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A Prospective Comparison of MRI-Guided Targeted Biopsy with 12-Core Transrectal Ultrasound-Guided Systematic Biopsy in the Diagnosis of Clinically Significant Prostate Cancer: An Indian Experience

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Abstract

Objective The aim of this study was to compare the sensitivity and prostate cancer detection rate of magnetic resonance (MR) in-bore biopsy with transrectal ultrasound (TRUS) guided systematic biopsy. We also compared the cancer detection rate of the combined MR in-bore and TRUS-guided systematic biopsy with the TRUS-guided biopsy only approach.

Materials and Methods In this prospective study, 61 consecutive patients with prostate-specific antigen (PSA) $\geq$ 3 ng/mL and Prostate Imaging Reporting and Data System (PI-RADS) score $\geq$4 were recruited between July 2017 and January 2020. One patient with prior prostate surgery was excluded. Among the remaining 60 patients, 30 underwent MR in-bore biopsy followed by systematic biopsy (study arm A) and 30 underwent systematic biopsy only (study arm B).

Results The mean PSA range of study population ($n = 60$ patients) was 4.2 to 72.7 ng/mL. Twenty-seven patients had a PI-RADS score of 4, and 33 patients had a PI-RADS score of 5. Among 60 patients, 30 had prostate carcinoma on biopsy, of which 18 were clinically significant prostate cancers (csPCa). In study arm A, TRUS-guided systematic biopsy had a lower sensitivity (0.9) for detection of csPCa compared with MR in-bore biopsy (1.0) with overdetection of insignificant cancers (sensitivity: 0.89 vs. 0.56). TRUS-guided biopsy yielded 112 positive cores out of 360, whereas MR in-bore biopsy yielded 15 positive cores out of 30 (31.1 vs. 50%; $p = 0.03$). On comparison of study arms A and B, the diagnostic yield for detection of both prostate cancer and csPCa were high in study arm A (60 vs. 40%, and 33.3 vs. 26.7%, respectively)

Conclusion MRI in-bore targeted biopsy had a greater sensitivity to detect csPCa with fewer number of biopsy cores and lower sensitivity to detect insignificant cancers compared with systematic biopsy. Systematic biopsies were associated with over-detection of clinically insignificant cancers.

Keywords
- MRI
- MRI in-bore biopsy
- prostate cancer
- systematic biopsy
- targeted biopsy
- transrectal ultrasound

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Introduction

Prostate cancer is the second most common cancer in men worldwide.[1,2] However, prostate cancer has a high 5-year survival rate of 98%, possibly due to screening-related greater detection of clinically insignificant cancers. Patients who have elevated prostate-specific antigen (PSA) levels or suspicious digital rectal examination (DRE) findings undergo transrectal ultrasound (TRUS) guided systematic biopsy, which is the current standard for the diagnosis of prostate cancer. However, TRUS-guided systematic biopsy can miss up to 40 to 50% of prostate carcinoma (PCa) with a relevant proportion of clinically significant prostate carcinoma (csPCa).[3,4] There has been an evolving interest in recent years in the magnetic resonance imaging (MRI) guided prostate biopsies due to the greater detection of csPCa in comparison to systematic biopsies. MRI has shown remarkable accuracy in the detection of csPCa with the help of T2-weighted imaging, diffusion-weighted imaging (DWI), and dynamic contrast-enhanced MRI (DCE-MRI).[5–7] MRI-guided prostate biopsies can thus improve the detection rate of PCa, especially of clinically significant tumors, which are more often missed on a TRUS-guided systematic biopsy.

There are various techniques of MR-targeted biopsy such as cognitive MR-TRUS fusion, software co-registered MR-TRUS fusion, and MR in-bore biopsy. American Urological Association (AUA) and Society of Abdominal Radiology (SAR) consensus statement recommends that MRI-targeted biopsy be strongly considered in patients with prior negative biopsy who have persistent clinical suspicion for prostate cancer.[8] Larger studies such as Prostate MR Imaging Study (PROMIS) and Prostate Evaluation for Clinically Important Disease: Sampling using Image Guidance or Not (PRECISION) trials have also validated the improved detection of csPCa by MRI-guided biopsy with a reduction in the overdiagnosis of clinically insignificant cancers.[9,10] MR in-bore biopsy has been observed to increase the detection rate for clinically significant cancers and reduce the number of biopsy cores required.[11] MR in-bore biopsy provides the crucial advantage of direct visualization of the target location and confirmation of needle placement within it prior to sampling.[12] On the other hand, MR-TRUS fusion biopsy provides the advantage of biopsy site documentation and real-time ultrasound guidance, although it can be associated with misregistration errors.[13] This prospective study compared the sensitivity and diagnostic yield of MR in-bore biopsy with 12-core TRUS-guided systematic biopsy in patients who underwent both biopsies (study arm A) and also compared the diagnostic yield between the patients who underwent both biopsies (study arm A) and those who underwent systematic biopsy alone (study arm B).

