized where necessary. Similar approaches to utilize less intense imaging protocols in specific clinical settings are already utilized in other areas of medicine, for example, in the case of using ultra low dose CT scans for follow up of patients with known kidney stones.[57] There can also be technology based implication, which might demand a use of mpMRI. MRI exams are especially susceptible to distortions from metallic materials; as a result, patients with metal implants, such as a hip prosthesis, can be expected to have DWI result in reduced diagnostic quality. Also, patients who received prostate treatment like hormonal treatments, embolization, or focal therapy can harbor altered prostate morphology, making an appropriate evaluation based on bpMRI challenging. **Similarly, a lower specificity can be seen in men history of prostatitis—which typically have wedge shaped areas of enhancement on mpMRI. In the case of prostate inflammation, it can be useful to report this on pathology reports in order to address this potential confounder.**

Along the same lines, men with high-risk prostate cancer are at risk for local invasion and regional metastasis. There is evidence that a true multiparametric approach including contrast enhanced sequences has greater ability to identify nodal metastases and seminal vesicle invasion.[58] Thus for men with likely high risk or regional risk group cancer the contrast enhanced sequences play a key role.

Can Biparametric MRI Improve Access?

The ability to increase the number of MR exams within a given time period, while reducing costs related to staffing (e.g. nursing and pharmacy) in MRI has significant implications for access, costs and dissemination. In the United States, the performance of MRI for men on active surveillance varies considerably from geographical region to region with far greater use among wealthier, non-minority men in coastal cities.[59] [60] There is hope that by reducing costs, bpMRI may increase the number of men who receive this test. This would lower a socioeconomic barrier in access to care. There is extensive evidence that that socioeconomic status and geography can increase disparities of care in cancer patients. [61] [62] [63] [64] [65] Reducing these barriers to access and receipt of MRI would be desirable and beneficial to many.

There is evidence supporting cost-effectiveness of pre-biopsy MRI strategy.[66] A recent analysis from the University of Alabama compared typical costs and insurance reimbursement for multi- versus bi-parametric MRI. They found that the profit achievable with a biparametric strategy was $510.44 versus $638.74 for a mpMRI. When controlling

for the time required for the two studies, and taking into account that three biparametric MRI studies can be performed within a 45 minute time window required multiparametric MRI, the total increase in earnings for a typical 9 hour business day was $10,710.9 using a biparametric strategy.[67] Although few would argue that such considerations ought to be the serious determinant of MRI strategy, the widespread adoption of prostate MRI clearly depends on hospitals and radiology groups assessing the value of these two approaches. **From a health systems perspective, the cost savings must be weighed against the biopsies themselves: The reduction in unneccsary biopsies in men with negative pre-biopsy MRI must be weighed against a potential need for more biopsies in borderline cases of men with bpMRI. A recent study of Medicare insurance claims for prostate biopsies reported a cost of $1,750 for office biopsies and $2,260 for those performed in ambulatory surgical centers. [68]**

Broadly speaking, more expensive but more accurate diagnostic tests can yield cost savings if they can avoid unnecessary procedures such as biopsies.[69] There is evidence that MRI as an initial screening test to determine who gets biopsies can be cost-effective.[66] The question of whether the additional marginal accuracy of multiparametric MRI can provide value which outweighs the costs of this technique versus biparametric MRI has not yet been answered. Various tools to improve standardization and quality of prostate MRI have been proposed but ultimately the benefit of "guard rails" of contrast enhanced MRIs must be weighed against the ability to provide these important tests to a far greater number of men.

Conclusion

In conclusion, the data broadly support that biparametric MRI can approach the accuracy of multiparametric MRI in high volume academic settings among expert radiologists with extensive experience. The caveat is that prospective, generalizable community-based trials are lacking and there remain specific use scenarios were mpMRI is necessary. There is likely a conflict, between the potentially higher expertise required to accurately read and report bpMRI and the stated goal of using bpMRI as a lever to support widespread dissemination or prostate MRI. From a health systems perspective, the opportunity to perform a larger number of MRIs in more settings and at lower costs must be weighed against the potential for a greater number of equivocal results and the potentially steeper learning curve with the bpMRI approach. While further evaluation of bpMRI in the diagnostic pathway remains underway, the DCE component of a mpMRI exam remains an integral part of most prostate MR exams.

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