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Original Research Article

# Multiparametric Prostate MRI and Histopathological Correlation

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**Abstract**

**Background and Objectives:** The selection of one of the many potential treatments is made easier by early identification of prostatic lesions and malignancies, which can also result in improved treatment outcomes. Historically, transrectal ultrasonography (TRUS) guided biopsy, prostate-specific antigen assay (PSA), and digital rectal examination (DRE) have all been used to diagnose them. Only a biopsy can be used to confirm a prostate cancer diagnosis, however even this procedure has several drawbacks and restrictions. Due to these drawbacks of the currently available techniques, researchers have begun to consider the use of radiological imaging techniques, particularly multiparametric MRI (MP-MRI), which has additional benefits over standard MRI. The radiological diagnosis of prostate cancer is aided by multiparametric MRI, which also provides biopsy guidance. Also, it aids in the assessment of the disease's degree of involvement. Additionally, it helps in determining which of the many treatment options to choose from and predicting the results of the treatment.

This study aims to assess the effectiveness of multiparametric MRI as a non-invasive inquiry in prostate lesion detection and characterization.

**Methodology:** All patients undergone MRI prostate and subsequently TRUS guided biopsy at dept. of radiology, Bansal Hospital, Shahpura, Bhopal were included in study. All patients were subjected to inclusion and exclusion criteria, recruited to study. PIRADS score, that we got from MP-MRI was compared with histopathological score i.e., Gleason's score.

Data was compiled and Association of PI-RADS and Gleason score with age was observed using ANOVA test. Assessment of relationship of PI-RADS & Gleason's score was done by Spearman correlation coefficient.

**Results and Conclusion:** As observed, in patients with raised PSA level multiparametric MRI PIRADS scoring is beneficial, being non-invasive and convenient for diagnosis for prostatic lesions. It found to have high sensitivity and specificity along with high predictive value and can recognise patients needing biopsy, it also helps in targeted biopsy as well as identifying extent and aggressiveness of malignancy.

**Keywords:** MRI, PIRADS, Prostate carcinoma, PSA, Gleason score.

## Introduction

Prostate cancer is one of the leading causes of cancer-related death in older men. Prostate cancer is another non-cutaneous cancer that affects men most frequently. Prostate cancer incidence is rising mostly as a result of increased use of screening tests and longer life expectancies. Since most prostate cancers are slow-growing and indolent rather than aggressive, they rarely show symptoms until they are advanced in stage. Hence, in addition to assisting in the selection of one of the many possible treatments, early diagnosis can result in improved treatment outcomes [1,2].

Prostate-specific antigen testing (PSA), transrectal ultrasound-guided biopsy, and digital rectal examination (DRE) have historically been used as diagnostic tools. Prostate cancer can only be definitively diagnosed through a biopsy. 8-core TRUS biopsy is typically performed. These techniques do, however, have some drawbacks and restrictions.

Given that the digital rectal examination is a crude technique with substantial inter-observer variability, it has a low positive predictive value. PSA levels are not sensitive or specific. Due to inadequate sampling of the apex, midline, and anterior prostate, numerous studies have demonstrated that TRUS biopsy can miss up to 20% of prostate malignancies [3].

The majority (about 70%) of prostate cancer biopsies originally conducted on men with elevated PSA levels are negative, which ultimately adds to the burden of negative biopsies and raises the cost of screening [4].

The need for a diagnostic method that is non-invasive, sensitive, reliable, specific, and has good positive and negative predictive values has led researchers to consider radiological imaging methods like MRI as a tool for diagnosis. In particular, multiparametric MRI (MP-MRI), which has gained considerable attention recently and offers additional benefits over standard MRI, has been the focus of this research.

The anatomical imaging in T1W and T2W pictures is combined with two functional techniques, such as diffusion weighted imaging (DWI) and dynamic contrast enhanced imaging (DCE) with or without magnetic resonance spectroscopy, to create multi-parametric MRI (MP-MRI).

