International Journal of Radiology Research
www.radiologyjournal.in
E-ISSN: 2663-4562, P-ISSN: 2663-4554
Received: 22-09-2025; Accepted: 21-10-2025; Published: 06-11-2025
Volume 7, Issue 2, 2025, Page No. 39-42

Role of multiparametric MRI in detecting clinically significant prostate cancer: A PI-RADS v2.1-Based Study

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Abstract
Background: Prostate cancer is among the most common malignancies in men worldwide. Accurate imaging plays a vital role in its early detection, localization, and staging. Multiparametric magnetic resonance imaging (mpMRI), evaluated through the Prostate Imaging Reporting and Data System (PI-RADS) version 2.1, has emerged as a key diagnostic tool to improve detection accuracy and guide clinical management.
Objective: To evaluate the diagnostic role of MRI in identifying prostate cancer and to assess its accuracy using PI-RADS version 2.1 in correlation with clinical significance.
Materials and Methods: This prospective study included 34 male patients aged 45–87 years with elevated serum PSA levels and clinical suspicion of prostate cancer. Each patient underwent mpMRI of the prostate using a 3-Tesla scanner with T1-, T2-, diffusion-weighted (DWI), and dynamic contrast-enhanced (DCE) sequences. Lesions were categorized using PI-RADS v2.1, and the likelihood of clinically significant cancer was recorded. Data were analysed for age distribution, affected prostatic zones, and PI-RADS classification.
Results: The mean age of patients was 66.41 ± 10.32 years, and the median PSA value was 22.87 ng/ml. The transitional zone was most frequently affected (44.12%), followed by multizonal (29.41%) and peripheral zone (20.59%) involvement. According to PI-RADS assessment, 12 patients (35.29%) were scored as PI-RADS 2, 13 (38.23%) as PI-RADS 3, 2 (5.89%) as PI-RADS 4, and 7 (20.59%) as PI-RADS 5. All highly clinically significant cancers corresponded to PI-RADS 4 and 5 lesions, confirming a strong correlation between PI-RADS scoring and clinical aggressiveness.
Conclusion: Multiparametric MRI, interpreted using PI-RADS version 2.1, demonstrates high diagnostic accuracy in detecting clinically significant prostate cancer. It provides superior lesion characterization compared to conventional imaging and serves as a reliable, non-invasive tool for disease assessment, staging, and treatment planning.

Keywords: Prostate cancer, mri, pi-rads v2.1, multiparametric mri, prostate imaging

Introduction

Prostate cancer is recognized as the most commonly diagnosed malignancy worldwide and stands as the sixth leading cause of cancer-related mortality among men [1]. Prostate cancer continues to be a major global health issue, greatly affecting men's well-being. It involves the abnormal and uncontrolled growth of cells in the prostate gland and often develops without obvious symptoms. Because of its silent progression, early detection is vital for improving treatment outcomes and increasing long-term survival rates [2]. Age is a significant and well-recognized risk factor for prostate cancer, with its incidence rising steadily as men grow older. The disease is uncommon in individuals under 40 years of age [3]. Globally, in 2020, prostate cancer accounted for about 1,414,259 newly diagnosed cases and 375,304 deaths [4].

Current clinical strategies for cancer diagnosis typically combine physical examinations to identify abnormal changes in various body regions with a variety of laboratory tests using blood and urine samples. These approaches are supported by non-invasive imaging techniques, including computed tomography (CT), ultrasonography (US), magnetic resonance imaging (MRI), bone scans, and positron emission tomography (PET). To confirm the diagnosis and determine the cancer stage, tissue samples are collected through minimally invasive procedures such as fine-needle aspiration or surgical biopsy, which are then analyzed through histopathological examination [5, 8].

