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Original Article

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Diagnostic accuracy of multiparametric magnetic resonance imaging (MRI) in patients with suspected prostate cancer

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ABSTRACT

BACKGROUND & OBJECTIVE: In addition to reducing the frequency of needless biopsies, multiparametric MRI (mpMRI) has a high sensitivity and specificity in identifying clinically relevant tumors. The goal of this study was to find out how accurate multiparametric MRI is at finding prostate cancer.

METHODOLOGY: Between March 1, 2023, and February 28, 2024, 123 male patients with suspected prostate cancer, ages 50 to 90, participated in this cross-sectional validation study. Patients with active urinary tract infections were excluded from immediate TRUS-guided biopsy because of the acute infection and post-biopsy urosepsis risk. A multiparametric MRI was generated at an outpatient diagnostic clinic. To achieve thorough coverage and precise imaging of the prostate gland, the mpMRI protocol used an 8-Channel Body Array coil and included T2-weighted imaging, diffusion-weighted imaging with ADC maps, and dynamic contrast-enhanced imaging; additional anatomical/localizer sequences were used only for localization. The mpMRI diagnostic indicators' sensitivity, specificity, accuracy, PPV, and NPV were analyzed.

RESULTS: Overall, mpMRI's sensitivity was 84.93%, specificity was 84.0%, PPV was 88.57%, NPV was 79.25%, and diagnostic accuracy was 84.55% when compared to TRUS-guided biopsy.

CONCLUSION: This study shows that prostate cancer can be detected with a very high degree of diagnostic accuracy using multiparametric MRI.

KEYWORDS: Prostate Cancer, Diagnosis, Imaging, Magnetic Resonance, Multiparametric MRI.

INTRODUCTION

Prostate cancer is the most frequent cancer in men and a major cause of cancer-related mortality [1]. The serum prostate-specific antigen test and digital rectal examination have traditionally been used to detect and stage localized prostate cancer; however, early detection remains challenging. TRUS has long been used for screening, diagnosis of benign prostatic disease, prediction of malignancy, and biopsy guidance. Still, it provides limited information about benign versus malignant prostate architecture, extracapsular extension, operator variability, and sampling of anterior prostate regions [2,3].

Multiparametric magnetic resonance imaging (mpMRI) has become a key diagnostic technique for patients with suspected PCa [3]. On a scale of 1 to 5, the Prostate Imaging-Reporting and Data System (PI-RADS) classification indicates the probability of csPCa [4]. It is uncertain, therefore, how well it can detect unusual histologies (UH), including ductal, intraductal prostate cancer (IDC-P), and cribriform architecture (CA). UHs are distinct from traditional acinar adenocarcinomas in terms of their development patterns, histological types, and subtypes [5,6].

This cutting-edge imaging method provides comprehensive anatomical and functional details on the prostate by combining numerous MRI sequences. An endorectal coil improves the signal-to-noise ratio, which raises the quality of the image even further. Magnetic resonance spectroscopy (MRS), dynamic contrast-enhanced (DCE) MRI, diffusion-weighted imaging (DWI), and T2-weighted imaging (T2WI) are commonly used in the multiparametric method. Together, these sequences aid in the diagnosis and localization of cancer by providing distinct information about the physiology and structure of the prostate [7-10].

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Many studies that have been carried out all around the world have produced a variety of findings. Despite a thorough review of the literature, we were unable to find any local study. Our study aims to evaluate the application of mpMRI in prostate cancer early detection. The outcomes will be contrasted with those of biopsies guided by TRUS.

METHODOLOGY

After approval from ethical review committee (SIMC/H.R/7723/23, dated 02-01-23), a cross-sectional validation study was conducted between March 1, 2023, and February 28, 2024, with 123 male patients aged 50 to 90 who had visited the urology departments of SITH, Lodhran and BVH, Bahawalpur. The patients exhibited increased PSA levels, enlarged hard nodular prostate with overlaying fixed mucosa on DRE. The sample size was determined by the 95% confidence level, the specificity and sensitivity of mpMRI in identifying prostate cancer, which were 37.30% and 81.80%, respectively, and the 10% precision[7]. The selection of 123 patients was done via non-probability purposive sampling.

