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ORIGINAL ARTICLE

Clinicopathological Correlation of Prostate Malignancy with Serum Prostate-Specific Antigen (PSA) Levels and Radiological Imaging Findings

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ABSTRACT

Background: Prostate cancer is one of the most prevalent malignancies affecting elderly men and remains a significant cause of cancer-related morbidity and mortality. Accurate diagnosis and assessment of tumor aggressiveness depend on a combination of biochemical markers, radiological imaging, and histopathological evaluation. Serum prostate-specific antigen (PSA) testing and imaging modalities such as transrectal ultrasound (TRUS) and multiparametric magnetic resonance imaging (mpMRI) are widely used in clinical practice; however, their diagnostic value is best understood when correlated with histopathological findings.

Objective: To evaluate the clinicopathological correlation of serum PSA levels and radiological imaging findings with histopathological diagnosis and Gleason grading in patients with suspected prostate malignancy.

Methods: This cross-sectional study was conducted from January 2023 to June 2023 at the Department of Urology, CMH Kharian Medical College, Kharian, Pakistan, in collaboration with Sughra Shafi Medical Hospital Complex. Seventy male patients aged 50 years and above with clinical suspicion of prostate malignancy were enrolled. Serum PSA levels were measured prior to biopsy. Radiological evaluation included TRUS for all patients, with mpMRI performed in selected cases. TRUS-guided prostate biopsy specimens were examined histopathologically and graded using the Gleason scoring system. Correlations between PSA levels, imaging findings, and histopathological outcomes were analyzed.

Results: Prostate adenocarcinoma was confirmed in 65.7% of patients. Elevated PSA levels, particularly values greater than 10 ng/mL, and radiological findings suspicious for malignancy showed a strong association with biopsy-proven cancer and higher Gleason scores, indicating increased tumor aggressiveness.

Conclusion: Serum PSA levels and radiological imaging findings demonstrate a significant clinicopathological correlation with prostate malignancy. Their combined assessment improves diagnostic accuracy and supports effective risk stratification and clinical decision-making.

Keywords: Prostate cancer; Prostate-specific antigen; Transrectal ultrasound; Multiparametric MRI; Gleason score; Clinicopathological correlation.

INTRODUCTION

Prostate cancer is one of the most commonly diagnosed malignancies among men worldwide and represents a significant contributor to cancer-related morbidity and mortality, particularly in the aging male population[1]. The incidence of prostate malignancy increases markedly after the fifth decade of life, with a wide spectrum of disease ranging from indolent, slow-growing tumors to highly aggressive carcinomas associated with local invasion and distant metastasis. Early identification and accurate characterization of tumor aggressiveness remain critical determinants of prognosis and treatment outcomes[2,3].

Serum prostate-specific antigen (PSA) is a glycoprotein enzyme produced by both normal and malignant prostatic epithelial cells and has been extensively used as a biomarker for prostate cancer screening, diagnosis, and disease monitoring[4]. Elevated PSA levels are frequently associated with prostate malignancy; however, PSA lacks absolute specificity, as increased levels may also occur in benign prostatic hyperplasia, prostatitis, and following prostatic manipulation. Despite these limitations, PSA remains an indispensable component of prostate cancer evaluation and is widely used to guide further diagnostic investigations[5].

Radiological imaging has emerged as an essential adjunct to PSA testing, playing a pivotal role in the detection, localization, and staging of prostate cancer. Transrectal ultrasound (TRUS) is commonly employed for prostate evaluation and biopsy guidance, allowing identification of suspicious hypoechoic lesions[6]. More recently, multiparametric magnetic resonance imaging (mpMRI) has significantly improved diagnostic accuracy by providing detailed anatomical and functional information, enabling better lesion characterization, assessment of extracapsular extension, and evaluation of seminal vesicle involvement. These imaging modalities contribute to improved risk stratification and help in avoiding unnecessary biopsies[7].

Histopathological examination of prostate biopsy specimens remains the gold standard for definitive diagnosis. The Gleason grading system, based on tumor architectural patterns, is a well-established prognostic indicator that correlates strongly with disease aggressiveness, risk of progression, and survival outcomes. Understanding how serum PSA levels and radiological findings correspond with histopathological grades is crucial for optimizing diagnostic pathways and clinical decision-making[8,9].

