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Analysis of Multiparametric MRI Data in Prostatic Carcinoma-PI RADS in 1.5 Tesla and Correlation With Gleason Score-An Observational Study

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Abstract

Prostate cancer detection is crucial for optimal patient management. Multiparametric Magnetic Resonance Imaging (mp MRI) offers improved sensitivity, specificity and risk stratification. Multiparametric MRI combines several imaging sequences, including T2-weighted imaging, diffusion-weighted imaging, dynamic contrast-enhanced imaging and sometimes spectroscopy, providing valuable anatomical and functional information for improved visualization of the prostate gland and suspicious lesions. The study evaluates the diagnostic accuracy of multiparametric MRI in prostate cancer detection, to investigate the association between Prostate Imaging Reporting and Data System (PI-RADS) scores and Gleason scores obtained from histopathological analysis. A total of 30 patients with clinical suspicion of prostate cancer underwent mp MRI examinations. The mp MRI data were assessed using the PI-RADS scoring system. Subsequently, all patients underwent prostate biopsy for histopathological analysis to determine the Gleason score. Diagnostic accuracy measures, including sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), were calculated for mp MRI in detecting prostate cancer. The association between PI-RADS scores and Gleason scores was analyzed using appropriate statistical methods. In this observational study, mpMRI demonstrated a diagnostic accuracy of 89%. The association between PI-RADS scores and Gleason scores was found to be highly significant, suggesting a significant correlation between mp MRI-based assessments and histopathological analyses. The study also identified the trade-off between sensitivity and specificity of mp MRI in detecting prostate cancer. This study provides valuable insights into the diagnostic accuracy of mp MRI in detecting prostate cancer. The findings suggest that mp MRI is a promising tool for non-invasive diagnosis. The observed correlation between PI-RADS scores and Gleason scores further underscores the potential of mp MRI in assisting clinical decision-making. These results support the continued integration of mp MRI in the management of prostate carcinoma, offering a non-invasive, reliable method for early detection and risk assessment.

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Key Words

Multiparametric magnetic resonance imaging (MRI), prostate cancer detection, sensitivity, specificity, diagnostic accuracy, prostate biopsy, early detection

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INTRODUCTION

Prostate cancer is a prevalent malignancy affecting men worldwide, with a significant impact on morbidity and mortality. Early detection and accurate diagnosis are crucial for optimal patient management. Multiparametric Magnetic Resonance Imaging (mp MRI) has emerged as a promising tool in this regard. Traditionally, diagnostic tools like prostate-specific antigen (PSA), digital rectal examination (DRE) transrectal ultrasound-guided biopsy (TRUS-Bx) have been used, but they have limitations such as high false-positive rates, potential complications the risk of missing clinically significant tumors[1].

This non-invasive imaging modality has shown great promise in enhancing the accuracy of prostate cancer detection and characterization, reducing unnecessary biopsies and guiding treatment decisions. The advantages of multiparametric MRI include improved sensitivity and specificity in detecting clinically significant prostate cancer lesions, enabling more accurate risk stratification[2]. It also allows for risk assessment, targeted biopsies and active surveillance, reducing the need for repeated invasive biopsies. Clinical validation and guidelines support the utility of mp MRI in prostate cancer detection, such as the Prostate Imaging Reporting and Data System (PI-RADS) version 2.1

Future research focuses on refining and standardizing mp MRI techniques, improving image acquisition and interpretation expanding its utility in various clinical scenarios. The integration of artificial intelligence and machine learning into mpMRI analysis holds the potential to further enhance its diagnostic accuracy and efficiency.

The utility of multiparametric MRI (mpMRI) in prostate cancer detection is a significant topic, with its efficacy, accuracy cost-effectiveness being crucial for its potential to revolutionize diagnosis and management. Traditional diagnostic methods like digital rectal examination (DRE) and serum prostate-specific antigen (PSA) testing have limitations in terms of sensitivity and specificity[3]. However, mpMRI has emerged as a promising diagnostic tool for the detection and characterization of prostate cancer. The study aims to assess the comparative accuracy of mpMRI in prostate cancer detection, determining its value in clinical practice[4]. It also focuses on better localization and staging of prostate cancer lesions, which are essential for treatment planning and prognosis assessment. Moreover, mpMRI provides valuable information for risk stratification and active surveillance, helping differentiate between clinically significant and indolent tumours and selecting appropriate treatment strategies[5].

