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Original Article

Comparative Role of Biparametric and Multiparametric MRI in Evaluation of Carcinoma Prostate

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ABSTRACT

Background: Prostate cancer is among the most prevalent cancers in men and a major cause of cancer-related mortality worldwide. Accurate imaging is crucial for its early detection and staging. Although multiparametric MRI (mpMRI) is the current gold standard, its reliance on contrast agents, extended scan duration, and higher cost have led to increased interest in biparametric MRI (bpMRI), which omits the dynamic contrast-enhanced (DCE) sequence while maintaining key diagnostic performance.
Objective: To compare the diagnostic performance of bpMRI and mpMRI in identifying and staging prostate carcinoma, and to determine the correlation of MRI findings with histopathological results.
Methods: This cross-sectional study included 35 male patients aged 18 years and above who presented with raised serum PSA or suspected prostatic lesions. Both bpMRI and mpMRI examinations were conducted, and the imaging results were correlated with histopathological findings. Data were analyzed using SPSS version 23, and a p-value of less than 0.05 was considered statistically significant.
Results: mpMRI demonstrated superior diagnostic accuracy, with a sensitivity of 91.7%, specificity of 100%, and overall accuracy of 93.8%, compared with bpMRI, which achieved 66.7%, 75%, and 68.8%, respectively. There was a statistically significant relationship between elevated PSA, PSA density, and histopathological confirmation of malignancy ($p < 0.05$).
Conclusion: Multiparametric MRI offers superior diagnostic accuracy and staging precision in prostate carcinoma, while biparametric MRI remains a reliable, faster, and cost-effective alternative for screening or when contrast use is contraindicated.

Keywords*: Prostate cancer, biparametric MRI, multiparametric MRI, diffusion-weighted imaging, dynamic contrast enhancement, histopathological correlation.*

INTRODUCTION

Prostate cancer remains a major cause of illness and death from cancer around the world, and it is the most prevalent cancer in men. The prostate gland, a vital organ of the male reproductive system, surrounds the upper portion of the urethra and produces the fluid that nourishes and transports sperm [1]. Due to its anatomical position and variable biological behavior, early and precise detection of prostate cancer is essential for selecting appropriate treatment and avoiding unwarranted interventions. Magnetic resonance imaging (MRI) has emerged as a key non-invasive modality for evaluating the prostate and identifying cancer with high accuracy [1]. This is because MRI provides better contrast between soft tissues and clearer images, which help doctors find tumors and determine how far the cancer has spread [1].

To better understand both the structure and function of prostate lesions, multiparametric Traditionally, "multiparametric MRI (mpMRI) includes T2-weighted imaging, diffusion-weighted imaging (DWI), and dynamic contrast-enhanced (DCE)

sequences". However, the administration of intravenous contrast agents can sometimes cause patient discomfort and carries a potential risk of renal complications. Also, mpMRI can take a long time and be costly [2]. Because of these issues, biparametric MRI (bpMRI) is becoming more common. This method keeps T2-weighted and DWI sequences, which are the most important for diagnosis, but skips the DCE part [3].

Recent studies show that bpMRI cuts down on imaging time and costs while still detecting prostate cancer as well as mpMRI [4]. Another study reported that" bpMRI performs comparably to mpMRI in assessing tumor stage and identifying extracapsular extension of prostate cancer" [5]. Omitting the DCE sequence shortens examination time, enhances patient comfort, and improves workflow efficiency—an advantage particularly valuable in high-volume clinical settings [6]. Furthermore, the latest "Prostate Imaging–Reporting and Data System (PI-RADS v2.1) guidelines indicate that bpMRI provides diagnostic accuracy equivalent to mpMRI for detecting clinically significant disease" [7]. Many large analyses show "bpMRI is a dependable, effective, and cheaper option that gives similar confidence in diagnosis without losing accuracy" [8].

MATERIALS AND METHODS

Study design: Cross-sectional observational study.

Study setting: This study was conducted in the Department of Radio diagnosis, Imaging & Interventional radiology in collaboration with the department of Medicine, Surgery and Pathology N.S.C.B Subharti Medical College, CSS Hospital, Meerut under the aegis of Swami Vivekanand Subharti University, Meerut.

Duration of Study: July 2023 to Feb 2025 for 18 months.

Sample Size: The study was conducted on a minimum of 30 patients.

Inclusion Criteria:

- Patients Men at least 18 years or Above Age Group
- Patients presenting with diferent prostatic lesions or with raised PSA>4 ng/dl or with a hard nodule by digital rectal examination

Exclusion Criteria:

1. Patients with biopsy proven carcinoma prostate.
2. Previous history of prostate surgery.
3. Patients with general contraindications to MRI (Cardiac pacemakers, metallic bone implants, cochlear implants, defibrillators)
4. General contraindications to TRUS as piles and acute painful perianal disorders.

Data Analysis: Data were analyzed in SPSS v23 using descriptive, comparative, and ROC analyses; $p < 0.05$ was considered statistically significant.

RESULTS

A total of 35 patients underwent prostate MRI; 32 were analyzed after excluding 3 with inconclusive biopsies. Sixty-four index nodules (transitional and peripheral zones) were evaluated using bpMRI and mpMRI protocols.