Prostate cancer can be detected radiologically with the help of multiparametric MRI, which also offers real-time, cognitive TRUS guided biopsy or fusion biopsy guidance.

Moreover, MP-MRI aids in determining the degree of illness involvement, which can aid in less invasive operations. Predicting treatment outcomes and choosing from among the many treatment alternatives are also made easier with its help.

Diffusion-weighted imaging (DWI), dynamic contrast enhanced (DCE), and magnetic resonance spectroscopy (MRSI) all have promise for improving the characterisation of lesions and determining the aggressiveness of cancer in relation to low, middle, and high Gleason scores.

The preferred histological method for assessing the aggressiveness of prostate cancer is Gleason's grading system (5,6). In terms of tumour aggressiveness, it is used to categorise tumours as low grade (Gleason's score 6), intermediate grade (Gleason's score = 7), or high grade (Gleason's score > 7). Increases in Gleason's score and tumour core involvement in biopsy specimens both enhance the likelihood of the disease recurring (7,8). As a result, precise scoring is required to choose the best course of treatment.

Usual treatment options are as follows- 1- Active surveillance for low risk tumors

(Gleason's score ≤6), 2- monotherapy for intermediate risk tumors (Gleason's score = 7) and 3- combination therapy for high-risk tumors (Gleason's score, >7).

Confirmatory diagnosis of prostate cancer still done by histological examination done on a biopsy specimen and by application of Gleason Score, a system named for the pathologist Dr. Donald Gleason, who developed it in the 1960s. He observed that prostate cells come into five distinct patterns as they change from normal to tumour cells. These cells are graded on a scale of 1 to 5. Grade 1 cells are normal prostate tissue. Grade 5 cells are considered "high-grade" and have totally mutated so that they barely matches normal cells.

A Gleason grade is assigned to the most predominant pattern in biopsy sample and a second Gleason grade to the second most predominant pattern by pathologist. These two grades will be added to determine final Gleason score. Theoretically, it ranges from 2-10. However, following Dr. Gleason's original classification, pathologists almost never give scores 2-5, so range of Gleason scores will be from 6 to 10, in which 6 being the lowest grade cancer.

This study was planned to assess the efficacy of multi-parametric MRI in correlation with Gleason scores of the biopsies among the men with prostate lesions.

## Aim And Objectives

To evaluate the efficacy of Multiparametric MRI as a non-invasive investigation in detection and characterization of prostate lesions.

## Materials and Methods

Study conducted in department of radiology, Bansal Hospital, Shahpura, Bhopal, from September 2020 to August 2021. Patients selected as per inclusion and exclusion criterias. All patients undergoing MP-MRI prostate and subsequently TRUS guided biopsy

## Inclusion Criteria

- Patients undergone MRI prostate and subsequently TRUS guided biopsy
- Raised PSA levels

## Exclusion Criteria

- Patients only undergone either for MRI or TRUS guided biopsy.
- All absolute contraindications for MRI.
- Subjects unwilling for participation.

## Observation and Results

The present study entitled "Multiparametric Prostate MRI and Histopathological Correlation" was conducted on a total of 28 cases with prostatic lesions.

The mean ± SD of serum PSA level was 43.82 ± 32.5, range 8 - 110 ng/ml, median 38 and IQR 12.25 – 71.5. The mean ± SD for prostate volume 52.3 ± 20.4, range 30-102 gm, median 45 and IQR 38.25 – 54.75. The Gleason sum score ranged from 6-9 for malignant tissues reported by TRUS biopsy.