Materials and Methods

Study Cohort

This prospective single-center study was approved by the institute's review board. The study period was from July 2017 to January 2020, and informed consent was obtained from all participants. Sixty-one consecutive patients who had PSA $\geq$ 3 ng/mL and PI-RADS 4 or 5 lesions on MRI were recruited. The exclusion criteria were as follows: previous surgery or radiation to the prostate ($n = 1$), contraindication to MRI like claustrophobia or pacemaker ($n = 0$), and poor general condition ($n = 0$). Among 60 patients, alternative patients were sequentially assigned to study arm A (who underwent both MR in-bore and TRUS-guided systematic 12 core biopsy, $n = 30$) and study arm B (who underwent systematic TRUS-guided systematic 12-core biopsy, $n = 30$). Among the 60 patients, 8 had 1 prior negative TRUS biopsy. Participant flow is summarized in ►**Fig. 1**.

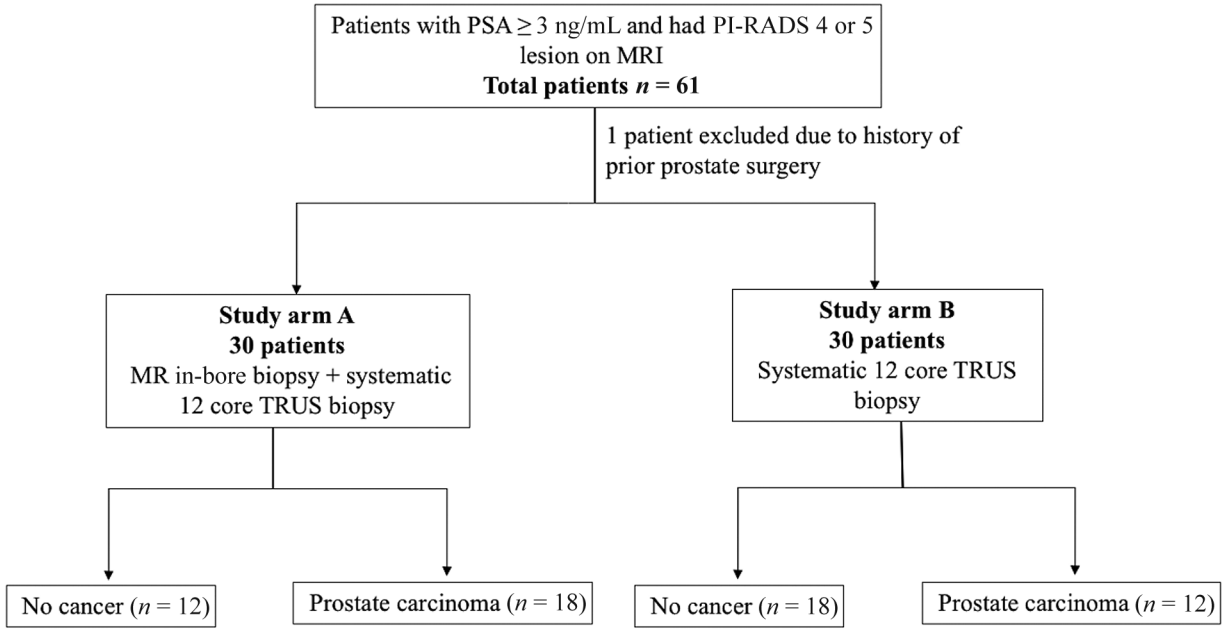

Fig. 1 Patient flowchart. MRI, magnetic resonance imaging; PI-RADS, Prostate Imaging Reporting and Data System; PSA, prostate-specific antigen; TRUS, transrectal ultrasound.

Biopsy Protocol

The patient was advised to take a single oral dose of ciprofloxacin the night before the biopsy and was continued on antibiotics 3 days postprocedure. The patient was advised a self-administered enema on the morning of the procedure. Both MR in-bore biopsy and TRUS-guided systematic 12-core biopsy were performed under mild conscious sedation and local anesthesia. The patients in study arm A underwent both MR in-bore biopsy and TRUS-guided systematic 12-core biopsy. The previous MR (T2 and DWI sequence) images were reviewed to localize the suspicious lesion for these lesions. Two radiologists reviewed the images: one senior radiologist with 10 years of experience and another junior radiologist with 3 years of experience in prostate MRI. The MR in-bore biopsy was performed on a 1.5-T clinical MRI system (Achieva 1.5 T, Philips, Eindhoven, The Netherlands) equipped with a dedicated prostate biopsy platform DynaTRIM (Invivo) by a radiologist who was not involved in the subsequent TRUS-guided systematic biopsy. The MRI protocol is detailed in ►**Table 1**. Preliminary T2 sequence (sagittal and axial planes) was acquired to locate the needle guide within the rectum and to calculate the coordinates of the target lesion relative to the needle guide through DynaCad (Invivo) software. The needle guide was then positioned accordingly, and an 18-gauge double-shot core biopsy gun was inserted through the needle guide and triggered. Repeat T2-weighted axial and sagittal images were acquired to confirm the correct placement of the needle slot within the target site. The biopsy gun was then fired, and a single core of tissue was sampled (►**Fig. 2**). The patient was later shifted to the ultrasound procedure room, where a TRUS-guided systematic 12-core biopsy was performed by another radiologist who was blinded to the MRI findings and was not involved in the MR-targeted biopsy. The patients in study arm B underwent only the TRUS-guided systematic 12-core biopsy. The operator who performed the TRUS-guided systematic biopsy was unaware of the MRI findings. Their biopsy cores were analyzed for cancer by a dedicated uropathologist. csPCa was defined as a Gleason score $\geq 7\,(3+4)$