Abdominal CT scans provide minimal valuable prognostic insight in men with prostate cancer and are generally unnecessary for routine staging before radiotherapy [9]. The role of ultrasound in prostate cancer detection is shifting from a simple imaging method to a more sophisticated diagnostic approach through advanced techniques such as Doppler and elastography, which can detect elevated blood flow and tissue stiffness. However, conventional ultrasound still has limitations in providing a definitive cancer diagnosis [10]. MRI has become a pivotal tool in managing prostate cancer, offering significant improvements in diagnosis, staging, and treatment planning through multiparametric MRI (mpMRI). This approach increases the accuracy of tumor detection and localization, assists in distinguishing aggressive cancers from less harmful ones, and guides targeted biopsy and therapy decisions. Furthermore, mpMRI is widely used in active surveillance programs to track disease progression and optimize ongoing patient management [11, 13]. In the other hand, PET imaging is an important modality in prostate cancer management, offering enhanced accuracy in diagnosis, staging, and disease monitoring through the use of targeted tracers such as prostate-specific membrane antigen (PSMA). In particular, PSMA-PET/CT has proven highly effective in identifying cancer recurrence in patients with elevated PSA levels, even when traditional imaging methods fail to detect lesions. It is also gaining prominence as a valuable tool for initial staging in patients with high-risk prostate cancer [14, 15]. The Prostate Imaging Reporting and Data System (PI-RADS) is a standardized framework used to evaluate the probability of clinically significant prostate cancer using mpMRI. In 2019 PI-RADS version 2.1 was developed. It employs a five-point scale, with scores of 1 and 2 reflecting a very low likelihood of malignancy and scores of 4 and 5 indicating a high probability of cancer. This system provides a structured approach for interpreting MRI findings and supports clinical decision-making regarding the need for further diagnostic procedures, such as targeted prostate biopsy [16, 18].

The present study is planned with the objective to investigate the role of MRI in identifying prostate cancer and to analyse its diagnostic accuracy in terms of sensitivity and specificity.

Material and Methods

This study included a total of 34 male patients aged between 45 and 87 years who presented with elevated serum PSA levels and were clinically suspected of having prostate cancer were prospectively enrolled between April and September 2025. (Fig.1) Ethical approval was obtained from the Institutional Ethics Committee of Max Super Specialty Hospital, Noida (U.P., India), and written informed consent was secured from all participants prior to inclusion.

Patients with contraindications to MRI such as metallic implants, cardiac pacemakers, severe claustrophobia, poor general condition, bleeding disorders, acute sepsis or severe liver or kidney disease were excluded. Each patient underwent a detailed clinical evaluation, including serum PSA measurement, followed by mpMRI of the prostate using a standardized protocol on a 3-Tesla scanner. The MRI sequences included T1- and T2-weighted imaging, diffusion-weighted imaging (DWI), and dynamic contrast-enhanced (DCE) imaging to assess lesion characteristics.

Imaging findings were interpreted by experienced radiologists using the PI-RADS v2.1 for lesion categorization. The probability of clinically significant cancer was graded from PI-RADS 2 (very low likelihood) to PI-RADS 5 (very high likelihood).