The findings of present study are described as under-

**Table 1: Distribution according to age**

| Age | Frequency (n=28) | Percentage |
|---|---|---|
| ≤ 60 | 8 | 28.6 |
| 61 – 70 | 9 | 32.1 |
| 71 – 80 | 9 | 32.1 |
| ≥ 80 | 2 | 7.1 |
| Mean | 68.04 ± 8.96 | |
| Median | 68.6 | |
| IQR | 60-75 | |
| Range | 50-84 | |

The mean age of the patients included in study was 68.04 ± 8.96 years. Median age was 68.6 years (IQR 60 – 75). The age of patients followed normal distribution. Majority of the patients (64.2%) belonged 61 to 80 years of years of age whereas 8 (28.6%) patients belonged to less than 60 years of age and only 2 (7.1%) patients were above 80 years.

**Table 2: Distribution according to prostate volume and prostate specific antigen**

| Prostate | Mean | Median | IQR | Range |
|---|---|---|---|---|
| Prostate volume | 52.3±20.4 | 45 | 38.25-54.75 | 30-102 |
| PSA (ng/ml) | 43.82±32.5 | 38 | 12.25-71.5 | 8-110 |

The prostate value and PSA did not follow normal distribution curve. Mean prostate volume was 52.3±20.4 cc and mean PSA was 43.82±32.5 ng/ml. Median prostate volume and PSA level was 45 cc (IQR 38.25-54.75) and 38ng/ml (IQR 12.25-71.5) respectively.

**Table 3: Distribution according to PI-RADS**

| PI-RADS | | Frequency (n=28) | Percentage |
|---|---|---|---|
| 3 | Intermediate | 3 | 10.7 |
| 4 | Highly Suspicious of malignancy | 13 | 46.4 |
| 5 | Very high suspicion of malignancy | 12 | 42.9 |

Out of 28 patients with prostate lesions, PI-RADS revealed that majority of lesions were highly suspicious of malignancy (46.4%) followed by 42.9% lesions with very high suspicion for malignancy. Only 3 (10.7%) had intermediate suspicion of presence of cancer as evaluated by PIRADS.

**Table 4: Distribution according to Gleason's score**

| Gleason's score | | Frequency (n=28) | Percentage |
|---|---|---|---|
| Low (n = 7) | 6(3+3) | 7 | 25 |
| Intermediate (n = 9) | 7(3+4) | 6 | 21.4 |
| | 7(4+3) | 3 | 10.7 |
| High (n = 12) | 8(4+4) | 3 | 10.7 |
| | 8(5+3) | 3 | 10.7 |
| | 9(5+4) | 6 | 21.4 |

In present study, majority (25%) of the patients with prostate lesions had low Gleason's score (GS) 6(3+3). This was followed by 21.4% each with Gleason score of 7(3+4) and 9(5+4). Only 3 (10.7%) patients each had Gleason score of 7(4+3), 8(4+4) and 8(5+3).

**Table 5: Distribution according to Gleason Score**

| Gleason | Frequency (n=28) | Percentage |
|---|---|---|
| 6 | 7 | 25 |
| 7 | 9 | 32.1 |
| 8 | 6 | 21.4 |
| 9 | 6 | 21.4 |

Out of 28 patients with prostate lesions, Gleason score was 7 in majority of cases (32.1%) indicating intermediate risk of malignancy, followed by 25% cases with low risk of malignancy. About 21.4% cases each had Gleason score of 8 and 9.

**Table 6: Association between age and Gleason's score**

| Age | Gleason score | | |
|---|---|---|---|
| | Low (n=7) | Intermediate (n=9) | High (n=12) |
| Mean | 63.14 | 67.44 | 71.33 |
| SD | 8.591 | 9.180 | 8.261 |
| 95% CI | 55.20-71.09 | 60.39-74.50 | 66.08-76.58 |
| ANOVA | 2.02 | | |
| P value | 0.15 | | |

In present study, mean age of patients with low risk of malignancy was 63.14±8.58 years and that of patients with intermediate and high risk of malignancy was 67.44±9.180 and 71.33±8.261 years respectively. Though the age of patients increased with risk of malignancy, the observed difference was statistically insignificant (p>0.05).

