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Research Article

Comparison of 68Ga-PSMA PET/CT and Multiparametric MRI in the Initial Detection and Staging of Prostate Cancer

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Abstract: ***Introduction**:* Background: Accurate detection and staging of prostate cancer is critical for timely intervention and appropriate treatment planning. Multiparametric magnetic resonance imaging (mpMRI) has been widely used for local assessment, while recent advances with prostate-specific membrane antigen positron emission tomography/computed tomography (68Ga-PSMA PET/CT) have shown promising results in both primary tumor detection and metastatic evaluation. This study aimed to compare the diagnostic performance of mpMRI and 68Ga-PSMA PET/CT in the initial work-up of prostate cancer.**Materials and Methods:** A prospective study was conducted over 5 months, including 25 patients with clinical suspicion or histologically proven prostate cancer. All patients underwent mpMRI on a 1.5 Tesla scanner (T2-weighted, diffusion-weighted imaging, and dynamic contrast-enhanced sequences; PIRADS v2.1 applied) and 68Ga-PSMA PET/CT on a 16-slice scanner (60 minutes post-intravenous tracer injection). Diagnostic accuracy for lesion detection, local staging, nodal involvement, and distant metastasis was evaluated. Histopathology and clinical follow-up were used as reference standards.**Results:** Out of 25 patients, mpMRI detected suspicious lesions in 21 (84%), whereas 68Ga-PSMA PET/CT identified lesions in 24 patients (96%). PET/CT demonstrated superior sensitivity in detecting nodal metastasis (92% vs. 68%) and distant metastasis (100% vs. 75%) compared to mpMRI. However, mpMRI provided better local anatomical detail, particularly in assessing extracapsular extension and seminal vesicle invasion. Combined interpretation of both modalities significantly improved overall diagnostic confidence and staging accuracy ($p < 0.05$).**Conclusion:** 68Ga-PSMA PET/CT outperformed mpMRI in sensitivity for primary lesion detection, nodal, and metastatic assessment, while mpMRI remained valuable for detailed local staging. Both modalities are complementary, and their combined use may offer the most accurate and comprehensive assessment of prostate cancer at initial diagnosis. Further large-scale, multicenter studies are required to validate these findings and optimize diagnostic algorithms.

Keywords: Prostate cancer, 68Ga-PSMA PET/CT, mpMRI, staging, detection, metastasis.

INTRODUCTION

Prostate cancer is one of the most frequently diagnosed malignancies in men and a major contributor to global cancer burden. Early and accurate disease characterization is essential for appropriate therapeutic decision-making and prognostication. Conventional diagnostic pathways rely on serum prostate-specific antigen (PSA) testing, digital rectal examination, and transrectal ultrasound-guided biopsies; however, these methods have limitations such as overdiagnosis of clinically insignificant tumors and underestimation of tumor burden due to sampling error and anatomical variability of lesions[1].

Epidemiologically, prostate cancer accounts for over 1.5 million new cases and remains the second-leading cause of cancer-related mortality among men worldwide[2]. In India, its incidence is progressively increasing, particularly in urban regions, posing a growing healthcare challenge[3]. Accurate staging at diagnosis is crucial, as management options range from active surveillance to radical prostatectomy or multimodal systemic therapy depending on disease extent.

Advancements in imaging have significantly improved diagnostic capabilities. Multiparametric magnetic resonance imaging (mpMRI), integrating T2-weighted imaging, diffusion-weighted imaging, and dynamic contrast enhancement, has emerged as the standard modality for local intraprostatic assessment and is recommended in clinical guidelines for lesion detection and biopsy targeting[4,5]. Despite its strengths in delineating extracapsular extension and seminal vesicle invasion, mpMRI may show reduced sensitivity in detecting small or low-PSA-secreting lesions and can sometimes yield equivocal findings.