Table 1. Diagnostic values for overall bpMRI vs mpMRI (per-patient, histopathology as reference)

Modality	Pathology	Benign (n)	Malignant (n)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
bpMRI	Benign (PI-RADS 1,2 and 3)	6	8	66.7	75	88.9	42.9	68.8
	Malignant (PI-RADS 4 and 5)	2	16					
mpMRI	Benign (PI-RADS 1,2 and 3)	8	2	91.7	100	100	80	93.8
	Malignant (PI-RADS 4 and 5	0	22					

Table 1 shows that Compared with bpMRI, mpMRI demonstrated markedly superior diagnostic performance, with **higher sensitivity (91.7%)** and **perfect specificity (100%)**, yielding the fewest false positives and a substantially higher overall

accuracy. The paired comparison (**p = 0.039**) confirms that adding DCE to T2WI+DWI significantly improves discrimination between malignant and benign lesions."

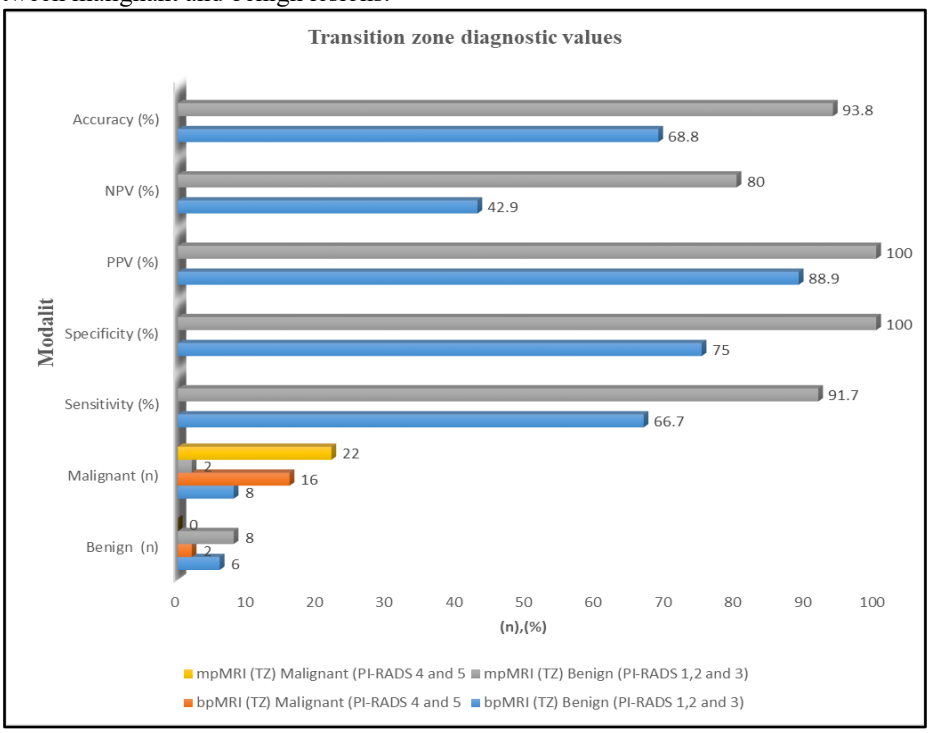


Figure 1: Transition zone diagnostic values (histopathology as reference)

In Figure 1, the TZ, mpMRI achieved 100% specificity and high sensitivity (91.7%), substantially reducing false positives seen with bpMRI. The significant association between PI-RADS category and histopathology in the TZ confirms the additive value of DCE for TZ lesion characterization.

Table 2. Baseline characteristics by histopathology

Variable	Benign (n=8)	Malignant (n=24)	p-value
Age, years (mean ± SD)	64.2 ± 6.5	68.9 ± 7.9	0.041
PSA, ng/mL (mean ± SD)	9.5 ± 2.2	15.3 ± 3.4	<0.001
PSA density (mean ± SD)	0.18 ± 0.05	0.28 ± 0.06	0.002

Table 2 shows that the Malignant cases were older (p = 0.041) and had significantly higher PSA (p < 0.001) and PSAD (p = 0.002) than benign cases. The PSAD separation supports its role as a more specific risk stratifier than absolute PSA, particularly for decision-making around indeterminate (PI-RADS 3) lesions."

