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ORIGINAL ARTICLE

Comparative diagnostic accuracy of sonourethrography and retrograde urethrography in anterior urethral strictures.

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ABSTRACT… Objective: To evaluate the diagnostic accuracy of retrograde urethrography and sonourethrography making cystourethroscopic findings as gold standard. **Study Design:** Cross-sectional Validation study. **Setting:** Department of Radiology and Urology, Gujranwala Teaching Hospital, Gujranwala. **Period:** April to October 2025. **Methods:** Over the course of six months (April to October 2025), fifty four patients with a clinical suspicion of anterior urethral strictures were enrolled in this cross sectional validation study and equally assigned to the RGU and SUG groups. Cystoscopy findings were used to compare diagnostic accuracy, sensitivity, specificity and stricture length. **Results:** Using intra-operative stricture length as the reference, sonourethrography (SUG) shows better diagnostic performance, with a sensitivity of 96.9%, specificity of 100%, positive predictive value (PPV) of 100%, and negative predictive value (NPV) of 95.7%. Retrograde urethrography (RUG) showed a sensitivity of 93.8%, specificity of 95.5%, PPV of 96.8%, and NPV of 91.3%. Overall diagnostic accuracy was higher for SUG (98.1%) compared with RUG (94.4%). **Conclusion:** When evaluating anterior urethral strictures, SUG shows better assessment of stricture as compared to RGU in terms of diagnostic performance. As such, it should be used as an auxiliary or alternative imaging modality in clinical practice.

Key words: Cystoscopy, Retrograde Urethrogram, Sonourethrograpy, Stricture Urethra.

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INTRODUCTION

In past few years retrograde and ante grade urethrography has been considered as a gold standard imaging modality for the diagnosis of length and location of urethral stricture. Proper diagnosis for urethral stricture is important as it has direct impact on management plan of disease.[1] Considering the great prevalence of urethral stricture in, 1988, MCAninch et al evaluated urethra with a new technique known as sonourethrography (SUG).[2] In past few years, role of ultrasonography in diagnosis of urethral stricture has been emerged as superior modality and is now widely being considered as a better option in accessing the location and length of the stricture, presence of spongio-fibrosis and other periurethral conditions.[1] Urethral stricture is one of the common disorders among young and old male patients affecting their quality of life with symptoms like decreased urine flow, urinating drop by drop leading to a feeling of incomplete urination. In estimation, the prevalence of urethral stricture in industrial countries is around 0.9%.[3] Anterior urethral strictures arise from a variety of etiologies, most commonly iatrogenic, inflammatory, ischemic or congenital processes. These processes result in the formation of scar tissue along the tract and reduce the caliber of the urethra and ultimately causing urinary retention. Treatment plan for stricture depends on proper diagnosis. In addition to understand urethral anatomy, knowledge about normal periurethral structures is necessary to avoid misdiagnosis, such as Cowper's ducts, the glands of Littre, and the prostatic and ejaculatory ducts. Surgical management depends on the stricture location and length.[4] In retrograde urethrography, Foleys catheter is used to inject contrast material inside the urethra then location and length of stricture is accessed through AP and Right / left oblique X-ray imaging. This method has its own deficits, such as higher chances of infection, using radiations are inevitable for patients and particularly exposing testicles. Moreover, periphery of the urethra and the strictures cannot be diagnosed. Furthermore, patient's positioning during retrograde urethrogram is painful.[5]

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One of the alternative methods used for this purpose is the utilization of Sonography to diagnose urethral strictures which is known as sonourethrogram (SUG). This method helps us to check for the presence of stricture, the length of stricture, complications outside the urethra which cause the stricture.[6]

METHODS

This cross-sectional Validation study was conducted at Department of Radiology and Urology, Gujranwala Teaching Hospital, Gujranwala between April to October 2025 after getting approval from institutional review board of Gujranwala Medical College Gujranwala (Ref 300/GMC, Dated 18-04-2025). Fifty four male patients with lower urinary tract symptoms with predominance of thin stream, and straining were selected from the outpatient urology department.

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	1000000
Hypothesized % frequency of outcome factor in the population (*p*):	0.9%+/-5
Confidence limits as % of 100(absolute +/- %)(*d*):	5%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	14
80%	6
90%	10
97%	17
99%	24
99.9%	39
99.99%	55

Equation

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

A detailed history was taken, including history of reaction to contrast media, perineal trauma, infection, urethral surgery including open / endoscopic and stone passage and urethral discharge. Meatal stenosis, epispadias, hypospadias, urethro-cutaneous fistulae was ruled out during the examination.

