

Comparison of Targeted vs Systematic Prostate Biopsy in Men Who Are Biopsy Naïve

The Prospective Assessment of Image Registration in the Diagnosis of Prostate Cancer (PAIREDCAP) Study

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IMPORTANCE Magnetic resonance imaging (MRI) guidance improves the accuracy of prostate biopsy for the detection of clinically significant prostate cancer, but the optimal use of such guidance is not yet clear.

OBJECTIVE To determine the cancer detection rate (CDR) of targeting MRI-visible lesions vs systematic prostate sampling in the diagnosis of clinically significant prostate cancer in men who were biopsy naïve.

DESIGN, SETTING, AND PARTICIPANTS This paired cohort trial, known as the Prospective Assessment of Image Registration in the Diagnosis of Prostate Cancer (PAIREDCAP) study, was conducted in an academic medical center from January 2015 to April 2018. Men undergoing first-time prostate biopsy were enrolled. Paired-cohort participants were a consecutive series of men with MRI-visible lesions (defined by a Prostate Imaging Reporting & Data System version 2 score ≥ 3), who each underwent 3 biopsy methods at the same sitting: first, a systematic biopsy; second, an MRI-lesion biopsy targeted by cognitive fusion; and third, an MRI-lesion targeted by software fusion. Another consecutive series of men without MRI-visible lesions underwent systematic biopsies to help determine the false-negative rate of MRI during the trial period.

MAIN OUTCOMES AND MEASURES The primary end point was the detection rate of clinically significant prostate cancer (Gleason grade group ≥ 2) overall and by each biopsy method separately. The secondary end points were the effects of the Prostate Imaging Reporting & Data System version 2 grade, prostate-specific antigen density, and prostate volume on the primary end point. Tertiary end points were the false-negative rate of MRI and concordance of biopsy-method results by location of detected cancers within the prostate.

RESULTS A total of 300 men participated; 248 had MRI-visible lesions (mean [SD] age, 65.5 [7.7] years; 197 were white [79.4%]), and 52 were control participants (mean [SD] age, 63.6 [5.9] years; 39 were white [75%]). The overall CDR was 70% in the paired cohort group, achieved by combining systematic and targeted biopsy results. The CDR by systematic sampling was 15% in the group without MRI-visible lesions. In the paired-cohort group, CDRs varied from 47% (116 of 248 men) when using cognitive fusion biopsy alone, to approximately 60% when using systematic biopsy (149 of 248 men) or either fusion method alone (154 of 248 men), to 70% (174 of 248 men) when combining systematic and targeted biopsy. Discordance of tumor locations suggests that the different biopsy methods detect different tumors. Thus, combining targeting and systematic sampling provide greatest sensitivity for detection of clinically significant prostate cancer. For all biopsy methods, the Prostate Imaging Reporting & Data System version 2 grade and prostate-specific antigen density were directly associated with CDRs, and prostate volume was inversely associated.

CONCLUSIONS AND RELEVANCE An MRI-visible lesion in men undergoing first-time prostate biopsy identifies those with a heightened risk of clinically significant prostate cancer. Combining targeted and systematic biopsy offers the best chances of detecting the cancer.

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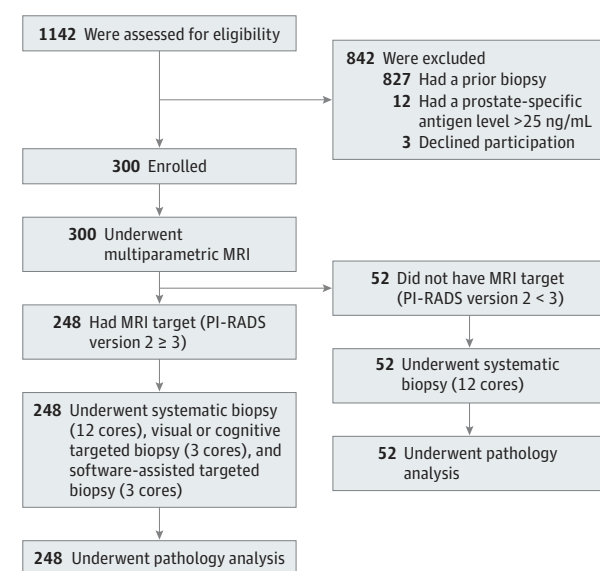
The value of magnetic resonance imaging (MRI)-guided prostate biopsy, performed via MRI and ultrasonography fusion, has been confirmed in large prospective studies,¹⁻⁴ and endorsement of its use in the repeated biopsy setting has come from both urological and radiological organizations.⁵ Despite advances, the optimal method for use of MRI-guided biopsy is not yet clear. Is sampling of only MRI-visible lesions (or regions of interest [ROIs]) sufficient, or should systematic sampling also be used? Should MRI guidance be reserved for men undergoing a repeated biopsy, or should it be used in men undergoing a first biopsy? Is software-based image fusion necessary, or can a cost-saving cognitive approach suffice? Should an MRI without lesions obviate biopsy? Answers to these questions are vital because of the importance of diagnosing prostate cancer early vis-à-vis cost-effectiveness issues associated with the new method.⁶ The Prospective Assessment of Image Registration for Diagnosis of Prostate Cancer (PAIREDCAP) trial was designed to help answer some of these questions.

