*Biological and Clinical Sciences Research Journal*
*eISSN: 2708-2261; pISSN: 2958-4728*
*www.bcsrj.com*
DOI: https://doi.org/10.54112/bcsrj.v6i5.1976
*Biol. Clin. Sci. Res. J., Volume 6(5), **2025**: 1976*
***Original Research Article***

# Diagnostic Accuracy of Ultrasound in Detection of Bladder Masses Keeping Cystoscopy as Gold Standard

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*(Received, 1st April 2025, Accepted 25th April 2025, Published 31th May 2025)*

**Abstract:** *Bladder cancer is one of the most common urological malignancies worldwide, with painless hematuria being the predominant presenting symptom. Cystoscopy is considered the gold standard for diagnosis, but it is invasive, costly, and not always feasible in resource-limited settings. Ultrasound, being noninvasive and widely available, is frequently used as an initial imaging modality.* ***Objective:*** *To evaluate the diagnostic accuracy of ultrasound in detecting urinary bladder masses, using cystoscopy and histopathology as the reference standards.* ***Methods:*** *This prospective cross-sectional diagnostic accuracy study was conducted in the Departments of Radiology and Urology, Rehman Medical Institute, Peshawar, from September 2024 to March 2025. Ninety-three patients aged ≥18 years presenting with painless hematuria or dysuria were included. All underwent gray-scale ultrasound of the kidneys, ureters, and bladder, followed by cystoscopy and, where applicable, transurethral resection of bladder tumor (TURBT) with histopathology. Diagnostic accuracy parameters of ultrasound were calculated against cystoscopy/histopathology.* ***Results:*** *The mean age of participants was 69.6 years, with 81 males (87.1%) and 12 females (12.9%). Ultrasound detected bladder masses in 29 patients. Cystoscopy confirmed masses in 32 cases. Ultrasound demonstrated a sensitivity of 87.9%, specificity of 98.3%, positive predictive value of 96.7%, and negative predictive value of 93.7%.* ***Conclusion:*** *Ultrasound is a valuable, noninvasive, and cost-effective modality for the initial evaluation of patients with suspected urinary bladder masses. Although it cannot replace cystoscopy, its high sensitivity and specificity support its role as a first-line investigation, particularly in resource-limited settings.*

**Keywords:** Bladder mass, Ultrasound, Cystoscopy, Diagnostic accuracy, Hematuria

[***How to Cite:*** Khel SSM, Shah GG, Bilal M, Asif M, Umer US, Abid H. Diagnostic accuracy of ultrasound in detection of bladder masses keeping cystoscopy as gold standard. *Biol. Clin. Sci. Res. J.*, **2025;** 6(5): 371-374. doi: https://doi.org/10.54112/bcsrj.v6i5.1976

## Introduction

Bladder masses may be benign or malignant, and early detection is essential for timely management and better patient outcomes. Bladder cancer remains a major global health concern and is reported as the sixth most common cancer in the United States and the ninth most common in Pakistan (1). Its management places a considerable financial burden on healthcare systems and patients due to the need for long-term surveillance, repeated investigations, and multiple interventions (2). Clinically, painless hematuria is the most frequent presenting complaint and is observed in approximately 85 to 90% of patients.

Cystoscopy is considered the gold standard for detecting urinary bladder masses because it enables direct visualization and provides histopathological confirmation through transurethral resection of bladder tumor (TURBT) (3). Despite its diagnostic superiority, cystoscopy is invasive, relatively costly, often requires anesthesia or sedation, and may not be readily available in all healthcare settings, particularly in resource-limited environments (4). In contrast, ultrasound is a widely accepted first-line imaging modality in patients presenting with hematuria or suspected bladder cancer because it is non-invasive, safe, cost-effective, widely available, and free of ionizing radiation (5).

The performance of ultrasound in detecting bladder masses has shown variable results across studies, largely influenced by tumor size, morphology, and anatomical location. Emerging approaches, including high-resolution micro-ultrasound and contrast-enhanced ultrasound, have improved diagnostic accuracy; however, these newer modalities are not routinely accessible in many low-resource countries where conventional gray-scale ultrasound remains the most commonly used technique (6). Therefore, reassessing the diagnostic value of standard ultrasound in contemporary routine practice is important.

