Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v6i3.1583
*Biol. Clin. Sci. Res. J., Volume 6(3), **2025**: 1583*
Original Research Article

Diagnostic Accuracy of Contrast-Enhanced MRI in Diagnosing and Staging Urinary Bladder Carcinoma, Taking Histopathology as Gold Standard

Piriha Nisar*, Varsha, Sanjna, Shaista Shoukat, Abdul Samad

Department of Radiology, Jinnah Postgraduate Medical Centre Karachi, Pakistan
**Corresponding author's email address:* Pirahnisar919@gmail.com

(Received, 4th March 2025, Accepted 28th March 2025, Published 31st March 2025)

Abstract: *Urinary bladder carcinoma is a common malignancy with significant morbidity and mortality. Accurate diagnosis and staging are essential for guiding treatment decisions. Contrast-enhanced magnetic resonance imaging (CE-MRI) provides a non-invasive approach for evaluating bladder tumours; however, its diagnostic accuracy compared to histopathology, the gold standard, requires validation.* ***Objective:*** *To evaluate the sensitivity, specificity, and diagnostic accuracy of contrast-enhanced MRI in diagnosing and staging urinary bladder carcinoma in comparison to histopathological findings.* ***Methods:*** *This prospective observational study was conducted at the Jinnah Postgraduate Medical Centre (JPMC), Karachi, from September 1, 2024, to February 28, 2025, following ethical approval. A total of 25 patients aged ≥18 years, of either gender, with clinical suspicion of urinary bladder carcinoma, were enrolled using non-probability consecutive sampling. Patients with contraindications to MRI or a history of contrast allergy were excluded. All patients underwent CE-MRI followed by cystoscopic biopsy for histopathological confirmation. The sensitivity, specificity, and diagnostic accuracy of CE-MRI were calculated by comparing MRI findings with histopathological results.* ***Results:*** *CE-MRI demonstrated a sensitivity of 53.85%, specificity of 75%, and an overall diagnostic accuracy of 64% in detecting and staging urinary bladder carcinoma.* ***Conclusion:*** *Contrast-enhanced MRI shows moderate diagnostic accuracy in the detection and staging of urinary bladder carcinoma. While it provides valuable non-invasive insights, its limited sensitivity underscores the continued importance of histopathology for definitive diagnosis.*

Keywords: MRI, Bladder carcinoma, Histopathology, accuracy

[***How to Cite:*** Nisar P, Varsha, Sanjna, Shoukat S, Samad A. Diagnostic accuracy of contrast-enhanced MRI in diagnosing and staging urinary bladder carcinoma taking histopathology as the gold standard. *Biol. Clin. Sci. Res. J.*, **2025;** 6(3): 5-8. doi: https://doi.org/10.54112/bcsrj.v6i3.1583

Introduction

Malignant neoplasm of the urinary bladder is a significant public health problem and, according to estimates, the 10th most frequent cancer in the World; it affects men more frequently than women (1). Proper diagnosis, aside from cancer detection, also plays a vital role in the treatment and survival of patients with cancer (2). The conventional test for diagnosing bladder carcinoma is cystoscopy followed by histopathological examination; the accuracy of these tests is high. However, biopsies are invasive and are associated with certain risks and drawbacks, especially in staging the tumor (3). MRI is a non-invasive technique that has been used recently for diagnosing urinary bladder carcinoma through contrast-enhanced MRI (4). MRI provides better contrast among various soft tissues, which is crucial for the diagnosis and staging of bladder malignancies, evaluating muscular infiltration, and determining the location of adjacent structures (5). Literature has shown that MRI, mainly when performed with the aid of gadolinium enhancements, can provide precise anatomical data essential for accurate cancer staging and help minimise the need for biopsies (6). While there is an increasing trend in the use of MRI for diagnosing bladder cancer, the diagnostic precision of this method remains under investigation. Using MRI, sensitivity and specificity in detecting and staging bladder carcinoma have been reported as high, comparable to those of histopathology, in some studies. At the same time, certain limitations have been noted, especially in diagnosing small or superficial tumours in other studies (7). Such variability underscores the need for further research to clarify the role of MRI in clinical practice more definitively. The purpose of this study is to evaluate the sensitivity and specificity of contrast-enhanced MRI in diagnosing and staging urinary bladder carcinoma in comparison to histopathological results. Through the assessment of the sensitivity, specificity, and accuracy of MRI in diagnosing bladder cancer, this study aims to contribute to the growing literature on the applicability of MRI in managing bladder cancer.