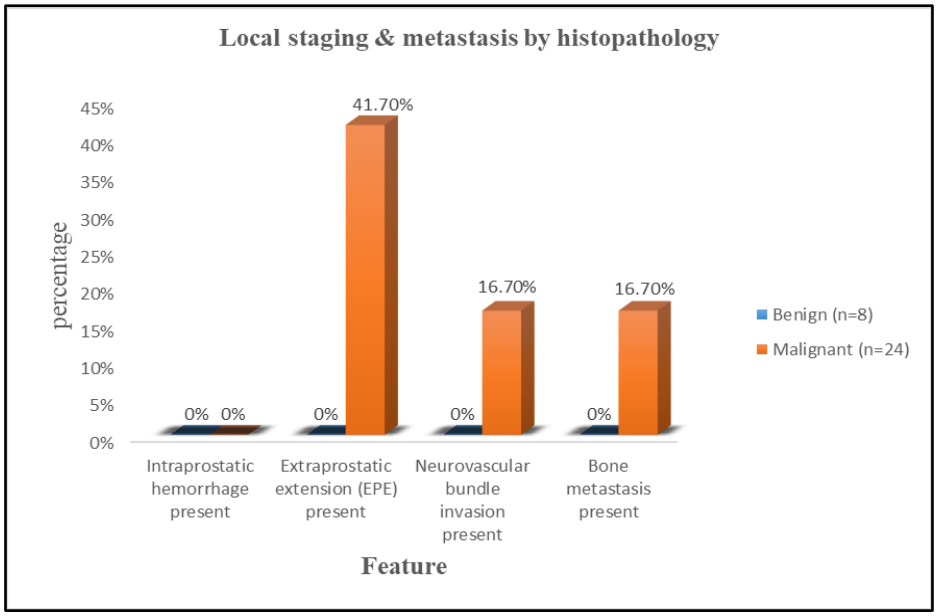


Figure 2: Local staging & metastasis by histopathology

In Figure 2, Extraprostatic extension (41.7%) and neurovascular bundle invasion (16.7%) occurred exclusively in malignant disease, reinforcing their specificity for locally advanced cancer. Bone metastases (16.7%) were confined to malignant cases and reached statistical significance ($p = 0.049$). Intraprostatic hemorrhage was absent across the cohort, excluding post-biopsy artifact as a confounder for MRI interpretation.

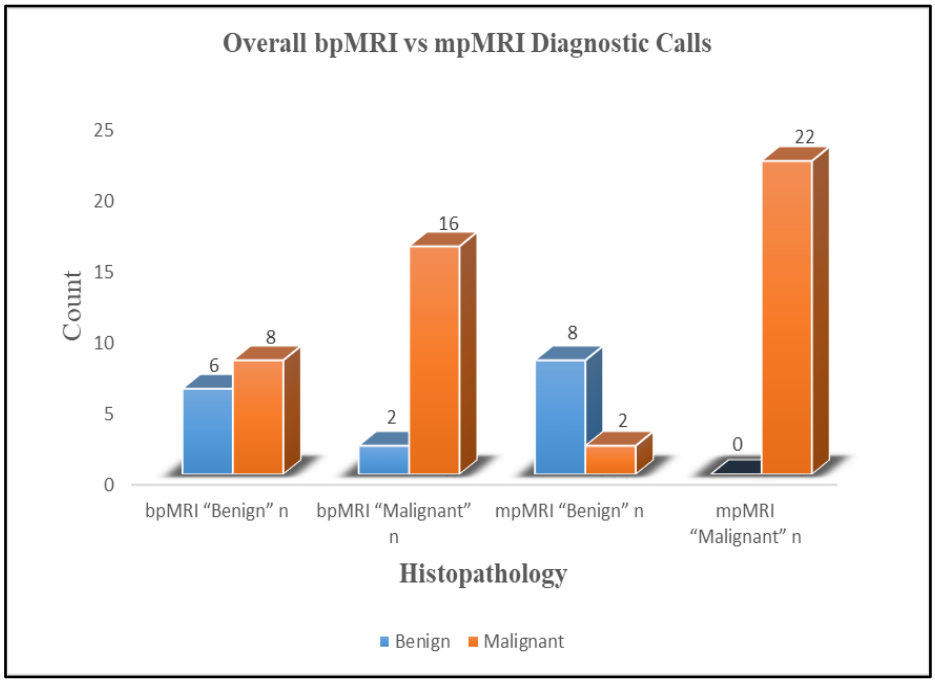


Figure 3: Overall bpMRI vs mpMRI Diagnostic Calls

In Figure 3, compared with bpMRI, mpMRI demonstrated significantly superior diagnostic performance. bpMRI correctly identified 75.0% of histologically benign cases and 66.7% of malignant cases, whereas mpMRI achieved 100% specificity (no false positives) and 91.7% sensitivity for malignancy. The paired analysis (McNemar $p = 0.039$) confirms the incremental value of adding dynamic contrast enhancement, resulting in a marked improvement in overall diagnostic accuracy.

CASE 1: 65 YEAR MALE WITH PSA- 66.48 NG/DL (INCREASED)

