Original Article

Impact of Adding Urethral Sonography with Retrograde Urethrography in Preoperative Assessment of Anterior Urethral Stricture

Nidhi Sehgal[1]*, Vinod Priyadarshi[2]

[1]Department of Radiology, Gouri Devi Institute of Medical Sciences and Hospital, Durgapur, West Bengal, India, [2]Department of Surgery, Gouri Devi Institute of Medical Sciences and Hospital, Durgapur, West Bengal, India

Abstract

Background: Even with underlying risk factors and limitations, retrograde urethrography (RGU) is the most popular imaging modality in the assessment of anterior urethral stricture. Urethral sonography (SUG) is an able imaging modality in use for the last few years which evaluates anterior urethral stricture without these risks, though it is still not much popular due to its complexity. This prospective study was designed to compare the assessment made on SUG with the results of RGU and to analyze its impact on surgical decision-making when the results of SUG were taken into consideration with RGU. **Methods:** Thirty patients with anterior urethral stricture were assessed for stricture location, length, and associated urethral pathologies with RGU and surgery planned accordingly. Later, all were reevaluated with SUG, results compared with that of RGU and surgery replanned, considering both RGU and SUG findings. All results were compared with operative findings. **Results:** The mean stricture lengths on SUG, RGU, and surgery were 20.45 mm, 17.15 mm, and 20.38 mm, respectively. Overall sensitivity and specificity of SUG in actual stricture length prediction were 92.3% and 96.1%, whereas these were 78.9% and 85.1%, respectively, on RGU. Spongiofibrosis was assessed only with SUG, that too, with 85%–90% accuracy. Surgical plan was changed in 31% of cases when SUG findings were taken into account along with RGU findings. **Conclusion:** SUG was found more precise modality in the measurement of stricture length and more informative and elaborative in providing added knowledge of degree of spongiofibrosis and associated pathologies of diseased urethra and periurethral tissue. For better preoperative planning of anterior urethral strictures, SUG should be added to work-up along with RGU.

Keywords: Anterior urethral stricture, retrograde urethrography, sonourethrography

Introduction

A good radiological assessment is a prerequisite before planning the management of any urethral stricture disease.[1] Although retrograde urethrography (RGU) is the most popular and preferred imaging modality for the assessment of anterior urethra, it has some essential limitations. In addition to the radiation exposure to the testis and risk of urinary tract infection (UTI),[2] inappropriate posture of patient and penile traction while injecting contrast significantly changes the appearance and length of stricture.[1] Furthermore, it provides only a two-dimensional image and does not delineate any periurethral spongiofibrosis.[3] Moreover, as the bulbar urethra remains fixed in the axis of pelvis, RGU gives only an "End-on View" of bulbar strictures that consequently reduces its apparent length.[2] In comparison, urethral sonography (SUG) is an infrequently used but promising technique for imaging anterior urethra. Since mid-1980s, when it was first reported,[3] quite a lot of studies have demonstrated its higher degree of accuracy in the evaluation of anterior urethral stricture.[4-7] One step further, Bryk *et al*. claimed that SUG can be used as a single imaging modality along with cystoscopy in the assessment of anterior urethral stricture, without the need for RUG.[4] Need of technical expertise, operator dependence, and inadequate assessment of posterior urethra are some major limitations of SUG.[8] In such backdrop, this study

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Address for correspondence: Dr. Nidhi Sehgal, Department of Radiology, Gouri Devi Institute of Medical Sciences and Hospital, Durgapur - 713 212, West Bengal, India.
E-mail: nidhinikki2005@yahoo.com

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has been done with anterior urethral strictures to compare their preoperative assessment, done with SUG and RGU, respectively, with intraoperative findings and to find the impact of SUG on overall assessment and surgical planning when it is considered along with RGU.

Materials and Methods

This prospective study was conducted between March 2021 and December 2022 in the Radiology and Urology Departments of our tertiary health care center. The study was conducted in accordance with the Declaration of Helsinki. After the ethical committee of our institute permitted us for this study approval no. GIMSH/EC/01/014, dated 22.01.2021 and informed consent, forty consecutive patients of suspected urethral stricture disease with no previous history of any surgery for the same disease were assessed in the Department of Radiology for RGU and SUG on separate dates, followed by cystoscopy and corrective surgery in the Department of Urology. Six patients who were found to have posterior urethral stricture and two patients having normal urethra in both studies and cystoscopy were excluded from the study. Two other patients who had associated periurethral sinus and abscess diagnosed on SUG and underwent suprapubic catheterization and abscess drainage were excluded from the data analysis. In each case, the study began with a conventional urethrography (RGU and micturating cystourethrography) of the suspected stricture patient, followed by primary surgical planning by the urologist. Later, all such patients underwent ultrasonography (SUG) of the urethra keeping the operator blind from the RGU findings. Each case thereafter reassessed by the urologist comparing the RGU and SUG findings and surgical planning restructured, if required, in view of both the findings. All these findings and preoperative notes were compared with each other and with the cystourethroscopy and operative findings, as gold standard. Ureteric catheters were used to measure stricture length, whereas spongiofibrosis was differentiated by the color of mucosa, and by the resistance and grittiness felt during the incision, as described by Gupta *et al*.[6] The accuracy of each method in prediction of stricture length and spongiofibrosis was ascertained, and the significance of their difference was analyzed using the Chi-square test and Student's *t*-test. At the end, impact of information gathered with SUG was scrutinized in view of surgical planning and execution.