Table 1 MRI protocol

MRI parameter	T2 sagittal	T2 axial
TR (ms)	4,750	3,715
TE (ms)	100	100
No. of slices	36	36
Slice thickness (mm)	3	3
Gap (mm)	0	0
FOV (mm)	160 × 160	160 × 160
Matrix	248 × 207	292 × 246
Voxel size (mm)	0.65 × 0.77 × 3	0.55 × 0.65 × 3
Phase encoding direction	FH	RL
No. of acquisitions	1	2
Acquisition time (min: s)	4: 34	5: 20

Abbreviations: FH, foot to head; FOV, field of view; RL, right to left; TE, echo time; TR, repetition time.

Statistical Analysis

Continuous variables are expressed as means ± standard deviation (SD), and categorical variables are presented as frequencies or percentages. In study arm A, a positive test was defined as cancer detected on either test. Diagnostic yield was defined as the total number of patients positive for cancer on biopsy divided by the total number of patients biopsied. The chi-squared test was used to test the null hypothesis. Sensitivity was calculated as the number of positive results divided by the total number of cancers detected. Relative sensitivity was the sensitivity ratio between MR in-bore biopsy and TRUS-guided systematic biopsy.[11] Commercially available software was used (SPSS, 26.0; SPSS, Chicago, IL, United States). A p-values less than 0.05 was considered significant.

Results

Participant Characteristics

The mean age of the study participants was 64.1years (SD: 7.1 years; range: 48–80 years). The mean PSA was 12.6 ng/mL (SD: 9.1; range: 4.2–72.7 ng/mL). There were 27 patients with PI-RADS 4 lesions and 33 patients with PI-RADS 5 lesions. Among 60 patients who underwent biopsy, 30 turned out to be positive for PCa, out of which 12 were clinically insignificant cancers (Gleason score 6) and 18 were clinically significant cancers (≥7). Among 18 patients with clinically significant cancer, 7 patients had a Gleason score of 7, 10 patients had a Gleason score of 8, and 1 had a Gleason score 9. The participant characteristics of study arms A and B are summarized in ►**Table 2** (no statistical significance seen between the groups, $p < 0.05$)

Comparison between TRUS-Guided Systematic 12-Core Biopsy and MR In-Bore Targeted Biopsy in Study Arm A

The biopsy results for study arm A in the detection of prostate cancer are summarized in ►**Table 3**. MR in-bore biopsy cores detected 15 prostate cancers, of which 10 were clinically significant. TRUS-guided systematic biopsy cores detected 17 prostate cancers, of which 9 were clinically significant. TRUS-guided systematic biopsy cores overdetected three clinically insignificant cancers, which were not detected by MR in-bore biopsy cores. Also, one patient got upgraded from insignificant cancer to clinically significant cancer due to the MR in-bore biopsy core. None of the csPCa detected by systematic biopsy cores was missed by the MR in-bore biopsy cores.

The diagnostic yield of TRUS-guided 12-core systematic biopsy and MR in-bore biopsy for overall prostate cancer detection was 56.7% (17/30) and 50% (15/30), respectively ($p = 0.6$). The diagnostic yield of TRUS-guided 12-core systematic biopsy and MR in-bore biopsy for csPCa detection was 30% (9/30) and 33.3% (10/30), respectively ($p = 0.78$).

The sensitivity of TRUS-guided systematic 12-core biopsy and MR in-bore biopsy for overall prostate cancer detection