Methods

Trial Design

The PAIREDCAP trial is a prospective, paired cohort study comparing the cancer detection rate (CDR) of systematic prostate biopsy with 2 forms of targeted biopsy: a cognitive method and a software fusion method (Figure 1). Each patient served as his own control. Each biopsy session was preceded by multiparametric MRI (3-T Magnetom Trio [Siemens]) using an abdominal coil within 60 days of the procedure. Images were read, delineated, and assigned a degree of suspicion by 1 of 3 radi-

Figure 1. Flowchart for Study Inclusion Among Men With Clinical Suspicion for Prostate Cancer



MRI indicates magnetic resonance imaging; PI-RADS, the Prostate Imaging Reporting & Data System.

Key Points

Question In men undergoing a first prostate biopsy to rule out clinically significant cancer, should samples be taken exclusively from lesions visible on magnetic resonance imaging, or should systematic sampling also be obtained?

Findings In a paired-cohort trial comparing biopsy methods in 248 men with magnetic resonance imaging-visible lesions, clinically significant prostate cancer was diagnosed in 70%. The targeted biopsy approach was marginally more sensitive than the systematic biopsy approach, but the 2 approaches combined detected 11% to 33% more cancers than either method alone.

Meaning In this study, the addition of systematic sampling to targeting of magnetic resonance imaging-visible lesions resulted in a sensitivity for detection of clinically significant prostate cancer beyond that of either method alone.

ologists (E.R.F. and 2 nonauthors), each of whom had interpreted more than 2000 prostate MRI results. The Prostate Imaging Reporting & Data System (PI-RADS) version 2 scoring system was used to assign a degree of suspicion to ROIs within the prostate.⁷ For men with an MRI-visible target with a PI-RADS score of 3 or more, the biopsy session proceeded in a set order (eFigure in Supplement 1). First, a standard handheld transrectal ultrasonographically guided 12-core systematic biopsy was performed with the operator blinded to the MRI report (termed the *systematic biopsy*). Next, with the MRI on a screen next to the patient, the radiologist (in the room; E.R.F. or a nonauthor) helped direct the urologic operator to aim the ultrasonographically guided biopsy at the prostate area corresponding to the lesion seen on MRI. Three directed biopsy cores were obtained cognitively from the index ROI (termed the *cognitive fusion biopsy*).⁸ Finally, the MRI and ultrasonographic fusion was performed using the Artemis device (Eigen) (termed the *software fusion biopsy*). The prostate was scanned 3-dimensionally using ultrasonography, and the ROI was brought into the 3-dimensional model via software fusion. The operator then performed 3 targeted biopsies aiming at the index lesion on the coregistered image. A detailed report of the method used for software-fusion biopsy has been published previously⁴; MRI/ultrasonographic coregistration error with this method approximates 3 mm.

This sequence was chosen to avoid operator bias, since visible biopsy tracks from the targeting methods could influence core placement during the systematic method. All biopsies in the study were performed by the same experienced operator (L.S.M.). Antibiotic prophylaxis was ertapenem (1 gram, intramuscular) 1 hour prior to biopsy. No infectious events were encountered.

Men encountered during the study period without an MRI-visible lesion (with a PI-RADS score <3) were enrolled in a companion cohort. These men underwent a 12-core systematic biopsy.⁴ The purpose of this cohort was to estimate the false-negative MRI rate during the trial period.

Patient recruitment and informed consent and prostate biopsies were obtained in the University of California, Los Angeles Urology Center. The study was registered on

ClinicalTrials.gov (identifier: [NCT02425228](#)) and approved by the University of California, Los Angeles institutional review board. Contemporaneous oversight was performed by a data safety monitoring board (at the University of California, Los Angeles Jonsson Comprehensive Cancer Center). No commercial entity was involved in the trial. The study protocol is available in [Supplement 2](#).