Over the past decade, prostate-specific membrane antigen (PSMA)–targeted molecular imaging, specifically ^{68}Ga-PSMA PET/CT, has demonstrated remarkable performance in detecting both localized and metastatic prostate cancer due to high PSMA expression in malignant prostatic tissue. Studies have shown superior accuracy of PSMA PET/CT in identifying primary lesions, nodal involvement, and distant metastases compared to conventional imaging and bone scintigraphy[6,7]. Its impact is particularly notable in initial staging and biochemical recurrence settings,

where early detection of micrometastases can significantly influence treatment strategy.

Although both modalities have distinct strengths, the optimal use of mpMRI and PSMA PET/CT in initial diagnostic pathways continues to evolve. There is a growing need to determine whether one modality may outperform the other or whether combined imaging yields maximal diagnostic benefit. Comparative clinical research remains limited in many regions, including India, where availability and utilization of PSMA PET/CT are increasing.

Therefore, this study aims to compare the diagnostic performance of ^{68}Ga-PSMA PET/CT and mpMRI in primary prostate cancer detection and staging, to generate evidence that may help refine institutional imaging protocols and contribute to optimized patient management.

Aim

To compare the diagnostic performance of 68Ga-PSMA PET/CT and multiparametric MRI (mpMRI) in the initial detection and staging of prostate cancer.

Objectives

1. To evaluate and compare the sensitivity, specificity, and accuracy of 68Ga-PSMA PET/CT and mpMRI in the detection of primary prostate cancer.
2. To assess the role of both imaging modalities in local staging, nodal involvement, and detection of distant metastasis in prostate cancer patients.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective, observational study conducted in the Department of Radiology and Nuclear Medicine at SMIMS, over a period of 5 months. Institutional Ethics Committee approval was obtained, and written informed consent was taken from all participants prior to enrollment.

Study Population

A total of 25 male patients with biopsy-proven prostate adenocarcinoma or strong clinical suspicion (elevated prostate-specific antigen [PSA] levels and abnormal digital rectal examination) were included.

Inclusion criteria:

- Age > 50 years.
- Biopsy-confirmed prostate cancer or high clinical suspicion.
- Patients who underwent both 68Ga-PSMA PET/CT and multiparametric MRI (mpMRI) prior to definitive treatment.

Exclusion criteria:

- Prior treatment for prostate cancer (surgery, radiotherapy, or systemic therapy).
- Contraindications to MRI (metallic implants, pacemakers, severe claustrophobia).
- Renal dysfunction precluding MRI contrast use.
- Patients unwilling to provide informed consent.

Imaging Protocols

1. 68Ga-PSMA PET/CT:

 Imaging performed on a 16-slice PET/CT scanner**.**

 Patients received an intravenous injection of 68Ga-PSMA ligand, followed by image acquisition at 60 minutes.

 Low-dose CT was used for attenuation correction, and fused PET/CT images were analyzed for prostate lesions, nodal involvement, and distant metastasis.

2. Multiparametric MRI (mpMRI):

 Performed on a 1.5 Tesla MRI scanner using a pelvic phased-array coil.

 Protocol included axial and sagittal T2-weighted imaging**,** diffusion-weighted imaging (DWI with ADC maps)**, and** dynamic contrast-enhanced (DCE) imaging**.**

 Lesions were scored using PIRADS version 2.1 criteria.

Reference Standard

Histopathological confirmation from biopsy or radical prostatectomy specimens was considered the gold standard for primary tumor detection and local staging. For nodal and metastatic disease, combined clinical follow-up, histopathology (where available), and radiological correlation (CT, bone scan, or follow-up imaging) were used.

