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Implications of mpMRI Guided Targeted Biopsy for Diagnosis of Prostate Cancer: Experience in a Military Hospital of Bangladesh

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Abstract

Background: Targeted prostate biopsy (TGBx) has become widely adopted technique, driven by advances in multiparametric magnetic resonance imaging (mpMRI). Unlike systematic biopsy (SBx), which samples the prostate in a uniform, non-specific manner, TGBx directs biopsy cores to suspicious lesions identified on mpMRI, potentially enhancing detection of clinically significant disease. Several studies have reported superior diagnostic yield with TGBx compared to SBx. Against this backdrop this study has been designed to evaluate and compare the prostate cancer detection rates of SBx and TGBx in biopsy-naive men in Bangladesh.

Methods: A cross-sectional study was conducted in the Department of Urology, CMH Dhaka, from July 2022 to June 2023. Total 178 men have been enrolled aging 41–80 years with serum PSA >4 ng/ml and/or abnormal digital rectal examination findings, and with a Prostate Imaging Reporting and Data System (PI-RADS) score ≥3.

Results: Out of 178 study population, the overall cancer detection rate (CDR) was 53.4% (95/178). Both total and clinically significant (CS) prostate cancer detection rates were higher in patients who underwent mpMRI compared with those who did not. The CDR was higher in the targeted group than in the systematic group (55.81% vs. 48.15% respectively, p > 0.05). Again, targeted biopsy was superior than systematic biopsy in the detection rate of CS PCa patients, though the difference was not statistically significant (48.8% vs. 40.7%, respectively, p = 0.732). The clinically insignificant (CI) PCa detection rate was almost similar between the two groups (6.98% vs. 7.41%, p > 0.05).

Conclusion: Pre-biopsy mpMRI with targeted sampling improves prostate cancer detection compared with systematic biopsy and may contribute better diagnostic accuracy in our country.

Keywords: Prostate cancer, PSA, mpMRI, Systematic biopsy, Targeted biopsy.

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Introduction:

Prostate cancer (PCa) has been the most common non-cutaneous malignancy in men since 1984. From a medical standpoint, PCa carries a high incidence rate among the current male population, with a lifetime risk of about 12.9%. The data shows a low case-fatality rate, where only 1 in 40 men will experience a fatal outcome. This highlights the effectiveness of early detection and intervention in managing this malignancy.[1]

Since the introduction of PSA screening in the beginning of the 80's, a marked increase in incidence has been observed. Fortunately, this trend has been counterbalanced by a reduction in mortality since the 1990s, owing to earlier detection and improved curative treatments. Despite this progress, mortality attributed to PCa is projected to rise in the coming decades, indicating an increasing burden on healthcare systems.[2]

At present, the definitive diagnosis of prostate cancer relies on histopathological evaluation of prostate biopsy specimens. For decades, transrectal ultrasound (TRUS)-guided biopsy has been regarded as the gold standard

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for detecting prostate adenocarcinoma. The conventional approach involves a random systematic 12-core biopsy (SBx), aimed at sampling the entire prostate gland. With advancement in imaging, three primary approaches to MRI-targeted biopsy (TGBx) have been developed: cognitive registration, MRI/TRUS fusion-guided biopsy, and in-bore MRI biopsy. Cognitive registration, also called visual registration, involves performing a prebiopsy multiparametric MRI (mpMRI) to localize suspicious lesions, followed by TRUS-guided biopsy targeting the estimated lesion area. MRI/TRUS fusion biopsy utilizes software assistance to combine MRI and ultrasound images, though this technology is not yet widely available. The in bore MRI-guided biopsy, while precise, has not been widely adopted due to procedural complexity.[3]

TGBx has gained popularity in recent years with technological advancements. Although the procedure is more complex than SBx, numerous studies have demonstrated its effectiveness. Unlike systematic biopsy, TGBx allows targeted sampling of lesions identified on mpMRI, potentially improving detection of clinically significant (CS) cancers.[4]

Evidence suggests that MRI-targeted biopsies enhance the detection rates of clinically significant, high-grade prostate cancers compared with systematic biopsy (SBx). Nevertheless, debate persists regarding whether MRI-targeted biopsy should replace or complement SBx.[5]

Prostate biopsy is the definitive investigation to diagnose PCa. The ideal procedure would be one that offers fast and efficient result safely as an outpatient procedure.