Participants

Men undergoing a first-time prostate biopsy prompted by prostate-specific antigen (PSA) elevation or an abnormal digital rectal examination were consecutively enrolled during a 30-month period, ending in April 2018. Eligibility criteria included an age between 45 and 80 years, a serum PSA level less than 25 ng/mL and a prostate volume of 20 to 100 mL. Excluded were those with any prior prostate biopsy, any contraindications to MRI, or any condition precluding prostate biopsy. Men who had an MRI-visible target (PI-RADS version 2 score ≥ 3) underwent the 3 different biopsy methods at the same sitting. Men with no MRI-visible lesions underwent 12-core systematic biopsy using the template built into the Artemis device.

Outcome Measures

The primary outcome of interest was detection of clinically significant prostate cancer (with a Gleason score $\geq 3+4$ [ie, grade group 2]), stratified first by biopsy method and then by prostate volume, PSA density, and MRI grade of lesion (ie, by PI-RADS version 2 score). Grade group 2 was chosen as an indicator of clinical significance because of the typically indolent nature of cases in grade group 1, the increasing aggressiveness beyond that level,⁹ and the author groups' experience with tumor progression in grade group 2.¹⁰ Other outcome measures of interest included overall CDR, detection of insignificant cancers (with a Gleason score of 6), and the false-negative rate of MRI. Results of targeted biopsies (cognitive and software fusion) were compared with the results of systematic biopsies in the same patient.

Concordance between biopsy methods was an important secondary end point and is defined as agreement by method of intraprostatic tumor location (eg, right vs left vs bilateral). For example, if a tumor were detected on the left side by targeted biopsy but on the right side by systematic method (or not at all or bilaterally), then discordance would be present. For purposes of concordance analysis, results of targeting by cognitive and software fusion were combined and compared with systematic results.

Sample Size

Power estimates were based on probabilities of finding cancers with grade group 2 or greater, in men with PI-RADS scores of 3 or more lesions on multiparametric MRI.^{3,4} Data from in-house experience of more than 3000 MRI-guided biopsy procedures were used to create the estimates. A power calculation was performed using the McNemar matched test and Power Analysis and Sample Size version 11 (NCSS Statistical Software) sample size software. A sample size of 248 men undergoing a first prostate biopsy would be required to yield 80% power ($\alpha = .05$), assuming an odds ratio of 2.0 or more be-

tween groups and a discordance of at least 30%. No power estimate was made for the additional 52 men undergoing systematic biopsy without MRI-visible lesions.

Statistical Methods

Results are reported in accordance with the Standards of Reporting for MRI-targeted Biopsy Studies recommendations.¹¹ In evaluating the 3 biopsy methods, we compared the detection of clinically significant prostate cancer (CSCAP) by systematic biopsy with either fusion method, stratified by PI-RADS version 2 score, prostate volume, and PSA density, using the McNemar paired test. All tests were 2-sided with an α of .05 for statistical significance.

Results

Patient characteristics are shown in [Table 1](#). A total of 300 men participated; of these, 248 men had MRI-visible lesions and underwent all 3 procedures (mean [SD] age, 65.5 [7.7] years; 197 were white [79.4%]), and 52 had results negative for MRI-visible lesions and served as the control group (mean [SD] age, 63.6 [5.9] years; 39 were white [75%]).

The overall CDR of CSCAP among systematic, cognitive, and software fusion biopsy methods for men with an MRI-visible target was 70.2% (174 of 248 men; [Figure 2A](#)). When each biopsy method was used alone, CDRs ranged from 46.8% (116 of 248 men) for cognitive targeting to 60.1% (149 of 248 men) for systematic sampling and 62.1% (154 of 248 men) for either cognitive or software fusion ($P = .70$; [Figure 2A](#)). Thus, 20 of 174 CSCAP cases (11.5%) to 58 of 174 CSCAP cases (33.3%) would have been missed by using any 1 biopsy method alone. The overall CDR or biopsy sensitivity was greatest when systematic and targeted results were combined.