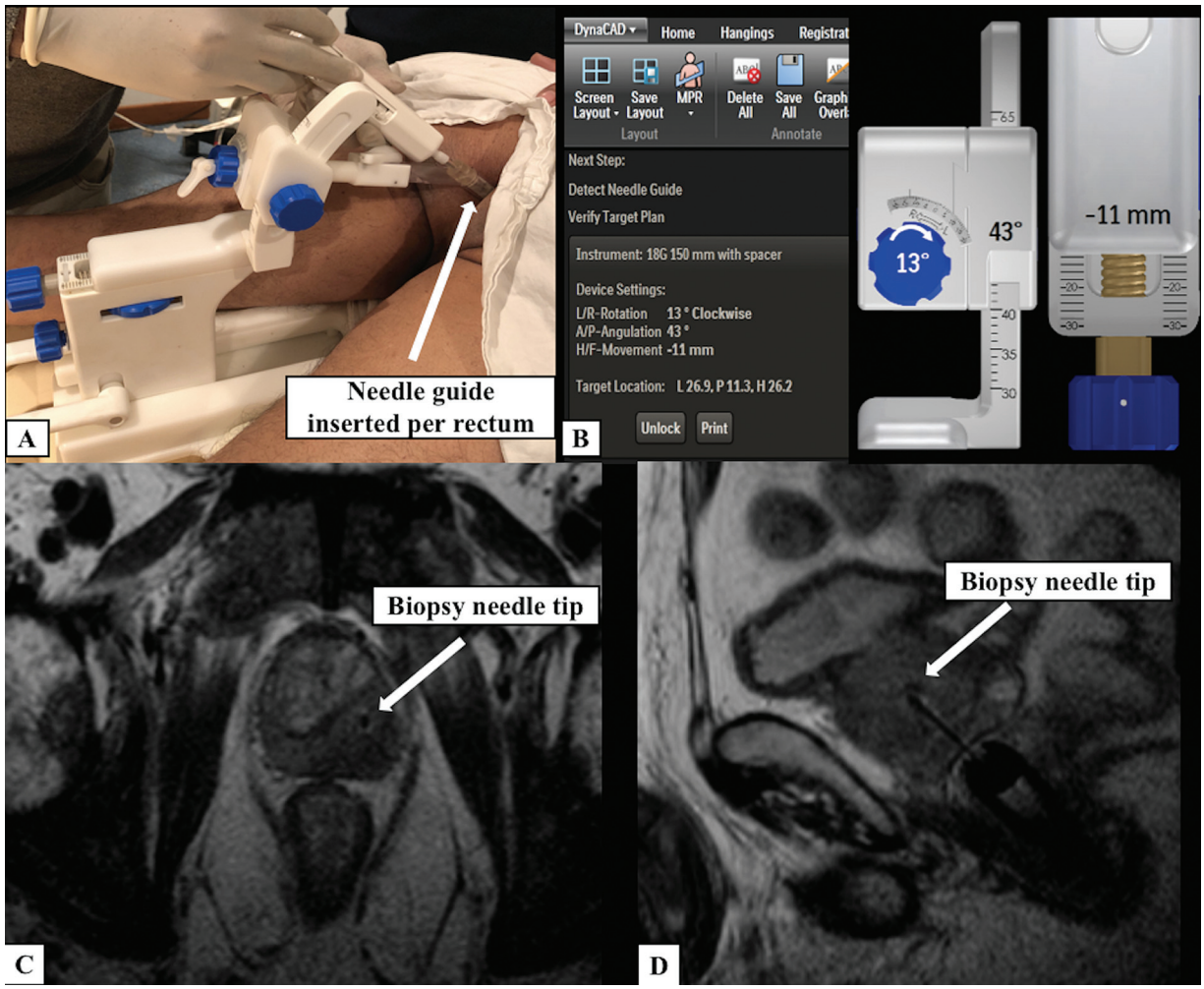

Fig. 2 (**A**) The double-shot core biopsy gun being introduced through the needle guide, which has been inserted per rectum (*double arrow*). (**B**) The calculated coordinates of the target lesion relative to the needle guide in the DynaCAD software. (**C, D**) T2 axial and sagittal images showing the needle tip position (*double arrows*) within the target lesion.

was 0.94 (17/18; 95% confidence interval [CI]: 0.71–0.99) and 0.83 (15/18; 95% CI, 0.58–0.96), respectively, with the relative sensitivity of MR in-bore biopsy being 0.88. The sensitivity of TRUS-guided systematic biopsy and MR in-bore biopsy for detection of csPCa was 0.9 (9/10; 95% CI: 0.54–0.99) and 1.0 (10/10; 95% CI: 0.66–1.0), respectively, with the relative sensitivity of MR in-bore biopsy being 1.1. The sensitivity of TRUS-guided systematic biopsy and MR in-bore biopsy for detection of insignificant prostate cancer was 0.89 (8/9; 95% CI: 0.51–0.99) and 0.56 (5/9; 95% CI: 0.23–0.85), respectively, with the relative sensitivity of MR in-bore biopsy being 0.63. In other words, MR in-bore biopsy successfully did not detect insignificant cancer in 44% of cases, whereas TRUS-guided systematic biopsy did not detect insignificant cancer in only 11% of cases.

The results are summarized in ►**Table 4**.

None of the patients in study arm A suffered from any major complication that required hospitalization or surgical intervention, such as major bleeding or sepsis.