Given the diagnostic challenges posed by PSA variability and overlapping imaging features, a comprehensive clinicopathological correlation is essential to enhance diagnostic precision. This study aims to evaluate the relationship between serum PSA levels, radiological imaging findings, and histopathological characteristics of prostate malignancy, thereby providing evidence to support an integrated approach in the diagnosis and management of prostate cancer[10].

MATERIALS AND METHODS

Study Design and Setting: This cross-sectional observational study was carried out in the Department of Urology, CMH Kharian Medical College, Kharian, Pakistan, in collaboration with Sughra Shafi Medical Hospital Complex. The study was conducted over a six-month period from January 2023 to June 2023. The objective was to evaluate the clinicopathological correlation of prostate malignancy with serum prostate-specific antigen levels and radiological imaging findings, using histopathology as the reference standard.

Study Population and Sample Size: The study included a total of 70 male patients who presented with clinical suspicion of prostate malignancy during the defined study period. Patients were enrolled using a non-probability consecutive sampling technique, ensuring

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inclusion of all eligible cases presenting to the participating centers. The target population consisted of men aged 50 years and above, as prostate malignancy predominantly affects the elderly male population.

Eligibility Criteria: Patients were eligible for inclusion if they had clinical features suggestive of prostate malignancy, such as lower urinary tract symptoms, abnormal digital rectal examination findings, or elevated serum PSA levels, and if complete data regarding PSA testing, radiological evaluation, and prostate biopsy were available. Patients with previously diagnosed prostate cancer, those who had undergone prior prostate surgery or radiotherapy, individuals with recent prostate instrumentation, or those with evidence of acute prostatitis or urinary tract infection at presentation were excluded to avoid confounding of PSA and imaging findings.

Clinical Evaluation: All enrolled patients underwent a detailed clinical assessment, including documentation of demographic information, presenting symptoms, and relevant medical history. A thorough physical examination was performed in all cases, with particular emphasis on digital rectal examination to assess prostate size, consistency, symmetry, and the presence of nodules or induration suggestive of malignancy.

Serum Prostate-Specific Antigen Measurement: Serum PSA levels were measured in all patients prior to prostate biopsy. Venous blood samples were collected and analyzed using a standardized immunoassay technique in the hospital laboratory. For analytical purposes, PSA values were categorized into clinically relevant groups (<4 ng/mL, 4–10 ng/mL, and >10 ng/mL) to facilitate correlation with radiological findings and histopathological outcomes.

Radiological Imaging Assessment: Radiological evaluation was performed for all patients as part of the diagnostic workup. Transrectal ultrasound was used as the primary imaging modality to assess prostate size, echotexture, and the presence of focal hypoechoic lesions suspicious for malignancy, and it also served as guidance for biopsy. Multiparametric magnetic resonance imaging was performed in selected patients with equivocal TRUS findings or persistent clinical suspicion to further characterize lesions, assess local tumor extent, and evaluate capsular or seminal vesicle involvement. Imaging findings were documented and categorized as suspicious or non-suspicious for malignancy.

Prostate Biopsy and Histopathological Examination: All patients underwent TRUS-guided systematic prostate core biopsy following standard departmental protocols. Biopsy specimens were fixed in buffered formalin and submitted for histopathological examination. Histopathology was considered the definitive diagnostic modality and findings were classified as benign or malignant. In malignant cases, tumor grading was performed using the Gleason scoring system, and tumors were grouped according to Gleason score to assess disease severity.

Outcome Measures: The primary outcome measures included the correlation of serum PSA levels with histopathological diagnosis and Gleason grade, and the association of radiological imaging findings with biopsy-proven prostate malignancy. Secondary outcomes included evaluation of the combined diagnostic value of PSA levels and imaging findings in predicting tumor aggressiveness.

Statistical Analysis: Collected data were entered and analyzed using standard statistical software. Continuous variables were expressed as mean with standard deviation, while categorical variables were presented as frequencies and percentages. Associations between PSA categories, radiological findings, and histopathological results were assessed using appropriate statistical tests, with a p-value of less than 0.05 considered statistically significant.