SUG was done with a standard linear array high-frequency transducer (10–12 MHz) in the supine and dorsal positions, through the ventral surface of the penis and subsequently through the transscrotal and transperineal surfaces. Moderate traction was applied so that the pendular part of the penis remained stretched straight. After proper disinfection of the glans and meatus, the urethra was dilated by retrograde instillation of sterile 2% lignocaine jelly through a conical nozzle snuggly fitting with meatus along with a digital compressor applied at the tip of the penis. Serial transverse and longitudinal sections were scanned, right from the level of corona to as far as visible posteriorly. With the instillation of jelly, normal urethra usually distends up to 8–10 mm in diameter and appears as anechoic homogenous band with posterior acoustic enhancement and reflection from the tunica albuginea. In comparison, strictures were identified as segments showing reduced distensibility with the instillation of jelly. Whenever the proximal extent of the stricture was not clear, patients were asked to strain with a full bladder, which helped in the delineation of the proximal limit. Electronic calipers were used to measure the stricture length, whereas periurethral tissue was scanned for the presence of false tracts, filling defects, diverticula, and abscess, if any. Spongiofibrosis was categorized as mild (when the fibrotic encroachment remains <1/3 of the lumen), moderate (when the encroachment extends to 1/3–1/2 of the lumen), and severe (when the fibrosis encroaches more than half of the lumen or the urethral diameter measured <3 mm during maximal retrograde distension), as described by McAninch *et al*.[3,9]

Retrograde urethrography (RGU) was done in 45° oblique supine position. To stretch the pendular urethra straight, a 10–12 F Foley catheter was used, with its bulb seated in the fossa navicularis, inflated with 2 mL of saline. 10–15 mL of 76% urografin was infused under fluoroscopy, and spot films were taken. Stricture lengths were measured directly from the films without correcting for magnification from variations in the tube–film distance. Strictures were classified as a short segment (if the length remains 15 mm or less), an intermediate segment (if the length 16 mm – 25 mm), and a long segment (if the length >25 mm).

Results

Overall, thirty male patients of anterior urethral stricture disease were evaluated. Dysuria (90%, 27 patients), straining (84%, 25 patients), and poor urinary stream (80%, 24 patients) were the most common symptom at presentation [Table 1]. Sixty percent of patients were in between 35- and 45-year age groups, whereas the mean age was 38 years (range: 15–65 years). Majority (57%) of the strictures were in bulbar urethra and of intermediate length (16–25 mm) [Figures 1 and 2]. Majority were posttraumatic (including iatrogenic) in etiology, whereas the rest were infective and idiopathic in nature [Figure 3].

Table 1: Clinical presentation in urethral stricture patients

Symptoms	No. of cases	Percentage
Dysuria	27	90
Straining	25	85
Poor urinary stream	24	80
Frequency	22	74
Suprapubic discomfort and fullness	20	66.6
Dribbling of Urine	10	33.3
Haematuria	6	20
Acute Urinary Retention	6	20
Pus discharge per urethra	3	10
Dyspareunia and sexual discomfort	2	6.6

The mean length of stricture on SUG, RGU, and surgery was 20.45, 17.15, and 20.38 mm, respectively, and the lengths calculated during SUG were more approximate with stricture lengths measured during the surgery. Overall sensitivity and specificity of SUG in predicting the actual stricture length were 92.3% and 96.1%, whereas with RGU, these were 78.9% and 85.1%, respectively [Table 2]. The diagnostic advantage thus obtained with SUG was found statistically significant ($P < 0.05$).

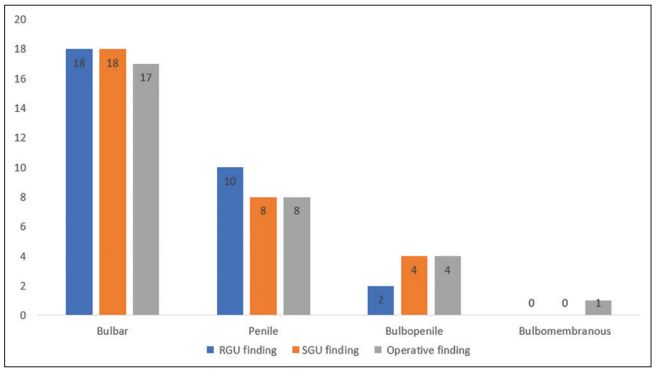

Figure 1: Location of strictures in different assessments. SUG: Urethral sonography, RGU: Retrograde urethrography