Table 2 Patient characteristics in study arms A and B

	Study arm A ($n = 30$)	Study arm B ($n = 30$)
Age (y), mean (SD)	62.3 (6.5)	66.1 (7)
PSA (ng/mL), mean (SD)	12.9 (8.3)	11.4 (9.7)
Prostate volume (mL), mean (SD)	49.6 (21.4)	37.8 (20.5)
PSA density (ng/mL^2), mean (SD)	0.56 (0.52)	0.49 (0.43)

Abbreviation: PSA, prostate-specific antigen; SD, standard deviation.

Comparison between Study Arm A (MR In-Bore Biopsy + TRUS-Guided Systematic Biopsy) and Study Arm B (TRUS-Guided Systematic Biopsy Alone)

The combined MR in-bore and TRUS-guided systematic biopsy approach (study arm A) detected 18 patients with prostate cancers, of which 10 were clinically significant and 8 were insignificant cancers. TRUS-guided systematic biopsy alone approach (study arm B) detected 12 prostate cancers, of which 8 were clinically significant and 4 were insignificant cancers.

Table 3 A 3 × 3 contingency table for prostate cancer detected by MRI in-bore biopsy (index test) and TRUS-guided systematic biopsy (current standard) indicating concordance and discordance of test results in patients who underwent both biopsies (study arm A)

	TRUS-guided systematic biopsy ($n = 30$)			
MR in-bore biopsy ($n = 30$)		No cancer	Clinically insignificant cancer	Clinically significant cancer
	No cancer	12	3	0
	Clinically insignificant cancer	1	4	0
	Clinically significant cancer	0	1	9

Abbreviation: MRI, magnetic resonance imaging; TRUS, transrectal ultrasound.
For analysis, a positive reference standard was redefined as cancer detected on either test.

Table 4 Comparison between TRUS-guided systematic 12-core biopsy and MR in-bore targeted biopsy cores in patients who underwent both biopsies (study arm A)

	Systematic 12-core TRUS biopsy ($n = 30$)	MR in-bore targeted biopsy ($n = 30$)	Difference; 95% CI	*p*-value
Diagnostic yield for prostate cancer (PCa) detection	56.7% (17/30)	50% (15/30)	6.7%; −18.5 to 31.9%	0.6
Diagnostic yield for csPCa detection	30% (9/30)	33.3% (10/30)	−3.3%; −26.9 to 20.2%	0.78
Diagnostic yield for detection of insignificant PCa	26.7% (8/30)	16.6% (5/30)	10%; −10.7 to 30.7%	0.35
Positive biopsy cores in %	31.1% (112/360)	50% (15/30)	−18.9%; −37.4 to −0.4%	0.03
Mean positive biopsy cores per patient with PCa (no. of positive cores/total no. of cores in patients with PCa)	55% (112/204)	100% (15/15)	−45%; −54.8 to −35.2%	<0.001
Biopsy cores needed to detect 1 PCa	21 (360/17)	2 (30/15)	–	–
Biopsy cores needed to detect 1 significant PCa	40 (360/9)	3 (30/10)	–	–

Abbreviations: CI, confidence interval; csPCa, clinically significant prostate cancers; MR, magnetic resonance; SD, standard deviation; TRUS, transrectal ultrasound.

Table 5 Comparison between study arm A (MR in-bore biopsy + systematic TRUS biopsy) and study arm B (systematic TRUS biopsy only)

	Systematic TRUS biopsy (study arm B), $n = 30$	MR in-bore biopsy + systematic TRUS biopsy (study arm A), $n = 30$	Difference; 95% CI	*p*-value
Diagnostic yield for prostate cancer (PCa) detection	40% (12/30)	60% (18/30)	−20%; −44.8 to 4.8%	0.121
Diagnostic yield for csPCa detection	26.7% (8/30)	33.3% (10/30)	−6.7%; −29.8 to 16.5%	0.57
Diagnostic yield for detection of insignificant PCa	13.3% (4/30)	26.7% (8/30)	−13.3%; −33.3 to 6.6%	0.20
Positive biopsy cores in %	18.3% (66/360)	32.6% (127/390)	−14.2%; −20.4 to −8.1%	<0.001
Mean positive biopsy cores per patient with PCa (no. of positive cores/total number of cores in patients with PCa)	46% (66/144)	54% (137/234)	−8%; −21.8 to 5.8%	0.26
Biopsy cores needed to detect 1 PCa	30 (360/12)	22 (390/18)	–	–
Biopsy cores needed to detect 1 significant PCa	45 (360/8)	39 (390/10)	–	–

Abbreviations: CI, confidence interval; csPCa, clinically significant prostate cancers; MR, magnetic resonance; SD, standard deviation; TRUS, transrectal ultrasound.

The overall diagnostic yield of 12-core TRUS-guided systematic biopsy (study arm B) and combined MR in-bore biopsy with TRUS-guided systematic biopsy (study arm A) for prostate cancer detection was 40% (12/30) and 60% (18/30), respectively ($p = 0.12$). The overall diagnostic yield of 12-core TRUS-guided systematic biopsy (study arm B) and combined MR in-bore biopsy with TRUS-guided systematic biopsy (study arm A) for csPCa detection was 26.7% (8/30) and 33.3% (10/30), respectively ($p = 0.57$).