Historically, prostate biopsy was performed transperineally. The introduction of TRUS in the 1980s significantly changed biopsy practices, with the sextant method described by Hodge et al.- sampling six systematic cores from each lobe, becoming the standard. This approach was later compared with targeted TRUS biopsy of palpable or ultrasound-visible abnormalities. Although the 6-core method improved cancer detection rate, it had limitations, particularly in sampling the anterior and apical regions of the prostate. Joseph Presti et al. subsequently advocated a 10-core systematic TRUS biopsy, including lateral and peripheral zone cores, which increased cancer detection rates by 20–35%.[6]

Despite the wealth of research on SBx versus TGBx, most studies have been conducted in international settings, with limited data from Bangladesh. To address this gap, a systematic review of existing studies was undertaken, comparing SBx and TGBx in assessing cancer detection rates (CDR) in biopsy-naïve men.

In this study, TGBx was performed for lesions with a Prostate Imaging Reporting and Data System (PI-RADS) score ≥3. The study population was divided into two groups: one underwent standard SBx (12 cores), while the other underwent mpMRI-guided TGBx. CDRs were meticulously evaluated to provide insight into the optimal prostate biopsy approach. This study aims to generate evidence that can inform the development of a practical protocol for integrating mpMRI into urological practice in Bangladesh, while improving detection of clinically significant prostate cancer.

Materials & Methods:

A cross-sectional study was conducted from July 2022 to June 2023 at Combined Military Hospital (CMH), Dhaka to compare the cancer detection rates (CDR) of systematic biopsy and multiparametric MRI (mpMRI) targeted prostate biopsy. The study protocol was approved by the Ethical Committee of the Armed Forces Medical Institute.

This hospital-based single center, observational study involved all the patients who were at risk of having PCa. This study enrolled male patients only aged between 41 and 80 years, presenting to the Urology Outpatient Department or admitted to the Urology Ward at CMH Dhaka. Cases were considered for inclusion if they presented with lower urinary tract symptoms (LUTS) and suspicious findings on a Digital Rectal Examination (DRE) or an elevated serum Prostate-Specific Antigen (PSA) level (>4ng/ml). The patients who underwent prior prostate biopsy/surgery or was suffering from acute prostatitis, active urinary tract infection (UTI) or any painful anorectal pathology, were not enrolled. Again, patients who had any major psychiatric illness/dementia, significant coagulopathy/ recent myocardial infarction, severe immunosuppression or any contraindication for MRI, were excluded from this study. Informed verbal and written consent was obtained from every respondent prior to start this research work.

Total 194 patients reported to outpatient department (OPD) or admitted in ward, were found suitable for our

study. Amongst them, who had high serum PSA and hard/suspicious prostate on DRE were selected for SBX. An mpMRI score of 3 or greater designated a suspicious scan for the purpose of our primary outcomes. A total of 55 patients performed mpMRI and 11 of them had PI-RADS score ≤2 and subsequently excluded from the study. One patient with PI-RADS score 3, went abroad to perform biopsy and therefore, not included in the research.

In this study, the whole population was divided into two groups. First group underwent SBX (12-14 cores), whereas mpMRI TGBX was performed for the second group. But for the second group, practically we obtained 2-5 cores per mpMRI targeted lesion (depending on the level of suspicion and lesion's size) at first and followed by standard 12 cores to avoid repeated biopsy for the same patient at different set up as per European Association of Urologists (EAU) recommendation.[7,8] For the study purpose, only targeted cores were considered to get CDR from second group. Fulfilling both the inclusion and exclusion criteria, total 178 patients were enrolled for the study finally.

In this clinical study, data were collected in a predesigned data collection sheet and, tabulated, interpreted and subsequently analyzed by using computer-based program IBM SPSS V23 (Statistical Package for Social Sciences, Version 23.0). Statistical significance was assessed by Analysis of Variance (ANOVA) and non-parametric X^2 or Chi squared test and correlation analysis. For all analytical tests, the level of significance was set at 5% and $p < 0.05$ was considered statistically significant. The findings of the results and summarized data were presented in the form tables and charts. All results were compared with internationally published data of same and different modalities of procedures used worldwide.

Results:

1. Socio-demographic characteristics

Table 1 illustrates the demographic characteristics of the respondents. Total sample size was n=178. All the patients in this study were males (100%). Here, minimum recorded age was 43, whereas maximum age was 79 and mean age was 66.17±7.79. Again, maximum 76 (42.7%) respondents were in the age group of 61-70 years followed by 56 (31%) cases were in the age range of 71-80 years. Maximum 170 (95.5%) respondents were muslim and rest were hindu. Only 3 (1.7%) of the respondents were underweight, 119 (66.9%) patients that is, maximum cases were within the normal group, 45 (25.3%) were overweight and rest of the 11 (6.2%) patients were obese.