The CDR by all methods was significantly higher in men with PI-RADS scores of 4 (58 of 91 men [64%]) or 5 (81 of 101 men [80.2%]) than men with a score of 3 (13 of 56 men [23%]; $P = .006$) with no significant difference between biopsy methods ([Figure 2B](#)). Additionally, CDRs by all methods were positively associated with PSA density (25 of 72 men [35%] with low-density PSA, 28 of 50 men [56%] with moderate-density PSA, and 98 of 126 men [77.8%] with high-density PSA; $P = .009$) ([Figure 2C](#)) and inversely associated with prostate volume (32 of 42 men [77%] with low volumes, 98 of 156 men [62.8%] with moderate volumes, and 21 of 50 men [42%] with high volumes; $P = .006$) ([Figure 2D](#)), with no significant difference between biopsy methods. The distribution of Gleason scores detected did not vary significantly by biopsy method, with the detection rate of all Gleason scores similar across biopsy methods ($P = .57$; eTable in [Supplement 1](#)).

On a per-core basis, CDR by systematic biopsy was 467 of 2972 total cores (15.7%), while CDR by cognitive or software fusion biopsy was 248 of 744 total cores (33.3%) and 282 of 741 total cores (38.1%), respectively ($P = .008$; [Figure 3](#)). Men with CSCAP had a median of 5 (interquartile range, 2-8) positive cores by any method. Those with only clinically insignificant prostate cancer (Gleason scores of 3 + 3) had a median of 4 (interquartile range, 2-7) positive cores. Of the 37 patients with

Table 1. Patient Characteristics

Characteristic	No. (%)	
	With Magnetic Resonance Imaging Target (n = 248)	Without Magnetic Resonance Imaging Target (n = 52) ^a
Age at biopsy, mean (SD), y	65.5 (7.7)	63.6 (5.9)
Race		
White	197 (79)	39 (75)
African American	16 (6)	2 (4)
Other	35 (14)	11 (21)
Clinical T stage (n = 237)		
T1c	149 (82)	44 (86)
T2a	33 (18)	7 (14)
Prostate-specific antigen, median (IQR), ng/mL	6.2 (4.6-8.2)	5.2 (4.1-6.6)
Prostate volume by magnetic resonance imaging, cm ³		
20-30	42 (17)	8 (15)
31-60	156 (63)	28 (54)
61-100	50 (20)	16 (31)
Prostate density, ng/mL/cm ³		
<0.10	72 (29)	24 (46)
0.10-0.15	50 (20)	14 (27)
>0.15	126 (51)	14 (27)
Prostate Imaging Reporting & Data System version 2 score		
3	56 (23)	NA
4	91 (37)	NA
5	101 (41)	NA
Region of interest		
Location, anterior	93 (38)	NA
Maximum diameter, mm		
<10	46 (19)	NA
10-15	96 (39)	NA
>15	106 (43)	NA

Abbreviation: NA, not applicable.

^a The 52 men with no magnetic resonance imaging-visible targets were included to help estimate the incidence of false-negative magnetic resonance imaging studies encountered during the trial period and not for purposes of comparison with the targeted biopsy group.

only Gleason scores 3 + 3 whose disease statuses were detected by any method, 20 patients (54%) had more than 3 positive cores.

Concordance of Cancer Detection by Prostate Biopsy Method

To evaluate the possibility that targeted and systematic biopsies may detect different cancers, a subanalysis was performed based on the intraprostatic location of detected tumors. If a tumor were detected on only 1 side of the prostate by 1 biopsy method, but another tumor was detected on the other side by a second method, then the 2 methods must be detecting different tumors. For purposes of this analysis, results of targeting by cognitive and software fusion were combined.

Table 2 shows the concordance of cancer detection between systematic and targeted biopsy based on tumor location. Overall, the concordance between targeted and systematic methods is 64.1% (159 of 248 men); in other words, both methods detected tumors in the same location or both detected no tumors. In 85 of 248 men (34.3%), the same tumor was detected by both systematic and targeted biopsy; in 74 of 248 men (29.8%), no tumor was detected by either biopsy method. In 89 of 248 men (35.9%), the 2 biopsy methods lacked concordance; 52 of 248 men (20.9%) had a tumor detected by systematic biopsy that was missed by targeted biopsy, while 9.7% (24 of 248 men) had a tumor detected by targeted biopsy that was missed by systematic biopsy. Neither side of the prostate exhibited propensity for tumor detection by 1 method or the other. When tumor was detected by targeting a lesion (n = 154), CSCAP was detected exclusively by software fusion in 38 patients (24.7%), exclusively by cognitive fusion in 20 patients (13.0%), and by both software and cognitive fusion in 96 patients (64.2%).

