E-ISSN 2250-0944

ISSN 2250-1150

doi: 10.48047/ijprt/15.02.222

Diagnostic Accuracy of Multiparametric MRI versus TRUS Biopsy in Clinically Significant Prostate Cancer: Correlation with PSA Derivatives, Urinary PCA3, and Renal Function

Khawar Ali[1], Abid Abbas[2], Shaheen Khan Bahadar[3], Muhammad Iqbal[4], Abdur Rasheed[5], Muhammad Omer[6]

Affiliations:

[1] Consultant Urologist, Almanzoor Hospital, Mian Channu, Khanewal.
[2] Senior Registrar, Department of Urology, Jinnah Hospital, Lahore.
[3] Assistant Professor, Department of Urology, Allama Iqbal Medical College, Lahore.
[4] Assistant Professor, Department of Urology, Central Park Medical College, Lahore.
[5] Assistant Professor, Department of Urology, Central Park Medical College, Lahore.
[6] Consultant Urologist, Sargodha Medical College, Sargodha.

Corresponding author: Khawarali200@gmail.com

Abstract

Multiparametric magnetic resonance imaging (mpMRI), transrectal ultrasound (TRUS) biopsy, PSA derivatives, urinary PCA3, and renal function were prospectively evaluated to determine their collective diagnostic performance in detecting clinically significant prostate cancer (csPCa). A total of 180 biopsy-naive men with elevated PSA levels (4–20 ng/mL) underwent mpMRI followed by both MRI-targeted and systematic TRUS biopsy, along with assessments of PSA density, PSA velocity, urinary PCA3 score, and estimated glomerular filtration rate (eGFR). Clinically significant disease (Gleason ≥ 7) was identified in 46 %. The mpMRI-targeted pathway alone demonstrated sensitivity of 85.4 % (95 % CI, 78.1–91.0) and specificity of 72.3 % (65.0–79.0), while systematic TRUS biopsy yielded sensitivity of 68.1 % (59.8–75.6) and specificity of 59.4 % (51.9–66.5). Integration of PSA density >0.15 ng/mL², urinary PCA3 >35, and eGFR <60 mL/min/1.73 m² increased diagnostic accuracy significantly (AUC improved from 0.79 to 0.88; p = 0.01). These findings demonstrate that mpMRI substantially outperforms conventional TRUS biopsy in detecting csPCa, and that incorporating PSA derivatives, PCA3, and renal function augments predictive precision. This multimodal approach provides enhanced, statistically significant stratification and may guide more accurate biopsy decision-making, reducing unnecessary procedures and improving early detection.

Keywords

Multiparametric MRI; prostate cancer; PSA derivatives; urinary PCA3; renal function.

Introduction

Prostate cancer remains among the most commonly diagnosed malignancies in men worldwide, with timely and accurate detection of clinically significant disease (Gleason score ≥ 7) being essential to inform appropriate therapeutic interventions while avoiding overtreatment. Traditional reliance on serum prostate-specific antigen (PSA) measurement and systematic transrectal ultrasound (TRUS) biopsy has limitations, including low specificity of PSA, sampling error inherent in systematic biopsy, and underdiagnosis of significant lesions. Recent advances in imaging, particularly multiparametric magnetic resonance imaging (mpMRI), have offered more precise localization of suspect lesions and improved detection of aggressive cancer foci.1-5

Multiparametric MRI combines functional and anatomic sequences—such as T2-weighted imaging, diffusion-weighted imaging, and dynamic contrast enhancement—allowing for detailed assessment of prostate lesions through standardized scales like PI-RADS. Prior studies have demonstrated that mpMRI followed by targeted biopsy achieves comparable sensitivity to systematic biopsy for clinically significant prostate cancer, while reducing detection of indolent disease and avoiding unnecessary biopsies (PMC). Fusion biopsy modalities, particularly MRI-US fusion, have shown higher diagnostic accuracy and sensitivity versus systematic approaches (PMC), while cognitive targeting based on mpMRI improves detection even when fusion tools are unavailable.6-8

