Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 2623-2629 | ISSN:2251-6727

Histopathological Correlation of Prostate Cancer with CT Scan Findings

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(Received: 16 January 2026 Revised: 25 February 2026 Accepted: 30 March 2026)

KEYWORDS:

Histopathology, Prostate Cancer, CT Scan.

ABSTRACT:

Background: Prostate cancer is one of the most common malignancies in men worldwide, with early detection and accurate staging being critical for effective management and improved outcomes. This study aims to evaluate the correlation between CT scan findings and histopathological grade in patients with prostate cancer.

Methods: This cross-sectional study at the Department of Radiology and Imaging, Bangladesh Medical University, and the National Institute of Kidney Diseases and Urology, Dhaka, Bangladesh, included 100 male patients with elevated PSA or abnormal DRE who underwent CT imaging and histopathological evaluation. Tumors were classified by Gleason score, CT scans were assessed for mass, extracapsular extension, lymph node enlargement, and bone metastasis, and findings were correlated with histopathology using SPSS with $p < 0.05$ considered significant.

Results: Among 100 patients (mean age 66.4 ± 7.2 years, range 51–82), 20.0% had Gleason 6, 35.0% Gleason 7, 25.0% Gleason 8, and 20.0% Gleason 9–10 tumors. CT scans showed a visible prostate mass in 75.0%, extracapsular extension in 30.0%, pelvic lymph node enlargement in 25.0%, and bone metastasis in 10.0%. Mass detection increased with grade from 60.0% in Gleason 6 to 88.0% in Gleason 8 ($p = 0.145$), while extracapsular extension and lymph node involvement rose significantly from 0.0% in Gleason 6 to 60.0% in Gleason 9–10 ($p < 0.001$ for both).

Conclusion: CT scan findings correlate with histopathological grade in prostate cancer, with higher-grade tumors more likely to show extracapsular extension and lymph node involvement, supporting its role in staging and clinical management..

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Introduction

Prostate cancer (PC) is recognized as the second most frequently diagnosed malignancy in men, with incidence rates varying considerably across different regions worldwide [1]. It continues to be a leading cause of illness and death among men globally, emphasizing the importance of timely diagnosis and intervention [2]. Early identification and precise diagnostic evaluation are critical to guide effective treatment strategies and improve clinical outcomes [3].

Assessing the risk profile of patients relies on a combination of pre-treatment parameters, including findings from digital rectal examination (DRE), serum prostate-specific antigen (PSA) levels, and the Gleason score (GS) obtained from prostate biopsy specimens [4]. Histopathological analysis remains the definitive method for diagnosing prostate cancer [5]. Moreover, prostate-specific membrane antigen (PSMA) has emerged as a potential biomarker for evaluating tumor aggressiveness in prostate malignancies [6].

Guidelines currently recommend the use of imaging modalities such as magnetic resonance imaging (MRI), computed tomography (CT), and bone scintigraphy for staging prostate cancer and informing treatment decisions [7]. Conventional diagnostic tools like PSA testing and DRE have inherent limitations in distinguishing malignant from benign lesions, which can lead to unnecessary biopsies or overlook clinically significant cancers [8]. Accurate initial staging following a prostate cancer diagnosis is essential for appropriate patient stratification and treatment planning [9]. Historically, pre-operative lymph node assessment has relied on CT or MRI; however, both modalities primarily use morphological criteria and are generally reliable only for detecting lymph node metastases larger than 8–10 mm [10].

Despite its clinical utility, conventional imaging such as CT has restricted sensitivity in detecting lymph node and bone metastases, particularly in patients with lower PSA levels. These limitations may result in inaccurate staging and suboptimal treatment decisions [11,12]. MRI, while highly informative, can also show low specificity in benign conditions like prostatitis, post-biopsy hemorrhage, or scarring that can mimic cancer [13]. Furthermore, direct correlation of histopathology with PET/CT imaging presents challenges due to prostate deformation during tissue processing and differences in the spatial resolution between imaging and histologic sections.