Table-I

Socio-demographic characteristics

Variables	Frequency	Percent
Age		
41-50	4	2.2
51-60	42	23.6
61-70	76	42.7
71-80	56	31.5
Mean±SD:66.17±7.79(43-79)		
Religion		
Islam	170	95.5
Hindusim	8	4.5
Body Mass Index (BMI)		
Underweight	3	1.7
Normal	119	66.9
Overweight	45	25.3
Obese	11	6.2

Results are expressed as frequency, percent and mean±SD. SD=Standard Deviation.

2. Overall cancer detection rate (CDR)

The following chart shows that out of 178 study population, malignancy was detected in 95 (53.4%) cases. For rest of the 83 (46.6%) cases, benign hyperplasia/prostatitis was found in histopathology report.

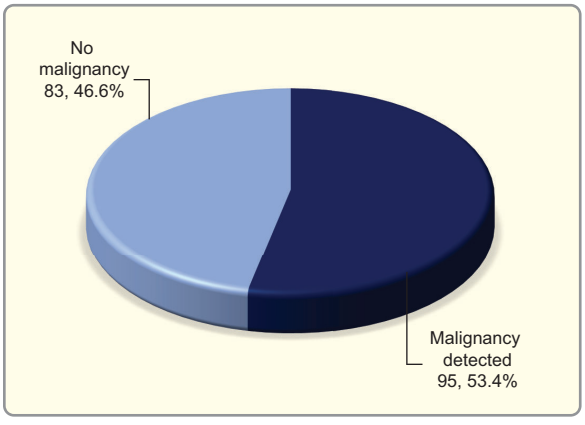

Figure 1: *Pie chart showing overall CDR.*

3. Comparative cancer detection rate (CDR)

Here, table 3 shows that CDR was little higher in the targeted group than in the systematic group (55.81% vs. 48.15% respectively, $p > 0.05$). In case of SBX group, 65/135 (48.15%) cases were diagnosed as adenocarcinoma. Whereas, in 24/43 (55.81%) cases, malignancy was detected by TGBX.

Table-III

Comparative CDR between SBX and TGBX group

Biopsy procedure	HPR		Total
	Positive Malignancy detected	Negative No malignancy	
SBX	65	70	135
	48.15%	51.85%	100.0%
TGBX	24	19	43
	55.81%	44.19%	100.0%

χ^2=0.77, df=1, p=0.3812

Results are expressed as positive and negative. χ^2= Chi-Square test, df=Degrees of Freedom, P=Probability.

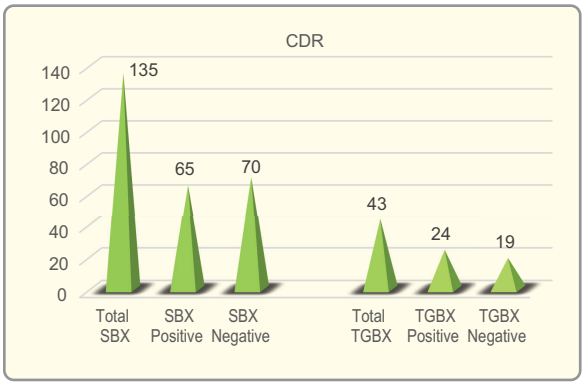

Figure 2: *Bar diagram showing biopsy results by both SBX and TGBX.*

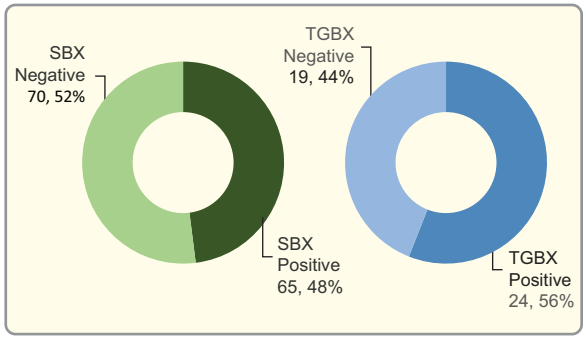

Figure 3: *Pie diagrams showing CDR by SBX and TGBX respectively.*

4. Comparative detection rate of CS PCa

The detection rate of clinically significant prostate cancer (CS PCa) was higher in the MRI-targeted biopsy (TGBX) group compared with the systematic biopsy (SBX) group; however, this difference was not statistically significant (21/43, 48.8% vs. 55/135, 40.7%, respectively; x^2 =0.1169,df=1, p = 0.732). The CI PCa detection rate was almost similar between the two groups (3/43, 6.98% vs. 10/135, 7.41%; $p > 0.05$).