After taking the written informed consent, one shot of IV antibiotic was given before performing RUG. Then RUG was performed and oral antibiotics for 5 days were advised. SUG was performed after 1 week.

RUG was performed after emptying the urinary bladder of patient. A Scout image of the pelvis was taken. Then under ASM , 8Fr Foley catheter was passed upto navicular fossa and balloon was inflated by 2ml distilled water diluted contrast 10 ml in 40 ml of NS was then pushed in the Foley's and radiographs were taken in AP and Lateral views. For lateral view, the right leg was partially flexed, with the left leg stretched above it and left hip just above the table this position was made. RUG was reported for the site, length and number of the strictures.

For SUG, we disinfect the penis. Then Foley's was placed in navicular fossa and balloon inflated. 100 ml of normal saline was pushed into the Foley by using 60ml feeding syringe. USG was performed from ventral aspects of penis.

Upto the penoscrotal junction penile urethra was visualized trans-scrotaly penile and bulbar urethra and trans-perineally bulbar urethra was visualized.

Normal saline was pushed in Foley's strictures were identified as segments of small caliber. The findings of RUG and SUG were compared with the findings of cystourethroscopy.

Sensitivity, specificity, positive and negative predictive value of all parameters was calculated. Kappa test was used to access the level of agreement between RUG and SUG. The level of agreement between RUG and SUG was assessed using the kappa statistic. A kappa value below 0.20 was taken as poor agreement, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as good, and values between 0.81 and 1.00 indicated very good agreement. The chi-square test was applied to determine whether there was a statistically significant difference between the two methods in estimating stricture length and in the rate of complications.

RESULTS

Out of 54 patients 40 (74.1%) patients have predominance of thin stream and 14 (25.9%) have chief complaint of straining.

Out of total 24 (44.4%) patients had history of urethral surgery (endoscopic / open). 22 (40.7%) patients gave a history of trauma (trauma by ball, perineal trauma, catheterization due to AUR or stone passage).

FIGURE-1

Symptoms at presentation

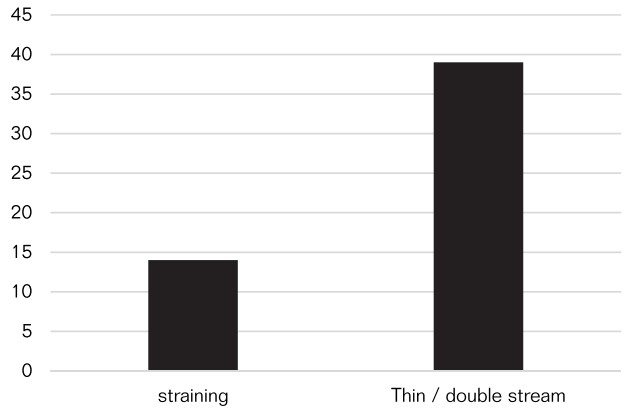


TABLE-I

Cross-Tabulation of Sonourethrography Findings Against Cystoscopy for Urethral Stricture Diagnosis (n=54)

	Cystoscopy Stricture Present	Cystoscopy Stricture Absent	Total
SUG (+) Test Positive	31(96.9%)	0 (0%)	31
SUG (-) Test Negative	01 (3.1%)	22 (100%)	23
Total	32	22	54
Metric		Value	
Sensitivity		30/32 = 93.8%	
Specificity		21/22 = 95.5%	
PPV		30/31 = 96.8%	
NPV		21/23 = 91.3%	
Accuracy		51/54 = 94.4%	

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for imaging modalities keeping cystoscopy findings as reference value.

SUG showed excellent diagnostic performance in identifying long urethral strictures, with a sensitivity of 96.9%, specificity of 100%, PPV of 100%, and NPV of 95.7%.

In comparison, retrograde urethrography (RUG) showed a sensitivity of 93.8%, specificity of 95.5%, PPV of 96.8%, and NPV of 91.3%.