In our study, around 42 needle cores (720 (total number of TRUS-guided biopsy cores – 12×60)/17 (number of patients with csPCa detected on TRUS guided biopsy)) were necessary for TRUS-guided systematic biopsy to detect 1 csPCa, which MR in-bore biopsy was able to detect in only 3 cores (30/10).

The results are summarized in ►**Table 5**.

None of the patients in study arm B suffered from any major complications.

Discussion

Histologically, prostate cancers can be classified broadly into clinically insignificant and csPCa based on the Gleason score. Clinically insignificant prostate cancer is a low-grade (Gleason score of $\leq$6), small-volume, and organ-confined PCa that is not likely to progress to clinical or biologic significance without treatment, detection of which is considered an overdiagnosis.[14,15] The repeat TRUS-guided systematic biopsies during the active surveillance or overtreatment of these clinically insignificant PCa may itself increase the cost and morbidity and reduce the quality of life. The TRUS-guided systematic 12-core biopsies have been associated with various complications such as genitourinary tract infection, rectal bleeding, and acute urinary retention.[16] MRI-guided biopsy has been shown to have a decreased rate of pain, lower urinary tract symptoms, and serious infections.[17] In our study, we compared MR in-bore biopsy with TRUS-guided systematic 12-core biopsy, for the detection of csPCa requiring treatment, detection of insignificant cancers leading to overdiagnosis and overtreatment, and number of biopsy cores required per patient diagnosed with prostate cancer.

In our study, in study arm A, the MR in-bore biopsy had a relative sensitivity of 1.1 for the detection of csPCa, which means MR-targeted biopsy had a 10% better detection rate of csPCa compared with TRUS-guided systematic biopsy. Also, we found that the relative sensitivity of MR in-bore biopsy for detection of insignificant cancer was 0.63, which means MR-targeted biopsy performed ($1/0.63 = 1.6$) one and half times better than systematic biopsy in avoiding detection of insignificant cancer. The difference of diagnostic yield between MR in-bore biopsy and TRUS-guided systematic biopsy for cancer detection was statistically significant when compared according to the positive core percentage ($p = 0.03$). We found that TRUS-guided systematic biopsy cores overdetected three clinically insignificant cancers, which were not detected by MR in-bore biopsy cores. Also, one patient got upgraded from insignificant cancer into clinically significant cancer due to the MR in-bore biopsy core. Thus, MR-targeted biopsy detected more clinically significant cancers and overlooked insignificant cancers with a fewer number of biopsy cores as compared with the TRUS-guided systematic biopsy. These findings corroborate the results of the trials that evaluated the MR-targeted biopsies such as the PRECISION and PROMIS trials.[9,10] Similar to our study, the systematic analyses by Schoots et al[11] and Wegelin et al[18] that reviewed 16 and 43 studies on MR-targeted biopsy, respectively, revealed that MR-targeted biopsy had a similar overall detection rate of cancers compared with systematic biopsy with higher detection of csPCa and fewer detection of insignificant cancers. However, in comparison with these studies, MR in-bore biopsy had higher sensitivity of one in our study, probably due to smaller sample size of our study, inclusion of PI-RADS score 4 and 5 lesions, which have higher sensitivity for csPCa, and absence of comparison with histopathological standard of prostatectomy specimen.

We also made a comparison between combined MR in-bore and systematic TRUS biopsy approach (study arm A) with systematic TRUS biopsy only approach (study arm B). The combined biopsy approach had greater overall and significant prostate cancer detection rate compared with systematic TRUS biopsy only approach. However, there was also an increased detection of insignificant cancers in the combined approach compared with the systematic biopsy only approach (26.7 vs. 13.3%). Higher detection of insignificant cancers in study arm A (where patient underwent both MR in-bore and TRUS-guided biopsy) may be due to higher detection of insignificant cancer by TRUS-guided biopsy in study arm A. Therefore, MR-targeted biopsy only approach replacing the systematic biopsy would be preferred to combat this problem. There may be a concern about the significant cancers that might be missed by the MR-targeted biopsy but detected by the 12-core systematic biopsy. Prior studies have shown that the percentage of csPCa cases that were missed by MR-targeted biopsy but detected by systematic biopsy is significantly low, between 0 and 10%.[19,20] In our study also, none of the csPCa cases detected by the systematic biopsy cores were missed by the MR-targeted biopsy cores. The number of biopsy cores needed to detect one significant PCa for MR in-bore biopsy was much lesser when compared with TRUS-guided systematic biopsy (3 vs. 42), thus highlighting the drastic decrease in the number of needle cores in cancer detection and its associated complications. A recent study conducted by van der Leest et al showed an 89% reduction in the number of needle cores when MR-targeted biopsy was used to detect prostate cancer compared with TRUS-guided biopsy.[21] We also found that MR-targeted biopsy had a significantly greater mean positive biopsy cores per patient with prostate cancer compared with systematic TRUS-guided biopsy. Arsov et al found a 26% increase in the mean positive biopsy cores per patient with prostate cancer in the MR-targeted biopsy cores compared with systematic TRUS-guided biopsy.[22]