People with urinary tract infections (UTIs), a history of prostate surgery, general reasons not to have an MRI (claustrophobia, pacemaker implants), and general reasons not to have a TRUS (piles and acute severe perianal illnesses) were not allowed to take part in the study.

All patients who met the inclusion criteria and made an appointment in the outpatient department were included in the study (as described above). Before being enrolled, the patient gave their informed consent after being fully informed about the trial. Clinical information and demographics were collected at the time of enrollment.

Amultiparametric MRI was generated at an outpatient diagnostic clinic. To achieve thorough coverage and precise imaging of the prostate gland, the mpMRI protocol used an 8-Channel Body Array coil and included T2-weighted imaging, diffusion-weighted imaging with ADC maps, and dynamic contrast-enhanced imaging; additional anatomical/localizer sequences were used only for localization. Each prostate gland tumor was diagnosed and evaluated using the PI-RADS v2, where 1 meant exceedingly unlikely, 2 meant unlikely, 3 meant equivocal, 4 meant likely, and 5 meant highly likely. This allowed for the reporting of the likelihood of prostate carcinoma. PI-RADS ≥ 3 was therefore regarded as prostate cancer in this investigation.

Then each patient underwent TRUS-guided biopsy from another consultant radiologist who was blinded to the mpMRI results. Prophylactic antibiotics were started the day before the surgery, along with a cleansing enema before the biopsy. A local anesthetic of 2% lignocaine jelly was also administered prior to the biopsy. With the right knee and hip flexed, the patient was positioned in the left lateral position. Using a semi-automatic, 18-gauge biopsy pistol with a biopsy guide attached to the TRUS probe, the prostate biopsy was performed. Each biopsy core was gathered, tagged, and placed in a different formalin-filled container for histological analysis. The PIRADS score and Gleason's score, which denotes positive TRUS biopsy results, were used to compare mpMRI findings with TRUS-guided biopsy histopathology. IHC employing AMACR, p63, and HMWCK was then performed on those who had abnormal acinar cell proliferation on biopsy in accordance with institution policy.

Following biopsy and MRI, information on intervention-specific side effects was gathered using participant-reported questionnaires. To enable clear and efficient dissemination of the findings, the study's results were painstakingly collated and displayed in graphs, tables, and charts. The study's dedication to using up-to-date and reliable analytical methods was demonstrated by the statistical analysis conducted using SPSS 26.0, which strengthened the validity of the research findings. TRUS-guided biopsy was the best way to check the sensitivity, specificity, accuracy, PPV, and NPV of mpMRI diagnostic tests.

The diagnostic accuracy of multiparametric magnetic resonance imaging (mpMRI) for detecting prostate cancer was assessed by comparing its findings with those of transrectal ultrasound (TRUS)-guided biopsy, which was used as the reference standard. Patients were classified according to whether prostate cancer was present or absent on mpMRI and whether it was confirmed or absent on TRUS-guided biopsy. Accordingly, true-positive (TP) cases were those in which prostate cancer was detected by both mpMRI and TRUS-guided biopsy; false-positive (FP) cases were those in which mpMRI indicated prostate cancer but the biopsy did not confirm it. False-negative (FN) cases were those in which mpMRI did not detect cancer despite a positive biopsy, whereas true-negative (TN) cases were those in which both mpMRI and biopsy showed no evidence of prostate cancer.

RESULTS

Mean age was 72.85 ± 6.93 years. The majority of the 64 patients (52.03%) were in the 71–90 age range. The prostate weighed 54.03 ± 13.57 grams on average. The average BMI was 25.68 ± 3.34 kg/m2. The average blood PSA was 15.80 ± 10.87 ng/ml.