**Table 7: Association between age and PI-RADS**

| Age | PI-RADS | | |
|---|---|---|---|
| | Intermediate (n=3) | Highly Suspicious of malignancy (n=13) | Very high suspicion of malignancy (n=12) |
| Mean | 63.67 | 65.00 | 72.15 |
| SD | 9.180 | 8.888 | 7.625 |
| 95% CI | 48.31-71.69 | 59.96-71.04 | 68.92-77.58 |
| ANOVA | 2.98 | | |
| P value | 0.07 | | |

As with Gleason Score, suspicion of malignancy was higher in cases with advanced age group, but the difference was statistically insignificant (p>0.05).

**Table 8: Correlation of PIRADS with Gleason score**

| R | R Square | Adjusted R Square | Std. Error of the Estimate | F | P value |
|---|---|---|---|---|---|
| 0.600 | 0.360 | 0.336 | 0.897 | 14.6 | 0.001 |

The present study observed a statistically significant positive correlation ($R^2$ -0.36) of PIRADS with Gleason score, indicating as the Gleason score increase, PI-RADS score increased significantly (p<0.05).

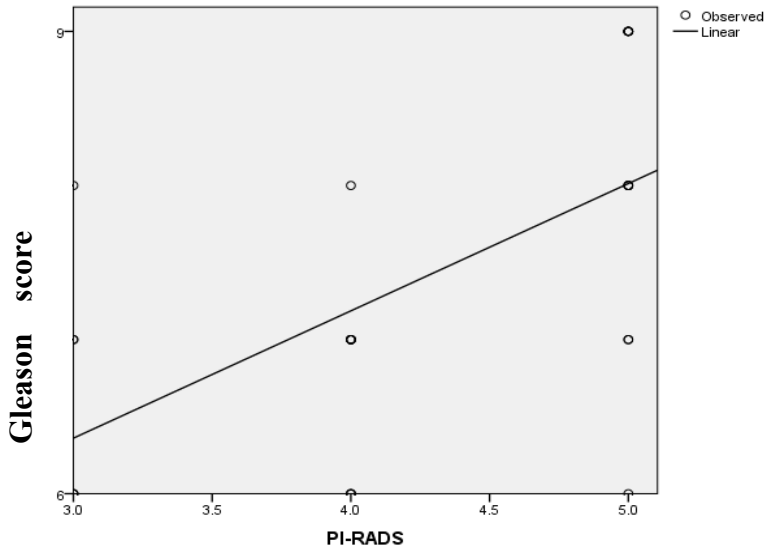



**Figure 1: Correlation of PIRADS with Gleason score**

**Table 9: Association between PI-RADS and Gleason's score**

| PIRADS | Gleason | | | Total |
|---|---|---|---|---|
| | Low | Intermediate | High | |
| Intermediate | 3 (42.9) | 0 (0) | 0 (0) | 3 (10.7) |
| Highly Suspicious of malignancy | 4 (57.1) | 7 (77.8) | 2 (16.7) | 13 (46.4) |
| Very high suspicion of malignancy | 0 (0) | 2 (22.2) | 10 (83.3) | 12 (42.9) |
| Total | 7 | 9 | 12 | 28 |
| $\chi^2$ | 12.6 | | | |
| P value | 0.014 | | | |

Out of 7 cases with low risk of malignancy as per Gleason score, 42.9% cases had intermediate risk as per Pi-RADS. Out of 12 cases with high risk of malignancy according to Gleason score, 83.3% cases had very high suspicion of malignancy according to PI-RADS. The present study documented statistically significant association of PI-RADS with Gleason score ($p<0.05$).