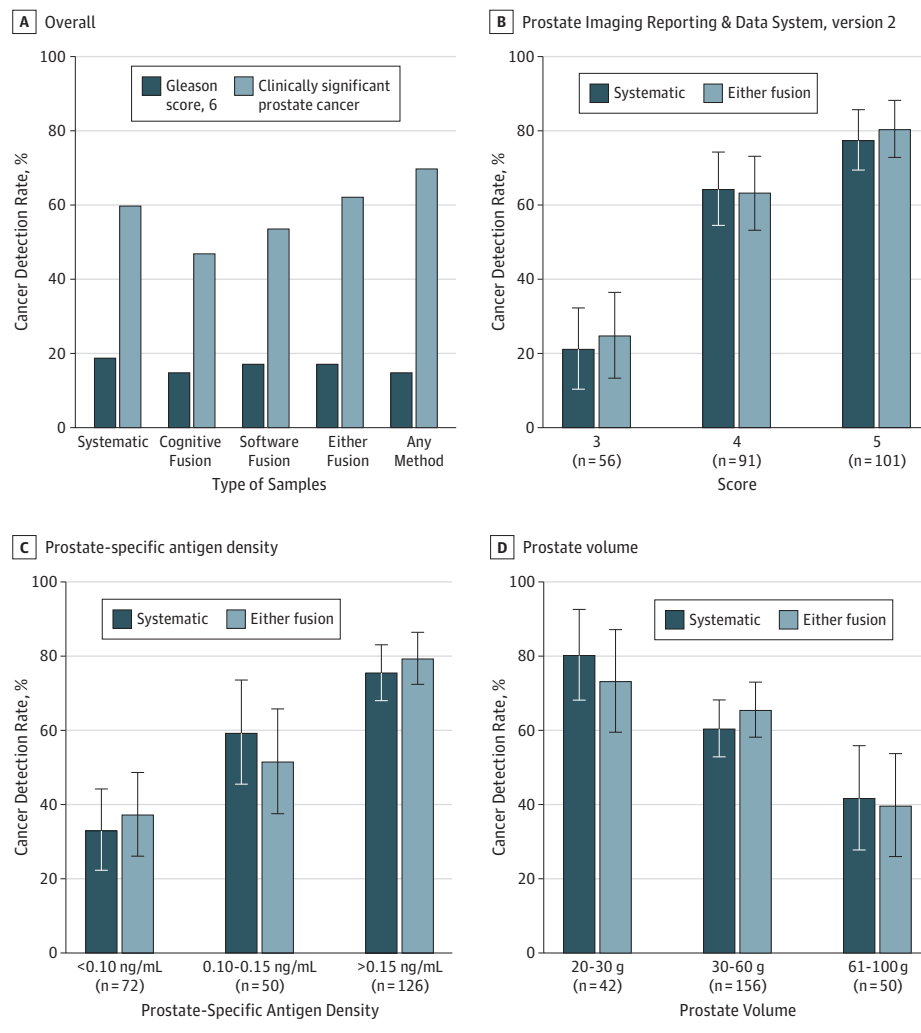
Negative Multiparametric MRI Cohort Analysis

The CDR in the nontargeted cohort was 15% (8 of 52 men), compared with 70.2% (174 of 248 men) in the group with lesions. Clinical characteristics of the nontargeted group reveal similarities to the larger group with MRI-visible lesions, except for PSA density (Table 1). A greater percentage of the group with targets had elevated PSA density compared with those without targets. Among those 14 men with negative MRI results and PSA density greater than 0.15 ng/mL/cm³, 5 (36%) had CSCAP detected by a systematic biopsy. Among the 38 with PSA density less than or equal to 0.15 ng/mL/cm³, 3 (8%) had CSCAP. In other words, combining a negative MRI with a low PSA density yielded only an 8% incidence of CSCAP.

Discussion

The present study, by showing that the detection rate of CSCAP is highest when both systematic and targeted biopsies are combined, differs in design from other studies in several respects. First, different biopsy methods were compared against one another in the same patients, optimizing control of inter-individual differences. Second, all participants were biopsy naïve, a sample for which the study was powered. Third, PI-RADS version 2 was used uniformly for MRI results. Fourth, the investigators were highly experienced with all aspects of the procedures, with 10 years of experience with MRI-guided prostate biopsy.¹² Finally, during the trial, a parallel cohort was studied to help estimate the false-negative rate of MRI during the study period. The idea for the trial came from an earlier observational study⁴ involving 1042 men, which suggested that systematic and targeted biopsies were both required to maximize cancer detection. The present data confirm and expand on the observations of several recent studies.¹³⁻¹⁵

