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Research Article

Histopathological Correlation of Prostate Cancer with Magnetic Resonance Imaging Findings

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Abstract: ***Background:*** Prostate cancer (PCa) is the most common cancer in men, and early detection plays a critical role in improving patient outcomes. Multiparametric magnetic resonance imaging (mpMRI), with the PI-RADS scoring system, has emerged as a valuable tool for the diagnosis and localization of PCa. This study aims to correlate mpMRI findings with histopathological diagnoses of prostate cancer. ***Methods:*** A total of 130 patients suspected of having prostate cancer were included in this study, conducted between 1st July 2019 and 30th June 2020 at Bangha Bandhu Sheikh Mujib Medical University (BSMMU), Dhaka. All patients underwent mpMRI, and PI-RADS scores were assigned. The histopathological diagnoses were made based on biopsy results. Data analysis was performed using SPSS version 22. ***Results:*** Among the 130 patients, 75 (57.7%) were diagnosed with prostatic adenocarcinoma, 40 (30.8%) with benign prostatic hyperplasia (BPH), and 15 (11.5%) with high-grade prostatic intraepithelial neoplasia (HGPIN). PSA levels showed that 45 (34.6%) patients had levels greater than 20 ng/mL, indicating high-risk. Regarding PI-RADS scores, 45 (34.6%) patients had PI-RADS 4, and 40 (30.8%) had PI-RADS 5, both strongly associated with malignancy. ***Conclusion:*** Our study supports mpMRI as a reliable and non-invasive imaging modality for detecting prostate cancer, especially in patients with higher PI-RADS scores. The strong correlation between mpMRI findings and histopathological diagnoses underscores its role in early detection and targeted biopsy.

Keywords: Prostate cancer, mpMRI, PI-RADS, histopathology, benign prostatic hyperplasia, high-grade prostatic intraepithelial neoplasia, early detection, targeted biopsy.

INTRODUCTION

Prostate cancer is one of the most common malignancies affecting men worldwide and remains a significant cause of morbidity and mortality [1]. Early detection and accurate diagnosis are crucial for effective management and improved patient outcomes [2]. Conventional diagnostic methods such as serum prostate-specific antigen (PSA) testing and digital rectal examination (DRE) have limitations in differentiating benign from malignant prostate lesions, often leading to unnecessary biopsies or missed clinically significant cancers [3]. Therefore, advanced imaging techniques like multiparametric magnetic resonance imaging (mpMRI) have emerged as valuable tools in the assessment of prostate cancer [4].

Multiparametric MRI combines T2-weighted imaging (T2WI), diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and dynamic contrast-enhanced (DCE) imaging, offering detailed anatomical and functional information about prostate lesions [5]. The Prostate Imaging Reporting and Data System (PI-RADS v2.1) provides standardized criteria for evaluating prostate lesions based on mpMRI findings, categorizing them according to the likelihood of malignancy [6]. Several studies have demonstrated the efficacy of mpMRI in detecting clinically significant prostate cancer, reducing unnecessary biopsies, and improving localization of aggressive tumors. However, histopathological confirmation remains the gold standard for definitive diagnosis [7].

In Bangladesh, the burden of prostate cancer is increasing due to factors such as aging, lifestyle changes, and improved diagnostic capabilities. However, there is limited local data on the accuracy of mpMRI in detecting prostate malignancies and its correlation with histopathological findings [8, 9]. Given the variability in radiological interpretation and potential differences in tumor biology, it is essential to evaluate the diagnostic

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performance of mpMRI in the Bangladeshi population [10].

This study aimed to establish the correlation between multiparametric MRI findings and histopathological results in patients with suspected prostate cancer. By comparing PI-RADS scores with biopsy-confirmed histopathology, we seek to assess the sensitivity, specificity, and overall diagnostic accuracy of mpMRI. The findings of this study will help determine the reliability of mpMRI in prostate cancer detection, potentially guiding clinicians toward more precise, targeted biopsy approaches and reducing unnecessary procedures.

METHODOLOGY & MATERIALS

This cross-sectional study was conducted in the Department of Radiology and Imaging, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, from 1st July 2019 to 30th June 2020. A total of 130 patients with suspected prostate cancer, referred for multiparametric MRI (mpMRI) and subsequent histopathological evaluation, were included in the study. Data were collected from BSMMU and other referral center of Dhaka City.

Inclusion criteria consisted of patients with elevated serum prostate-specific antigen (PSA) levels (>4.0 ng/mL), abnormal digital rectal examination (DRE) findings, or clinically suspected prostate malignancy. Patients who had histopathologically confirmed prostate cancer or benign prostatic hyperplasia (BPH) after biopsy or prostatectomy were also included. Exclusion criteria involved patients with incomplete imaging or biopsy data, previous prostate cancer treatment, active urinary tract infections, or contraindications to MRI (e.g., metallic implants, severe claustrophobia).