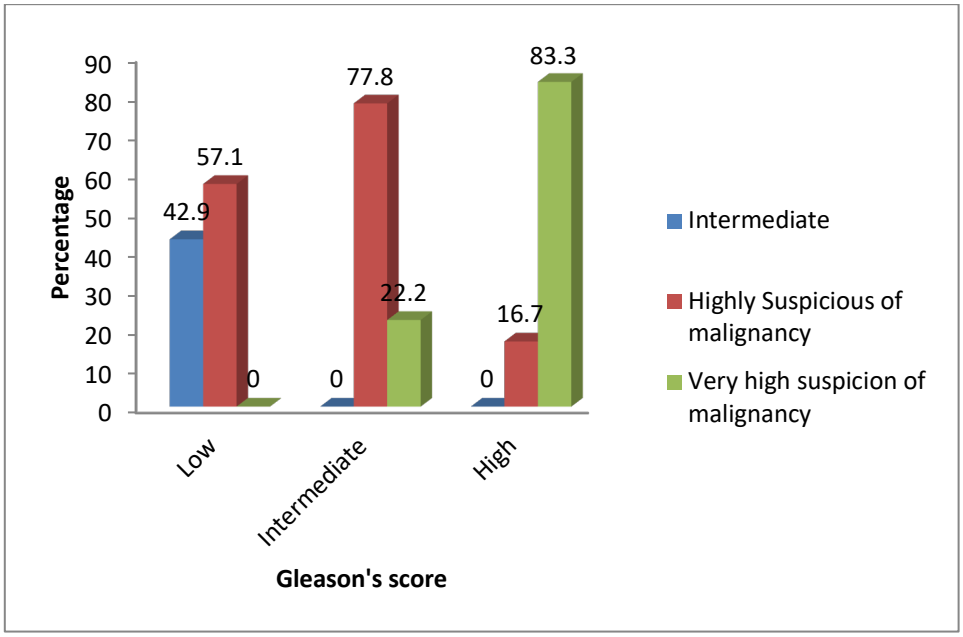



**Figure 2: Association between PI-RADS and Gleason's score**

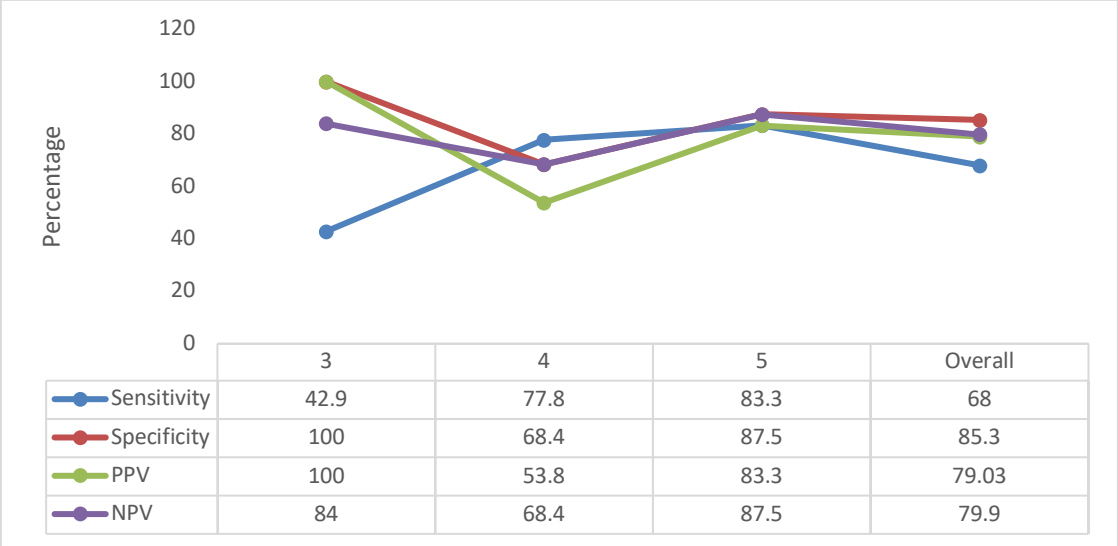
**Table 10: Diagnostic accuracy of PI-RADS against Gleason Score**

| PIRADS | Gleason | Sensitivity | Specificity | PPV | NPV | Kappa | P value |
|---|---|---|---|---|---|---|---|
| 3 | ≤6 | 42.9 | 100 | 100 | 84 | 0.53 | 0.001 |
| 4 | 7 | 77.8 | 68.4 | 53.8 | 68.4 | 0.42 | 0.02 |
| 5 | >7 | 83.3 | 87.5 | 83.3 | 87.5 | 0.71 | 0.001 |
| Overall accuracy | | 68 | 85.3 | 79.03 | 79.9 | 0.55 | |