Methodology

After obtaining ethical approval from the institutional review board, this prospective observational study was conducted at JPMC, Karachi, from September 1, 2024, to February 28, 2025. Through non-probability consecutive sampling, 25 patients aged 18 years or older of both genders, suspected of having urinary bladder carcinoma, were included in the present study. Patients with contraindications to MRI or those allergic to MRI contrast agents were excluded from the present study. During registration, patients who met the given criteria received both contrast-enhanced MRI (CE-MRI) and cystoscopic evaluation as part of their further treatment plan. CE-MRI images were obtained according to a protocol developed explicitly for the optimal detection and staging of bladder cancer. Two experienced radiologists, blinded to the histological findings, reviewed the CE-MRI images and determined the presence of bladder lesions, searching for signs of infiltration into adjacent tissues. Urologists performed cystoscopy to evaluate the appearance of the bladder lesions and obtain tissue samples, which were used for histological examination. Clinical records of patients containing structured data on patient demographics, imaging, and histopathological data were obtained and entered into a database for this study. Data collection was conducted in accordance with ethical principles and guidelines for the protection of patient information. Before participating in the survey, all participants were required to sign a consent form. To characterise the demographic parameters of the study population, simple descriptive statistics were conducted on the attributes, including age, gender, and clinical profile. Subsequently, the diagnostic performance of CE-MRI was assessed and measured by sensitivity, specificity, positive

predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. MedCalc software was used to analyse the data.

The study involved a total of 25 patients with a mean age of 59.36 years (±8.2 years). Of these patients, 17 were male (68%), and eight were female (32%), reflecting a higher prevalence of urinary bladder carcinoma in males within this cohort (Table 1). In the analysis comparing contrast-enhanced MRI to histopathology, which served as the gold standard, the sensitivity of MRI in detecting bladder carcinoma was found to be 53.85% (Table 2). This indicates that MRI correctly identified 53.85% of the cases confirmed as positive by histopathology. The specificity of MRI was 75%, indicating that the imaging modality correctly identified 75% of patients who did not have bladder carcinoma, as confirmed by histopathology. The Positive Predictive Value (PPV) of MRI was calculated to be 70%, indicating that when MRI results were positive, there was a 70% likelihood of genuine positivity confirmed by histopathology. Conversely, the Negative Predictive Value (NPV) was 60%, indicating that when MRI results were negative, there was a 60% likelihood that the patient indeed did not have bladder carcinoma. Overall, the accuracy of MRI in this study was 64%, reflecting its moderate performance in diagnosing and staging urinary bladder carcinoma compared to histopathological findings. Figure 1 shows the ROC curve analysis comparing MRI and histopathology findings, with an area under the curve (AUC) of 0.65 and a p-value of 0.13. The comparison of staging between MRI and histopathology in diagnosing urinary bladder carcinoma reveals some discrepancies (Table 3). According to the MRI findings, seven patients were staged as T2 and six as T3, with no patients identified at the T1 stage. In contrast, histopathology, the gold standard, identified one patient at the T1 stage, five at the T2 stage, and five at the T3 stage. This variation highlights the challenges in accurately staging bladder carcinoma using MRI alone, particularly in detecting early-stage (T1) tumours.

Results

Table 1: Demographic analysis

Parameters	N=25
Age (years)	59.36±8.2
Gender	
Female	8 (32%)
Male	17 (68%)

Table 2: Sensitivity and Specificity Analysis

Histopathology	MRI Positive	MRI Negative	Total
Positive	7	3	10
Negative	6	9	15
Total	13	12	25
Sensitivity	53.85%		
Specificity	75%		
NPV	60%		
PPV	70%		
Accuracy	64%		

