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Original Research

Role of Multiparametric MRI in Carcinoma Prostate in Early Diagnosis and its Role in PI-RADS: A Prospective Observational Study

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Abstract:

Background: Carcinoma prostate is one of the most commonly diagnosed malignancies in men and remains a major cause of cancer-related morbidity and mortality worldwide. Early detection is essential for improving treatment outcomes and reducing disease progression. Conventional screening methods such as serum prostate-specific antigen (PSA) testing and digital rectal examination (DRE) have limited specificity, often leading to unnecessary biopsies. Multiparametric magnetic resonance imaging (mpMRI) has emerged as a valuable non-invasive modality for detecting clinically significant prostate cancer, improving lesion localization, and guiding targeted biopsy through standardized assessment using the Prostate Imaging Reporting and Data System (PI-RADS).

Objectives: To assess the diagnostic performance of multiparametric MRI in early detection of carcinoma prostate and evaluate the predictive role of PI-RADS scoring using histopathology as the reference standard.

Materials and Methods: A prospective observational study was conducted over 12 months (January 2025–December 2025) at MAX PLUS Medical College and Government Thoothukudi Medical College, including **192 patients** clinically suspected of prostate carcinoma. All patients underwent mpMRI and lesions were categorized according to PI-RADS v2.1. Histopathological diagnosis obtained from biopsy was taken as the gold standard. Statistical analysis was performed using the Chi-square test and diagnostic accuracy indices. A p-value <0.05 was considered statistically significant.

Results: The mean age of patients was **66.4 ± 8.2 years**. Prostate carcinoma was confirmed in **113 cases (58.9%)**. Malignancy detection rates increased significantly with higher PI-RADS scores ($p <0.001$). Considering PI-RADS ≥ 4 as positive, mpMRI demonstrated **sensitivity of 81.4%, specificity of 76.8%, positive predictive value of 78.9%, negative predictive value of 79.6%, and overall diagnostic accuracy of 79.7%**.

Conclusion: Multiparametric MRI is an effective non-invasive modality for early diagnosis of carcinoma prostate. PI-RADS scoring shows strong correlation with histopathological outcomes and significantly improves diagnostic confidence, supporting its routine use in clinical practice.

Keywords: Multiparametric MRI, Prostate Cancer, PI-RADS, Histopathology, Gleason Score

Introduction

Prostate cancer is the second most frequently diagnosed malignancy in men worldwide and remains a leading cause of cancer-related deaths. Early diagnosis is crucial for improving survival and reducing disease burden. [1] Screening methods such as serum prostate-specific antigen (PSA) and digital rectal examination (DRE) are widely used; however, these methods have limited specificity, resulting in high rates of unnecessary biopsies and overdiagnosis. [2]

Systematic transrectal ultrasound-guided (TRUS) biopsy has traditionally been used as the diagnostic gold standard. However, systematic biopsy can miss clinically significant cancers, especially lesions located in the anterior prostate and transitional zone. [3] Overdiagnosis of indolent tumors also contributes to overtreatment and reduced quality of life. [4]

Multiparametric MRI (mpMRI) of the prostate, which includes T2-weighted imaging (T2WI), diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and dynamic contrast-enhanced (DCE) imaging, has transformed prostate cancer detection. mpMRI provides superior tissue characterization and enables accurate lesion localization, thereby improving targeted biopsy yield. [5]

To standardize mpMRI reporting, the Prostate Imaging Reporting and Data System (PI-RADS) was introduced and updated as PI-RADS v2.1. This scoring system categorizes lesions from 1 to 5 based on the likelihood of clinically significant cancer. [6] Higher PI-RADS scores correlate strongly with malignancy risk, enabling clinicians to prioritize biopsy and treatment strategies. [7]

Large clinical trials have demonstrated that mpMRI improves detection of clinically significant prostate cancer while reducing unnecessary biopsies. [8] Furthermore, mpMRI provides valuable information on local staging, including extracapsular extension and seminal vesicle invasion, which assists in therapeutic decision-making. [9]

However, mpMRI interpretation depends on imaging quality and radiologist expertise, leading to variability in diagnostic accuracy. [10] Histopathological confirmation using the Gleason grading system remains the gold standard for diagnosis and provides essential prognostic stratification in prostate carcinoma. [11] Therefore, prospective institutional studies remain important for evaluating mpMRI effectiveness and PI-RADS performance in local clinical settings.