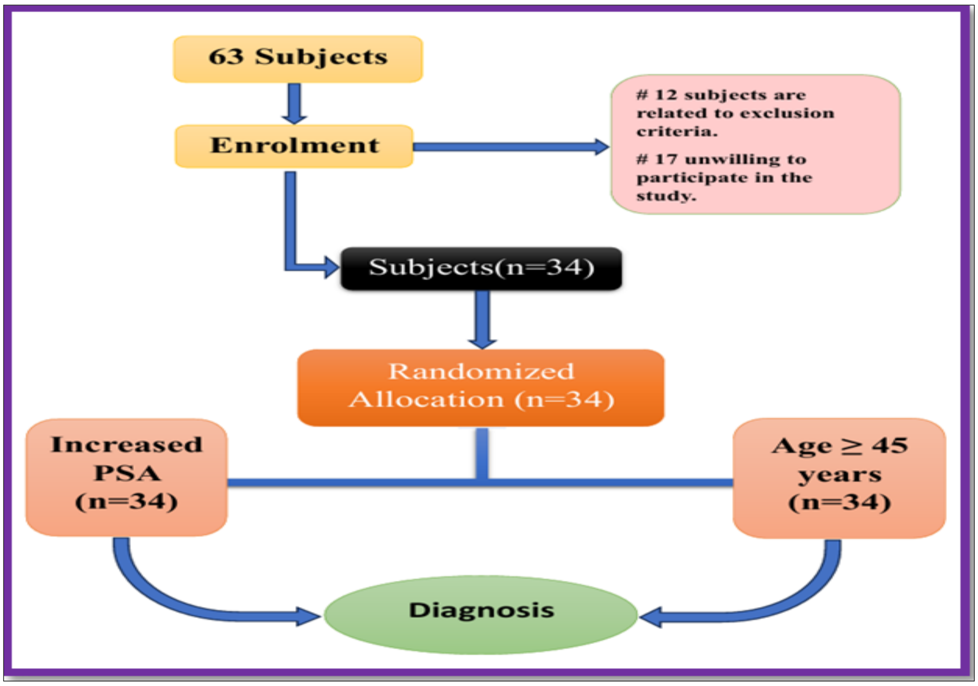

Fig 1: Flow chart of the inclusion of the patients

Results

A total of 34 purposively selected male patients aged between 45 and 87 years were included in the study, with a mean age of 66.41 ± 10.32 years. The prostate-specific antigen (PSA) levels ranged from 6.3 to 73.6 ng/ml, with a median value of 22.87 ng/ml. Analysis of age-related data revealed that prostate cancer was most frequently observed among individuals aged 56-75 years, which accounted for 70.58% of the total cases. Specifically, 4 patients (11.77%) were within the age group of 45-55 years, 12 (35.29%) were aged 56-65 years, another 12 (35.29%) belonged to the 66-75 years group, and 6 (17.65%) were aged above 75 years. MRI evaluation revealed that the transitional zone was the most commonly affected region, observed in 15 patients (44.12%). The peripheral zone was involved in 7 cases (20.59%), while the central zone was affected in 2 cases (5.88%). Additionally, 10 patients (29.41%) showed lesions involving more than one zone of the prostate. Based on MRI findings and PI-RADS version 2.1 assessment, 12 patients (35.29%) were categorized as PI-RADS 2, 13 (38.23%) as PI-RADS 3, 2 (5.89%) as PI-RADS 4, and 7 (20.59%) as PI-RADS 5.(Table 1) Based on findings 9 patients (26.47%) had highly clinically significant prostate cancer, 10 patients (29.41%) exhibited intermediate clinically significant and remaining 15 patients (44.12%) were found to have clinically insignificant. (Fig. 2) All highly clinically significant prostate cancer were assigned to PI-RADS 4 (2 cases, 5.88%) and PI-RADS 5 (7 cases, 20.59%) categories. Those patients exhibited intermediate clinically significant, all belonging to the PI-RADS 3 category. The remaining clinically insignificant cases, predominantly associated with PI-RADS 2 (12 cases, 35.29%) and PI-RADS 3 (3 cases, 8.82%). (Fig. 3)

Table 1: Distribution of age group, PSA, affected prostatic zones and PIRADS value of the patients

Variables		n= 34
Age (years)		66.41 ± 10.32(Mean ± SD)
PSA (ng/ml)		22.87(6.3- 73.6)
Age Group (In years)	45-55	4(11.77%)
	56-65	12(35.29%)
	66-7a0e.455	12(35.29%)
	75- above	6(17.65%)
Affected prostatic zones	Peripheral zone	7(20.59%)
	Central zone	2(5.88%)
	Transitional zone	15(44.12%)
	> 1 zone	10(29.41%)
PIRADS	PIRADS 2	12(35.29%)
	PIRADS 3	13(38.23%)
	PIRADS 4	2(5.89%)
	PIRADS 5	7(20.59%)