Although MR in-bore biopsy is initially more expensive, these extra costs are compensated for by the fewer detection of clinically insignificant cancers by avoiding the subsequent repeat TRUS-guided systematic biopsies and the treatment of its complications. The patient's "quality-adjusted life

years" (QALY) is thus improved by preventing unnecessary management of insignificant tumors and avoiding the delay in the diagnosis of significant tumors.[23,24] MR-TRUS fusion biopsy enables the co-registration of previously acquired MRI with real-time ultrasound to target the lesion. This technique combines the advantages of each procedure in a single technique while decreasing sampling errors, which is a major problem in TRUS-guided biopsy. The advantages of MR in-bore biopsy can also be applicable to that of MR-TRUS fusion biopsy as previous studies have shown that there is no significant difference in the detection rates of csPCa between these two techniques.[25,26]

Our study had a few limitations. The sample size is relatively small, and validation with further studies is necessary before universal application of the same. Sixty patients were alternatively assigned to study arms A and B with 30 patients in each group. We believe that blinded alternate patient assignment between the groups may not necessarily guarantee proper matching between the groups. Widespread use of MR in-bore biopsy may be limited due to high cost of MR in-bore biopsy, and its software, and longer time required for MR in-bore biopsy (~30 minutes to an hour). A surgical histopathologic correlation was not performed as a reference standard since some of these patients had a concurrent extra-prostatic extension or metastatic disease and thus did not undergo a radical prostatectomy. Hence, clinically significant cancer was defined only based on the Gleason score and not on risk classification systems such as National Comprehensive Cancer Network (NCCN) or D'Amico risk groups. Second, in study arm A, there is a possibility that MR in-bore biopsy's needle track could have biased the operator who performed the systematic TRUS-guided biopsy. However, the postbiopsy hemorrhage would partly negate this effect. This study has been reported and discussed based on the State, Thoroughly, Analyze, Report, Translate (START) guidelines that were recommended by an international working group for the studies evaluating MR-targeted biopsy.[27]

Conclusion

In conclusion, MRI in-bore targeted biopsy of the lesion with PI-RADS score of 4 or 5 had a greater sensitivity for detecting csPCa, with fewer number of biopsy cores and lesser sensitivity to detect insignificant cancers compared with TRUS-guided systematic biopsy. In contrast, TRUS-guided systematic 12-core biopsy had a greater overall prostate cancer detection rate associated with the overdetection of clinically insignificant cancers. Thus, routine use of MR in-bore biopsy over TRUS-guided systematic 12-core biopsy protocol could avoid overdetection of clinically insignificant cancers with fewer biopsy-related complications. However, this approach requires validation in further studies.

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None.

Conflict of Interest
None declared.