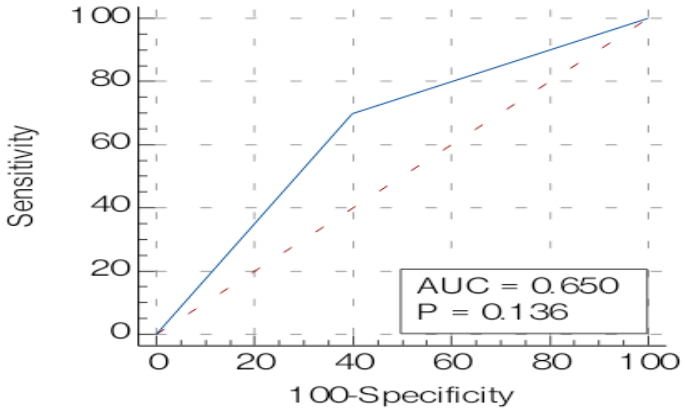

Figure 1: ROC curve analysis

Table 3: Comparison of staging in MRI and Histopathology

Staging	MRI	Histopathology
T1	0	1
T2	7	5
T3	6	5

Discussion

Thus, the present study demonstrates a moderate accuracy of contrast-enhanced MRI in evaluating the extent of urinary bladder carcinoma, with a sensitivity of 53.85% and a specificity of 75%. From these findings, it can be inferred that, although MRI exhibited moderate accuracy in excluding patients with negative results for bladder carcinoma, the sensitivity scores demonstrated its inability to include all actual positive

results accurately. In the current study, the sensitivity was found to be 53.85%, which is lower compared to the sensitivities reported in several previous studies. For instance, a survey by Sim et al. (2020) estimated MRI sensitivity to be approximately 80% in detecting bladder carcinoma with muscle invasion (8). This difference may be attributed to several causes, including technical aspects of MRI, such as variations in acquisition protocols, differences in imaging technologies, or discrepancies in the expertise and skills of the radiologists interpreting the images, which can result in lower sensitivities (9). Also, the current study could have possibly included more patients detected with muscle-invasive bladder carcinoma (MIBC), which is challenging to diagnose with MRI. The lower sensitivity also indicates that the MRI may fail to detect a significant number of true positives, especially in the early stages or small tumours – a disadvantage in its application for early diagnosis and staging. The general specificity for MRI in diagnosing bladder carcinoma is 75% in this study, which is in concordance with other studies that range from 70% to 90%. Panebianco et al. (2020), for instance, found that MRI is beneficial in excluding non-cancerous cases, mainly when multiple imaging approaches are employed (10). More precisely, the authors demonstrated that MRI can effectively rule out bladder carcinoma, which is crucial for minimising the use of invasive investigations. Nevertheless, this suggests that 25% of the results are false positives, potentially leading to patients being treated for conditions they do not have (11). From this analysis, a PPV of 70% and an NPV of 60% indicate that MRI has a fair accuracy in classifying accurate positive and true negative results. The PPV is in line with the idea that the MRI is comparatively more accurate when the examination findings suggest the existence of cancer. However, the NPV is lower than in prior research, where values are described as higher, particularly in the case of MIBC (12). It is for this reason that the lower NPV indicates that a negative MRI in this study population does not necessarily deem the patient unlikely to harbour bladder carcinoma, which highlights an area where MRI's diagnostic efficacy may be particularly weak (13). The overall performance yielded an accuracy of 64% with an AUC of 0.64. In this study, the accuracy of MRI ranged from 65% to 75%, suggesting moderate effectiveness of MRI in diagnosing and staging bladder carcinoma. The AUC, though, was more significant than 0. 5. It shows that MRI's diagnostic accuracy is slightly higher than mere guessing and is far from being statistically substantial equality (p=0. 13). This result is comparatively lower to works like Gandhi et al. (2018) wherein higher accuracy and AUC were obtained, mainly where advanced MRI was used, diffusion-weighted imaging (DWI) (14).

Several factors may have contributed to the disparities between the current study's results and those reported in the literature. These disparities include differences in patients' population characteristics, tumour pathophysiology, MRI modalities, and methods, as well as the radiologists' perception of the images. The tuning parameters applied in the current study are lower in sensitivity and accuracy compared to other studies, indicating that, although MRI is functional, it may not always be as effective as earlier studies have suggested, especially in identifying non-muscle-invasive bladder carcinoma. This highlights the importance of using MRI in conjunction with other diagnostic procedures, including cystoscopy and advanced imaging modalities, to enhance the precision of diagnosis (15).

