ORIGINAL ARTICLE

# DIAGNOSTIC ACCURACY OF SONOURETHROGRAPHY IN THE DIAGNOSIS OF ANTERIOR URETHRAL STRICTURE TAKING RETROGRADE URETHROGRAM AS A REFERENCE STANDARD

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## ABSTRACT

**Objective:** To determine the Diagnostic accuracy of sonourethrography (SUG) in the diagnosis of anterior urethral stricture, taking retrograde urethrogram (RUG) as a reference standard

**Materials and Methods:** This cross-sectional study was performed at the Radiology Department of the Combined Military Hospital (CMH) in Peshawar, Pakistan, from November 3, 2022, to May 3, 2023. A total of 104 clinically suspected cases of anterior urethral stricture were included. Male patients aged 15–65 years presenting with lower urinary tract symptoms for at least one week were enrolled. Patients with posterior urethral strictures, allergies to contrast media, or severe perineal conditions were excluded. SUG was conducted using a Toshiba Xario 200 Doppler scanner, with RUG serving as the gold standard for confirmation. Diagnostic accuracy metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy, were calculated using SPSS version 25.

**Results:** The average age of participants was 37.80 ± 9.245 years. SUG identified strictures in 32 patients, with 71.8% located in the bulbar urethra and 28.1% in the penile urethra. Severity assessment showed 65.6% of strictures as mild, 28.1% as moderate, and 6.25% as severe. Average stricture lengths were 2.1 ± 0.31 mm on SUG and 2.8 ± 0.46 mm on RUG. SUG demonstrated a sensitivity of 97%, specificity of 96%, PPV of 91.2%, NPV of 98.6%, and a diagnostic accuracy of 96.1%.

**Conclusion:** Sonourethrography is a dependable diagnostic tool for anterior urethral strictures, showing excellent sensitivity and specificity. Its superior ability to evaluate stricture length and severity makes it a crucial modality for clinical practice.

**Keywords:** Sonourethrography, Retrograde urethrography, Diagnostic accuracy

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## INTRODUCTION

Urethral strictures, a common cause of bladder outflow obstruction, are important urological conditions that cause significant physical and psychological burdens. This condition is marked by narrowing of the urethral lumen due to fibrosis and scarring, often leading to obstructive voiding symptoms such as difficult micturation, decreased urinary flow, and pain during urination. [1, 2] The causes of urethral strictures vary by region, with Lichen sclerosis being the main cause in developed countries and trauma being the leading cause in developing nations. [3, 4] In the past, infections like sexually transmitted diseases were the main causes of urethral strictures, but recent studies show that trauma, including blunt injuries and iatrogenic causes, now make up most of the etiological spectrum. Pelvic fractures and incorrect instrumentation, such as improper Foley catheter use, are often involved, especially in male patients whose longer urethra makes them more prone to these injuries. Urethral strictures mainly affect older men, with the prevalence increasing after age 55. [4, 5]

The impact of urethral strictures on quality of life can be significant, as patients often face considerable distress and discomfort from their symptoms. This condition's complexity demands accurate diagnosis and effective treatment to alleviate symptoms and prevent long-term complications. Traditional imaging methods, including retrograde urethrography (RUG) and voiding cystourethrography (VCUG), have long been the standard for diagnosing urethral strictures. While RUG is highly sensitive in detecting strictures, it has notable limitations, such as static two-dimensional imaging, underestimating stricture length, and radiation exposure. [6] The accuracy of RUG can also be influenced by patient positioning and the degree of penile stretching, making it less reliable for assessing complex or periurethral pathologies. [7] Furthermore, RGU

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provides limited information on spongiofibrosis—a critical factor in surgical planning—and carries risks like contrast extravasation and infection. [8, 9]