Among the 248 participants with MRI-visible lesions, CSCAP was detected in 174 (70.2%). This percentage is considerably higher than the CDR of conventional biopsy,^{1,16-18} likely reflecting the outcomes of the MRI screening. These data

Figure 2. Comparison of Cancer Detection Rates by Biopsy Method in Men With Lesions Visible on Magnetic Resonance Imaging

A, Cancer detection rates (CDRs) are by highest Gleason score; where a Gleason score of 6 was found along with a higher score, only the highest score is reported. A, Overall CDRs by systematic, cognitive fusion, software fusion, either fusion, and any biopsy method in men with a magnetic resonance imaging-visible target. There was no significant difference in CDR between systematic and either fusion biopsy method. B, Prostate Imaging Reporting & Data System (PI-RADS) version 2 grade. A CDR of clinically significant prostate cancer is directly proportional to Prostate Imaging Reporting & Data System version 2 scores, with no significant difference between biopsy methods. C, Prostate-specific antigen density. A CDR of clinically significant prostate cancer is directly proportional to prostate-specific antigen density; no significant difference is found between biopsy methods. D, Prostate volume. A CDR of clinically significant prostate cancer is inversely proportional to prostate volume, regardless of biopsy method. The CDRs can be further stratified by combining Prostate Imaging Reporting & Data System score with prostate-specific antigen density.

thus serve to confirm the value of MRI for providing risk assessment when considering biopsy. In agreement with other studies,^{4,19,20} men in the present study with a suspicious lesion on MRI had increased likelihood of harboring CSCAP, with the chances increasing as PI-RADS version 2 score increased. Among the target-detected CSCAP lesions in the present study, the CDR increased from 25% in grade 3 lesions to 81% in grade 5 lesions (Figure 2B); little difference was noted between the 2 targeting methods. The detection rate of CSCAP in men whose MRI results were normal was 15%, similar to that found in other studies.^{4,13,21,22} Thus, MRI lesions (or the absence thereof) appear as graduated risk indicators rather than as definitive harbingers of a benign or a malignant state. Based on these results, a negative MRI result should not obviate the need for prostate biopsy when otherwise clinically indicated (eg, PSA density, family history, racial/ethnic vulnerability, palpable nodule).

Systematic biopsies performed similarly to targeted biopsies in all studied categories (Figure 2). The assessment of PSA density yielded results similar to MRI score: the greater the den-

sity, the greater the risk, which was similar across all biopsy methods (Figure 2C). The overall CDR was inversely associated with prostate volume, which was true for all biopsy methods (Figure 2D). All together, these data indicate only a marginal increase in sensitivity of CSCAP detection when targeting is used, compared with systematic sampling. The combination of methods appears to provide the greatest CDR.

To help explain the increased CDR of combined methods, which has been reported by others,²³⁻²⁵ we examined the location of the detected tumors vs biopsy method and found a substantial discordance. Table 2 demonstrates that targeted and systematic biopsies detect different tumors and highlights examples of the discordances. Why CSCAP should exist apart from an MRI lesion in the same prostate is not clear. Registration errors might be invoked, but the present discordance study was based on laterality, and thus registration errors are an unlikely explanation. Regardless of explanation, not all sites of CSCAP resided within MRI-visible ROIs.

The sample of 248 men constitutes a cancer-enriched group because of the entry criterion of a suspicious MRI. Can

efficiency of biopsy be improved in such a group? We found that efficiency of targeting is superior to that of systematic sampling, since twice the number of systematic biopsy cores as targeted cores were required to detect CSCAP (Figure 3). The efficiency argument appears strongest in the case of grade 5 ROIs, where CDR by targeting biopsy alone approximates 80%.^{1,4} However, systematic sampling should be considered in all cases for several reasons. Some MRI-visible lesions will contain indolent forms of CSCAP, for which various management options exist. Active surveillance or focal therapy, in which knowledge of whole-organ status is important, may be considered in such cases. Furthermore, in some cases, as represented by the discordances shown in Table 2, the MRI-visible lesion may be falsely positive, with the tumor residing elsewhere in the prostate. Further, recognition of MRI lesions (and their severity) is not uniform even among experts.²⁶