References

1 World Cancer Research Fund. Prostate cancer statistics. 2019. Accessed November 11, 2024 at: https://www.wcrf.org/dietandcancer/cancer-trends/prostate-cancer-statistics
2 Siegel RL, Miller KD, Jemal A. Cancer statistics, 2020. CA Cancer J Clin 2020;70(01):7–30
3 Lane BR, Zippe CD, Abouassaly R, Schoenfield L, Magi-Galluzzi C, Jones JS. Saturation technique does not decrease cancer detection during followup after initial prostate biopsy. J Urol 2008;179(05): 1746–1750, discussion 1750
4 Jones JS. Saturation biopsy for detecting and characterizing prostate cancer. BJU Int 2007;99(06):1340–1344
5 Dickinson L, Ahmed HU, Allen C, et al. Magnetic resonance imaging for the detection, localisation, and characterisation of prostate cancer: recommendations from a European consensus meeting. Eur Urol 2011;59(04):477–494
6 Delongchamps NB, Rouanne M, Flam T, et al. Multiparametric magnetic resonance imaging for the detection and localization of prostate cancer: combination of T2-weighted, dynamic contrast-enhanced and diffusion-weighted imaging. BJU Int 2011;107(09): 1411–1418
7 Rosenkrantz AB, Deng F-M, Kim S, et al. Prostate cancer: multiparametric MRI for index lesion localization: a multiple-reader study. AJR Am J Roentgenol 2012;199(04):830–837
8 Rosenkrantz AB, Verma S, Choyke P, et al. Prostate magnetic resonance imaging and magnetic resonance imaging targeted biopsy in patients with a prior negative biopsy: a consensus statement by AUA and SAR. J Urol 2016;196(06):1613–1618
9 Ahmed HU, El-Shater Bosaily A, Brown LC, et al; PROMIS study group. Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study. Lancet 2017;389(10071):815–822
10 Kasivisvanathan V, Rannikko AS, Borghi M, et al; PRECISION Study Group Collaborators. MRI-targeted or standard biopsy for prostate-cancer diagnosis. N Engl J Med 2018;378(19):1767–1777
11 Schoots IG, Roobol MJ, Nieboer D, Bangma CH, Steyerberg EW, Hunink MGM. Magnetic resonance imaging-targeted biopsy may enhance the diagnostic accuracy of significant prostate cancer detection compared to standard transrectal ultrasound-guided biopsy: a systematic review and meta-analysis. Eur Urol 2015;68 (03):438–450
12 Verma S, Choyke PL, Eberhardt SC, et al. The current state of MR imaging-targeted biopsy techniques for detection of prostate cancer. Radiology 2017;285(02):343–356
13 Das CJ, Razik A, Netaji A, Verma S. Prostate MRI-TRUS fusion biopsy: a review of the state of the art procedure. Abdom Radiol (NY) 2020;45(07):2176–2183
14 Etzioni R, Penson DF, Legler JM, et al. Overdiagnosis due to prostate-specific antigen screening: lessons from U.S. prostate cancer incidence trends. J Natl Cancer Inst 2002;94(13):981–990
15 Ploussard G, Epstein JI, Montironi R, et al. The contemporary concept of significant versus insignificant prostate cancer. Eur Urol 2011;60(02):291–303
16 Efesoy O, Bozlu M, Çayan S, Akbay E. Complications of transrectal ultrasound-guided 12-core prostate biopsy: a single center experience with 2049 patients. Turk J Urol 2013;39(01):6–11
17 Borghesi M, Ahmed H, Nam R, et al. Complications after systematic, random, and image-guided prostate biopsy. Eur Urol 2017;71 (03):353–365
18 Wegelin O, van Melick HHE, Hooft L, et al. Comparing three different techniques for magnetic resonance imaging-targeted prostate biopsies: a systematic review of in-bore versus magnetic resonance imaging-transrectal ultrasound fusion versus cognitive registration. is there a preferred technique? Eur Urol 2017;71 (04):517–531
19 Siddiqui MM, Rais-Bahrami S, Turkbey B, et al. Comparison of MR/ultrasound fusion-guided biopsy with ultrasound-guided

biopsy for the diagnosis of prostate cancer. JAMA 2015;313(04): 390–397
20 Wysock JS, Rosenkrantz AB, Huang WC, et al. A prospective, blinded comparison of magnetic resonance (MR) imaging-ultrasound fusion and visual estimation in the performance of MR-targeted prostate biopsy: the PROFUS trial. Eur Urol 2014;66(02): 343–351
21 van der Leest M, Cornel E, Israël B, et al. Head-to-head comparison of transrectal ultrasound-guided prostate biopsy versus multiparametric prostate resonance imaging with subsequent magnetic resonance-guided biopsy in biopsy-naïve men with elevated prostate-specific antigen: a large prospective multicenter clinical study. Eur Urol 2019;75(04):570–578
22 Arsov C, Rabenalt R, Blondin D, et al. Prospective randomized trial comparing magnetic resonance imaging (MRI)-guided in-bore biopsy to MRI-ultrasound fusion and transrectal ultrasound-guided prostate biopsy in patients with prior negative biopsies. Eur Urol 2015;68(04):713–720
23 de Rooij M, Crienen S, Witjes JA, Barentsz JO, Rovers MM, Grutters JPC. Cost-effectiveness of magnetic resonance (MR) imaging and MR-guided targeted biopsy versus systematic transrectal ultrasound-guided biopsy in diagnosing prostate cancer: a modelling study from a health care perspective. Eur Urol 2014;66(03): 430–436
24 Faria R, Soares MO, Spackman E, et al. Optimising the diagnosis of prostate cancer in the era of multiparametric magnetic resonance imaging: a cost-effectiveness analysis based on the Prostate MR Imaging Study (PROMIS). Eur Urol 2018;73(01):23–30
25 Venderink W, van der Leest M, van Luijtelaar A, et al. Retrospective comparison of direct in-bore magnetic resonance imaging (MRI)-guided biopsy and fusion-guided biopsy in patients with MRI lesions which are likely or highly likely to be clinically significant prostate cancer. World J Urol 2017;35(12):1849–1855
26 Wegelin O, Exterkate L, van der Leest M, et al. The FUTURE trial: a multicenter randomised controlled trial on target biopsy techniques based on magnetic resonance imaging in the diagnosis of prostate cancer in patients with prior negative biopsies. Eur Urol 2019;75(04):582–590
27 Moore CM, Kasivisvanathan V, Eggener S, et al; START Consortium. Standards of reporting for MRI-targeted biopsy studies (START) of the prostate: recommendations from an International Working Group. Eur Urol 2013;64(04):544–552