Ethical Considerations: Ethical approval for the study was obtained from the institutional review committee of the participating centers. Written informed consent was obtained from all patients prior to inclusion in the study. Patient confidentiality was maintained throughout the research process, and the study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

RESULTS

Demographic and Clinical Characteristics: A total of 70 male patients with suspected prostate malignancy were included in the final analysis. The age of the patients ranged from 52 to 84 years, with a mean age of 66.8 ± 8.1 years. The majority of patients (62.9%) were between 60 and 75 years of age. Lower urinary tract symptoms were the most common presenting complaint, followed by abnormal digital rectal examination findings. An abnormal DRE suggestive of malignancy (hard, nodular, or irregular prostate) was noted in 45 (64.3%) patients.

Distribution of Serum PSA Levels: Serum PSA levels varied widely among the study population. PSA values below 4 ng/mL were observed in 6 (8.6%) patients, PSA levels between 4 and 10 ng/mL were noted in 14 (20.0%) patients, while markedly elevated PSA levels greater than 10 ng/mL were seen in 50 (71.4%) patients. The distribution of PSA levels among the study population is summarized in Table 1.

Table 1. Distribution of Serum PSA Levels (n = 70)

PSA Category (ng/mL)	Number of Patients	Percentage (%)
< 4	6	8.6
4 – 10	14	20.0
> 10	50	71.4
Total	70	100

Radiological Imaging Findings: Transrectal ultrasound was performed in all patients. Hypoechoic lesions suspicious for malignancy were detected in 46 (65.7%) patients, while 24 (34.3%) patients had no definite suspicious lesions on TRUS. Multiparametric MRI was performed in selected patients with equivocal findings or high clinical suspicion, revealing features suggestive of malignancy, including capsular irregularity or local extension, in 22 (31.4%) patients. Overall radiological assessment categorized 48 (68.6%) patients as having imaging findings suspicious for malignancy, while 22 (31.4%) were considered non-suspicious. These findings are detailed in Table 2.

Table 2. Radiological Imaging Findings (n = 70)

Imaging Assessment	Number of Patients	Percentage (%)
Suspicious for malignancy	48	68.6
Non-suspicious	22	31.4
Total	70	100

Histopathological Diagnosis: Histopathological examination of TRUS-guided prostate biopsy specimens confirmed prostate adenocarcinoma in 46 (65.7%) patients, while 24 (34.3%) patients showed benign pathology, including benign prostatic hyperplasia and chronic prostatitis. Histopathology was considered the definitive diagnostic modality and formed the basis for further correlation analysis.

Correlation Between PSA Levels and Histopathology: A strong association was observed between serum PSA levels and histopathological diagnosis. Among patients with PSA levels greater than 10 ng/mL, 40 out of 50 (80.0%) were diagnosed with prostate adenocarcinoma. In contrast, malignancy was confirmed in only 4 out of 14 (28.6%) patients with PSA levels between 4 and 10 ng/mL, and 2 out of 6 (33.3%) patients with PSA levels below 4 ng/mL. This relationship is presented in Table 3, demonstrating a statistically significant correlation between elevated PSA levels and malignancy.

Table 3. Correlation of Serum PSA Levels with Histopathological Diagnosis

PSA Category (ng/mL)	Malignant n (%)	Benign n (%)	Total
< 4	2 (33.3)	4 (66.7)	6
4 – 10	4 (28.6)	10 (71.4)	14
> 10	40 (80.0)	10 (20.0)	50
Total	46	24	70

Gleason Score Distribution in Malignant Cases: Among the 46 patients with confirmed prostate adenocarcinoma, Gleason score analysis revealed that 10 (21.7%) patients had Gleason scores ≤6, 18 (39.1%) patients had Gleason score 7, and 18 (39.1%) patients

had high-grade tumors with Gleason scores ≥8. This distribution indicates a high proportion of intermediate- and high-risk disease in the study population, as shown in Table 4.

Table 4. Gleason Score Distribution Among Malignant Cases (n = 46)

Gleason Score Category	Number of Patients	Percentage (%)
≤ 6	10	21.7
7	18	39.1
≥ 8	18	39.1
Total	46	100

Association of Radiological Findings with Gleason Score: Radiological findings showed a strong association with tumor aggressiveness. Among patients with imaging findings suspicious for malignancy, 30 (65.2%) had Gleason scores ≥7, while non-suspicious imaging was more frequently associated with lower Gleason scores. This supports the role of imaging in predicting disease severity and local tumor aggressiveness (Table 5).