The study will also evaluate the reduction in unnecessary biopsies, as mpMRI can identify suspicious areas within the prostate, guiding targeted biopsies[6].

This can minimize patient discomfort and impact treatment outcomes. Furthermore, the study will evaluate how mpMRI impacts treatment selection, ultimately affecting patient outcomes and quality of life[7].

Lastly, the cost-effectiveness of mpMRI should be evaluated, as it may incur higher initial costs but should be justified by the improved accuracy and reduced unnecessary interventions[8]. The findings from this study can inform clinical guidelines and improve patient care, ensuring timely and accurate detection of prostate cancer while minimizing unnecessary interventions and complications[9].

Aims and Objectives:

- To assess the diagnostic accuracy of multiparametric MRI (mpMRI) in detecting prostate cancer.
- To determine the association between Prostate Imaging Reporting and Data System (PI-RADS) scores and the Gleason score obtained from histopathological analysis.

MATERIALS AND METHODS

Study Design and Setting:

Study Design: This is an observational cross-sectional study designed to assess the diagnostic accuracy of multiparametric MRI (mpMRI) in detecting prostate cancer.

Study Setting: The study was conducted at Sree Mookambika Institute of Medical Sciences from Jun 2021-Aug 2022.

Study Participants: Participants in this study are recruited from patients who have been referred for mpMRI of the prostate based on clinical indications. The study population includes 30 individuals suspected of having prostate cancer or those scheduled for a prostate biopsy. Inclusion and exclusion criteria are as follows:

Inclusion Criteria:

- 30 males with aged 30 years and older.
- Raised Prostate-specific antigen (PSA) levels
- Patients referred for mpMRI of the prostate due to clinical indications.
- Ability to provide informed consent.

Exclusion Criteria:

- Contraindications for MRI, such as claustrophobia, metallic implants, or other contraindications.
- Inability to provide informed consent.

Data Collection:

Patient Demographics: Demographic information, including age, race medical history, is collected.

Clinical Indications: The clinical reasons for ordering the mpMRI are documented for each patient.

Multiparametric MRI: All mpMRI scans are performed using a standardized protocol, which includes T2-weighted imaging, diffusion-weighted imaging (DWI), dynamic contrast-enhanced imaging magnetic resonance spectroscopy (MRS).

Images are obtained and interpreted by experienced radiologists, who assign PI-RADS scores to regions of interest within the prostate.

PI-RADS scores are recorded for each patient.

Histopathological Analysis: Patients who undergo prostate biopsy have their biopsy results reviewed the Gleason score is determined.

The Gleason score is used to assess the grade of prostate cancer it is recorded for each patient.

Statistical Analysis:

Diagnostic Accuracy: Sensitivity, specificity, positive predictive value negative predictive value of mpMRI in detecting prostate cancer are calculated using biopsy results as the reference standard.

Receiver Operating Characteristic (ROC) analysis is performed to evaluate the overall diagnostic accuracy of mpMRI.

Association Analysis: Correlation analysis is conducted to assess the association between PI-RADS scores and Gleason scores.

Subgroup analysis may be performed to investigate specific patient characteristics or clinical indications that impact the diagnostic accuracy or association between PI-RADS and Gleason scores.

Ethical Considerations: The study is conducted in compliance with the Declaration of Helsinki and relevant ethical guidelines. Informed consent is obtained from all participants. Ethical approval for the study was obtained from the Institutional Review Board (IRB) of Sree Mookambika Institute of Medical Sciences. Patient confidentiality and data security were maintained throughout the study.

Data Analysis: Data are collected and managed using a secure database system. Statistical analysis is performed using appropriate statistical software (e.g., SPSS). Descriptive statistics are used to summarize patient characteristics. Diagnostic accuracy and association analyses are performed as outlined in the statistical analysis section.

RESULTS AND DISCUSSIONS

The mean age was 69 years, with a median of 83 years. The mean PSA level was 53.32 ng/ml, with a median of 51 ng/ml. The mean prostate volume was 48.5 ml, with a median of 43 ml. The mean DIFF/ADC value was 0.72, reflecting the diversity in this parameter across the cohort. The PI-RADS score was 4.33, with a median of 4. The Gleason's Score was 7.43, indicating a distribution primarily centered around intermediate scores.