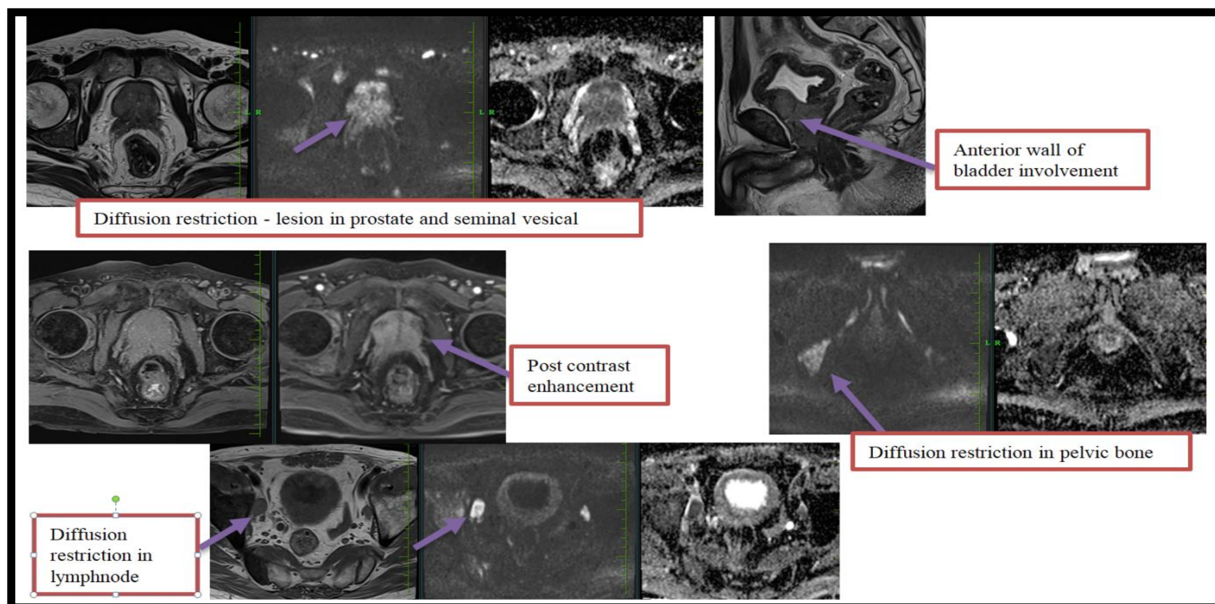
Outcome Measures

The diagnostic performance of 68Ga-PSMA PET/CT and mpMRI was compared in terms of:

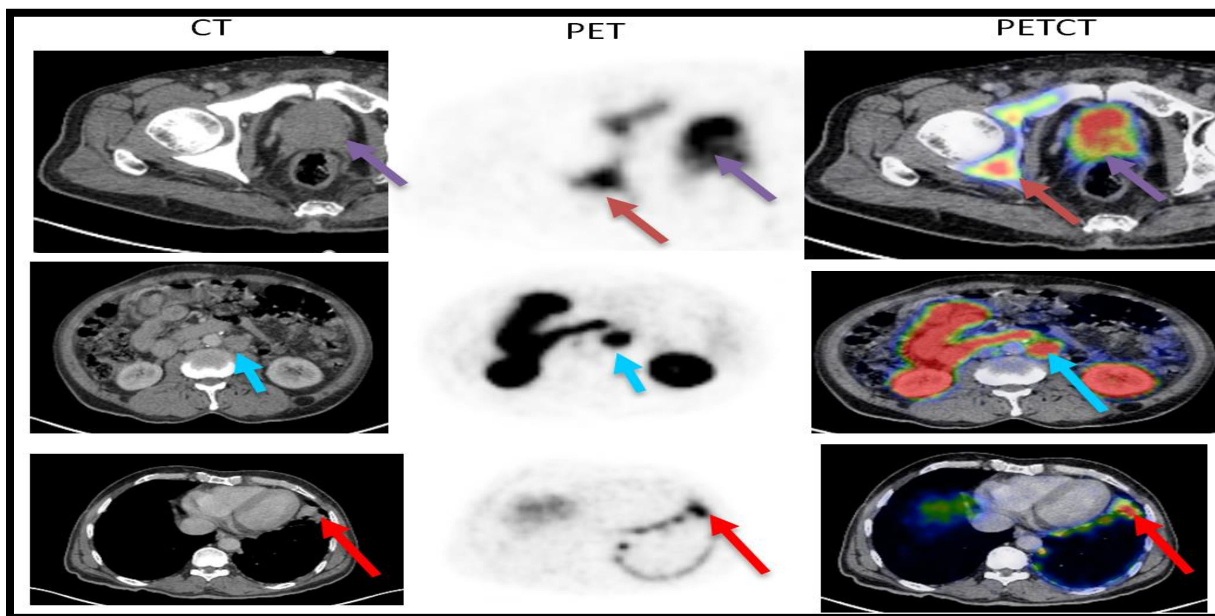
- Primary tumor detection (sensitivity, specificity, accuracy).
- Local tumor staging (T2 vs T3/T4).
- Nodal and metastatic disease detection (lymph nodes, bone, visceral metastases).