Diagnostic accuracy of PI-RADS was calculated independently for low, intermediate and high risk of malignancy. The sensitivity, specificity, PPV and NPV of PIRADS at cut off of 3 for diagnosis of low risk of malignant lesions was 42.9%, 100%, 100% and 84% respectively with moderate Kappa agreement ($\kappa=0.53$; $p<0.05$).

Similarly, for intermediate malignant lesions, at the cut off value of 7 for PI-RADS, the sensitivity was 77.8%, with specificity of 68.4% with moderate agreement ($\kappa 0.42$; $p<0.05$).

The sensitivity (83.3%) and NPV (87.5%) of PI-RADS was maximum for prostatic lesions with high risk of malignancy with substantial agreement ($\kappa=0.71$; $p<0.01$).




| | 3 | 4 | 5 | Overall |
|---|---|---|---|---|
| Sensitivity | 42.9 | 77.8 | 83.3 | 68 |
| Specificity | 100 | 68.4 | 87.5 | 85.3 |
| PPV | 100 | 53.8 | 83.3 | 79.03 |
| NPV | 84 | 68.4 | 87.5 | 79.9 |

**Figure 3: Diagnostic accuracy of PI-RADS against Gleason Score**

Overall, sensitivity, specificity, PPV and NPV of PI-RADS was 68%, 85.3%, 79.03% and 79.9% respectively with moderate Kappa agreement (κ=0.55).

## Discussion

The age range from 50 to 84 years, with a mean age of 68.04 ± 8.96 years.

The mean serum PSA level found to be 43.82 ± 32.5, range 8 - 110 ng/ml, median 38 and IQR 12.25 – 71.5.

The mean ± SD for prostate volume 52.3 ± 20.4, range 30-102 gm, median 45 and IQR 38.25 – 54.75.

Of the 28 patients who underwent TRUS biopsy and were subsequently followed, approximately 7 patients (25%) had a Gleason score of 6, about 9 patients (32.1%) received a Gleason score of 7, and 12 patients (42.8%) reported a Gleason score of 8 or above, indicating malignancy.

Out of 28 patients who underwent TRUS biopsy in our study, about 3 patients (10.7%) reported a PIRADS score of 3, 13 patients (46.4%) reported a PIRADS score of 4, and 12 patients (42.9%) reported a PIRADS score of 5, suggesting malignancy.

Prostate cancer is typically diagnosed, characterized, and staged using magnetic resonance imaging (MRI). The need for better characterization of cancer aggressiveness to choose the most suitable treatment has increased due to the availability of better conservative treatment options and an increase in cases of indolent lesions.

We are looking into the efficacy of MP-MRI as a non-invasive method to estimate tumour aggression because TRUS guided biopsies are invasive and also because sample errors allow them to misclassify Gleason's score in roughly 38% of all cases [9].

Functional imaging techniques, such as diffusion weighted imaging (DWI)/ADC, dynamic contrast enhanced imaging (DCE), and occasionally MR spectroscopy (MRSI), are also included in multi-parametric prostate studies along with the use of standard T1W and T2W sequences for the detection and characterization of prostate cancer.

In this study, seven (25.0%) out of the 28 subjects had a Gleason's score of 6 (GS 3+3), nine (32.1%) had a Gleason's score of 7 (six had a GS of 3+4 and three had a GS of 4+3), and twelve (42.8%) had a Gleason's score >7 (three had GS 4+4, six

had GS 5+4 and three had GS 5+3).