Accumulating evidence indicates that the detection of prostate cancer on imaging is influenced by tumor location and histological characteristics, including Gleason score, tumor volume, and architectural pattern [14–18]. While advanced imaging modalities, such as PSMA-PET/CT, have demonstrated potential to influence treatment decisions, their impact on long-term clinical outcomes requires further validation [19].

In Bangladesh, the incidence of prostate cancer is rising, driven by factors such as population aging, lifestyle changes, and enhanced diagnostic capabilities. Nevertheless, local data on the performance of mpMRI and CT in detecting prostate malignancies and correlating imaging findings with histopathology remain limited [20]. Considering variability in radiological interpretation and potential differences in tumor biology, it is crucial to evaluate how imaging features correspond with Gleason grading in the Bangladeshi population [21]. Therefore, this study aims to evaluate the correlation between CT scan findings and histopathological grade in patients with prostate cancer.

Objective

- To evaluate the correlation between CT scan findings and histopathological grade in patients with prostate cancer.

Methodology & Materials

This cross-sectional observational study was conducted at the Department of Radiology and Imaging, Bangladesh Medical University, in collaboration with the National Institute of Kidney Diseases and Urology, Dhaka, Bangladesh, from July 2021 to December 2021. A total of 100 male patients with clinically suspected prostate cancer were included, selected based on elevated prostate-specific antigen (PSA) levels or abnormal findings on digital rectal examination (DRE), and availability of both CT imaging and histopathological evaluation. The study aimed to evaluate the correlation between CT scan findings and histopathological grade of prostate cancer.

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Inclusion Criteria:

- Male patients with elevated PSA levels.
- Patients with abnormal DRE findings.
- Patients who underwent both CT imaging and histopathological evaluation.

Exclusion Criteria:

- Patients with a history of prior prostate surgery.
- Patients who had received chemotherapy.
- Patients with incomplete or missing clinical records.

Demographic data, including age, were recorded for all participants. Histopathological diagnosis was established through prostate biopsy, and tumors were classified using the Gleason scoring system as low-grade (Gleason 6), intermediate-grade (Gleason 7), or high-grade (Gleason 8–10). All patients underwent contrast-enhanced CT scans of the pelvis and abdomen following standard departmental protocols. Images were evaluated by experienced radiologists for the presence of a visible prostate mass, extracapsular extension (ECE), pelvic lymph node enlargement (short-axis diameter ≥10 mm), and bone metastasis. CT findings were then correlated with histopathological grades to assess their association with tumor aggressiveness. Statistical analysis, including calculation of percentages and the Chi-square test for trend (Mantel-Haenszel), was performed using IBM SPSS Statistics software (version XX), with a p-value < 0.05 considered statistically significant. Written informed consent was obtained from all participants prior to inclusion in the study.

Results

Table 1: Baseline Demographic and Histopathological Characteristics of the Study Population (n = 100)

Characteristic	Value
Age (years)	
Mean ± SD	66.4 ± 7.2
Range	51 – 82
Histopathological Grade (Gleason Score)	n (%)
6 (3+3)	20 (20.0%)
7 (3+4 / 4+3)	35 (35.0%)
8 (4+4)	25 (25.0%)
9–10 (4+5 / 5+4 / 5+5)	20 (20.0%)
Total	100 (100.0%)

The mean age of the study participants was 66.4 ± 7.2 years, ranging from 51 to 82 years. Among the 100 patients, 20 (20.0%) had a Gleason score of 6 (3+3), 35 (35.0%) had Gleason 7 (3+4 / 4+3), 25 (25.0%) had Gleason 8 (4+4), and 20 (20.0%) had high-grade tumors with Gleason 9–10 (4+5 / 5+4 / 5+5).