To address these limitations, sonourethrography (SUG) has become a superior imaging method, providing dynamic, high-resolution, three-dimensional images without the risks of radiation exposure. [1, 3] Introduced by McAninch et al. in 1988, SUG has transformed the evaluation of anterior urethral strictures by offering detailed views of the urethral lumen, periurethral fibrosis, and stricture length. [3, 8] Compared to RGU, SUG not only improves diagnostic accuracy but also greatly enhances preoperative planning by identifying key features such as spongiofibrosis and related conditions, including diverticula, fistulae, and polyps. [6, 7]

The benefits of SUG go beyond just diagnosis. This method is non-invasive, affordable, and especially suitable for children and older adults because of its safety. [10] Studies consistently show that SUG measures stricture length more accurately than RGU, which helps in planning better surgeries and lowers the chance of relapse. [4, 11] However, it is important to remember that SUG has limitations in assessing posterior urethral strictures, where RGU is still the preferred choice. [2, 6] Even with its increased use, SUG presents some challenges. It requires skilled radiologists and special equipment, like high-frequency transducers, for the best imaging results. Also, interpreting SUG results needs a systematic approach and experience to ensure accurate diagnosis, especially in complicated cases. [11]

Given the evolving landscape of diagnostic imaging for urethral strictures, this study aims to reevaluate the diagnostic accuracy of sonourethrography compared to retrograde urethrography. By assessing the strengths and limitations of these modalities, this research seeks to add to the growing evidence supporting the integration of advanced imaging techniques into routine clinical practice. With the potential to enhance patient outcomes and quality of life, further investigation into the role of SUG in diagnosing urethral strictures is justified.

## MATERIALS AND METHODS

This cross-sectional study was carried out at the Department of Radiology in the Combined Military Hospital in Peshawar, Pakistan, from November 3, 2022, to May 3, 2023. The study included 104 clinically suspected cases of anterior urethral stricture. The sample size was determined using an expected sensitivity of 81.6%, specificity of 91.6%, prevalence of 26.28%, and an absolute precision of 15%. Non-probability consecutive sampling was used to ensure that all eligible patients were included.

The inclusion criteria for this study were male patients aged 15–65 years with lower urinary tract symptoms lasting at least 1 week and clinically suspected of having an anterior urethral stricture. Patients with allergies to contrast material, posterior urethral stricture, Fournier's gangrene, or watering-can perineum were excluded. After obtaining ethical approval, patients meeting the inclusion criteria were recruited from the outpatient department (OPD) or emergency room (ER). Study details were explained to each patient, and informed consent was obtained to ensure participants fully understood the study's purpose and procedures.

Demographic data, including age, occupational and residential status, and symptom duration, were recorded for each patient. A documented history of diabetes mellitus and hypertension was also noted, as these comorbidities might influence the development or severity of urethral strictures. Patients underwent sonourethrography (SUG) using a Toshiba Xario 200 Doppler scanner with a 7.5 MHz linear probe. Strict aseptic techniques were followed, and local anesthesia was applied with 2% lignocaine jelly to reduce discomfort during the procedure. A 12 Fr catheter was inserted, inflated, and used to infuse saline for imaging. Both transverse and longitudinal scans were performed, with a transperineal approach to provide clear visualization of the bulbous urethra.

The diagnosis of anterior urethral stricture via SUG was confirmed using a retrograde urethrogram (RUG), performed with Foley's catheter and Urografin 76% contrast media, followed by single-spot imaging. Findings from both methods were recorded and compared to evaluate the diagnostic accuracy of SUG. SPSS version 25 was used for data analysis. Quantitative variables such as age, BMI, and symptom duration were assessed for normality using the Shapiro-Wilk test and reported as means with standard deviations and medians with interquartile ranges.

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of SUG were calculated using RUG as the gold standard. Effect modifiers were stratified, and diagnostic metrics were recalculated after stratification to address potential confounding variables.