FIGURE-2

SUG

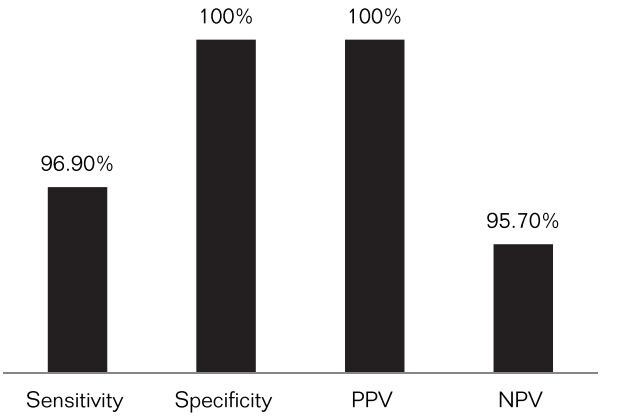
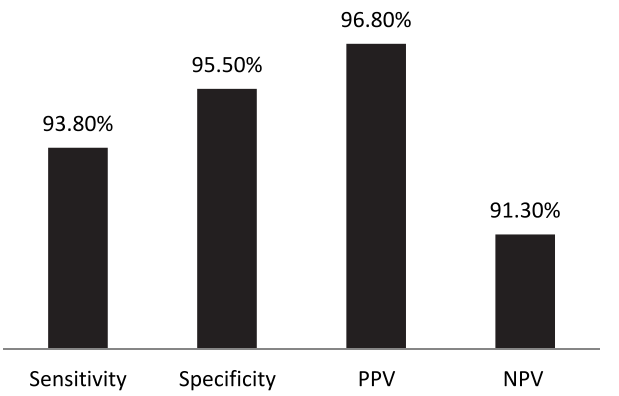


FIGURE-2

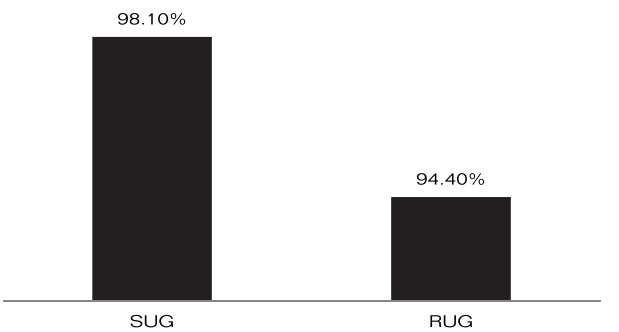
RUG



Overall diagnostic accuracy was higher for sonourethrography (98.1%) than for RUG (94.4%).

FIGURE-3

Diagnostic accuracy



The association between imaging findings and cystoscopy measurements was statistically significant ($p < 0.05$). A strong positive correlation

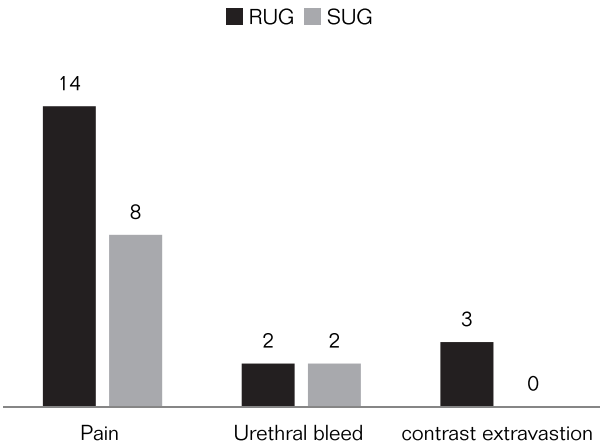
was observed between stricture length measured on RUG and SUG ($p < 0.001$). There was significant agreement between imaging modalities and cystoscopy findings.

SUG measured slightly longer stricture lengths compared to RUG, reflecting improved identification of spongiofibrosis beyond the luminal narrowing. Kappa analysis shows significant agreement between RUG and SUG in identifying stricture length. This showed high reliability of SUG for the diagnosis of stricture length.

The complications during RUG and SUG are summarized below

FIGURE-4

Complications



Patients experienced more pain during RUG as compared to SUG ($p<0.001$). Urethral bleeding occurred in 2 patients after SUG. The difference in frequency of bleeding in the two procedures was statistically insignificant ($p<0.5$).