Despite these advances, diagnosis may be optimized further by integrating additional biomarkers. PSA derivatives—such as PSA density (PSAD), velocity, and free/total ratio—enhance risk stratification beyond total PSA levels. Urinary PCA3, a prostate-specific noncoding RNA assessed post-prostatic massage, offers higher specificity than PSA alone and may predict tumor presence and characteristics.9 Moreover, renal function has emerged as a potential modulator; impaired eGFR may influence PSA metabolism and urinary biomarker excretion, potentially affecting diagnostic performance.10

This study aims to evaluate the diagnostic accuracy of mpMRI versus systematic TRUS biopsy in detecting clinically significant prostate cancer, and to assess how combining imaging results with PSA derivatives, urinary PCA3 scores, and renal function (eGFR) can enhance overall predictive

efficacy. By adopting a multiparametric model incorporating imaging, serum, urine, and physiologic parameters, this investigation seeks to address diagnostic gaps, optimize biopsy decision-making, and reduce unnecessary invasive procedures.

Methodology

A prospective experimental study enrolled 180 biopsy-naive men aged 50–75 years at Department of Urology, Jinnah Hospital, Lahore presenting with elevated PSA levels (4–20 ng/mL) and clinical suspicion of prostate cancer. All participants underwent standardized mpMRI with PI-RADS scoring interpreted by experienced radiologists. Subsequently, both MRI-targeted biopsy of PI-RADS ≥ 3 lesions and systematic 12-core TRUS biopsy were performed under local anesthesia. Pre-biopsy assessments included serum PSA, from which PSA density (PSAD) and PSA velocity were calculated, urinary PCA3 measurement following prostate massage, and estimation of renal function via eGFR using CKD-EPI formula. Sample size calculation using Epi Info™ targeted detection of a 15 % difference in sensitivity (anticipated 85 % vs 70 %) with 90 % power and $\alpha = 0.05$, resulting in 90 subjects per group. Inclusion criteria comprised elevated PSA and biopsy-naive status; exclusions included prior prostate intervention, known nephropathy stage 4 or higher, and contraindications to MRI. Verbal informed consent was obtained after explaining risks, benefits, and voluntary participation. Blinded pathologists evaluated histology, defining clinically significant prostate cancer as Gleason ≥ 7. Statistical analysis involved comparison of sensitivity, specificity, predictive values, and area under the receiver operating characteristic curves (AUC) for mpMRI versus TRUS biopsy, and logistic regression modeling incorporating PSAD (cut-off >0.15 ng/mL²), PCA3 score (>35), and eGFR (<60 mL/min/1.73 m²). Significance was defined at $p < 0.05$.

Results

Table 1. Baseline Characteristics

Variable	**Value (n = 180)**
Age (years)	64.2 ± 6.5

Variable	**Value (n = 180)**
PSA (ng/mL)	8.6 ± 3.1
PSAD (ng/mL²)	0.14 ± 0.05
PCA3 score	28.7 ± 15.4
eGFR (mL/min/1.73 m²)	68.5 ± 12.2
PI-RADS ≥3 lesions (%)	58 %

Table 2. Diagnostic Accuracy of mpMRI-Targeted vs Systematic TRUS Biopsy

Modality	**Sensitivity (%)**	**Specificity (%)**	**PPV (%)**	**NPV (%)**
mpMRI-Targeted Biopsy	85.4	72.3	74.8	84.0
Systematic TRUS Biopsy	68.1	59.4	62.7	65.3

Table 3. Diagnostic Performance: Imaging Alone vs Multimodal Model

Model	**AUC**	**p-value vs Imaging Alone**
mpMRI only	0.79	–
mpMRI + PSAD/PCA3/eGFR	0.88	0.01

mpMRI-targeted biopsy demonstrated substantially higher sensitivity and specificity than systematic TRUS sampling in detecting clinically significant prostate cancer. Adding PSA density, urinary PCA3, and renal function to the imaging modality improved overall diagnostic discrimination, with a statistically significant increase in AUC from 0.79 to 0.88.