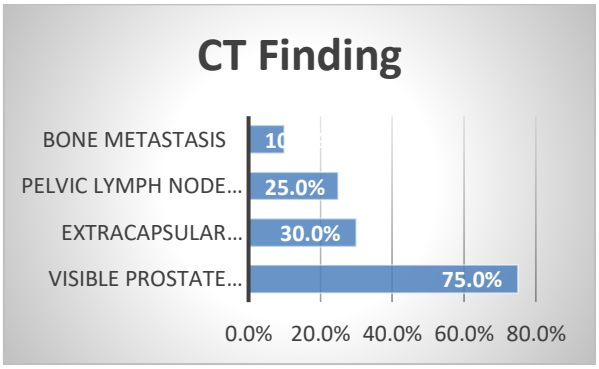

Figure 1: Distribution of CT Scan Findings Among Patients with Prostate Cancer (n = 100)

CT scan evaluation revealed a visible prostate mass in 75 patients (75.0%), extracapsular extension (ECE) in 30 patients (30.0%), pelvic lymph node enlargement in 25 patients (25.0%), and bone metastasis in 10 patients (10.0%).

Table 2: Correlation Between CT Findings and Histopathological Grade of Prostate Cancer

Histopathological Grade	n	Mass Detected	Extracapsular Extension	Lymph Node Involvement
6 (3+3)	20	12 (60.0%)	0 (0.0%)	0 (0.0%)
7 (3+4 / 4+3)	3	28 (80.0	5 (14.3%)	5

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JCHR (2026) 16(2), 2623-2629 | ISSN:2251-6727

	5	%)		(14.3%)
8 (4+4)	25	22 (88.0 %)	13 (52.0%)	8 (32.0%)
9–10 (4+5 / 5+4 / 5+5)	20	13 (65.0 %)	12 (60.0%)	12 (60.0%)
p-value		0.145	<0.001	<0.001

Correlation analysis showed that prostate mass detection increased with tumor grade: 12 of 20 patients (60.0%) with Gleason 6, 28 of 35 patients (80.0%) with Gleason 7, 22 of 25 patients (88.0%) with Gleason 8, and 13 of 20 patients (65.0%) with Gleason 9–10 had a visible mass on CT. Extracapsular extension was present in 0.0%, 14.3%, 52.0%, and 60.0% of patients across Gleason 6, 7, 8, and 9–10 groups, respectively. Lymph node involvement increased from 0.0% in Gleason 6 to 60.0% in Gleason 9–10. Statistical analysis using the Chi-square test for trend demonstrated significant associations for extracapsular extension ($p < 0.001$) and lymph node involvement ($p < 0.001$), while the trend for mass detection was not statistically significant ($p = 0.145$).

Discussion

In this cross-sectional study conducted at the Department of Radiology and Imaging, Bangladesh Medical University, in collaboration with the National Institute of Kidney Diseases and Urology, a substantial proportion of patients with clinically suspected prostate cancer had intermediate- to high-grade tumors, with Gleason score 7 being the most frequent. CT imaging detected visible prostate masses in most patients, while extracapsular extension and lymph node involvement were predominantly observed in those with higher-grade tumors, emphasizing the role of CT in assessing tumor aggressiveness and local or nodal spread in this population.