DISCUSSION

For the management of urethral stricture, location and stricture length is most important for planning of technique. In our study, SUG shows higher sensitivity, specificity, positive predictive value, and overall diagnostic accuracy than RUG when stricture length was measured with flexible cystoscopy which was used as the gold standard in our study. These findings are similar to the recent literature showing the limitations of RUG and growing role of SUG in anterior urethral stricture.[7-9]

Several recent studies show that RUG, while effective in outlining luminal narrowing, frequently underestimates true stricture length because it cannot visualize spongiofibrosis.[7-10] Frankiewicz et al. demonstrated that high-frequency ultrasound enables direct visualization of the urethral wall and corpus spongiosum, allowing more accurate estimation of stricture length and fibrosis severity.[7] This anatomical advantage explains why SUG consistently measures slightly longer strictures than RUG. These finding are also observed in our study.

Prospective comparisons between SUG and RUG have repeatedly shown better correlation between SUG and cystourethroscopy measurements of stricture urethra. Abbasi et al. reported that SUG is more close to the intra-operative findings and reduced unexpected stricture extension at surgery.[8] Similarly, Chitrakar et al. found that length of stricture measured by SUG is nearer to the stricture length measured by cystourethroscopy than RUG, particularly in dense bulbar strictures.[9] These observations support our study's findings.

Wong et al., in a review of modern urethral imaging, showed that while RUG remains essential for defining urethral anatomy and detecting posterior urethral involvement, SUG provides additional information on tissue quality, spongiofibrosis, and urethral caliber that directly influences decision making while treating the disease.[10]

Many other studies have also emphasized the clinical significance of pre operative accurate stricture length measurement. Orakzai et al. demonstrated that underestimation of stricture length was associated with higher recurrence rates after urethroplasty, particularly when graft length was insufficient.[11] Bischoff, R et al. showed that use of sonourethrography into preoperative assessment significantly reduced intraoperative modification of surgical plans and better coordination between processes that are planned and carried out.[12] These findings demonstrate the importance of pre operative SUG which is also observed in our study.

From a surgical planning perspective, Naud, E. et al. emphasized that imaging which shows fibrosis length rather than luminal narrowing alone leads to better

graft selection and reduced tension at anastomotic sites.[13] This is very important in substitution urethroplasty, where even small discrepancies in length estimation can affect outcomes of surgery. The excellent agreement demonstrated between SUG and cystoscopy findings in this study aligns with these conclusions.

Miszewski et al. reported substantial to excellent agreement between SUG measurements and operative findings, while agreement between RUG and surgery was comparatively lower.[14] Zhang, J et al. further confirmed that sonourethrography showed higher reproducibility and inter-observer reliability when standardized acquisition protocols were used.[15] The strong correlation and excellent agreement observed in the present study are therefore consistent with broader multicentre experience.

Guideline statements from both the European Association of Urology and the American Urological Association reflect this evolving evidence base. The EAU Guidelines (2024) recommend RUG as the primary diagnostic modality but acknowledge the value of sonourethrography in anterior urethral strictures, particularly for assessing spongiofibrosis and surgical planning.[16] Similarly, the AUA guideline update highlights sonourethrography as a useful tool when precise length determination is required.[17] Harris, D et al. further states that modern imaging strategies should move beyond accessing the lumen and focus on disease biology and tissue characteristics, areas in which ultrasound has clear advantage.[18]

An important secondary observation in the present study is the limited predictive value of clinical symptoms alone. Palminteri et al. demonstrated poor correlation between symptom severity and actual stricture length or complexity, highlighting how unreliable clinical presentation with the length of stricture.[19] Al-Nabulsi et al., similarly showed that etiological factors and symptom duration did not reliably predict stricture extent.[20] These findings align with our study.

Harris et al., reported results using advanced techniques and imaging-based prediction models to stratify stricture complexity and surgical difficulty.[21]

CONCLUSION

For anterior urethral strictures, Sonourethrography gives better diagnostic sensitivity, specificity, and accuracy than retrograde urethrography. Its expanding usage in clinical practice is supported by its advantages in measuring stricture length and radiation free detection of spongiofibrosis. Preoperative planning and patient outcomes may be improved by adding SUG into the diagnostic process.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Khalid Hussain:** Conception of idea.
2	**Mian Waheed Ahmad:** Proof reading.
3	**Maria Tariq:** Data analysis, writing.
4	**Adeela Shafiq:** Writing.
5	**Jawad Ahmed:** Data analysis.
6	**Rameez Ahmed:** Data collection.