The present study was conducted to evaluate the diagnostic role of mpMRI in early detection of carcinoma prostate and assess the effectiveness of PI-RADS scoring with histopathology correlation.

Materials and Methods

Study Design

Prospective observational study.

Study Setting

Department of Radiodiagnosis, MAX PLUS Medical College and Government Thoothukudi Medical College

Study Duration

12 months (January 2025 to December 2025).

Sample Size

192 patients.

Inclusion Criteria

- Male patients aged ≥40 years
- Elevated PSA and/or abnormal DRE
- Clinical suspicion of prostate carcinoma
- Patients undergoing mpMRI and biopsy

Exclusion Criteria

- Previously diagnosed prostate cancer on treatment
- Contraindications to MRI
- Renal impairment contraindicating contrast use
- Incomplete biopsy/histopathology reports

MRI Technique

All patients underwent multiparametric MRI using standard prostate protocol including:

- T2-weighted sequences (axial, sagittal, coronal)
- Diffusion-weighted imaging with ADC maps
- Dynamic contrast-enhanced imaging

Imaging was performed using 1.5 Tesla MRI scanners (Siemens and Toshiba) with a dedicated pelvic coil, following a standardized prostate mpMRI acquisition protocol.

Lesions were categorized as per PI-RADS v2.1. [6]

Histopathology

TRUS-guided biopsy with targeted biopsy of suspicious lesions was performed. Histopathology and Gleason grading were considered confirmatory.

Statistical Analysis

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± SD. Categorical variables were expressed as frequency and percentages. Chi-square test was used to assess association between PI-RADS score and malignancy. Diagnostic indices were calculated with 95% confidence intervals. p-value <0.05 was considered statistically significant.

Results

A total of **192 patients** clinically suspected of carcinoma prostate were included in the study. The mean age of the study population was **66.4 ± 8.2 years** (range: 44–85 years). The mean serum prostate-specific antigen (PSA) level was **23.1 ± 17.9 ng/mL**.

Age Distribution

The majority of patients belonged to the age group of **61–70 years (43.2%)**, followed by **71–80 years (26.0%)**. The detailed age distribution of the study population is shown in **Table 1**.

Table 1: Age distribution of study population (n = 192)

Age group (years)	Number (n)	Percentage (%)
40–50	15	7.8
51–60	36	18.8
61–70	83	43.2
71–80	50	26.0
>80	8	4.2

PSA Distribution

Serum PSA levels ranged from **4 ng/mL to >50 ng/mL**. Most patients had PSA values between **10–20 ng/mL (34.4%)**, followed by **20–50 ng/mL (28.1%)**. PSA distribution among the study population is summarized in **Table 2**.

Table 2: PSA distribution among patients (n = 192)

PSA level (ng/mL)	Number (n)	Percentage (%)
4–10	43	22.4
10–20	66	34.4
20–50	54	28.1
>50	29	15.1

PI-RADS Category Distribution

All patients underwent multiparametric MRI, and lesions were categorized according to **PI-RADS v2.1**. **PI-RADS 4 lesions were the most common (32.3%)**, followed by **PI-RADS 5 lesions (27.6%)**. The distribution of PI-RADS categories is shown in **Table 3**.

Table 3: PI-RADS distribution (n = 192)

PI-RADS category	Number (n)	Percentage (%)
PI-RADS 1	11	5.7
PI-RADS 2	26	13.5
PI-RADS 3	40	20.8
PI-RADS 4	62	32.3
PI-RADS 5	53	27.6

Histopathological Diagnosis

Histopathological examination confirmed **malignancy in 113 patients (58.9%)**, while **79 patients (41.1%)** had benign pathology, including benign prostatic hyperplasia and prostatitis.

Correlation Between PI-RADS Category and Histopathology

A progressive increase in malignancy rate was observed with higher PI-RADS categories. **No malignancy was detected in PI-RADS 1 lesions**, whereas **PI-RADS 5 lesions demonstrated malignancy in 88.7% of cases**. The correlation between PI-RADS category and histopathological diagnosis is detailed in **Table 4**.

Table 4: Correlation of PI-RADS category with histopathology (n = 192)

PI-RADS category	Malignant (n)	Benign (n)	Malignancy rate (%)
PI-RADS 1	0	11	0
PI-RADS 2	4	22	15.4
PI-RADS 3	18	22	45.0
PI-RADS 4	44	18	71.0
PI-RADS 5	47	6	88.7

A statistically significant association was observed between PI-RADS category and malignancy (**Chi-square = 62.1, df = 4, p <0.001**).