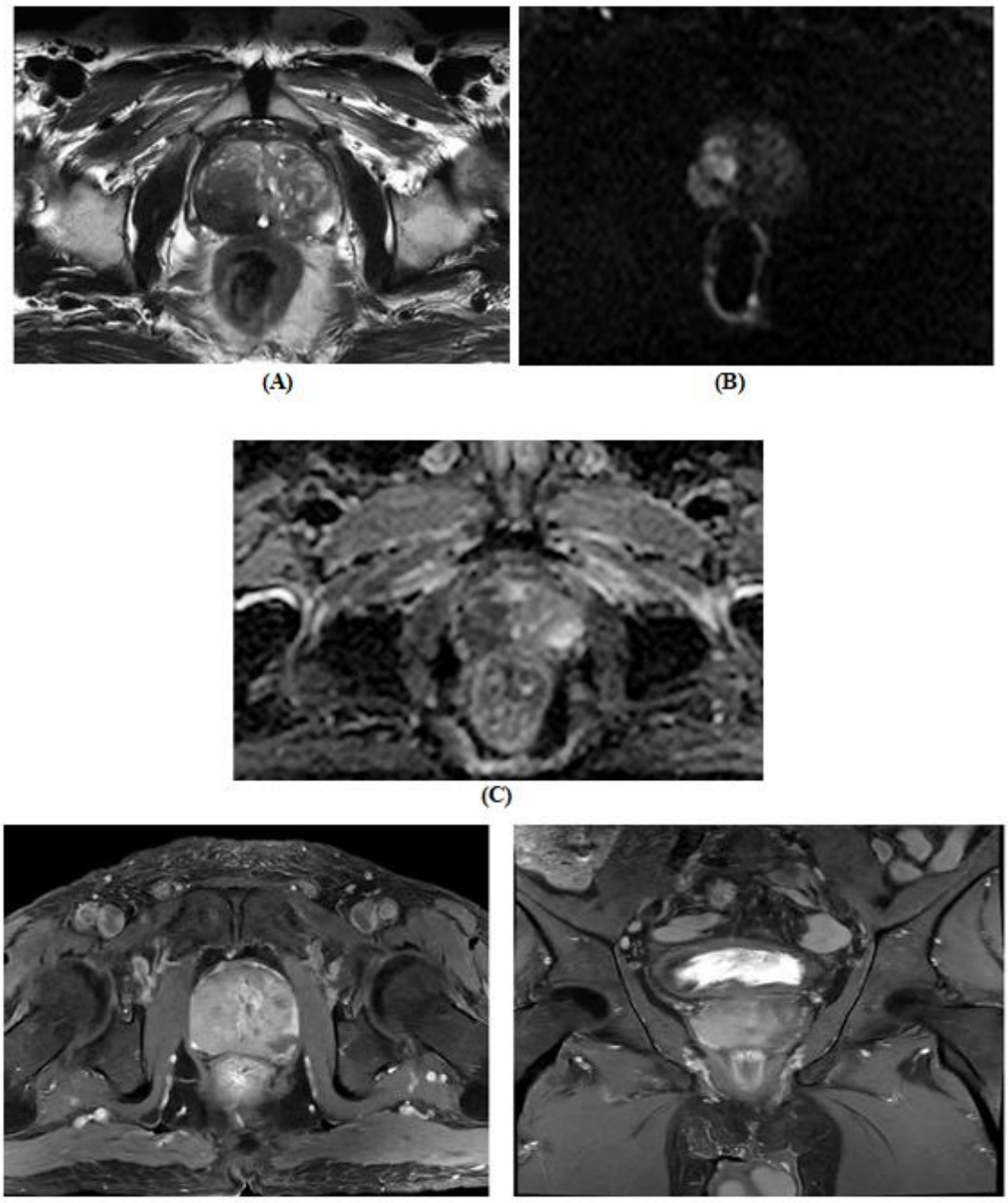


Figure: A-T2W axial, B-DWI at b 2000 axial, CADC map axial, Post contrast T1 axial and COR

Peripheral zone: Focal T2 hypointense lesion in the right peripheral zone showing restricted diffusion on DWI with early post-contrast enhancement.
Transition zone: Continuity of the lesion extending into the right transition zone.
Histopathology -Acinar adeno carcinoma
BpMRI-PIRADS 5
MpMRI-PIRADS 5

Case 2. 72 year male with PSA -42ng/dl (increased)