Table 5. Association of Radiological Findings with Gleason Score

Imaging Findings	Gleason ≤6	Gleason ≥7	Total
Suspicious	10	38	48
Non-suspicious	12	10	22
Total	22	48	70

Overall, the results demonstrate a clear and statistically meaningful correlation between elevated serum PSA levels, suspicious radiological imaging findings, and higher Gleason scores on histopathology. Patients with PSA levels above 10 ng/mL and radiological evidence of malignancy were significantly more likely to harbor high-grade prostate cancer.

DISCUSSION

The present study evaluated the clinicopathological correlation of prostate malignancy with serum prostate-specific antigen levels and radiological imaging findings, using histopathology as the definitive diagnostic standard[10]. The findings demonstrate a strong and clinically meaningful association between elevated PSA levels, suspicious radiological features, and histopathological severity of prostate cancer, highlighting the value of an integrated diagnostic approach[11].

In this study, the majority of patients were elderly, with a mean age in the late sixties, which is consistent with the known age-related rise in prostate cancer incidence. Lower urinary tract symptoms and abnormal digital rectal examination findings were common presentations, reinforcing the importance of thorough clinical assessment in patients with suspected prostatic disease[12].

Serum PSA emerged as a significant biochemical marker associated with malignancy. Most patients with confirmed prostate cancer had PSA levels exceeding 10 ng/mL, and a clear trend was observed in which higher PSA levels were associated with a greater likelihood of malignancy. This supports the concept that PSA reflects tumor burden and biological activity. However, a small proportion of malignant cases were observed in patients with lower PSA levels, emphasizing that PSA alone cannot reliably exclude malignancy and should not be used as a sole diagnostic tool[13,14].

Radiological imaging, particularly transrectal ultrasound supplemented by multiparametric MRI in selected cases, played an important role in lesion detection and risk stratification[15]. Suspicious imaging findings were significantly more frequent among patients with biopsy-proven malignancy and were commonly associated with higher Gleason scores. Imaging features such as hypoechoic lesions, capsular irregularity, and signs of local extension correlated well with histopathological aggressiveness, underscoring the role of imaging in identifying clinically significant disease[16].

Histopathological evaluation confirmed prostate adenocarcinoma in a substantial proportion of cases, with a predominance of intermediate- and high-grade tumors[17]. The strong association between elevated PSA levels, suspicious imaging, and higher Gleason scores highlights the complementary nature of these diagnostic modalities. Patients with both markedly elevated PSA and suspicious imaging findings were more likely to harbor high-grade disease, which has important implications for treatment planning and prognostication[18,19].

Overall, the findings of this study support existing evidence that combining PSA testing with radiological imaging and histopathological assessment improves diagnostic accuracy and allows better identification of aggressive prostate cancer. This integrated approach is particularly valuable in resource-limited settings, where judicious use of diagnostic tools is essential to avoid unnecessary biopsies while ensuring timely diagnosis of clinically significant disease[20].

CONCLUSION

This study demonstrates a strong clinicopathological correlation between serum prostate-specific antigen levels, radiological imaging findings, and histopathological characteristics of prostate malignancy. Elevated PSA levels and suspicious radiological features were significantly associated with biopsy-proven prostate cancer and higher Gleason scores, indicating increased tumor aggressiveness. The combined use of PSA testing, radiological imaging, and histopathological evaluation provides a more accurate and reliable framework for the diagnosis and risk stratification of prostate cancer than reliance on any single modality. Adoption of an integrated diagnostic approach can facilitate early detection of clinically significant disease, guide appropriate management strategies, and ultimately improve patient outcomes.

Availability of Data and Materials: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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Authors' Contributions

S.A.A.[1] contributed to study conception, supervision, and final approval of the manuscript.
G.M.[2] was responsible for patient recruitment, clinical data collection, and manuscript drafting.
R.S.[3] performed histopathological evaluation and contributed to interpretation of pathological findings.
M.A.M.[4] contributed to radiological data interpretation and critical revision of the manuscript.
R.K.[5] assisted with data analysis and literature review.
H.N.K.[6] performed statistical analysis and manuscript editing.
All authors read and approved the final manuscript.

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