## RESULTS

In this study, patients' ages ranged from 15 to 65 years. The average age was 37.80 ± 9.245 years. Comparisons of ultrasonography findings from sonourethrography with retrograde urethrography, based on the location of the stricture, are shown in Table 2. A total of 32 patients had strictures on SUG, of whom 23 had a stricture in the bulbar urethra, while 9 had a stricture in the penile urethra.

Distribution of urethral stricture severity on SUG is given in Table 3. Out of 32 cases diagnosed as urethral strictures, 21 were mild, 9 were moderate, and 2 were severe.

Mean stricture length was calculated as 2.1 ± 0.31 mm on SUG, while 2.8 ± 0.46 mm on RUG. The comparison of SUG with RUG for anterior urethral stricture is shown in Table 4. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of SUG for detecting anterior urethral stricture were 97%, 96%, 91.2%, 98.6%, and 96.1%, respectively.

**Table No 1: Mean ± SD of patients according to age, weight, and BMI**

| Demographics And Baseline Characteristics | MEAN ± STD. DEVIATION |
|---|---|
| Patient Age (Years) | 37.80 ± 9.245 |
| Patient Weight (Kg) | 65.22 ± 7.101 |
| BMI (Kg/m2) | 21.40 ± 3.1042 |

**Table No 2: Stricture category on SUG**

| Category | Frequency (n) | Percent (%) |
|---|---|---|
| Bulbar | 23 | 71.8 |
| Penile | 09 | 28.1 |
| Total | 32 | 100 % |

**Table No 3: SUG outcome of anterior urethral strictures according to severity**

| SUG Outcome | Frequency(n) | Percent |
|---|---|---|
| (%) | 23 | 71.8 |
| Mild | 21 | 65.6 |
| Moderate | 09 | 28.1 |
| Severe | 02 | 6.25 |
| Total | 32 | 100 % |

**Table No 4: Comparison of SUG and RUG for diagnosing anterior urethral stricture**

| SUG outcome | RUG Outcome | | Total |
|---|---|---|---|
| | Positive | Negative | |
| Positive | 31 (TP)* | 1 (FP)** | 32 |
| Negative | 3 (FN)*** | 69 (TN)**** | 74 |
| Total | 34 | 70 | 104 |

*TP = True positive, **FP = False positive, ***FN = False negative, ****TN = True Negative

## DISCUSSION

The present study aimed to determine the diagnostic accuracy of sonourethrography (SUG) in identifying anterior urethral strictures, with retrograde urethrography (RUG) serving as the reference standard. Our findings revealed that SUG diagnosed urethral strictures in 30.8% of patients, while RUG identified strictures in 32.7% of cases. These results are slightly higher than those reported by Hassan et al., where SUG identified strictures in 23.5% and RUG in 24.5% of cases. Shahsavari et al. also reported similar findings. [4,11,12] This variation might stem from differences in patient demographics or imaging techniques used in the studies. However, the close agreement between SUG and RUG detection rates in both studies highlights the reliability of these diagnostic modalities.

When analyzing the location of urethral strictures, SUG in our study identified 71.8% of strictures in the bulbar urethra and 28.1% in the penile urethra. These findings closely match Hassan et al., who reported 66.66% of strictures in the bulbar urethra and 33.33% in the penile urethra.[4]

The predominance of bulbar strictures seen in both studies reflects a consistent trend across patient groups. These results are also similar to those of Alam et al., who documented that bulbomembranous strictures were the most common.[13] The consistency in stricture location across studies suggests that SUG and RUG are both effective in detecting strictures in different parts of the urethra.

Severity grading of strictures in our study showed that SUG identified 65.6% of strictures as mild, 28.1% as moderate, and 6.25% as severe. In comparison, Hassan et al. reported mild, moderate, and severe cases as 14, 9, and 1, respectively. [4]

While the distribution of mild and moderate strictures is similar, our study recorded a slightly higher percentage of severe strictures. These results are also similar to those of Hatgonkar et al. [14.] This variation may reflect differences in grading criteria or patient characteristics. However, both studies highlight SUG's ability to detect a full range of stricture severities, including severe cases that RUG may underreport.