Results from the present study compare favorably with the Assessment of Prostate MRI Before Prostate Biopsies (MRI-FIRST) trial, in which men naïve to biopsy underwent MRI, and if positive, systematic biopsy followed by targeted

biopsy. Each patient was his own control, as in the present study, and no significant difference in CDR was noted between systematic and targeted biopsy methods.¹³ The authors concluded that combining both biopsy methods optimizes cancer detection vs either method alone. In contrast, in the Prostate Evaluation for Clinically Important Disease: Sampling Using Image Guidance or Not? (PRECISION) trial, a targeted biopsy detected more prostate cancer than a systematic biopsy (38% vs 26%, respectively).¹ In PRECISION, men were randomized to either ultrasonographically guided systematic biopsy or MRI, and if an MRI lesion were seen, a targeted biopsy. Combined biopsies were not done. No systematic cores were taken from the MRI group. In PAIREDCAP, all 248 men with positive MRI results (PI-RADS version 2 ≥ 3 target) underwent both systematic (12 cores) and targeted biopsy (6 cores).

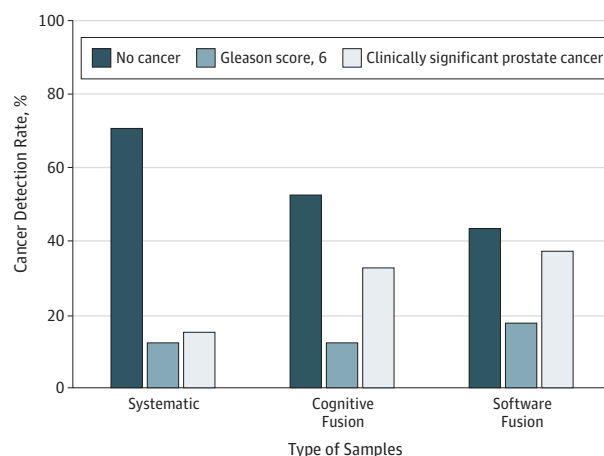
These data suggest that creation of a risk assessment model that includes other information, such as PSA density, might constitute an important means of assessing CSCAP when paired with findings on MRI. Among the 63 men in the present study with PI-RADS version 2 MRI score of 5 and a PSA density greater than 0.15 ng/mL/cm³, 57 men (90%) had CSCAP. Conversely, among the 38 men with a negative MRI result and a PSA density less than 0.15, only 3 (8%) had CSCAP. These results will augment future studies to develop prediction models incorporating MRI results, PSA density, and other data to optimally identify men most likely to have CSCAP.²⁷

Previous studies show that targeted biopsy detects more high-risk prostate cancer than systematic biopsy.³ In the MRI-FIRST trial, targeted biopsies detected more high-grade (ie, grade group >3) disease than systematic biopsies did, but no difference was seen between biopsy methods for individuals with Gleason scores greater than 3 + 4. Wysock et al¹⁴ similarly found no difference in detection of disease with Gleason scores greater than 3 + 4 between systematic and targeted biopsy methods, although systematic biopsies detected more cases in individuals with Gleason scores greater than 3 + 3. In the present study, the distribution of Gleason scores was similar among biopsy methods (eTable in the Supplement).

Limitations

The following are potential limitations of this work. First, the definitive incidence, size, and location of cancer in study par-

Figure 3. Cancer Detection Rate on a per-Biopsy Basis



Clinically significant prostate cancer was detected on 16% of systematic biopsy cores, 33% of cognitive fusion biopsy cores, and 38% of software fusion biopsy cores. Targeted biopsy was more efficient than systematic biopsy for detection of clinically significant prostate cancer, the difference being most pronounced for Prostate Imaging Reporting & Data System grade 5 lesions.

Table 2. Location of Cancers Detected by Targeted vs Systematic Biopsy (n = 248)^a

Location of Cancer on Systematic Biopsy	Location of Cancer on Targeted Biopsy, No. (%)				Total
	Left	Right	Bilateral ^b	Negative	
Left	43 (17) ^c	2 (1)	7 (3)	9 (4)	61
Right	6 (2)	40 (16) ^c	0 (0)	8 (3)	54
Bilateral	17 (7)	13 (5)	2 (0.9) ^c	3 (1)	35
Negative	13 (5)	10 (4)	1 (0.4)	74 (30) ^c	98
Total	79	65	10	94	248

^a The concordance of cancer detection rates (CDRs) by targeted vs systematic sampling biopsies is shown in association with the location of lesions within the prostate. The CDRs of cognitive and software fusion methods (targeted biopsies) are combined. Concordance of tumor locations is 64.1%; discordance is 35.9%. The locations of lesions was not associated with CDR concordance.