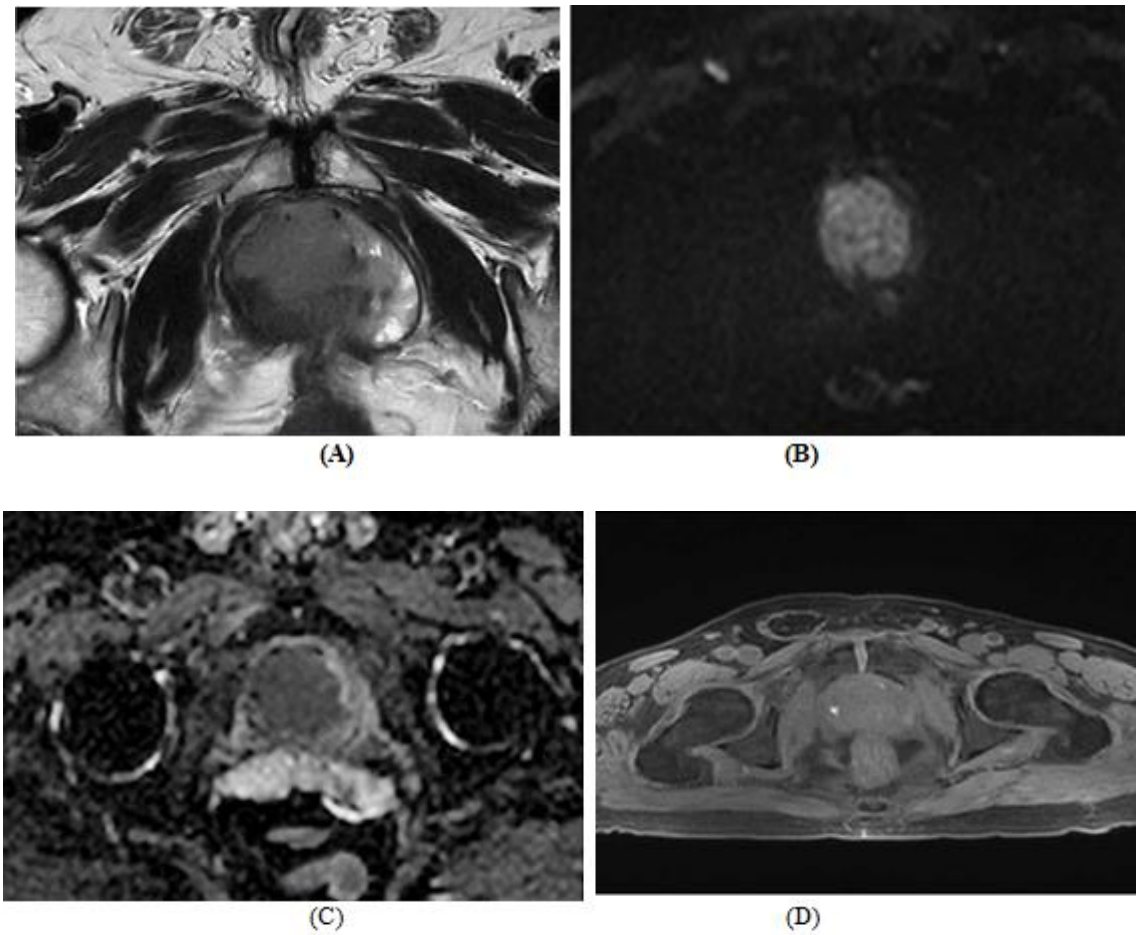


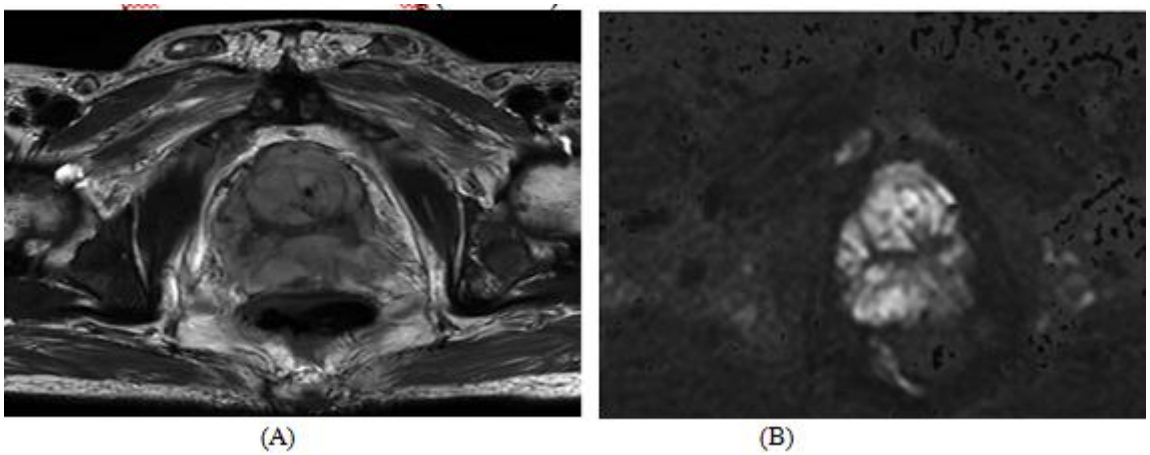
Figure: A T2W axial, B DWI at b 2000 axial, C ADC map axial, D Post contrast T1 axial

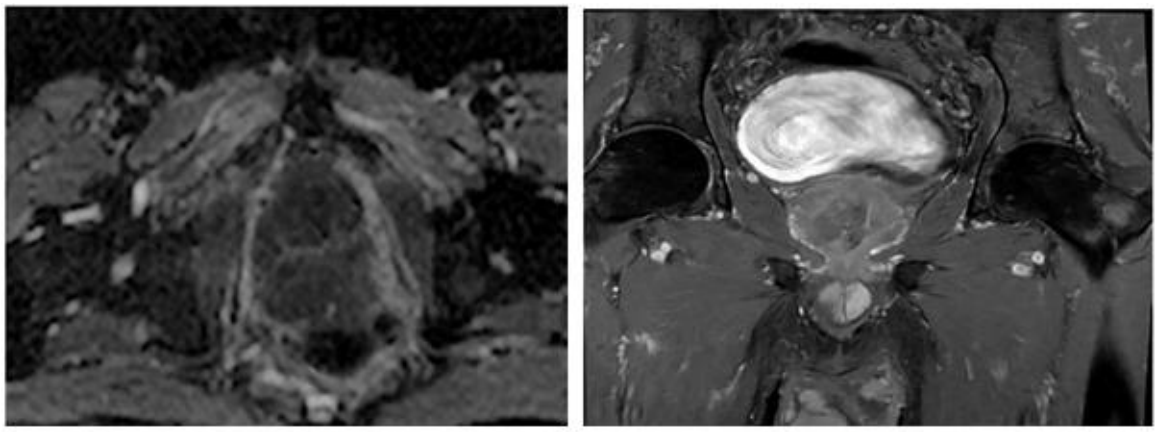
Peripheral zone: Large ill-defined lobulated T2 hypointense lesion in the right peripheral zone, demonstrating restricted diffusion on DWI with subtle early post contrast enhancement.

Transition zone: Extension of the above lesion into the bilateral transition zones.