Stricture length is a key parameter for management planning. In our study, the average stricture length was 2.1 ± 0.31 mm on SUG and 2.8 ± 0.46 mm on RUG. Hassan et al., however, reported mean lengths of 4.60 ± 4.26 mm for SUG and 1.83 ± 0.34 mm for RUG. Although the absolute lengths differ, both studies consistently show that SUG measures longer stricture lengths compared to RUG. This difference highlights SUG's improved ability to offer detailed anatomical assessments of strictures, as also shown by Akpayak et al.'s findings. [15]

Miszewski et al. documented that in 81% of cases, the estimated length of the stricture by SUG matched intraoperative findings. [16] Variations in reported lengths may result from differences in study populations or imaging techniques.

The diagnostic performance of SUG in our study was impressive, with sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of 97%, 96%, 91.2%, 98.6%, and 96.1%, respectively. These metrics align with those reported by Hassan et al., who found sensitivity and specificity

of 96% and 100%, respectively. [4] Additionally, Hassan et al. cited ranges of sensitivity (75-100%) and specificity (72-97%) from other studies, which match our findings. [4, 17] Ravikumar et al. also support these results, reporting 100% sensitivity, specificity, PPV, and NPV for SUG. [18] While our study slightly falls short of perfect values, it confirms the role of SUG as a highly accurate diagnostic tool. Janan et al. noted that sonourethrography is more effective than RUG in evaluating various causes of ureteric obstruction. [19]

Our study supports the growing evidence that SUG is a reliable and accurate tool for evaluating anterior urethral strictures. In addition to its high sensitivity and specificity, SUG has advantages over RUG, such as better visualization of periurethral structures and stricture lengths. These benefits are important for customizing management options like urethral dilation, urethrotomy, or reconstructive surgery. Furthermore, SUG's non-invasive nature and absence of ionizing radiation improve its usefulness and patient acceptance.

A limitation of our study was that it could not assess posterior urethral strictures due to the limitations of SUG, whereas RUG can be used to evaluate both anterior and posterior urethral strictures. Future studies may compare the diagnostic accuracy of SUG and RUG across different types of urethral strictures and explore the potential applications of SUG.

## CONCLUSION

Sonourethrography (SUG) is a highly accurate diagnostic tool for evaluating anterior urethral strictures, excelling in measuring stricture length, grading severity comprehensively, and providing high diagnostic precision.

These qualities make SUG a valuable resource in clinical practice, offering a reliable, non-invasive method for diagnosing and managing urethral strictures. Future research should seek to validate these findings across different populations and explore potential technological improvements to further boost its diagnostic abilities.

By incorporating SUG into routine clinical workflows, healthcare providers can improve the assessment and treatment of anterior urethral strictures, ultimately leading to better patient outcomes. The use of SUG can simplify diagnostic procedures, decrease reliance on invasive tests, and support more effective treatment planning, thereby improving the overall quality of care for patients with urethral strictures.

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Following authors have made substantial contributions to the manuscript as under

| Authors | Conceived & designed the analysis | Collected the data | Contributed data or analysis tools | Performed the analysis | Wrote the paper | Other contribution |
|---|---|---|---|---|---|---|
| Yadain SH | ✓ | ✓ | × | × | ✓ | × |
| Nisar U | ✓ | × | ✓ | ✓ | ✓ | × |
| Bukhari SARS | ✓ | ✓ | × | × | × | ✓ |
| Sultana SM | ✓ | × | ✓ | ✓ | ✓ | × |
| Ihsan HR | ✓ | ✓ | × | × | × | ✓ |
| Tahir F | ✓ | × | ✓ | ✓ | ✓ | × |

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**Ethical Approval:**

**This Manuscript was approved by the Ethical Review Board of Combined Military Hospital (CMH) Peshawar. Vide No. 379. Dated: 17 10 2022**