



ROLE OF MRI IN PROSTATE PATHOLOGY

Radiology

Dr. Kanishka Muneshwar*	Junior Resident III, Dept Of Radiology, GMCH Chhatrapati Sambhajnagar Maharashtra, India *Corresponding Author
Dr. Ajay Vare	Associate Professor, Department Of Radiology, GMCH Chhatrapati Sambhajnagar Maharashtra, India
Dr. Varsha Rote Kaginalkar	Prof & HOD, Department Of Radiology, GMCH Chhatrapati Sambhajnagar Maharashtra, India
Dr. Anjali Pawar Dahiphale	Associate Professor Department Of Radiology, GMCH Chhatrapati Sambhajnagar Maharashtra, India
Dr. Prashant Titare	Associate Professor Department Of Radiology, GMCH Chhatrapati Sambhajnagar Maharashtra, India

ABSTRACT

The high incidence of prostate cancer, combined with earlier detection and downstaging at the time of diagnosis and slow natural progression and biological heterogeneity of the disease has made its management a complex and controversial issue. Prostate tumours have a slow growth rate and allow for prolonged survival. MRI findings are significant pre-surgical predictors in patients with extracapsular extension in prostate cancer with augmentative value to clinical variable. The observational prospective study was conducted over a period of two year from July 2022 to June 2024 at the department of radiodiagnosis in a tertiary care centre among patients with difficulty in micturition and other urinary complaints referred from surgery department for MRI Prostate. Total 60 patients were enrolled in this study over the period of two year. About 30 patients had prostate carcinoma followed by 24 patients had BPH & only six patients had prostate abscess on HP examination. MRI had 100% accuracy to diagnose prostate abscess & overall accuracy was 91.67%. Overall sensitivity of MRI for prostate pathology was 0.93 & specificity was 0.94. We conclude that, our study aligns closely with previous research while showing potential improvements in specific diagnostic metrics, which may contribute to a more accurate and reliable diagnosis of prostate pathologies using mpMRI.

KEYWORDS

Prostate cancer, MRI, PSA level

INTRODUCTION:

The major goal for prostatic cancer (PC) imaging is more accurate disease characterization through the synthesis of anatomic, functional and molecular imaging information (1). The high incidence of prostate cancer, combined with earlier detection and downstaging at the time of diagnosis and slow natural progression and biological heterogeneity of the disease has made its management a complex and controversial issue. Prostate tumours have a slow growth rate and allow for prolonged survival (2).

The downstaging resulting from prostatic serum antigen (PSA) screening has been accompanied by an unfortunate trend of over detection and over treatment of biologically indolent (low-grade, clinically insignificant) disease. Primary therapies with curative intent (surgery or radiation) provide excellent long-term cancer control, but accompanied by a risk of treatment – related morbidity (2). The real challenge for physicians is to differentiate patients with advanced cancer and increased risk of morbidity/ mortality from those who will not require immediate or possibly delayed and therapeutic intervention (2).

There are a number of clinical parameters and clinical nomograms to help with the choice of treatment. Defining low risk is the value of prostate serum antigen (PSA) less than 10ng/ mL, Gleason score of 6 and lower, T stage of T2a or lower. High risk is defined as PSA value of more than 20ng/mL, Gleason score of 8 or higher or T2c, intermediate risk is defined as PSA of 10-20ng/mL, T2b, Gleason score of 7. The Partin staging nomogram is based on clinical stage, Gleason score, serum PSA level, nomograms are widely used for giving a prediction of the final pathologic stage, disease recurrence and estimate of biological potential. Other types of nomogram, such as Kattan's nomograms have been developed to predict stage, recurrence, biological potential (3).

Nomograms are limited by the lack of results from imaging studies that could guide interventions to control local disease. A sensitive and specific enough imaging modality is needed to help differentiate between patients with insignificant disease and patients in need of treatment. This might also decrease the need for biopsies or significantly lower the number of biopsy cores needed. Magnetic resonance imaging (MRI) is able to provide detailed anatomical

images due to high spatial resolution, superior contrast resolution and multiplanar capability (4).