Diagnostic Performance of mpMRI

For diagnostic performance analysis, **PI-RADS ≥4** was considered positive for malignancy.

- True Positive (TP): **91**
- False Positive (FP): **24**
- True Negative (TN): **55**
- False Negative (FN): **22**

The diagnostic performance parameters are summarized in **Table 5**.

Table 5: Diagnostic performance of mpMRI (PI-RADS ≥4 as positive)

Parameter	Value (%)	95% Confidence Interval
Sensitivity	81.4	72.9 – 88.0
Specificity	76.8	65.9 – 85.5
Positive Predictive Value (PPV)	78.9	70.4 – 85.9
Negative Predictive Value (NPV)	79.6	68.8 – 88.0
Accuracy	79.7	73.2 – 85.2

Gleason Score Distribution

Among the **113 histopathologically confirmed malignant cases**, the mean Gleason score was **7.3 ± 1.1**. **Gleason score 7** was the most common, observed in **48.7%** of cases. The Gleason score distribution is presented in **Table 6**.

Table 6: Gleason score distribution among malignant cases (n = 113)

Gleason score	Number (n)	Percentage (%)
≤6	22	19.5
7	55	48.7
≥8	36	31.8

A clear increasing trend in malignancy rates was observed with increasing PI-RADS categories. This trend is illustrated in **Figure 1**, which depicts malignancy rates across PI-RADS categories based on histopathological confirmation.

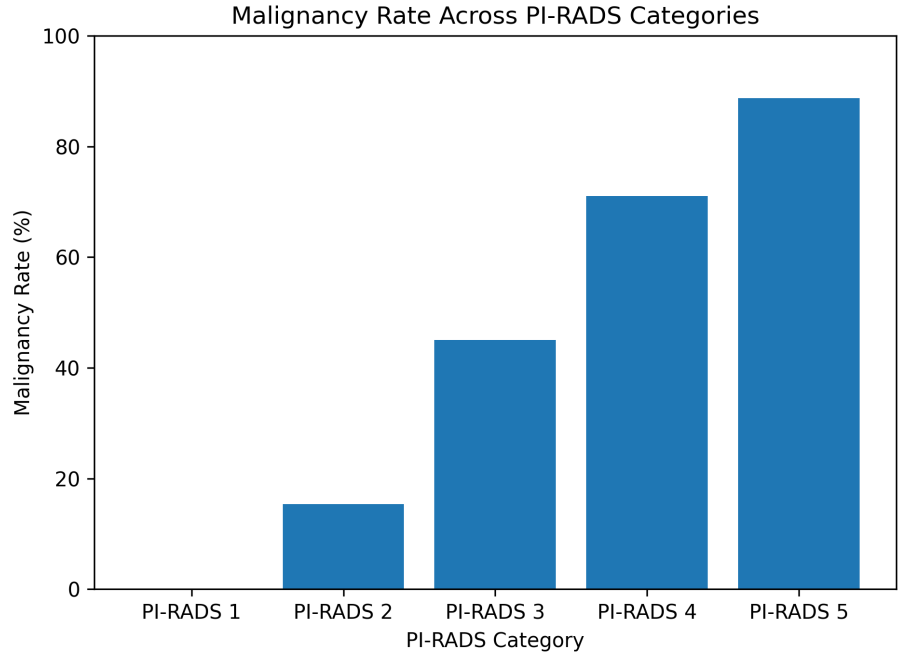

Figure 1: Bar chart showing malignancy rate across PI-RADS categories

Discussion

This prospective observational study evaluated the diagnostic role of multiparametric MRI (mpMRI) in the early detection of carcinoma prostate and assessed the predictive utility of PI-RADS scoring with histopathological correlation. In the present study, carcinoma prostate was confirmed in **113 out of 192 clinically suspected cases (58.9%)**, highlighting the importance of accurate diagnostic tools for early identification of clinically significant malignancies.