Histopathology -Acinar adeno carcinoma
BpMRI-PIRADS 5
MpMRI=PIRADS 5

Case3- 60 yrs male with PSA 1800 ng (increased)



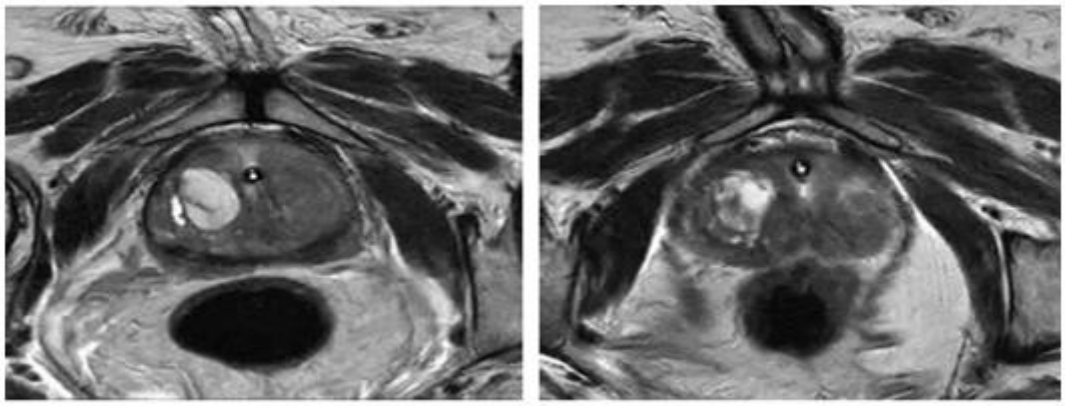


(C) (D)

Figure: A T2W axial, BDWI at b 2000 axial, C ADC map axial, D Post contrast T1 coronal

Prostate: Large infiltrative lesion of heterogeneous signal intensity on T2-weighted images, showing restricted diffusion on DWI with early post-contrast enhancement, involving the entire prostatic parenchyma (peripheral, central, and transition zones).
Histopathology -Acinar adeno carcinoma
BpMRI-PIRADS 5
MpMRI-PIRADS 5

Case 4. 74 years male with PSA ~44ng(increased)



(A)