In the last decade MRI has improved significantly in technology and reader experience. Newer techniques, such as MR spectroscopic imaging (MRSI), dynamic contrast enhanced MRI (DCE-MRI), perfusion MRI, diffusion weighted imaging (DWI), high-field strength scanning, image postprocessing and picture and communication systems (PACS) improved interpretation of MR prostate cancer images. MRI and MRSI can evaluate tumour aggressiveness, SI ratios from T2WI and biochemical data from MRSI correlate with the Gleason score for PC Gleason score. Recent studies demonstrate that MRI derived parameters (apparent diffusion coefficient [ADC] and T2-relaxation time) on 3.0 T system correlate with prostate tumour cellularity (5).

MRI provides noninvasively cancer staging, its biological potential, treatment planning, therapy response and local recurrence. MRSI identifies prostate cancer by an increased ratio of choline plus polyamines plus creatine to citrate, citrate level is reduced and choline level elevated in prostate cancer. DWI measures the Brownian motion of water molecules in tissues, while increased cellularity restricts water diffusion. ADC derived from DWI, demonstrates reduced ADC values and increased fractional anisotropy (FA) in prostate cancer. DCE-MRI visualises tumour perfusion and capillary wall permeability and hydrostatic pressure (6).

Tumor Localisation: The staging of PC is based on tumour, node and metastasis (TNM) staging. The latest modification was made in 2010 by the American Joint Committee on Cancer (AJCC). Most important is distinguishing between patients with pathologically organ-defined prostate cancer (pT2) with good prognosis from those with non-confined prostate cancer (pT3-4). Once the cancer extends outside the prostate, the chances of cure are substantially diminished (2).

A prospective study of 27 patients (MRI-MRSI group and staging nomograms) reported MRI had significantly higher standardized discriminant function coefficients than the Partin tables in prediction of organ-defined prostate cancer (2). MRI criteria for extracapsular extension include a contour deformity with a step-off or angulated

margin, an irregular bulge or edge retraction, direct tumour extension through the capsule, obliteration of the rectoprostatic angle and asymmetry of the neurovascular bundles.

MRI findings are significant pre-surgical predictors in patients with extracapsular extension in prostate cancer with augmentative value to clinical variables (7). MR imaging has been reported to have a 13%–95% sensitivity and 49%–97% specificity for detection of extracapsular extension. The gold standard in 1.5 T MR system for imaging of prostate cancer is dual examination with integrate pelvic phased-array/endorectal phased array.

In 3.0T MR the recent advances with faster imaging sequences, more powerful gradient coils, post-processing correction are able to exclude using the endorectal coil, surface phased-array coil is equivalent to endorectal coil in 3.0 T system (8)(9). However, it is expected, though not yet proven that the use of an endorectal coil at 3.0 T will allow better prostate cancer detection. A surface phased-array coil MRI accurately stages prostate cancer with elevated risk of extra prostatic disease. This mode of imaging may be reasonable at centres that do not have endorectal coil MRI(10). So, this study aimed to study the role & diagnostic accuracy of MRI in prostate pathology.

MATERIAL & METHOD

The observational prospective study was conducted over a period of two year from July 2022 to June 2024 at the department of radiodiagnosis in a tertiary care centre among patients with difficulty in micturition and other urinary complaints referred from surgery department for MRI Prostate. Total 60 patients were enrolled in this study. All patients having significant findings on MRI Prostate selected randomly. Patient with absolute contraindication of MRI, claustrophobia, allergy to contrast, deranged KFT, not feasible for follow up & not giving consent were excluded.

After research ethical approval & informed written informed consent from each patient, detailed clinical history and clinical examination findings were obtained. Study was conducted and any subject participating in the study was given full rights to leave the study at any time. No identity was disclosed of any subject participating in the study. Care was taken to see to it that no patients were harmed for the purpose of study. All patients underwent MRI prostate. The examination was done using 3.0 T GE Discovery 750W MRI. The imaging system is enclosed in a radio frequency room. The patients were examined in the tunnel of the machine in supine position & gadolinium contrast 0.2ml/kg administered intravenously. The patients were questioned about history of intracranial surgical clips, cardiac pacemakers, cochlear implants and metallic objects in the body before MR examination. Tissues for histological analysis were obtained at biopsy or at surgical tumor resection Histopathological studies were carried out at the Pathology department of our tertiary care, teaching hospital. Final diagnosis was made based on clinical & laboratory findings or at surgery & histopathology / biopsy.