^b Bilateral refers to large lesions that crossed the prostate midline. Only the index lesion was biopsied with the targeting biopsy method.

^c Concordant findings.

ticipants were not ascertained, since neither prostatectomy nor saturation biopsies were available to confirm the findings. Errors in MRI and ultrasonography coregistration are possible and difficult to quantify, but the 80% CDR in grade 5 targets means that such errors were unlikely to have been pervasive. Long-term follow-up data are not yet available. Considerations that might limit widespread generalizability of the present study include single-site enrollment, biopsy performance by a single experienced operator, and use of advanced radiology expertise. Nevertheless, the cohesive results of this trial provide high-level evidence not previously available regarding the value of MRI-guided biopsy and how tissue sampling should be performed in men undergoing initial biopsy.

Conclusions

In conclusion, the present PAIREDCAP trial provides evidence in favor of a prebiopsy MRI to identify men naïve for biopsy who are at increased risk of CSCAP. In men with MRI-visible lesions, the 2 biopsy methods combined—systematic and targeted—are required for maximal detection of CSCAP. The CDR was found to increase from 15% in men with no MRI-visible lesions to 70% in men with a PI-RADS version 2 lesion of grade 3 or greater who were undergoing combined biopsy. The discordance of tumor locations between biopsy methods indicates that targeted and systematic biopsies may detect different tumors.

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Acquisition, analysis, or interpretation of data: All authors.

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Invited Commentary

Closing the Loop on the Role of Multiparametric Magnetic Resonance Imaging-Targeted Prostate Biopsy

Ahmad Shabsigh, MD; Cheryl T. Lee, MD

Thirty years have passed since clinicians started using prostate-specific antigen level as a screening tool for prostate cancer. Over the years, the diagnosis of metastatic disease has decreased dramatically, and there has been a considerable decline in mortality.^{1,2}



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However, clinicians have struggled to find the balance between early diagnoses of lethal prostate cancer and overdiagnoses of clinically insignificant disease. Some lessons have been learned from large clinical trials, leading to the adjustment of the age and rate of screening and the development of better tests. In addition, better understanding of risk stratification and the role of active surveillance have improved treatment algorithms. In the recent past, technological advances have facilitated diagnosis. Specifically, multiparametric magnetic resonance imaging (MRI) of the prostate has significantly improved the detection of clinically significant cancer.

In the Prostate Evaluation for Clinically Important Disease: Sampling Using Image-Guidance or Not? (PRECISION) trial,³ men with an elevated prostate-specific antigen level or abnormal digital rectal examination results who had had no prior biopsy were randomly assigned to undergo either multiparametric MRI with or without targeted biopsy or a standard transrectal ultrasonography-guided (TRUS) biopsy. The trial showed that multiparametric MRI use with or without targeted biopsy was superior, with a significantly higher percentage of men diagnosed with clinically significant prostate cancer (38% vs 26%). Furthermore, fewer men in the MRI-targeted biopsy group were diagnosed with clinically insignificant cancer (9% vs 22%). More importantly, up to 28% of men in the MRI group were able to avoid prostate biopsy. Similarly, in the Prostate MRI Imaging Study (PROMIS) study, Ahmed et al⁴ found that multiparametric MRI was more sensitive than TRUS biopsy (93% vs 48%) and less specific. Again, 27% of patients would have avoided biopsy if multiparametric MRI had been used. Still, a critical question went unanswered by these studies: is it better to do a standard TRUS biopsy in addition to the MRI-targeted biopsy?

In this issue of *JAMA Surgery*, Elkhoury et al⁵ attempted to answer this question. In a prospective paired-cohort study, 248 men with multiparametric MRI lesions underwent 3 biopsy methods at the same sitting: a systematic TRUS biopsy, a cognitive biopsy, and a fusion biopsy of lesions identified on multiparametric MRI. A control group of 51 patients with negative multiparametric MRI results underwent standard TRUS biopsies. The Prospective Assessment of Image Registration in the Diagnosis of Prostate Cancer (PAIREDCAP) study⁵ confirmed published data. Compared with 47% when using cognitive fusion biopsy alone and up to 70% when using a standard approach with either targeted method, only 15% of patients with negative multiparametric MRI were diagnosed with clinically significant cancer in the control group. A few important lessons can be learned from this study: first, relying on targeted biopsy alone is suboptimal; second, if the urologist does not have a fusion machine, cognitive biopsy is still essential. The results reflect the reality that multiparametric MRI is better than what clinicians have had, but there is still a way to go.

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