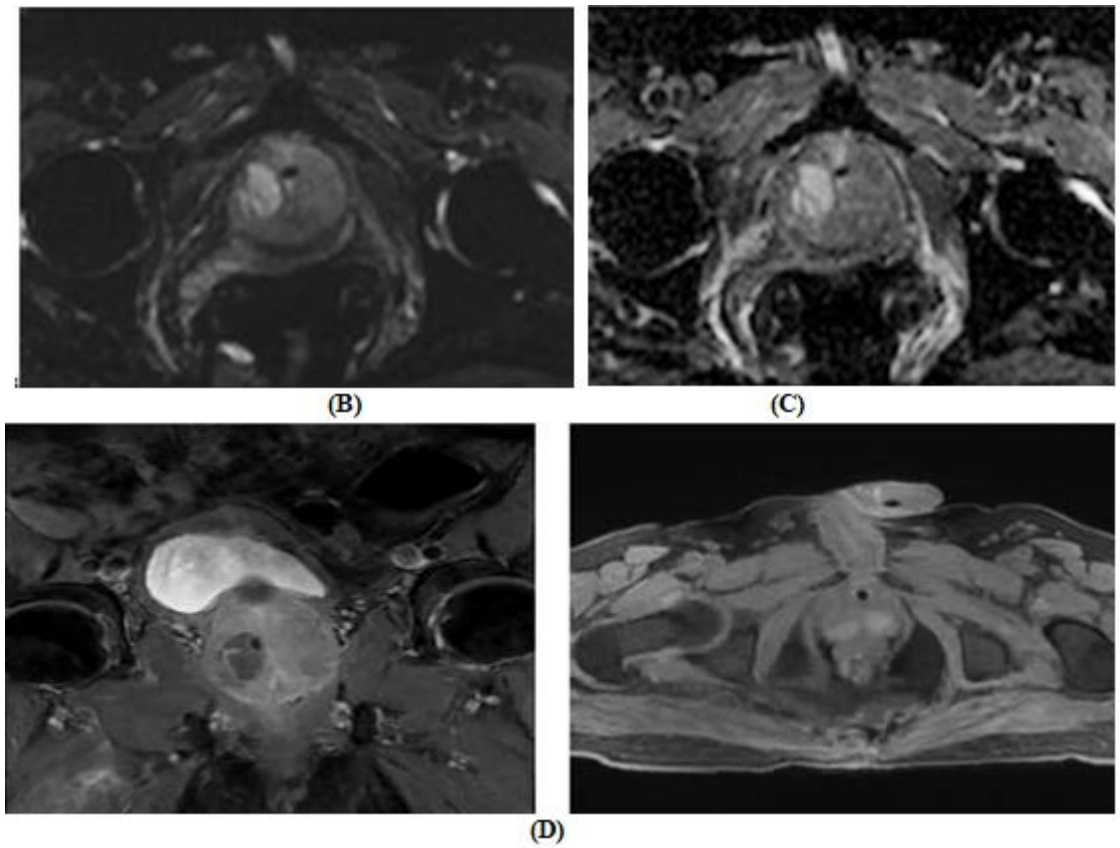


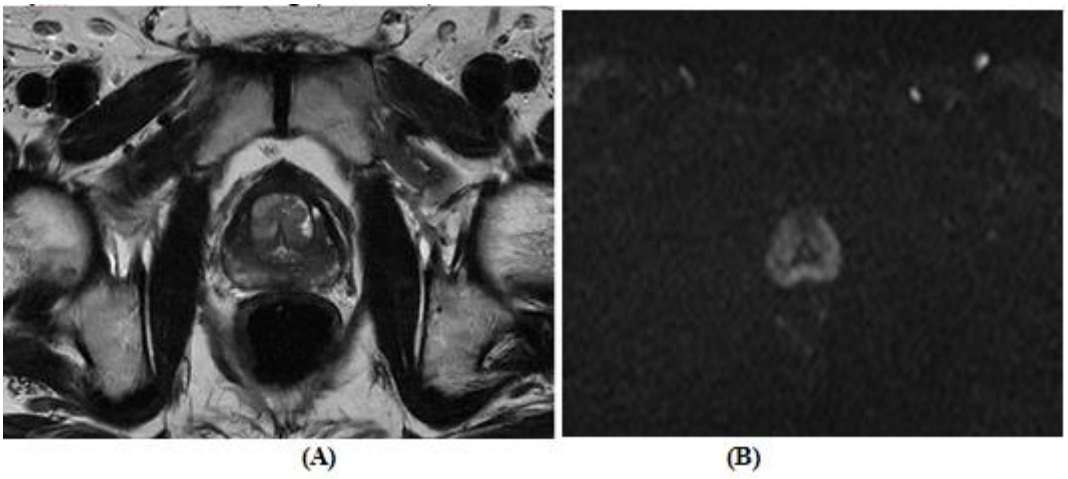
Figure: A T2W axial, B DWI at b 2000 axial, C ADC map axial, D Post contrast T1 axial and coronal

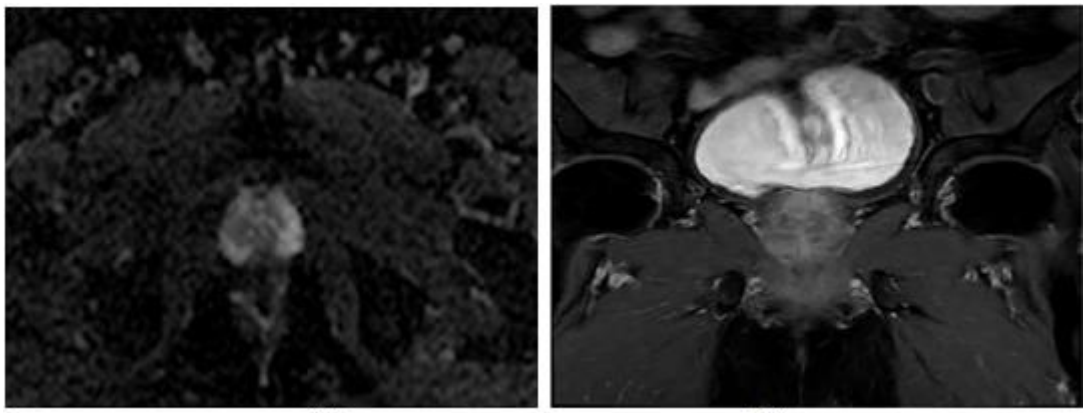
Transitional zone: Oblong T2 hyperintense cystic lesion along with a T2 hypointense lesion, both without diffusion restriction on DWI. Early post-contrast enhancement noted on the left side.
BpMRI -PIRADS 2
MpMRI- PIRADS 2

Peripheral zone: Two well-circumscribed T2 hypointense lesions at the apex bilaterally, demonstrating restricted diffusion and early post-contrast enhancement.
BpMRI-PIRADS 3
MpMRI-PIRADS 4

Histopathology -Chronic active Xanthogranulomatous prostatitis

Case 5, 73 yrs male with PSA-14ng (increased)





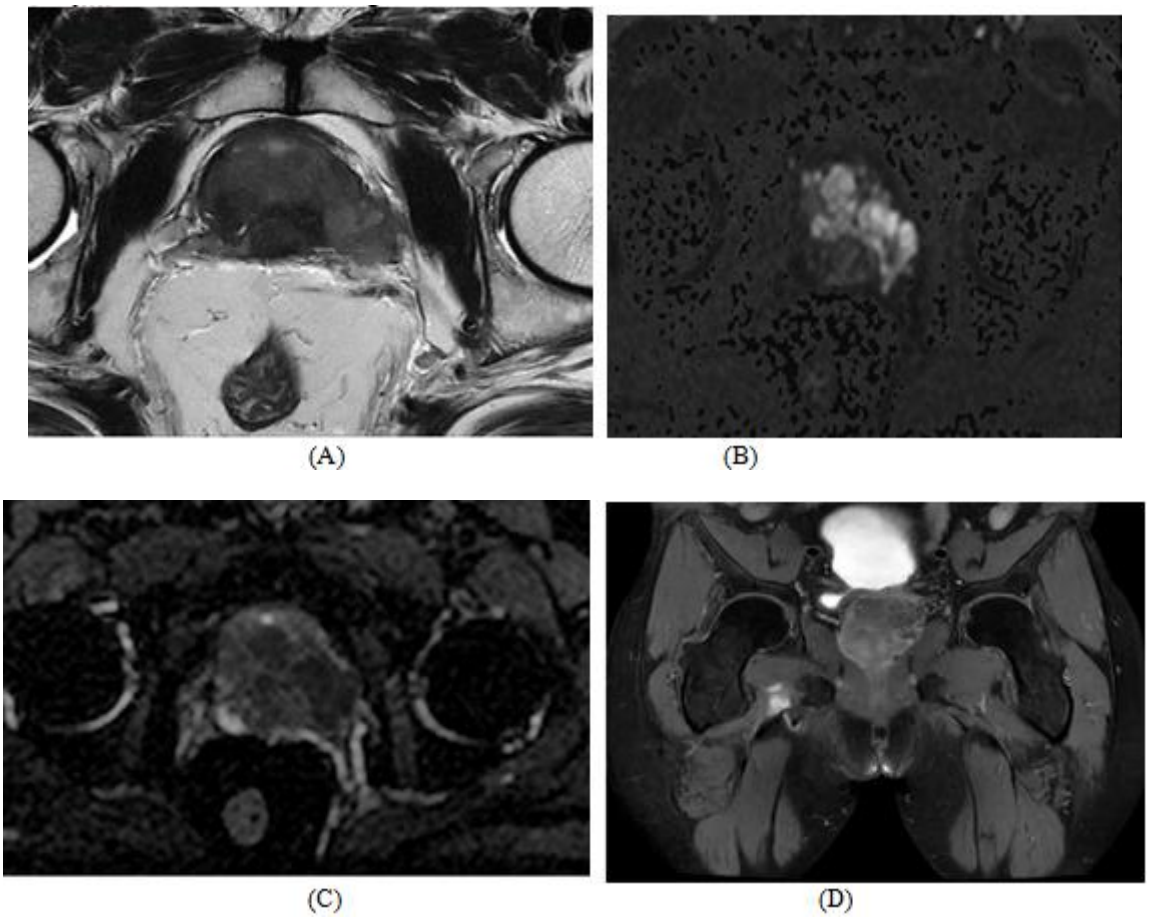
(C) (D)