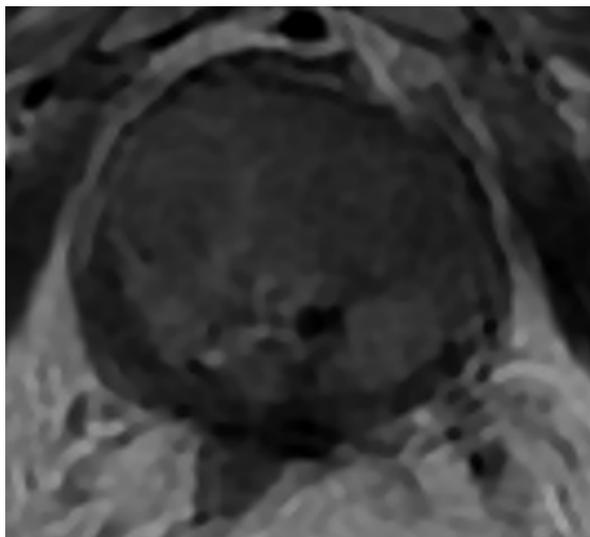


Image 1 : T2 Axial section shows a large hypointense area (erased charcoal appearance) in transitional zone in anterior half in both sides with focal bulge in capsule on left side.

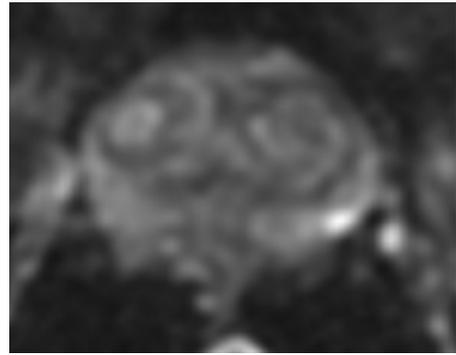


Image 2 : Axial DWi (b value 1400) show hyper intensity in bilateral transition and peripheral zones.

RESULTS:

Total 60 patients were enrolled in this study over the period of two year. About 35 patients belonged to the age group of 61-70 years followed by 71-80 years (16 Patients) & 51-60 years (9 patients). About 30 patients had prostate carcinoma followed by 24 patients had BPH & only six patients had prostate abscess on HP examination. (Table 1)

On MRI, among 38% patients had BPH followed by 27% had lesion in PZ & 25% had lesion in TZ (Fig 1)

Fig 2 shows PSA level in different prostate pathology. Fig 3 shows, about 23 patients had PIRADS SCORE 1.

Table 1: Clinico-social parameter

Parameter	Frequency	
Age Group	51-60	9
	61-70	35
	71-80	16
Histopathological Diagnosis	BPH	24
	Prostate abscess	6
	Prostate Carcinoma	30

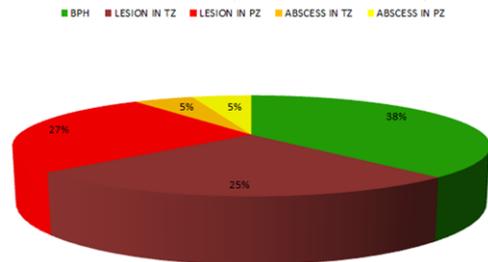


Fig 1: Mri Findings Distribution

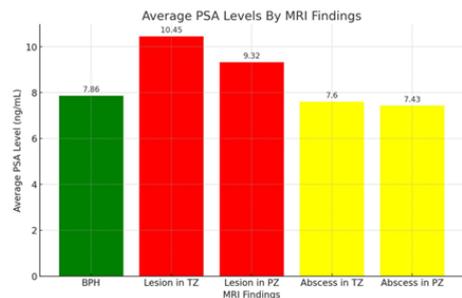


Fig 2: Mri Findings And Psa Level correlation

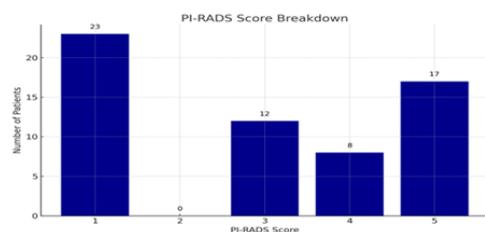


Fig 3: Pirads score breakdown

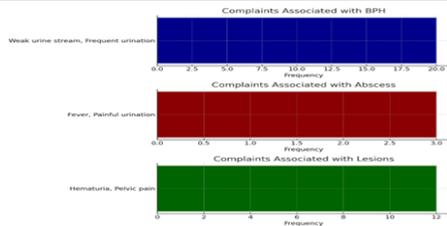


Fig 4: Complaints Associated With Mri Findings

Fig 4 shows, patients with BPH complaining of weak urine stream & frequent urination. Patients with prostate abscess presented with fever & painful urination.