In 70 mpMRI-positive patients, 62 (True Positive) had prostate cancer and 08 (False Positive) had no prostate cancer on TRUS-guided biopsy. Among 53 mpMRI-negative patients, 11 (False Negative) had prostate cancer on TRUS-guided biopsy whereas 42 (True Negative) had no prostate cancer on histopathology as shown in Table II. Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of mpMRI for detecting prostate cancer taking TRUS-guided biopsy as gold standard was 84.93%, 84.0%, 88.57%, 79.25% and 84.55% respectively Table-III. The area under the curve was corrected to 0.845, which is consistent with the reported sensitivity and specificity (Figure-I).

Table- I: Distribution of different variables (n=123).

Variables	Categories	n(%)
Hypertension	50-70	59(47.97)
	71-90	64(52.03)
Prostate weight (grams)	≤50	54(43.90)
	>50	69(56.10)
BMI (kg/m2)	≤30	104(84.55)
	>30	19(15.45)
PSA levels (ng/ml)	≤20	91(73.98)
	>20	32(26.02)

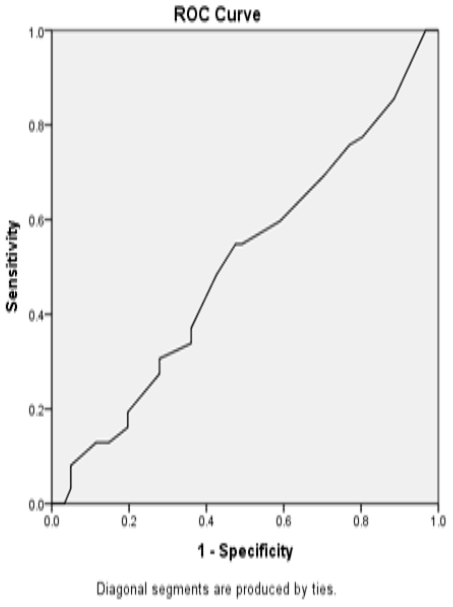
Table-II: MpMRI's diagnostic precision in identifying prostate cancer.

Variables	Positive result on biopsy	Negative result on biopsy	Chi -square	P-value
Positive on mp-MRI	62	08	57.49	0.0001
Negative on mp-MRI	11	42		

P-value is <0.05 which is statistically significant.

Table-III: mpMRI's Diagnostic parameters in identifying prostate cancer.

Diagnostic Parameter	Values
Sensitivity	84.93%
Specificity	84.0%
Positive Predictive Value (PPV)	88.57%
Negative Predictive Value (NPV)	79.25%
Diagnostic Accuracy	84.55%



Area under the curve = 0.845

DISCUSSION

Over the past few decades, magnetic resonance imaging (MRI) has become a more popular way to test for and treat prostate cancer that doesn't need cutting into the body [11]. It makes it possible to use a number of functional evaluation methods, like DWI and MRS [12]. When the surrounding zone is bright and normal, a low-signal intensity core at 2WI can be used to identify prostate cancer. However, when prostate cancer is in the core zone, it is hard to detect since benign prostatic enlargement generates a significant signal. With T2-weighted MRI, 67–77% of tumors can be found [13,14]. Previous studies found that multiparametric MRI improved diagnostic accuracy [15]. These results are consistent with another study that showed that the combination of MRS and ADC had a higher sensitivity of 94.2% and a higher specificity of 85% than either measure alone [16,17].

In a previously published study, 42 examined cases were determined to be malignant and 27 were determined to be noncancerous. Sensitivity and specificity were 88.2% and 67.2% for T2WI, 82.4% and 81.6% for DWI and 84.3% and 98.0% for MRS [14]. The DWI and MRS results were similar when the threshold was set at 4. T2WI+DWI+MRS had equivalent areas under the ROC curves (Az) of 0.978+/-0.009, according to the ROC analysis, while DWI, MRS, and T2WI had corresponding values of 0.848+/-0.030, 0.860+/-0.033, and 0.961+/-0.016, respectively [14].