Conclusion

In conclusion, this study reveals that contrast-enhanced MRI has moderate diagnostic accuracy in diagnosing urinary bladder carcinoma and staging it, with a sensitivity of 5.85% and a specificity of 75%. MRI also proves to be effective in excluding non-cancerous lesions and characteristics; however, the low accuracy, sensitivity, and negative predictive value indicate that MRI is not perfect in identifying all real positive cases. Based on these observations, it would be advisable to apply MRI as an additional method, rather than a final one, to enhance diagnostic accuracy in the clinic.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-MMS-033-24)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

PN (Postgraduate Trainee)
Manuscript drafting, Study Design,
V (Postgraduate Trainee)
Review of Literature, Data entry, Data analysis, and drafting articles.
S (PGR III)
Conception of Study, Development of Research Methodology Design,
SS (Professor)
Study Design, manuscript review, and critical input.
AS (Postgraduate Trainee)
Manuscript drafting, Study Design, Conception of Study, Development of Research Methodology Design,

All authors reviewed the results and approved the final manuscript version. They are also accountable for the integrity of the study.

References

1. Saginala K, Barsouk A, Aluru JS, Rawla P, Padala SA, Barsouk A. Epidemiology of bladder cancer. Medical sciences. 2020;8(1):15.
2. van Hoogstraten LM, Vrieling A, van der Heijden AG, Kogevinas M, Richters A, Kiemeney LA. Global Trends in the Epidemiology of Bladder Cancer: Challenges for Public Health and Clinical Practice. Nature reviews Clinical oncology. 2023;20(5):287-304.
3. Hensley PJ, Panebianco V, Pietzak E, Kutikov A, Vikram R, Galsky MD, et al. Contemporary staging for muscle-invasive bladder cancer: accuracy and limitations. European Urology Oncology. 2022;5(4):403-11.
4. Tufano A, Rosati D, Moriconi M, Santarelli V, Canale V, Salciccia S, et al. Diagnostic accuracy of contrast-enhanced ultrasound (CEUS) in the detection of muscle-invasive bladder cancer: A systematic review and diagnostic meta-analysis. Current Oncology. 2024;31(2):818-27.
5. Ahmed SA, Taher MGA, Ali WA, Ebrahem MAES. Diagnostic performance of contrast-enhanced dynamic and diffusion-weighted MR imaging in the assessment of tumour response to neoadjuvant therapy in muscle-invasive bladder cancer. Abdominal Radiology. 2021;46:2712-21.
6. Costelloe CM, Amini B, Madewell JE, editors. Risks and benefits of gadolinium-based contrast-enhanced MRI. Seminars in Ultrasound, CT and MRI; 2020: Elsevier.
7. Caglic I, Panebianco V, Vargas HA, Bura V, Woo S, Pecoraro M, et al. MRI of bladder cancer: local and nodal staging. Journal of Magnetic Resonance Imaging. 2020;52(3):649-67.
8. Sim KC, Sung DJ. Role of magnetic resonance imaging in tumour staging and follow-up for bladder cancer. Translational Andrology and Urology. 2020;9(6):2890.

9. Stabile A, Giganti F, Kasivisvanathan V, Giannarini G, Moore CM, Padhani AR, et al. Factors influencing variability in the performance of multiparametric magnetic resonance imaging in detecting clinically significant prostate cancer: a systematic literature review. European urology oncology. 2020;3(2):145-67.
10. Panebianco V, Narumi Y, Altun E, Bochner BH, Efstathiou JA, Hafeez S, et al. Multiparametric magnetic resonance imaging for bladder cancer: development of VI-RADS (Vesical Imaging-Reporting And Data System). European urology. 2018;74(3):294-306.
11. Rais-Bahrami S, Pietryga JA, Nix JW, editors. Contemporary Role of Advanced Imaging in Bladder Cancer Staging. Urologic Oncology: Seminars and Original Investigations; 2016: Elsevier.
12. Panebianco V, De Berardinis E, Barchetti G, Simone G, Leonardo C, Grompone MD, et al. An evaluation of morphological and functional multi-parametric MRI sequences in classifying non-muscle and muscle-invasive bladder cancer. European radiology. 2017;27:3759-66.
13. Lahdensuo K. Diagnostic and predictive tools in localised prostate cancer: biopsies, magnetic-resonance imaging, and tissue markers. 2017.
14. Gandhi N, Krishna S, Booth CM, Breau RH, Flood TA, Morgan SC, et al. Diagnostic accuracy of magnetic resonance imaging for tumour staging of bladder cancer: systematic review and meta-analysis. BJU international. 2018;122(5):744-53.
15. Galgano SJ, Porter KK, Burgan C, Rais-Bahrami S. The role of imaging in bladder cancer diagnosis and staging. Diagnostics. 2020;10(9):703.