The mean age of patients in the present study was **66.4 ± 8.2 years**, which is consistent with epidemiological data showing that prostate cancer incidence increases significantly with advancing age. [12] Serum PSA levels were elevated in most malignant cases, supporting PSA as a useful screening parameter; however, its limited specificity often leads to unnecessary biopsies in benign conditions. [13]

PI-RADS scoring in our study demonstrated a strong association with histopathological outcomes. The

malignancy detection rate increased progressively with higher PI-RADS categories, with **PI-RADS 5 lesions showing the highest malignancy probability (88.7%)**. These findings are consistent with studies that validate PI-RADS as a standardized and reliable reporting system for stratifying prostate lesions. [14]

When **PI-RADS ≥4** was considered positive, mpMRI showed good diagnostic performance with **high sensitivity (81.4%) and specificity (76.8%)**, indicating its effectiveness in identifying clinically significant prostate cancer. Similar diagnostic accuracy has been reported in large clinical trials and institutional studies demonstrating that mpMRI improves cancer detection while reducing unnecessary systematic biopsies. [15]

Targeted biopsy guided by mpMRI has been shown to improve detection of clinically significant tumors compared to conventional systematic biopsy alone. This approach enhances diagnostic precision and minimizes overdiagnosis of indolent lesions, thereby improving risk stratification and patient management. [16]

PI-RADS 3 lesions remain a diagnostic gray zone with variable malignancy risk. In the present study, **PI-RADS 3 lesions demonstrated malignancy in 45.0% of cases**. Previous studies suggest that PSA density and additional clinical parameters may help further stratify PI-RADS 3 lesions and guide biopsy decisions more effectively. [17]

The present findings also highlight the importance of diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) mapping in lesion characterization. Restricted diffusion has been strongly linked with increased tumor cellularity and higher-grade malignancies, making DWI a crucial sequence in mpMRI protocols. [18] Dynamic contrast-enhanced imaging provides supplementary information, particularly in equivocal lesions, and improves diagnostic confidence. [19]

In addition to diagnosis, mpMRI plays a significant role in local staging by detecting extracapsular extension and seminal vesicle invasion, which are critical for treatment planning and prognostic assessment. [20] Studies have reported that mpMRI improves staging accuracy and helps reduce positive surgical margin rates by guiding surgical decision-making. [21]

Furthermore, mpMRI has become increasingly valuable in active surveillance protocols for low-risk prostate cancer, as it enables monitoring of tumor progression and reduces the need for repeated biopsies. [22] This contributes to better patient compliance and quality of life. Interobserver variability remains a challenge; however, standardized PI-RADS training has been shown to improve reporting consistency. [23]

Recent meta-analyses have confirmed that mpMRI offers high accuracy in detecting clinically significant prostate cancer, supporting its role as a frontline diagnostic tool. [24] Current international guidelines also recommend pre-biopsy mpMRI as part of the standard diagnostic pathway, emphasizing its importance in modern prostate cancer evaluation. [25]

Overall, the findings of this study confirm that mpMRI with PI-RADS scoring is a reliable and clinically effective modality for early detection, risk stratification, and management planning in carcinoma prostate.

Conclusion

Multiparametric MRI is a valuable non-invasive diagnostic modality for early detection of carcinoma prostate. PI-RADS scoring provides a standardized reporting system and shows strong correlation with histopathological diagnosis. Higher PI-RADS categories are significantly associated with malignancy. Incorporation of mpMRI into routine diagnostic pathways

can improve detection of clinically significant prostate cancer and reduce unnecessary biopsies.

Limitations

This study has certain limitations. It was conducted as a dual-center prospective observational study with a relatively moderate sample size, which may limit the generalizability of the findings to a broader population. Interobserver variability in mpMRI interpretation was not assessed, although PI-RADS reporting can differ based on radiologist experience. Additionally, long-term follow-up of patients was not included, and hence prognostic outcomes such as disease progression, recurrence, or survival could not be evaluated. Furthermore, PSA density and other clinical parameters that could enhance risk stratification, particularly in PI-RADS 3 lesions, were not analyzed separately.