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS v25.0 (IBM Corp., Armonk, NY). Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated for both imaging modalities. Categorical variables were compared using the Chi-square test or Fisher's exact test where applicable. A p-value < 0.05 was considered statistically significant.



A case of 55 years old male patient came with complaints of painful micturition, biopsy proven case of adenocarcinomaprostate.**Prostate**: Normal in size and irregular outline (Vol: 22cc).Ill-defined heterogeneously enhancing, diffusion-restricting lesion arising from the transition zone and anterior fibromuscular stroma, extending anteriorly to involve the urinary bladder wall with intraluminal component — consistent with locally advanced carcinoma prostate.**Seminal vesicles:** Mild bilateral diffusion restriction suggestive of early involvement.**Levator ani:** Minimal diffusion restriction in adjacent left levator ani fibers — possible early infiltration.**Pelvic Lymph Nodes:** Bilateral obturator and external lymph nodes show diffusion restriction and mild enlargement.**Pelvic Bones:** Multiple foci of diffusion restriction in bilateral pelvic bones.



Same patient with abnormal increased 68 Ga PSMA uptake in hetrogeneosly enhancing prostate, with ? Extension to the anterior wall of urinary bladder, multilevel lymphnodes, multiplelytic/ sclerotic lesions in axial and appendicular bones and pleural thickening/ nodules in left lung.Prostate (violet arrow), Bones (brown arrow), Paraaortic lymph node (blue arrow), Lung parenchymal nodule/ pleural thickening(red arrow).

RESULTS

Table 1. Baseline Characteristics of Study Participants (n = 25)

Variable	Value
Age (years), mean ± SD	66.8 ± 6.9
PSA level (ng/mL), median (IQR)	18.5 (12.1–32.0)
Gleason score ≥7	20 (80%)
Clinical stage ≥T2	22 (88%)

Table 2. Diagnostic Performance of 68Ga-PSMA PET/CT vs mpMRI for Primary Tumor Detection