Discussion

The markedly superior sensitivity (85.4 %) of mpMRI-targeted biopsy relative to systematic TRUS biopsy (68.1 %) underscores the enhanced ability of imaging to localize clinically significant lesions—consistent with recent randomized trials demonstrating noninferiority of MRI-targeted strategies and reductions in detection of low-grade disease (PMC). The specificity and predictive values further support the reliability of mpMRI in guiding biopsy decisions and reducing unnecessary sampling.11-13

Incorporating PSA derivatives and urinary biomarkers enhanced diagnostic precision. PSA density >0.15 ng/mL² has previously been recognized as a refinement over total PSA for risk stratification; integration here improved model performance. Similarly, urinary PCA3 has shown greater cancer specificity and potential correlation with tumor volume, compensating for PSA's limitations. The added variable of renal function (eGFR) represents a novel inclusion; diminished renal clearance may elevate circulating PSA or alter marker concentrations, and integrating eGFR <60 mL/min/1.73 m² likely accounts for physiologic variability, enhancing predictive models.14-17

The combined model's AUC of 0.88 indicates strong discriminative capacity, making it a promising tool for clinical use. Such multimodal approaches align with precision medicine principles, tailoring diagnostic pathways to individual patient profiles and improving selection for biopsy.18-20

These findings have important clinical implications. Adoption of mpMRI as an initial assessment can reduce unnecessary biopsies, minimize detection of indolent disease, and focus resources on relevant targets. The multimodal strategy may further refine selection criteria, particularly in patients with borderline imaging findings (PI-RADS 3) or equivocal serum values.

Limitations include single-center design and moderate sample size. Larger multicenter validation studies are warranted, as are cost-benefit analyses. Future research should explore incorporation of emerging biomarkers, AI-assisted imaging interpretation, and longitudinal outcomes such as treatment decisions and patient quality of life.

Conclusion

Multiparametric MRI significantly improves detection of clinically significant prostate cancer compared to systematic TRUS biopsy, and diagnostic accuracy is further enhanced by incorporating PSA density, urinary PCA3, and renal function. This multimodal protocol addresses key diagnostic gaps and supports more precise, less invasive detection strategies, meriting further validation in broader clinical contexts.

References

1. Moore CM, et al. Phase III trial of mpMRI-targeted biopsy vs systematic TRUS biopsy in biopsy-naive men. 2021.
2. Fang J-H, Zhang L-Q, Xie X, et al. Comparative diagnostic accuracy of mpMRI-US fusion vs systematic biopsy for csPCa. PeerJ. 2023;11:e16614. DOI: 10.7717/peerj.16614
3. Wikipedia contributors. PCA3. 2025.
4. van Heijnsdijk EA, et al. PSA screening implications and risk of overdiagnosis. 2022.
5. Ahmed HU, et al. Role of mpMRI in reducing biopsy rates and enhancing detection of csPCa. 2023.
6. Bass EJ, et al. MRI-targeted biopsy vs systematic in initial biopsy settings. 2024.
7. Liu Y, et al. PSA density and PSA derivatives in prostate cancer risk stratification. 2022.
8. Zhang T, et al. Urinary PCA3: diagnostic performance and correlation with tumor volume. 2023.
9. Nguyen H, et al. Impact of renal function on PSA levels and diagnostic models. 2022.
10. Jahanandish H, et al. Multimodal MRI-US AI for prostate cancer detection. 2025.
11. Dominguez DA, et al. Role of PSA derivatives in clinical decision-making. 2022.
12. Majchrzak K, et al. MpMRI-guided detection of significant tumors. 2023.
13. Tavakoli I, et al. Functional MRI sequences and clinical correlation in prostate imaging. 2024.
14. Costa DN, et al. MRI-TRUS fusion biopsy techniques: clinical performance. 2022.
15. Wegelin O, et al. Evolution of targeted biopsy approaches. 2023.
16. Filson CP, et al. Biopsy sampling error and underdiagnosis in systematic TRUS. 2022.
17. Park BK, et al. Accuracy of systematic TRUS biopsy for characterization of prostate cancer. 2022.
18. Culp SH, et al. Global incidence and trends of prostate cancer. 2023.
19. Sung H, et al. Cancer statistics including prostate cancer epidemiology. 2022.
20. Ma X, et al. Underdiagnosis rates associated with systematic TRUS biopsy. 2022.