MRI was performed using a 1.5T or 3.0T scanner with a pelvic phased-array coil. Multiparametric sequences, including T2-weighted imaging (T2WI), diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and dynamic contrast-enhanced imaging (DCE-MRI), were analyzed. Lesions were graded using the Prostate Imaging Reporting and Data System (PI-RADS) v2.1 to classify the likelihood of malignancy. MRI findings were correlated with histopathological results from ultrasound-guided transrectal prostate biopsies or radical prostatectomy specimens.

Data were recorded and analyzed using IBM SPSS Statistics version 22. Descriptive statistics were applied to summarize demographic and clinical data. Chi-square tests were used to assess categorical variable associations, while Student's t-tests were applied for continuous variables. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI in detecting prostate cancer were calculated with histopathology as the gold standard.

RESULTS

Table 1: Patient Age Distribution

Age Group (Years)	Number of Patients (n = 130)	Percentage (%)
50 - 59	21	16.16%
60 - 69	45	34.62%
70 - 79	50	38.47%
80+	14	10.79%

Table 1 presents the age distribution of 130 patients included in the study. The majority of patients (38.47%) were aged 70-79 years, followed by 60-69 years (34.62%). A smaller proportion of patients were in the 50-59 years (16.16%) and 80+ years (10.79%) age groups.

Table 2: Distribution of PSA Levels

PSA Level (ng/mL)	Number of Patients (n = 130)	Percentage (%)
< 4.0 (Normal)	10	7.70%
4.0 - 10.0 (Borderline)	35	26.90%
10.1 - 20.0 (Suspicious)	40	30.80%
> 20.0 (High Risk)	45	34.60%

Table 2 shows the distribution of serum prostate-specific antigen (PSA) levels among the 130 patients. The highest proportion of patients (34.60%) had PSA levels > 20.0 ng/mL, indicating a high risk of prostate cancer. A significant number of patients had PSA levels between 10.1 - 20.0 ng/mL (30.80%), which are considered suspicious for malignancy. 26.90% of patients had PSA levels in the borderline range (4.0 - 10.0 ng/mL), and 7.70% had normal PSA levels (< 4.0 ng/mL).

Table 3: MRI Findings Based on PI-RADS Score

PI-RADS Score	MRI Interpretation	Number of Patients (n = 130)	Percentage (%)
1-2	Likely Benign	20	15.40%
3	Equivocal/Indeterminate	25	19.20%
4	Suspicious for Malignancy	45	34.60%
5	Highly Suspicious for Cancer	40	30.80%

Table 3 illustrates the MRI findings based on the PI-RADS scoring system for the 130 patients. The majority of patients (34.60%) had PI-RADS score 4, indicating suspicion for malignancy, followed closely by 30.80% with a PI-RADS score 5, which indicates a high likelihood of cancer. 19.20% of patients had an equivocal/indeterminate MRI result with a PI-RADS score of 3, and 15.40% were classified as likely benign with PI-RADS scores 1-2.

Table 4: Histopathological Findings

Diagnosis	Number of Patients (n = 130)	Percentage (%)
Benign Prostatic Hyperplasia (BPH)	40	30.80%
High-Grade Prostatic Intraepithelial Neoplasia (HGPIN)	15	11.50%
Prostatic Adenocarcinoma (Cancer)	75	57.70%

Table 4 presents the histopathological findings for the 130 patients. The majority of patients (57.70%) were diagnosed with prostatic adenocarcinoma (cancer), followed by Benign Prostatic Hyperplasia (BPH) in 30.80% of the cases. A smaller proportion of patients (11.50%) were diagnosed with High-Grade Prostatic Intraepithelial Neoplasia (HGPIN), a precursor lesion to prostate cancer.

Table 5: Correlation between PI-RADS and Histopathology

PI-RADS Score	Benign (BPH + HGPIN)	Malignant (Adenocarcinoma)	Total
1-2	18	2	20
3	15	10	25
4	12	33	45
5	10	30	40
Total	55 (42.3%)	75 (57.7%)	130

Table 5 shows the correlation between PI-RADS scores and histopathological diagnoses for the 130 patients. Among the patients with PI-RADS score 1-2 (likely benign), 18 were diagnosed with Benign Prostatic Hyperplasia (BPH) or High-Grade Prostatic Intraepithelial Neoplasia (HGPIN), and only 2 were diagnosed with prostatic adenocarcinoma (cancer). For PI-RADS score 3 (equivocal/indeterminate), 15 patients had benign findings, while 10 had malignant adenocarcinoma. In the PI-RADS score 4 (suspicious for malignancy), 12 patients had benign diagnoses and 33 had adenocarcinoma. Similarly, for PI-RADS score 5 (highly suspicious for cancer), 10 patients had benign findings, and 30 were diagnosed with adenocarcinoma. Overall, 42.3% of patients had benign diagnoses (BPH + HGPIN), and 57.7% had malignant adenocarcinoma, highlighting the higher likelihood of malignancy in patients with higher PI-RADS scores.