With a p value of 0.001, it was discovered that PIRADS and Gleason's scores have a positive linear connection (R2 = 0.36), meaning that when PIRADS scores rise, Gleason scores rise in lockstep, showing that in the majority of patients whose TRUS biopsy for prostate cancer was positive, the higher the Gleason's score, the higher the PIRADS score. Thus, it demonstrates the function of Multi parametric-MRI in defining the lesion and tumour aggressiveness. With the above function, there are a few other benefits that may be observed, such as the ability of pre-biopsy MRI to assist in lesion-targeted biopsy and targeted treatment that reduces the risk of recurrence and improves the accuracy of complete surgical resection.

The specificity and sensitivity of the connection between PIRADS and Gleason's score were 85.3% and 68.0%, respectively. Hence, the MP-MRI has a greater specificity, indicating that it can eliminate patients who would have otherwise had TRUS biopsy in the event of a negative result. By adopting MP-MRI, unneeded biopsies that are likely to reveal benign findings can be avoided, lessening the agony for patients and the unnecessary strain on the healthcare system.

Moreover, the negative predictive value (NPV) was 79.9%, while positive predictive value (PPV) was 79.03%. This high NPV shows if a patient does not have a malignant lesion on MP-MRI, then probability of having a malignant lesion in prostate is very low, in fact near to zero.

Here, diagnostic accuracy of a test is the capability of MP-MRI to correctly diagnose patients with disease and exclude those who don’t have the disease. So, MP-MRI can play a vital role in deciding, if TRUS guided biopsy is required or not, mainly in patients with increased PSA levels.

According to PIRADS classification, approx. 42.9% patients had very high suspicion of malignancy lesions and around 10.7% of the patients had intermediate lesions while 46.4% had a highly suspicious of malignancy lesions.

Previous studies have shown that TRUS is not recommended as first line screening tool for early prostate cancer because of the low predictive value [10-12].

There is debate over the appropriate PSA cut-off value at which additional testing, such as a TRUS-guided prostate biopsy, should be advised in order to rule out prostate cancer [13–15]. The issue is whether using a higher PSA threshold results in missing certain cancer lesions until they become incurable or whether using a lower PSA threshold results in wasteful biopsies.

According to earlier research, the TRUS guided biopsies have low sensitivity of about 60%, a low positive predictive value of only about 25%, and high false negative rates of up to 15–34% [16,17]. Therefore, using MP-MRI along with TRUS biopsy can aid in directing biopsy to the area that is most suspicious and ultimately improving detection rate, but more importantly, by avoiding biopsy in patients who do not have suspicious lesions on MRI, all complications and risks associated with a biopsy are eliminated.

Few prospective studies by Kumar V, Jagannathan NR, Kumar R, et al. that examined the role of MRI in men with PSA levels of 4–10 ng/mL, who have a very low cancer detection rate and the highest false-negative rate on TRUS biopsy, detected a cancer detection rate as high as three times that of TRUS biopsy and a negative predicting value that almost reached 100% [18,19]. Comparable NPV values were also found in this study.

The results of this investigation concur with those of Delong champs NB et al. Almost 80% of bilateral malignancies were found and the tumour size was accurately calculated in roughly 77% of cases. MP-MRI can also be utilised to screen for

bilateral involvement and has excellent prognostic value [20].

In a meta-analysis of studies evaluating the effectiveness of MP-MRI, de Rooij M et al. [21]. reported findings that were similar to those of this study, showing a sensitivity of 74% and a specificity of 88% for multiparametric MRI for diagnosis of prostate cancer. Also, in the aforementioned meta-analysis, the negative predictive value was in the range of 66% to 81%.

## Conclusion

As observed, in patients with raised PSA level multiparametric MRI PIRADS scoring is beneficial, being non-invasive and convenient for diagnosis for prostatic lesions. It found to have high sensitivity and specificity along with high predictive value and can recognise patients needing biopsy, it also helps in targeted biopsy as well as identifying extent and aggressiveness of malignancy.

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