The baseline demographic and histopathological characteristics of our study population revealed a mean age of 66.4 ± 7.2 years, ranging from 51 to 82 years, with Gleason score 7 (intermediate grade) being the most frequent (35.0%), followed by Gleason 8 (25.0%) and Gleason 6 (20.0%), and high-grade tumors (Gleason 9–10) accounting for 20.0% of cases. These findings are consistent with previous literature. Singh et al.[22], in a systematic review and meta-analysis of 8,764 prostate carcinoma needle biopsy samples, reported Gleason score 7 as the most common category (41.3%), with low-grade tumors (Gleason ≤6) comprising 28.5% and high-grade tumors (Gleason ≥8) 30.2%, a distribution closely aligning with the intermediate and high-grade predominance in our cohort. Similarly, Rani et al.[23], in a prospective study of 82 histologically confirmed prostate carcinoma cases, observed a mean age of approximately 70 years, with most patients aged 61–70 years and a substantial proportion having Gleason 7 or higher, reflecting comparable age and tumor grade patterns to our study. Furthermore, Sihag et al.[24] reported Gleason score 7 as the most common, followed by Gleason score 8 and then Gleason score 6, which mirrors the pattern seen in our population where intermediate-grade tumors predominated, followed by high-grade and low-grade disease. Overall, these studies support the demographic and histopathological profile observed in our cohort and highlight the consistent predominance of intermediate to high-grade prostate cancer in older male populations.

The CT scan findings in our study demonstrated a visible prostate mass in 75.0% of patients, extracapsular extension (ECE) in 30.0%, pelvic lymph node enlargement in 25.0%, and bone metastasis in 10.0% of cases. These observations are consistent with previous literature. Jia et al.[25] reported that focal areas of mass-like enhancement on contrast-enhanced CT imaging correlate closely with prostate neoplasm and show good agreement with MRI and biopsy findings, highlighting the ability of CT to detect mass-like abnormalities consistent with prostate cancer. Similarly, Turpin et al.[26] emphasized that although modern imaging techniques such as PSMA PET-CT are increasingly used, conventional CT remains an important tool for staging, particularly in detecting lymph node involvement and bony metastases, despite variable sensitivity. The distribution of findings in our cohort aligns with these reports, demonstrating that CT reliably identifies primary prostate masses and can detect features of local and metastatic spread in a substantial proportion of patients, supporting its continued use in the clinical assessment of prostate cancer.

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The correlation between CT findings and histopathological grade in our study demonstrated that detection of prostate mass, extracapsular extension (ECE), and lymph node involvement increased with higher Gleason scores. Specifically, visible mass detection was noted in 60.0% of Gleason 6 tumors and peaked at 88.0% in Gleason 8, while ECE and lymph node involvement were predominantly observed in higher-grade tumors, with up to 60.0% of patients in the Gleason 9–10 group exhibiting these features. These results align with existing literature on imaging-pathology correlations in prostate cancer. Öztürk et al.[27] reported that Gleason grade was significantly associated with nodal metastasis and that imaging parameters, such as SUVmax on PET/CT, correlated with tumor grade, highlighting that more aggressive tumors are more likely to demonstrate advanced imaging features, including nodal involvement. Similarly, Turpin et al.[26] noted that lymph node involvement detected by CT increases with tumor stage and grade, supporting the trend observed in our cohort of higher nodal involvement with elevated Gleason scores. Furthermore, Lovegrove et al.[28] emphasized that features such as extracapsular extension and lymph node involvement are more commonly associated with higher-grade tumors and correlate with aggressive histopathology, reinforcing our finding that CT-detectable ECE and nodal metastases were largely confined to patients with intermediate to high-grade disease. Collectively, these studies substantiate our observations and underscore the value of CT imaging in reflecting tumor aggressiveness and local or nodal spread in prostate cancer.

Limitations of the study

The study had a few limitations:

- The study had a relatively small sample size, which may limit the generalizability of the findings.
- CT imaging primarily relies on morphological assessment and may have limited sensitivity in detecting small lymph node or bone metastases, potentially affecting correlation with histopathology.

Conclusion

Prostate cancer staging relies heavily on imaging to evaluate tumor extent and potential spread. Our study demonstrates that CT scan findings correlate with histopathological grade, with higher-grade tumors more likely to show extracapsular extension and lymph node involvement. Although mass detection on CT was common across all grades, it did not exhibit a significant trend with tumor aggressiveness. These findings underscore the value of CT imaging in identifying primary tumors and assessing local and nodal disease, supporting its role in the clinical management and staging of prostate cancer.

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