DISCUSSION

This study aimed to correlate multiparametric magnetic resonance imaging (mpMRI) findings with histopathological diagnoses in prostate cancer, highlighting the value of mpMRI in detecting prostate malignancies. Our results demonstrate a strong relationship between PI-RADS scores and histopathological findings, supporting previous studies and emphasizing the role of mpMRI in the early detection and accurate localization of prostate cancer.

The majority of patients in our study (57.7%) were diagnosed with prostatic adenocarcinoma, aligning with global trends where prostate cancer remains the most common malignancy in men. This is consistent with findings from previous studies that report a similar prevalence of cancer cases in prostate biopsy or surgical specimens [11, 12]. Interestingly, benign prostatic hyperplasia (BPH) was found in 30.8% of our patients, reflecting its high incidence in older men, as BPH is a common benign condition of the prostate [5].

Regarding PSA levels, our study shows that a large proportion of patients (34.6%) had PSA levels > 20.0 ng/mL, corresponding to a high risk of prostate cancer. This finding is consistent with literature indicating that higher PSA levels are predictive of malignant prostate cancer, with a clear association between increased PSA and the likelihood of cancer detection [13]. Additionally, PI-RADS scores and histopathological diagnoses showed a significant correlation, with higher PI-RADS scores (4-5) indicating a greater likelihood of malignant lesions. Specifically, PI-RADS score 5, considered highly suspicious for

cancer, was associated with the highest rate of prostate cancer in our study (75%), which correlates well with findings by Rosenkrantz et al. and Turkbey et al. [14, 15].

Our results further demonstrate that PI-RADS score 4 also correlates strongly with malignant findings, supporting the study by Rosenkrantz et al., who reported that suspicious lesions (PI-RADS 4) are more likely to be malignant, especially when located in regions of the prostate that are difficult to access by traditional biopsy methods [14]. These results confirm that mpMRI, particularly when combined with PI-RADS scoring, enhances detection rates for prostate cancer and aids in the risk stratification of lesions.

Several studies, including Isebaert et al., and Borkowetz et al., have demonstrated that mpMRI is highly sensitive in identifying clinically significant prostate cancer. Our study's findings align with this, as PI-RADS 4 and 5 lesions were strongly associated with prostate adenocarcinoma, and those patients with PI-RADS 1-2 were largely diagnosed with benign conditions, notably BPH and HGPIN [11, 12]. This is in line with studies suggesting that low PI-RADS scores (1-2) are often associated with benign conditions, as noted by Bratan et al [16].

Our results also reflect the challenges in detecting small-volume or indistinct cancer foci on mpMRI, particularly with PI-RADS score 3, which showed mixed results (15 benign, 10 malignant). This finding is consistent with the work of Grivas et al., who noted that equivocal lesions (PI-RADS 3) can be difficult to characterize and often require further diagnostic investigation, such as MRI-guided biopsy or ultrasound fusion biopsy [17].

Moreover, the sensitivity of mpMRI in detecting extra-capsular extension and seminal vesicle invasion, as reported by Turkbey et al. and Grivas et al., was not directly evaluated in our study, but future investigations should consider these critical features [15, 17]. The application of multiparametric imaging, particularly for detecting high-risk features like extraprostatic extension, could further refine the management of prostate cancer by aiding clinical decision-making.

Finally, this study is consistent with the broader literature supporting mpMRI as a reliable tool for improving prostate cancer detection, reducing unnecessary biopsies, and better targeting biopsy locations [18, 19]. This makes mpMRI a crucial imaging modality in the early diagnosis and staging of prostate cancer, especially in cases where conventional biopsy techniques might fail to identify clinically significant disease.

Limitations of the study

One limitation of this study is the reliance on biopsy samples for histopathological diagnosis, which may not always represent the entire prostate gland. Additionally, mpMRI's sensitivity can vary depending on lesion size and location, potentially leading to missed small or indistinct tumors. Lastly, the study was conducted mostly at a single center, which may limit the generalizability of the findings to other populations or healthcare settings.

CONCLUSION

In conclusion, our study confirms the utility of mpMRI in detecting and stratifying the risk of prostate cancer using PI-RADS scoring. The strong correlation between MRI findings and histopathological diagnoses reinforces mpMRI as a non-invasive, reliable imaging tool in the detection, localization, and management of prostate cancer. Future research should focus on improving the accuracy of PI-RADS assessments and evaluating the role of mpMRI in targeted biopsy techniques.

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