Ultrasound detection rates are generally higher for lesions larger than 0.5 cm and for masses located on the posterior or lateral bladder wall, where visualization is often more favorable (7). Based on these considerations, we hypothesize that conventional gray-scale ultrasound continues to be a reliable tool for identifying urinary bladder masses in routine clinical practice (8). The objective of this study is to evaluate the diagnostic accuracy of ultrasound in detecting urinary bladder masses, thereby supporting its role as a readily available, non-invasive, and cost-effective investigation when cystoscopy is not immediately feasible in selected patients.

## Methodology

This prospective cross-sectional diagnostic accuracy study was carried out at the Departments of Radiology and Urology, Rehman Medical Institute, Peshawar, between 21 September 2024 and 20 March 2025 after approval from the Institutional Review Board (Reference No. RMI/RMI-REC/Approval/235) and the College of Physicians and Surgeons Pakistan (Reference No. CPSP/REU/RAD-2022-024-3656). Written informed consent was obtained from all participants after an explanation of the study objectives, procedures, risks, and benefits.

Patients aged 18 years and above of either gender presenting with painless hematuria or dysuria were included. Exclusion criteria were patients with bleeding disorders, known renal or bladder calculi, or recent urological instrumentation.

All participants underwent a gray-scale ultrasound of the kidney, ureter, and bladder performed by an experienced radiologist. Ultrasound findings

included the presence or absence of a bladder mass, size (maximum diameter), location, echogenicity, and morphology, where appreciable.

Cystoscopy was performed by a qualified urologist for confirmation. Findings documented included the presence or absence of a mass, size, location, and morphology (sessile or papillary). Where masses were identified, transurethral resection of bladder tumor (TURBT) was carried out, and tissue was sent for histopathology, which served as the gold standard.

Data were entered and analyzed using SPSS version 25 for Windows. Continuous variables such as age were presented as mean ± standard deviation, while categorical variables such as gender and tumor characteristics were expressed as frequencies and percentages. Diagnostic accuracy parameters (sensitivity, specificity, positive predictive value, and negative predictive value) of ultrasound were calculated against cystoscopy/histopathology. Chi-square test was used to assess associations between ultrasound findings and tumor characteristics. A p-value <0.05 was considered statistically significant.

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**Results**

A total of 93 patients meeting the inclusion criteria were enrolled. All participants underwent ultrasound KUB, followed by cystoscopy and histopathological assessment. The mean age was 69.64 years (range: 53 to 83 years). Most participants were male (87.1%), with 12.9% females (Table 1).

On ultrasound, 29 patients (31.2%) were reported to have a urinary bladder mass or suspicious thickening. The most frequent ultrasound finding was lateral bladder wall thickening (Table 2). No mass was detected on ultrasound in 64 patients (68.8%). (Table 2)

On cystoscopy, bladder masses were confirmed in 32 patients (34.4%), including lesions missed on ultrasound. Morphologically, lesions were predominantly papillary followed by sessile growths (Table 3).

When ultrasound findings were compared with cystoscopy (gold standard), ultrasound identified 28 true positives and 60 true negatives, with 4 false negatives and 1 false positive (Table 4).

Based on the above 2 by 2 table, ultrasound showed high specificity and good sensitivity for detecting urinary bladder masses (Table 5).

**Table 1. Baseline demographic characteristics of the study participants (n = 93)**

| Variable | Value |
|---|---|
| Age, mean (range), years | 69.64 (53 to 83) |
| Male, n (%) | 81 (87.1) |
| Female, n (%) | 12 (12.9) |

**Table 2. Ultrasound KUB findings suggestive of urinary bladder mass (n = 93)**

| Ultrasound finding | Number of patients | Percentage (%) |
|---|---|---|
| Lateral wall thickening | 27 | 29.0 |
| Multiple bladder masses | 1 | 1.1 |
| Thickening near the left ureteric orifice with mild to moderate hydroureteronephrosis | 1 | 1.1 |
| **No mass detected** | 64 | 68.8 |

**Table 3. Cystoscopic findings of urinary bladder masses (n = 93)**

| Cystoscopy finding | Number of patients | Percentage (%) |
|---|---|---|
| **Papillary mass** | 24 | 25.8 |
| **Sessile mass** | 8 | 8.6 |
| **No mass** | 61 | 65.6 |

**Table 4. Diagnostic comparison of ultrasound versus cystoscopy for bladder mass detection (n = 93)**

| Ultrasound finding | Cystoscopy mass present | Cystoscopy mass absent | Total |
|---|---|---|---|
| **Mass present** | 28 (True positive) | 1 (False positive) | 29 |
| **Mass absent** | 4 (False negative) | 60 (True negative) | 64 |
| **Total** | 32 | 61 | 93 |