According to MP-MRI data, 71.21% of people in another study had outcomes that were either cancerous or possibly cancerous (PIRADS 4/5) [18]. A TRUS biopsy confirmed cancer in 72.7% of individuals. There was a strong link between the Gleason score and the PIRADS score ($p < 0.05$). MP-MRI was 83.33% accurate at finding prostate cancer. It was 72.22% specific, 87.5% sensitive, 68.42% NPV, and 89.36% PPV. 66.67% of patients who had a cognitive MP-MRI-targeted biopsy and 56% of patients who received a systematic biopsy had cancer. The best diagnosis accuracy was reached when the two approaches were used together. There was a relatively strong agreement between the mpMRI and the TRUS biopsy, with an inter-rater kappa value of 0.587 and a p-value of less than 0.001.

In a published study by Javed et al., abnormal MRI results in 53 out of 60 individuals demonstrated that mpMRI had an 85% sensitivity and an 88.3% specificity in detecting prostate cancer, while 38.3% of patients were classified as PI-RADS IV [19]. These findings support the use of mpMRI and PI-RADS scoring as a triage approach for assessing prostate lesions. The researchers found that mpMRI might be used as a triage test to predict whether individuals can avoid additional biopsies after a negative biopsy. According to a recent study, during a 5-year longitudinal follow-up period, the clinical NPV of mpMRI for severe cancer was 89.6% [20].

According to Ahmed et al., the PIRADS score has a 93% sensitivity, 89% NPV, 41% specificity, and 51% PPV for identifying PCa [21]. According to another study, the NPV of a PIRADS ≤2 was 98%, while the AUC was 0.89. The

PPV of 49%, however, casts doubt on the PIRADS score's ability to forecast the result. Furthermore, several patients with PCa had a PIRADS score of less than 2 [22]. Thompson et al. (2016) reported that mp MRI exhibited sensitivity and specificity of 96% and 36% respectively [23].

A recent study indicated that the threshold for predicting PCa in individuals with PSA levels between 4 and 10 ng/mL was a PIRADS ≥4 [24]. Additionally, PIRADS 3 lesions solely identified benign conditions, as demonstrated in a study by Engelhard et al. that evaluated the efficacy of the score in distinguishing ambiguous lesions as benign or malignant. Consequently, in the administration of patient clinical care, the PIRADS 3 score could not be substantiated as a definitive indicator. Another study that examined the significance of a PIRADS score of 4 or above for identifying csPCa found that reader 1's sensitivity and specificity were 77.0% and 73.8%, whereas reader 2's were 77.3% and 71.4% [25]. These results align with prior studies indicating that employing PIRADS ≥4 (criterion 4) enhanced the specificity of the PIRADS score in identifying csPCa [22].

Limitations:

Single-center sampling, a limited patient group, possible observer bias, no long-term follow-up, and no multivariable or health economics analysis are some of the study's shortcomings. However, it offers useful prospective information about the relationship between the outcomes of TRUS-guided biopsy and mpMRI.

Implications:

These discoveries have a number of significant clinical ramifications. Multiparametric MRI is a useful technique for detecting prostate cancer, especially in men who are at higher risk, due to its high sensitivity. It can help direct additional therapeutic and diagnostic procedures, such surgery or biopsy. The need for a thorough clinical examination that considers additional risk factors and clinical context is highlighted by the intermediate specificity, which implies that it may result in false-positive results in a subgroup of patients. This diagnostic technique may reduce needless biopsies and relieve patients from invasive procedures when they are not essential.

Recommendations:

Prior to the biopsy in males who are unlikely to have clinically significant illness, MP-MRI should be done to prevent needless biopsies and consequences. Future studies should try to confirm these findings in a variety of clinical contexts and demographics. Furthermore, the incorporation of biomarkers and cutting-edge imaging technology may improve the prognostic and diagnostic precision of prostate cancer assessments.

CONCLUSION

The study's findings suggest that multiparametric MRI provides an acceptable degree of diagnostic precision in the detection of prostate cancer. Because of this, patients now have a better chance of getting better, and we can diagnose the condition much more accurately.

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Mudassar Saeed Pansota : Substantial contributions to the conception and design of the work.
Fariha Mumtaz : The acquisition of data for the work.
Muhammad Tariq : Analysis of data for the work.
Muhammad Asif : Drafting the work.
Muhammad Shahzad Saleem : Reviewing it critically for important intellectual content.
Muhammad Ajmal : Interpretation of data for the work.

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