5. Core wise comparison of SBX and TGBX

Table V summarizes the outcomes of the systematic and targeted cores in each group. The analysis of the cores in current study revealed that out of 2161 SBX cores, 626 cores were positive for malignancy (29%), whereas 56/168 (33%) cores were found involved by cancer cells in case of TGBX. The rate of cancer-positive cores was higher in targeted biopsies than in systematic biopsies (33% vs. 29% respectively, $p > 0.05$).

Table-IV

Detection rate of CS PCa in SBX and TGBX group

Biopsy procedure	Outcome			Total
	CS PCa	CI PCa	No PCa	
SBX	55	10	70	135
	40.74%	7.41%	51.85	100.0%
TGBX	21	3	19	43
	48.84%	6.98%	44.18%	100.0%

X^2=0.1169, df=1, p=0.732

Results are expressed as outcome. χ^2= Chi-Square test, df=Degrees of Freedom, P=Probability.

Table-V

Core wise comparison of SBX and TGBX

	No. of biopsy cores by SBX	No. of involved cores by SBX	No. of biopsy cores by TGBX	No. of involved cores by TGBX	P value
Frequency	178	95	43	24	p = 0.231
Total cores	2161	626.00 (29.0%)	168	56.00 (33.0%)	

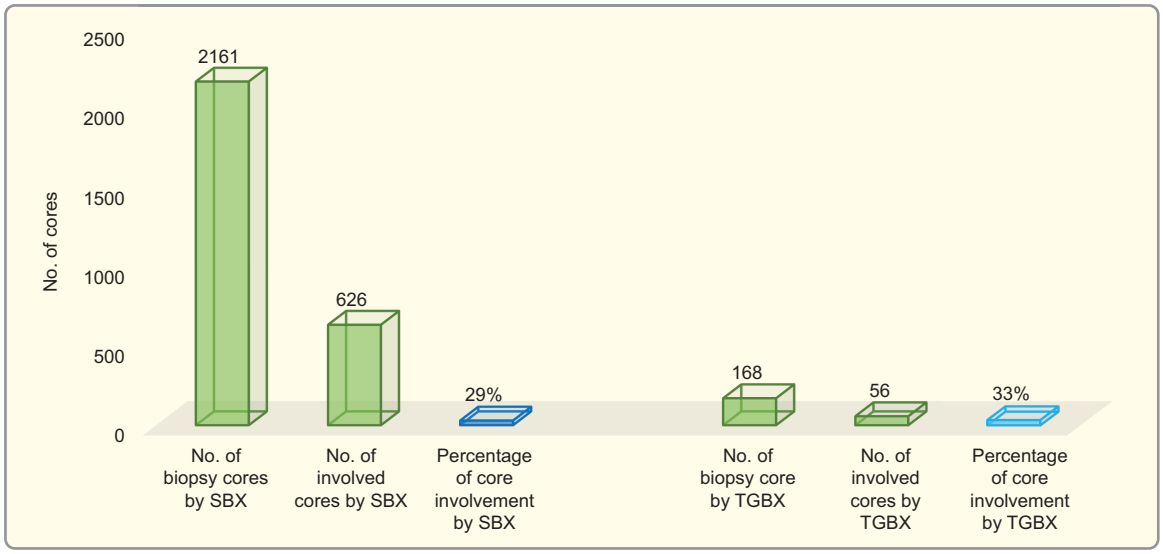

Figure 4: *Bar diagram shows outcome of systematic and targeted biopsy cores.*

Discussion:

In this study, 194 patients presented to the OPD or were admitted to the ward and were initially considered suitable. Among them, patients with elevated serum PSA and a hard or suspicious prostate on DRE were selected for systematic biopsy (SBx). At our institution, mpMRI of the prostate is recommended primarily for patients with PSA levels between 4 and 10 ng/ml who have normal DRE findings of the 55 patients who underwent mpMRI, 11 had PI-RADS scores ≤2, indicating a low likelihood of prostate cancer; these patients were not offered biopsy and were excluded. One patient with a PI-RADS score of 3 opted for biopsy abroad and was therefore excluded, while another patient aged above 80 with recent myocardial infarction and multiple comorbidities was also excluded. Three additional patients, despite fulfilling all inclusion criteria, did not consent to participate. Ultimately, 178 patients met all inclusion and exclusion criteria and were enrolled. Notably, using mpMRI for triage allowed 20% (11 out of 55) of patients to avoid primary biopsy, potentially reducing over-diagnosis of clinically insignificant disease. This is consistent with Ahmed et al. (2017), who reported that 27% of patients could safely avoid biopsy, with a 5% reduction in CI PCa diagnoses.[8] Biopsy procedures were performed in a separate session.