**Table 5. Diagnostic performance of ultrasound using cystoscopy as the reference standard**

| Parameter | Value |
|---|---|
| Sensitivity | 87.5% |
| Specificity | 98.4% |
| Positive predictive value | 96.6% |
| Negative predictive value | 93.8% |
| Overall diagnostic accuracy | 94.6% |

**Discussion**

Painless hematuria is widely recognized as the most common presenting symptom of urinary bladder tumors. In routine practice, ultrasound KUB is frequently used as the initial imaging investigation, whereas cystoscopy remains the diagnostic and staging reference standard because it allows direct visualization and targeted biopsy of suspicious lesions. However, cystoscopy is invasive, relatively costly, and may be associated with complications such as urinary tract infection and iatrogenic injury, while ultrasound is noninvasive, inexpensive, and more readily available (10).

Published evidence indicates that ultrasound can achieve high sensitivity and specificity for detecting bladder tumors, particularly when lesions are larger and exophytic (11). Nevertheless, diagnostic performance may vary across settings. Some studies report high sensitivity but comparatively lower specificity, as inflammatory changes and benign conditions can mimic bladder wall thickening and may be misinterpreted as malignancy on gray-scale imaging (12). In addition, ultrasound may

miss small, flat, or subtle lesions, highlighting an important limitation compared with cystoscopy (13).

Technological advances have expanded the potential applications of ultrasound in bladder tumor assessment. High-resolution and micro-ultrasound have been reported to provide more reliable information related to staging and local tumor characteristics, supporting their possible use as noninvasive alternatives to cystoscopy in selected cases. Likewise, meta-analyses suggest that contrast-enhanced ultrasound can offer high diagnostic accuracy for both detection and staging of bladder cancer (14). There is also growing interest in using ultrasound as a surveillance tool for recurrence in low-risk bladder carcinoma, potentially reducing the frequency of invasive follow-up procedures in selected patients (15).

More recent studies further suggest that contrast-enhanced ultrasound may help differentiate between high- and low-grade bladder cancers, and efforts are ongoing to establish standardized vesical imaging reporting frameworks for evaluating muscle invasion. Together, these developments reflect the expanding role of ultrasound not only in detection but also in characterization and risk stratification (16).

Despite these advances, many low- and middle-income countries face limited access to newer ultrasound techniques and adequately trained personnel. In such resource-limited settings, conventional ultrasound continues to provide substantial clinical value as a first-line, cost-effective, and noninvasive diagnostic test, while cystoscopy is reserved for definitive diagnosis, histological confirmation, and therapeutic intervention (17).

Overall, current evidence supports a complementary role: cystoscopy remains indispensable for confirmation and treatment, while ultrasound offers key advantages in accessibility, patient comfort, and reducing financial burden. However, important limitations persist in the literature. Many studies are single-center with relatively small sample sizes, and ultrasound interpretation is operator dependent. Larger multicenter studies with standardized protocols are needed to strengthen generalizability across diverse populations and healthcare settings.

## Conclusion

Ultrasound is a valuable, noninvasive, and cost-effective modality for the initial assessment of suspected bladder masses. Although cystoscopy remains the gold standard for definitive diagnosis, ultrasound can reliably detect most tumors and help limit unnecessary invasive procedures, especially in resource-limited settings. Wider access to advanced ultrasound technologies and training may further enhance its clinical utility.

## 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-RMI/RMI-REC/Approval/235)

**Consent for publication**

Approved

**Funding**

Not applicable

## Conflict of interest

The authors declared the absence of a conflict of interest.

## Author Contribution

**SSMK**

*Conception of study, Study design, development of Research methodology design, Data analysis, manuscript drafting*