References

1. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2024. CA Cancer J Clin. 2024;74(1):17–48.
2. Catalona WJ, Richie JP, Ahmann FR, et al. Comparison of prostate specific antigen concentration versus digital rectal examination and transrectal ultrasonography in the early detection of prostate cancer: results of a multicenter clinical trial. N Engl J Med. 1994;331(15):948–953.
3. Hodge KK, McNeal JE, Terris MK, Stamey TA. Random systematic versus directed ultrasound guided transrectal core biopsies of the prostate. J Urol. 1989;142(1):71–74.
4. Welch HG, Albertsen PC. Prostate cancer diagnosis and treatment after the introduction of prostate-specific antigen screening: 1986–2005. J Natl Cancer Inst. 2009;101(19):1325–1329.
5. Barentsz JO, Richenberg J, Clements R, et al. ESUR prostate MR guidelines 2012. Eur Radiol. 2012;22(4):746–757.
6. Turkbey B, Rosenkrantz AB, Haider MA, et al. Prostate Imaging Reporting and Data System version 2.1: 2019 update of prostate MRI reporting standards. Eur Urol. 2019;76(3):340–351.
7. Rosenkrantz AB, Ginocchio LA, Cornfeld D, et al. Interobserver reproducibility of the PI-RADS version 2 lexicon: a multicenter study. Radiology. 2016;280(3):793–804.
8. Ahmed HU, El-Shater Bosaily A, Brown LC, et al. Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study. Lancet. 2017;389(10071):815–822.
9. Baco E, Rud E, Ukimura O, et al. The added value of multiparametric MRI in staging and management of prostate cancer. World J Urol. 2014;32(4):867–872.
10. Fütterer JJ, Briganti A, De Visschere P, et al. Can clinically significant prostate cancer be detected with multiparametric magnetic resonance imaging? A systematic review of the literature. Eur Urol. 2015;68(6):1045–1053.
11. Epstein JI, Egevad L, Amin MB, et al. The 2014 International Society of Urological Pathology (ISUP) consensus conference on Gleason grading of prostatic carcinoma: definition of grading patterns and proposal for a new grading system. Am J Surg Pathol. 2016;40(2):244–252.
12. Rawla P. Epidemiology of prostate cancer. World J Oncol. 2019;10(2):63–89.
13. Thompson IM, Pauler DK, Goodman PJ, et al. Prevalence of prostate cancer among men with a prostate-specific antigen level ≤4.0 ng per milliliter. N Engl J Med. 2004;350(22):2239–2246.
14. Kasivisvanathan V, Rannikko AS, Borghi M, et al. MRI-targeted or standard biopsy for prostate-cancer diagnosis. N Engl J Med. 2018;378(19):1767–1777.
15. Rouvière O, Puech P, Renard-Penna R, et al. Use of prostate systematic and targeted biopsy on the basis of

multiparametric MRI in biopsy-naïve patients (MRI-FIRST): a prospective, multicentre, paired diagnostic study. Lancet Oncol. 2019;20(1):100–109.
16. Siddiqui MM, Rais-Bahrami S, Truong H, et al. Magnetic resonance imaging/ultrasound fusion biopsy significantly improves detection of prostate cancer compared with systematic biopsy. JAMA. 2015;313(4):390–397.
17. Mehralivand S, Shih JH, Rais-Bahrami S, et al. A magnetic resonance imaging-based prediction model for prostate biopsy risk stratification in PI-RADS 3 lesions. JAMA Oncol. 2018;4(5):678–685.
18. van der Leest M, Cornel E, Israël B, et al. Head-to-head comparison of transrectal ultrasound-guided prostate biopsy versus multiparametric prostate MRI with subsequent MRI-targeted biopsy in biopsy-naïve men with elevated PSA (4M study). Eur Urol. 2019;75(4):570–578.
19. Hambrock T, Somford DM, Hoeks C, et al. Diffusion-weighted magnetic resonance imaging for detection of prostate cancer in patients with repeated negative biopsies. Radiology. 2010;256(1):210–219.
20. Verma S, Turkbey B, Muradyan N, et al. Overview of dynamic contrast-enhanced MRI in prostate cancer diagnosis and management. AJR Am J Roentgenol. 2012;198(6):1277–1288.
21. de Rooij M, Hamoen EHJ, Fütterer JJ, Barentsz JO, Rovers MM. Accuracy of multiparametric MRI for prostate cancer detection: a meta-analysis. Eur Urol. 2014;65(6):1095–1105.
22. Schoots IG, Petrides N, Giganti F, et al. Magnetic resonance imaging in active surveillance of prostate cancer: a systematic review. Eur Urol. 2015;67(4):627–636.
23. Johnson DC, Raman SS, Mirak SA, et al. Multiparametric magnetic resonance imaging improves staging accuracy in prostate cancer: implications for surgical planning. Urology. 2019;124:98–104.
24. Woo S, Suh CH, Kim SY, Cho JY, Kim SH. Diagnostic performance of magnetic resonance imaging for detection of prostate cancer: a systematic review and meta-analysis. Eur Urol. 2017;72(2):177–188.
25. Mottet N, van den Bergh RCN, Briers E, et al. EAU guidelines on prostate cancer: 2024 update. Eur Urol. 2024;85(1):1–40.