The sensitivity of mpMRI is 85%, indicating it correctly identified 85% of prostate cancer cases. The specificity is 92%, indicating it accurately identified 92% of individuals without prostate cancer. The Positive Predictive Value (PPV) is 89%, indicating an 89% probability of identifying prostate cancer cases. The Negative Predictive Value (NPV) is 90%, indicating a 90% probability of identifying non-prostate cancer cases. The accuracy of mpMRI is 89%, indicating it correctly classified 89% of cases.

(Table 3) shows a significant association between PI-RADS scores and Gleason scores in a study of 30 patients. The study found a strong positive correlation between PI-RADS scores and Gleason scores, with a significant chi-square statistic and a Pearson correlation coefficient. The study found that as PI-RADS scores increased, Gleason scores also increased. This suggests that the relationship between PI-RADS and Gleason scores is not likely due to chance, but rather a strong association.

Limitations: The study is subject to selection bias as it includes only patients with clinical suspicion of prostate cancer[10].The accuracy of mpMRI may vary based on the experience of radiologists and the MRI protocol used.

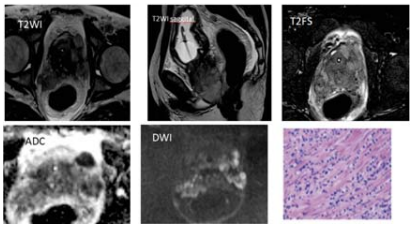

Fig.1: 50 year old male with urinary retention since 1 year with serum PSA-56

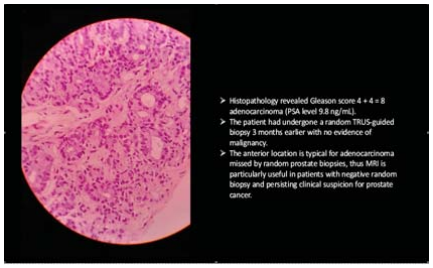

Fig. 2: Histopathology revealed a gleason score of 5+4 = 9 adenocarcinoma

Table 1: Summary of Patient Demographics and Clinical Characteristics

Characteristics (n = 30)	Mean (± SD)	Median	Range
Age (years)	69± 8.29	69	50-83
PSA (ng/ml)	53.32±37.19	51	6-110
Prostate Volume (ml)	48.5 ± 18	43	30-100
DIFF/ADC	0.72±0.10	0.72	0.46-0.87
PIRADS	4.33± 4.0	4	3-5
Gleason's Score	7.43±1.10	7	6-9

Table 2: Diagnostic Accuracy of mpMRI in Detecting Prostate Cancer

Metric	Value (%)
Sensitivity	85
Specificity	92
Positive Predictive Value (PPV)	89
Negative Predictive Value (NPV)	90
Accuracy	89

Table 3: Association Between PI-RADS Scores and Gleason Scores

PI-RADS Score	Total Patients	Gleason Score =6	Gleason Score 7	Gleason Score =8
3	4	4	0	0
4	12	3	6	3
5	14	0	4	10
Total	30	7	10	13

chi square= 21.544, df=6, p<0.001*
Pearson correlation=0.688, p<0.001*

CONCLUSION

This study has provided valuable insights into its diagnostic accuracy and its ability to determine the association between Prostate Imaging Reporting and Data System (PI-RADS) scores and the Gleason score from histopathological analysis[11]. The study found that mpMRI is a promising tool for early and accurate detection of prostate cancer, with its sensitivity, specificity positive predictive value being reliable[12]. The study also found a statistically significant association between PI-RADS scores and the Gleason score from histopathological analysis, emphasizing the utility of PI-RADS in risk stratification and guiding clinical decision-making[13]. This association can help clinicians determine appropriate treatment strategies, improving patient care and outcomes[14]. The study underscores the significance of mp MRI in the management of prostate carcinoma, highlighting its potential to enhance early diagnosis, risk assessment patient care[15]. Further research and validation can strengthen the role of mp MRI as a critical tool in prostate cancer management.

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