Figure: A T2W axial, B DWI at b 2000 axial, C ADC map axial , D Post contrast coronal

Peripheral zone (apex, right): Well-defined small T2 hypointense lesion at the apex of the right peripheral zone, demonstrating restricted diffusion on DWI with subtle post-contrast enhancement.
BpMRI- PIRADS 3
MpMRI-PIRADS 4

Histopathology-Acinar adenocarcinoma

Case 6. 60 yrs male with PSA 103.7ng



(A) (B)

(C) (D)

Figure: A T2W axial, BDWI at b 2000 axial, C ADC map axial, D Post contrast coronal

Peripheral zone: Reduced in bulk with heterogeneous T2 hypointensity. An ill defined lobulated lesion is seen at the base in the left posterior sector (PZp), demonstrating extraprostatic extension with infiltration of the left neurovascular bundle and abutment of the left seminal vesicle. The lesion appears hypointense on T2, shows restricted diffusion with corresponding low signal on ADC, and demonstrates post-contrast enhancement.

BpMRI-PIRADS 5
MpMRI-PIRADS-5

Transition zone: Appears bulky with heterogeneous T2 hypointensity. Multiple ill defined T2 hypointense lesions are scattered in both lobes, showing diffusion restriction on high b-value DWI with corresponding low signal intensity on ADC, and demonstrating early post-contrast enhancement.

BpMRI-PIRADS 5
MpMRI-PIRADS 5

Histopathology-Acinar adenocarcinoma

DISCUSSION

In the present study, mpMRI demonstrated higher diagnostic performance than bpMRI, with "sensitivity, specificity, and accuracy of 91.7%, 100%, and 93.8%, respectively", compared to 66.7%, 75%, and 68.8% for bpMRI. These findings align with Sherrer et al. (2019)[8], who reported comparable detection rates but emphasized the slightly superior yield of mpMRI for clinically significant lesions. Similarly, Di Campli et al. (2018)[9] found no major difference in AUC (0.68–0.72 vs 0.54–0.72), supporting bpMRI's utility with reduced time and contrast. Woo et al. (2018)[10] also noted nearly equivalent pooled sensitivity (0.74 vs 0.76) and specificity (0.90 vs 0.89). The significant PSA elevation (15.3 ± 3.4 ng/mL, $p<0.001$) and PSA density (0.28 ± 0.06, $p=0.002$) in malignant cases reinforce strong histopathological correlation, uniquely confirming mpMRI's superior diagnostic precision in this dataset. mpMRI showed superior diagnostic concordance with histopathology compared to bpMRI, correctly identifying 91.7% malignant and 100% benign cases ($p=0.039$), while bpMRI achieved 66.7% and 75%, respectively. These results correspond with Sherrer et al. (2019)[8], who observed that dynamic contrast minimally enhanced detection yet improved accuracy in ambiguous cases. Similarly, Di Campli et al. (2018)[9] reported comparable diagnostic reliability across MRI protocols, with mpMRI showing marginally better lesion delineation. Woo et al. (2018)[10] further confirmed equivalent pooled diagnostic performance (sensitivity 0.76 vs 0.74), consistent with the current findings. Unique to this dataset, extraprostatic extension (41.7%), neurovascular invasion (16.7%), and bone metastasis (16.7%, $p=0.049$) were observed exclusively in malignant cases, underlining mpMRI's higher sensitivity for local staging and metastatic assessment relative to bpMRI.

CONCLUSION

Multiparametric MRI (mpMRI) demonstrated superior diagnostic accuracy over biparametric MRI (bpMRI) in evaluating prostate carcinoma, with higher sensitivity (91.7%), specificity (100%), and accuracy (93.8%). The addition of dynamic contrast enhancement improved lesion characterization and staging, particularly for detecting extraprostatic extension, neurovascular invasion, and bone metastases. Although bpMRI is a faster and more economical option, its precision in advanced disease is limited. Thus, mpMRI remains the preferred modality for comprehensive prostate cancer assessment, while bpMRI serves as a practical alternative in resource-constrained settings.

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Funding: *None.*
Ethical Approval: *Obtained.*

Consent: *Written consent secured."*

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