Table 2 : Sensitivity, Specificity, PPV & NPV of MRI in different prostate pathology

Prostate Pathology	Sensitivity	Specificity	PPV	NPV	Accuracy
BPH	0.9091	0.9211	0.8696	0.9459	91.67%
Prostate Abscess	1	1	1	1	100%
Prostate Carcinoma	0.9063	0.9286	0.9355	0.8966	91.67%
Overall	0.9385	0.9499	0.935	0.9475	91.67%

Table 2 shows, MRI had 100% accuracy to diagnose prostate abscess & overall accuracy was 91.67%. Overall sensitivity of MRI for prostate pathology was 0.93 & specificity was 0.94.

DISCUSSION:

The most frequent complaint associated with BPH is "Weak urine stream and Frequent urination." This is consistent with the symptoms typically observed in patients with BPH, where the enlarged prostate causes obstruction in the urinary flow, leading to a weak stream and increased frequency of urination. Patients with BPH generally have mildly elevated PSA levels, though not as high as those with prostate carcinoma. In this dataset, PSA levels for BPH patients range from 5.8 to 11.0 ng/mL, with most around 6 to 10 ng/mL. The MRI findings confirm the diagnosis of BPH in these cases, with no sign

Patients with abscesses typically presented with "Fever and Painful urination." This reflects the inflammatory nature of abscesses, which often present with systemic symptoms like fever and localized pain due to infection. PSA levels in patients with abscesses are variable but generally in the mid-range, indicating inflammation rather than malignancy. The PSA levels for abscess patients in this dataset range from 5.4 to 9.0 ng/mL. MRI shows the presence of abscesses in various zones of the prostate (TZ and PZ), with lesion sizes ranging from 18 to 22 mm. These findings help differentiate abscesses from other types of lesions, like those seen in carcinoma.

The most frequent complaint associated with lesions, particularly those indicative of carcinoma, is "Hematuria and Pelvic pain." This symptomatology is concerning and warrants further investigation, as it often correlates with malignant changes in the prostate. PSA levels are notably higher in patients with lesions compared to those with BPH or abscesses, ranging from 7.1 to 14.5 ng/mL, reflecting the potential malignancy. The lesions are often found in the transitional zone (TZ) or peripheral zone (PZ) of the prostate, with significant lesion sizes (up to 30 mm) and high PI-RADS scores (3 to 5), which are strongly suggestive of prostate carcinoma. The correlation between high Gleason scores and the presence of large, high-grade lesions supports the aggressive nature of the disease in these patients. The patients in the dataset range from 54 to 75 years old. As age increases, so does the likelihood of elevated PSA levels, a common finding in older men due to prostate enlargement, inflammation, or malignancy. Older patients tend to have higher PSA levels. For instance, patients aged 70 and above often exhibit PSA levels above 10 ng/mL, which may indicate a higher risk for prostate carcinoma or significant prostatic conditions. Younger patients (around 54-60 years) tend to have lower PSA levels, though there are exceptions based on individual conditions.

Symptoms like "Hematuria and Pelvic pain" are often associated with higher PSA levels and more severe prostate conditions, particularly in older patients. On the other hand, "Weak urine stream and Frequent urination" are more common in younger to middle-aged men with lower PSA levels, typically indicating BPH. Age and PSA levels, when correlated with specific complaints, provide valuable insights for clinical decision-making. They help in differentiating between benign

conditions like BPH and more serious conditions such as prostate carcinoma, guiding the appropriate diagnostic and therapeutic approaches.

Weak urine stream & frequent urination is commonly associated with Benign Prostatic Hyperplasia (BPH) and is observed across a wide age range, particularly in men aged 55-70. The PSA levels in these cases are generally between 5.8 to 10.5 ng/mL, suggesting mild to moderate prostate enlargement. **Hematuria and Pelvic Pain** often indicative of more severe prostate issues such as carcinoma, is predominantly found in older patients (generally over 60). PSA levels in these cases are markedly higher, ranging from 7.5 to 14.5 ng/mL, reflecting a greater likelihood of malignancy. **Fever and Painful Urination** is less common but significant, often associated with prostate abscesses. Patients presenting with this symptom tend to have moderate PSA levels (around 5.4 to 9.0 ng/mL), suggesting an inflammatory process rather than a malignant one.