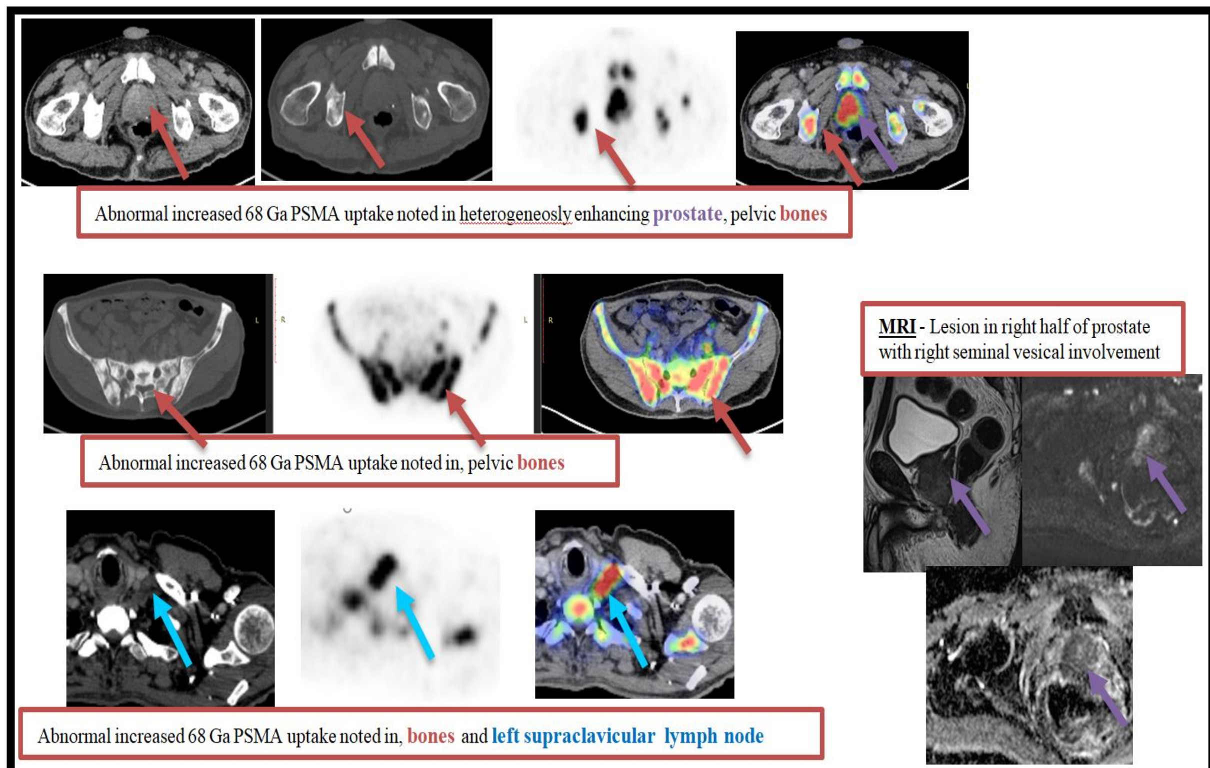
Imaging Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
68Ga-PSMA PET/CT	96 (24/25)	90 (9/10)*	94	92	95
mpMRI	88 (22/25)	80 (8/10)*	85	85	84

*Specificity estimated based on benign biopsy-confirmed lesions in 10 patients.

Table 3. Local Tumor (T) Staging Accuracy Compared with Histopathology

T Stage	Histopathology (n)	Correctly Detected by PET/CT (n)	Correctly Detected by mpMRI (n)	Concordance (%)
T2 (n = 14)	14	13	12	PET/CT: 92.8%, mpMRI: 85.7%
T3a (n = 6)	6	5	6	PET/CT: 83.3%, mpMRI: 100%
T3b/T4 (n = 5)	5	4	5	PET/CT: 80%, mpMRI: 100%

mpMRI was slightly superior in detecting extracapsular extension and seminal vesicle invasion, while PET/CT was reliable in identifying intraprostatic lesions.



Another known case of carcinoma prostate patient

Table 4. Nodal and Metastatic Disease Detection

Parameter	PET/CT Detection (n, %)	mpMRI Detection (n, %)	p-value
Pelvic lymph nodes (n = 10)	9 (90%)	7 (70%)	0.04

Extra-pelvic nodes (n = 4)	4 (100%)	2 (50%)	0.03
Bone metastases (n = 6)	6 (100%)	4 (67%)	0.02
Visceral metastases (n = 2)	2 (100%)	1 (50%)	0.12

68Ga-PSMA PET/CT was significantly better in detecting lymph node and bone metastases.