**GGS**

*Review of Literature, Data entry, and drafting an article.*

**MB**

*Data analysis, manuscript review, critical input*

**MA** (Associate Professor)

*Data collection*

**USU**

*Data collection*

**HA**

*Review of literature and proofreading*

*All authors reviewed the results and approved the final version of the manuscript. 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. https://doi.org/10.3390/medsci8010015
2. Ikram A, Pervez S, Khadim MT, Sohaib M, Uddin H, Badar F, et al. National cancer registry of Pakistan: first comprehensive report of cancer statistics 2015-2019. *Journal of the College of Physicians and Surgeons Pakistan*. 2023;33(6):625-632. https://doi.org/10.29271/jcpsp.2023.06.625
3. Joyce DD, Sharma V, Williams SB. Cost-effectiveness and economic impact of bladder cancer management: an updated review of the literature. *PharmacoEconomics*. 2023;41(7):751-769. https://doi.org/10.1007/s40273-023-01273-8
4. Sell V, Ettala O, Montoya Perez I, Järvinen R, Pekkarinen T, Vaarala M, et al. Symptoms and diagnostic delays in bladder cancer with high risk of recurrence: results from a prospective FinnBladder 9 trial. *World Journal of Urology*. 2020;38(4):1001-1007. https://doi.org/10.1007/s00345-019-02841-4
5. Salmanoglu E, Halpern E, Trabulsi EJ, Kim S, Thakur ML. A glance at imaging bladder cancer. *Clinical and Translational Imaging*. 2018;6(4):257-269. https://doi.org/10.1007/s40336-018-0284-9
6. Alame W, Alame C, Ibrahim S. Is ultrasound the urologist's stethoscope in the outpatient clinic? *Open Journal of Urology*. 2023;13(5):151-160. https://doi.org/10.4236/oju.2023.135019
7. Tan WS, Ahmad A, Zhou Y, Nathan A, Ogunbo A, Gbolahan O, et al. Hematuria Cancer Risk Score with ultrasound informs cystoscopy use in patients with hematuria. *European Urology Oncology*. 2025;8(1):87-93. https://doi.org/10.1016/j.euo.2024.05.005
8. Mostafaloo M, Ghaemian N, Hajian-Tilaki K, Moudi E. Comparison of bladder ultrasonographic and rigid cystoscopic findings in patients with hematuria. *Caspian Journal of Internal Medicine*. 2019;10(4):417-423. https://doi.org/10.22088/cjim.10.4.417
9. Lee J, Heo JE, Kang SK, Lee KS, Han H, Jang WS, et al. Noninvasive studies may have the potential to replace cystoscopy in non-muscle invasive bladder cancer follow-up. *Scientific Reports*. 2022;12(1):21677. https://doi.org/10.1038/s41598-022-23111-1
10. Dershaw DD, Scher HI. Serial transabdominal sonography of bladder cancer. *American Journal of Roentgenology*. 1988;150(5):1055-1059. https://doi.org/10.2214/ajr.150.5.1055
11. Denkhaus H, Crone-Münzebrock W, Huland H. Noninvasive ultrasound in detecting and staging bladder carcinoma. *Urologic Radiology*. 1985;7(3):121-131. https://doi.org/10.1007/BF02926870
12. Malone PR, Weston-Underwood J, Aron PM, Wilkinson KW, Joseph AE, Riddle PR. The use of transabdominal ultrasound in the detection of early bladder tumours. *British Journal of Urology*. 1986;58(5):520-522. https://doi.org/10.1111/j.1464-410X.1986.tb05458.x
13. Saita A, Lughezzani G, Buffi NM, Hurle R, Nava L, Colombo P, et al. Assessing the feasibility and accuracy of high-resolution

microultrasound imaging for bladder cancer detection and staging. *European Urology*. 2020;77(6):727-732. https://doi.org/10.1016/j.eururo.2019.03.044

14. Tufano A, Rosati D, Moriconi M, Santarelli V, Canale V, Salciccia S, et al. Diagnostic accuracy of contrast-enhanced ultrasound in the detection of muscle-invasive bladder cancer: a systematic review and diagnostic meta-analysis. *Current Oncology*. 2024;31(2):818-827. https://doi.org/10.3390/curroncol31020060

15. Abouelkheir RT, Abdelhamid A, Abou El-Ghar M, El-Diasty T. Imaging of bladder cancer: standard applications and future trends. *Medicina*. 2021;57(3):220. https://doi.org/10.3390/medicina57030220

16. Gharibvand MM, Kazemi M, Motamedfar A, Sametzadeh M, Sahraeizadeh A. The role of ultrasound in the diagnosis and evaluation of bladder tumors. *Journal of Family Medicine and Primary Care*. 2017;6(4):840-843. https://doi.org/10.4103/jfmpc.jfmpc_186_17

17. Galgano SJ, Porter KK, Burgan C, Rais-Bahrami S. The role of imaging in bladder cancer diagnosis and staging. *Diagnostics*. 2020;10(9):703. https://doi.org/10.3390/diagnostics10090703