Present study demonstrates slight improvements in sensitivity and specificity compared to the Nguyen & Patel (2022) (11) study, suggesting that the diagnostic performance of mpMRI for prostate pathologies has seen marginal advancements. These improvements might be reflective of technological progress, enhanced imaging protocols, or a more rigorous diagnostic process in your study. However, the slight decrease in overall accuracy indicates that there may still be room for further optimization in the diagnostic process, possibly through a more homogeneous study population or refined diagnostic criteria.

CONCLUSION

- **BPH:** Patients with BPH predominantly experience obstructive urinary symptoms without significant lesions, reflected by lower PSA levels and benign MRI findings.
- **Abscess:** Patients with abscesses present with systemic and urinary symptoms, with MRI confirming localized collections of infection within the prostate.
- **Lesions/Carcinoma:** Hematuria and pelvic pain are alarming symptoms often associated with malignant lesions, supported by high PSA levels, significant MRI findings, and high Gleason scores in histopathology.

So we conclude that, our study aligns closely with previous research while showing potential improvements in specific diagnostic metrics, which may contribute to a more accurate and reliable diagnosis of prostate pathologies using mpMRI.

REFERENCES:

1. Hricak H, Choyk PL, Eberhardt S, Leibel SA, Scardino PT. Imaging prostate cancer: a multidisciplinary perspective 2007. *Radiology*, pp. 243:28-53.
2. L., Wang. Incremental value of magnetic resonance imaging in the advanced management of prostate cancer. 2009, *World J Radiology*, pp. 31:3-14.
3. Kattan MW, Scardino PT. Prediction of progression: nomograms of clinical utility. *Clin Prostate Cancer*. 2002 and 1:90-6. 2002, pp. 1:90-6.
4. Claus FG, Hricak H, Hattery RR. Pretreatment evaluation of prostate cancer: role of MR imaging and 1 H MR spectroscopy 2004. *Radiographics*, p. 24:Suppl1:16780.
5. Giusti S, Caramella D, Fruzzetti E, Lazzereschi M, Tognetti A, Bartolozzi C. Peripheral zone prostate cancer. Pre-treatment evaluation with MRI and 3D (1)H MR spectroscopy imaging: correlation with pathologic findings. 2010. *Abdom Imaging*, pp. 35:757-63.
6. Wang L, Van den Bos IC, Hussain SM, Pattynama PM, Vogel MW, Krestin GP. Post-processing of dynamic gadolinium-enhanced magnetic resonance imaging exams of the liver: explanation and potential clinical applications for colour-coded qualitative and quantitative analysis 2008. *Acta Radiol*, pp. 49:6-18.
7. Wang L, Mullerad M, Chen HN, Eberhardt SC, Kattan MW, Scardino PT, Hricak H. Prostate cancer: incremental value of endorectal MR findings for prediction of extracapsular extension 2004. *Radiology*, pp. 232:133-9.
8. Futterer JJ, Engelbrecht RM, Jafer JG, Hartman RP, King BF, Hulsbergen-Van de Kaa CA, Witjes JA, Barents JO. Prostate cancer: comparison of local staging accuracy of pelvic phased - array coil versus integrated endorectal - pelvic phased-array coils. 2007. *Eur Radiol*, pp. 31(4):534-8.
9. Park BK, Kim B, KimCK, Lee HM, Kwon GY. Comparison of Phasedarray 3.0T and endorectal 1.5T magnetic resonance imaging in the evaluation of local staging accuracy for prostate cancer. 2007. *Comput Assist Tomogr*, pp. 31(4):534-8.
10. Kim B, Breau RH, Papadatos D, Fergusson D, Doucette S, Cagiannos I, Morash C. Diagnostic accuracy of surface coil magnetic resonance imaging at 1.5T for local staging of elevated risk prostate cancer 4:257-62.
11. Nguyen, T., & Patel, M. Targeted biopsy combined with mpMRI: A new standard in prostate cancer diagnosis. 2022, *Journal of Urology*, pp. 58(5), 317-325