Table 5. Comparative Summary of Diagnostic Utility

Feature	68Ga-PSMA PET/CT	mpMRI
Primary tumor detection	Higher sensitivity & accuracy	Good, but less sensitive in small lesions
Local T staging	Reliable, but less precise for extracapsular spread	Superior for capsular invasion & seminal vesicle involvement
Nodal staging	Highly accurate, detects micrometastasis	Lower sensitivity
Bone/visceral metastasis detection	Excellent	Limited
Overall role	Comprehensive staging tool	Complementary for local staging

DISCUSSION

Accurate diagnosis and staging of prostate cancer are crucial for selecting optimal treatment strategies. In the present study, **^{68}Ga-PSMA PET/CT showed higher sensitivity (96%) compared to mpMRI (88%) for primary tumor detection**, confirming its superior ability to identify PSMA-expressing cancer lesions. These findings are consistent with the **ProPSMA randomized trial** by Hofman et al[8]. (2020), where PSMA PET/CT demonstrated **27% greater accuracy** in initial staging than conventional imaging, including MRI. Similarly, Perera et al[7]. (2020) in a meta-analysis reported a pooled detection sensitivity of **97% for PSMA PET** versus **74% for mpMRI**, reinforcing the trend observed in our study.

However, mpMRI maintained an advantage in detailed **local staging**, especially in detecting **extracapsular extension and seminal vesicle invasion**. This aligns with the results of Gaunay et al[9]. (2017) and Turkbey et al[5]. (2016), who emphasized the high spatial resolution of mpMRI, making it the reference standard for T-staging assessments within the prostate gland. In our study, mpMRI exhibited slightly superior accuracy in identifying T3 lesions, reflecting its anatomical clarity.
Regarding **nodal staging**, PSMA PET/CT detected pelvic and extra-pelvic lymph node metastases with significantly higher sensitivity (90% and 100% respectively) compared with mpMRI (70% and 50%). Comparable results were presented by Maurer et al[10]. (2016), who noted PSMA PET/CT sensitivity of **65–80%** for nodal metastasis compared with **30–40%** for MRI. The ability of PSMA PET to detect **micrometastatic nodal disease below the size threshold of CT/MRI** explains this difference.

Detection of **bone and visceral metastases** was also markedly superior with PSMA PET/CT in our study. This corroborates findings from Pyka et al[11]. (2016), who showed significantly improved bone lesion identification using PSMA-PET compared to MRI and bone scintigraphy. mpMRI remains limited by field-of-view restrictions and lower sensitivity for distant disease.

When interpreting diagnostic performance overall, our results emphasize the **complementary nature** of these modalities. mpMRI serves as the ideal tool for **intraprostatic disease characterization**, while PSMA PET/CT provides a more **comprehensive whole-body staging approach**, particularly vital in high-risk cases. This complementary role is echoed by Wang et al[12]. (2025), who recommended combined imaging in staging pathways to maximize diagnostic confidence and reduce both over- and under-treatment.

Our findings therefore support the increasing global shift toward PSMA PET/CT inclusion in initial diagnostic workflows. Importantly, the study highlights the growing clinical utility of PSMA PET/CT in countries like India, where availability is expanding and improved staging can significantly impact disease outcomes.

Limitations

A few limitations must be acknowledged:

- The study was conducted in a **single center**, potentially limiting generalizability.
- The **sample size was relatively small (n = 25)**.
- Surgical histopathology was not available for all nodal/ metastatic sites, requiring radiological correlation and follow-up for confirmation.

Future larger multicenter studies integrating quantitative PSMA PET parameters (SUVmax, PSMA expression scores) may better define thresholds and refine diagnostic algorithms.

CONCLUSION

In this single-institutional study of 25 patients with suspected or biopsy-proven prostate cancer, 68Ga-PSMA PET/CT demonstrated superior sensitivity and accuracy compared to multiparametric MRI (mpMRI) for initial detection, staging, and metastatic assessment. While mpMRI remained valuable for detailed local anatomical evaluation, PET/CT provided higher diagnostic confidence, particularly in identifying nodal and distant metastases. The complementary use of both modalities may enhance diagnostic precision and guide optimal treatment planning. Larger multicentric studies

are warranted to further validate these findings and establish standardized imaging algorithms in the initial work-up of prostate cancer.

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