Of the 178 enrolled patients, 135 (75.8%) underwent SBx, while 43 (24.2%) experienced targeted biopsy (TGBx). Stratification by biopsy approach revealed meaningful differences. The majority of participants, 76 (42.7%), were aged 61–70 years, with a mean age of 66.17±7.79 years. Most participants were Muslim (170, 95.5%) (Table-1).

Patients who underwent prebiopsy mpMRI demonstrated higher detection rates for both total and clinically significant (CS) PCa. The CDR was slightly higher in the TGBx group compared with SBx (55.81% vs. 48.15%, p = 0.3812; Table 3), though this difference

was not statistically significant. Similarly, the detection of CS PCa was higher in the TGBx group (48.8% vs. 40.7%, p = 0.732). Detection rates of clinically insignificant prostate cancer were almost similar between the groups (6.98% vs. 7.41%, p > 0.05; Table 4). These findings align with prior studies. Huang et al. (2022) observed minimal statistical difference in overall PCa detection between SBx and TGBx (44.41% vs. 45.6%, P>0.05), while CS PCa detection was slightly higher in the TGBx group (40.83% vs. 38.15%, P=0.033).[9] Lee et al. (2022) evaluated 398 men, reporting overall PCa detection of 54% and CS PCa detection of 42%. CS PCa detection was 21% on SBx and 39% on TGBx, with combined systematic and targeted biopsy yielding CS detection rates of 13%, 35%, and 83% for PI-RADS 3, 4, and 5, respectively.[10] Kasivisvanathan et al. (2018) found that clinically significant cancer was detected in 95 men (38%) in the MRI-targeted biopsy group, as compared with 64 of 248 (26%) in the standard-biopsy group.[11] Washino et al. (2018) demonstrated significantly higher total and CS PCa detection in patients receiving prebiopsy mpMRI (55.3% and 46.0% vs. 42.0% and 35.2%, respectively; p = 0.004 and p = 0.016), with similar CI PCa detection between groups (9.3% vs. 6.8%; p = 0.32).[12] These findings indicate that mpMRI is particularly effective at detecting clinically significant prostate cancer (csPCa), with high sensitivity (ranges between 82-88%) and a strong negative predictive value, which can help reduce unnecessary biopsies.

Analysis of biopsy cores in our study showed that 626 of 2161 SBx cores (29%) and 56 of 168 TGBx cores (33%) were positive for malignancy, indicating a higher proportion of cancer-positive cores in targeted biopsies (p = 0.231) (Table-5). Kasivisvanathan et al. (2018) similarly reported 44% positive cores in MRI-targeted biopsies compared to 18% in standard biopsies.[11] Tonttila et al. reported a CDR of 57% for SBx versus 51% for mpMRI TGBx (p = 0.9).[13] Bansal et al. and Porpiglia et al. demonstrated a significantly higher cancer yield with TGBx (44.3% vs. 16.2% for SBx).[14] Thangarasu et al. (2021) evaluated cognitive targeted TRUS biopsy in 163 MRI-suspicious lesions, reporting 29.35% of SBx cores and 36.8% of mpMRI targeted cores positive for cancer (P<0.0001).[15]

Overall, these results closely mirror those reported in the literature, supporting the utility of mpMRI-guided targeted biopsy for improved detection of clinically significant prostate cancer, while also reducing unnecessary sampling of clinically insignificant disease.

Conclusion:

This study was undertaken to evaluate the CDR by comparing systematic and targeted prostate biopsies. Prebiopsy mpMRI and subsequent targeted biopsy with or without standard biopsy could yield more CS PCa than systematic biopsy alone. Moreover, fewer biopsy cores being taken could reduce the duration and decrease the risk of complications, making it a very acceptable investigation for patients. Besides, unnecessary biopsy and over-diagnosis of clinically insignificant disease can be avoided by implementing mpMRI as a triage test.

So, mpMRI may be considered as a potential diagnostic tool with growing importance for PCa evaluation in the present perspective of urological practice in our country.

Limitations of the study:

There may have been bias because of the small sample size and the data originating from a single institution. Moreover, the present study was conducted at a very short period of time of one year only. Here, non-probability sampling technique was used for this study. Samples were chosen non-randomly, especially mpMRI was advised for the TGBX group following local hospital guidelines. As mpMRI is a costly procedure, so that we could offer this investigation for selected cases only, resulting low sample size in the targeted group. Lastly, biopsies were not performed by the same clinician/ urologist, which could have affected the yielding rate and diagnostic accuracy as well.

Funding:

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Conflict of interest:

No potential conflict of interest relevant to this study was reported.

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