Fig 2: Pie chart of clinical significance of prostate cancer

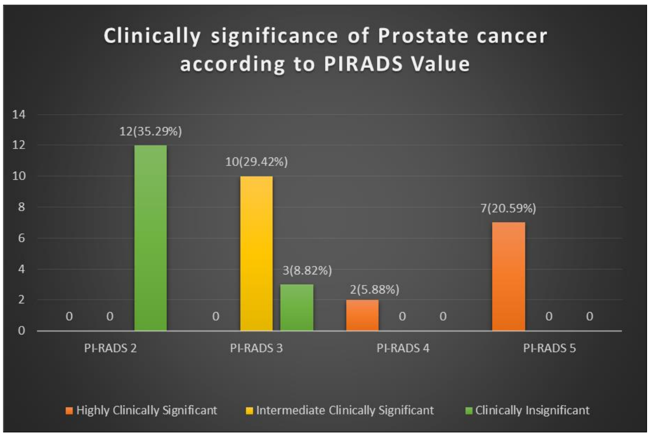

Fig 3: Graphical presentation of clinically significance of prostate cancer according to PIRADS value

Discussion

Prostate cancer continues to be one of the most prevalent malignancies among men worldwide, with incidence rates increasing significantly with age. The present study assessed the diagnostic performance of MRI using the PI-RADS v2.1in evaluating prostate cancer.

Age and PSA Correlation

In this study, the majority of patients were within the 56–75-year age group, consistent with the established understanding that prostate cancer incidence increases with advancing age [3]. The mean age of 66.41 ± 10.32 years aligns with global epidemiological data highlighting the predominance of prostate cancer in older males [4]. The mean PSA level in our study (22.87 ng/ml) falls within the range reported in other studies assessing men with suspected prostate cancer [2].

Zonal Distribution

The MRI revealed that the transitional zone was the most commonly affected area (44.12%), followed by multizonal involvement (29.41%) and peripheral zone (20.59%).

Traditionally, the peripheral zone has been described as the most common site for prostate carcinoma development; however, recent studies have identified a growing proportion of tumors originating in the transitional zone, especially in older men and those with benign prostatic hyperplasia (BPH). Our results are in partial agreement with [10], who observed similar involvement patterns and emphasized the diagnostic utility of multiparametric MRI in differentiating benign from malignant changes in these regions.

PI-RADS Classification and Clinical Significance

The correlation between PI-RADS category and clinical significance observed in this study underscores the diagnostic reliability of mpMRI. All highly significant prostate cancers were categorized as PI-RADS 4 or 5, confirming that higher PI-RADS scores are strongly associated with aggressive disease [16, 17]. Similar findings have been reported by Ahmed *et al* [13], who demonstrated a strong concordance between PI-RADS 4-5 lesions and histopathologically confirmed malignancy. Our data also indicated that clinically insignificant or indolent lesions were primarily associated with PI-RADS 2 and 3 scores, further validating the system's predictive accuracy.

Comparative Imaging Efficacy

Compared with conventional modalities, mpMRI demonstrated superior diagnostic performance. Ultrasound, though commonly used, is limited in specificity and tissue contrast [10]. Similarly, CT scanning offers little incremental value in local staging of prostate carcinoma [9]. In contrast, mpMRI combination of T2-weighted, diffusion-weighted (DWI), and dynamic contrast-enhanced (DCE) sequences enhances lesion detectability, particularly in differentiating clinically significant from insignificant tumors [11, 12].

Limitation

This study is limited by its small sample size and lack of histopathological confirmation in all cases, which may affect diagnostic accuracy. Being a single-centre study, potential selection bias and inter-observer variation cannot be excluded. Larger multicentre studies are needed to validate these findings.

Acknowledgments

The authors are thankful to all patients for their valuable cooperation in the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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