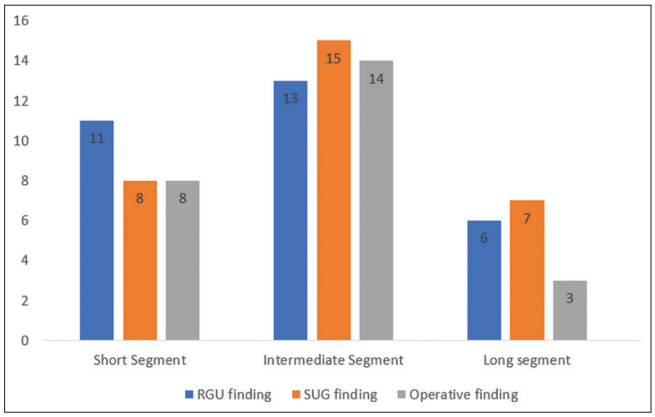

Figure 2: Length of stricture in different assessments. SUG: Urethral sonography, RGU: Retrograde urethrography

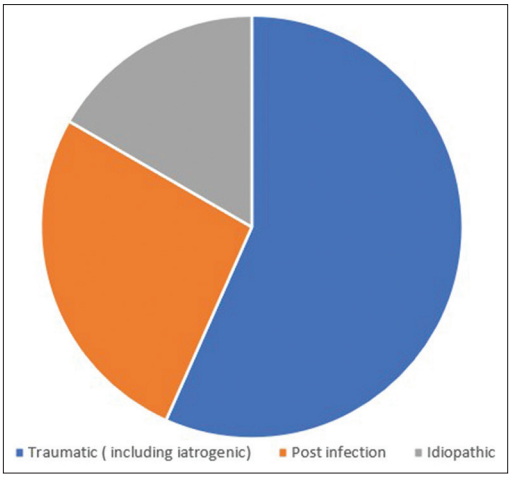

Figure 3: Etiology of strictures

During SUG, associated urethral abnormalities and periurethral pathologies were also detected. Periurethral spongiofibrosis was observed in all the cases and was appropriately categorized and compared with operative findings. The accuracy of SUG in the assessment of mild, moderate, and severe spongiofibrosis was 85.6%, 75%, and 90.9%, respectively [Table 3].

Surgical planning was done initially considering only the RGU findings, and later, it was revised again considering the additional information obtained from the SUG. In this study, when the findings of SUG were taken into consideration along with RGU findings, surgical plan was changed in 8 out of 30 cases (26.7%) [Table 4].

Two other patients with operative plans or anastomotic urethroplasty and substitution urethroplasty were canceled after findings of periurethral sinus and periurethral abscess, respectively, and underwent stage procedure (suprapubic catheterization) and were excluded from the study. Considering these two results with the present study sample, observations of SUG were found to modify the surgical plan in overall 10 out of 32 cases (31.2%).

Discussion

Although RGU is being used for long as gold standard for the imaging of anterior urethra, it has some inherent limitations. A little variation in patient's posture and penile traction during contrast instillation can lead to disproportionate alteration in the appearance of stenotic areas.[1,2]

During RGU, patients are kept mostly in a steep oblique posture, and as such, bulbar urethra lies in an oblique position relative to the axis of the falling X-ray beam that results in a shorter appearance of strictures if it is present in the bulbar

Table 2: Diagnostic accuracy of urethral sonography in comparison to retrograde urethrography in the diagnosis of different stricture categories (according to length)

	RGU			SUG		
	Short	Intermediate	Long	Short	Intermediate	Long
Sensitivity	100	73.2	62.5	100	91.2	85.7
Specificity	82.1	82.3	91.0	100	93.7	95.6
Accuracy	90.6	77.6	76.6	100	92.3	90.5

Table 3: Accuracy of urethral sonography in diagnosing Spongiofibrosis

	Spongiofibrosis		
	Mild	Moderate	Severe
SUG assessment	12	08	10
Operative assessment	13	06	11
Accuracy of SUG	85.6%	75%	90.9%

urethral region.[10] It also fails to evaluate periurethral tissues and extent of spongiofibrosis.[2,6,10] Besides, it has added disadvantage of radiation exposure to the gonads, risk of UTI, and extravasation and intravasation if contrast injected forcefully.[1,2,6] These all-inherent limitations and risks prevent RGU from being called as an "ideal test."[11]

The use of ultrasonography (SUG) in the evaluation of anterior urethral strictures was first reported in 1988 by McAninch *et al*. who claimed SUG a better tool in the diagnosis and characterization of these strictures, especially in the bulbar urethra.[3,6] As the scanner probe is aligned ventrally right over the penis, in its midsagittal plane, and remained similarly oriented along the whole course of the penile and bulbar urethra, the axis of measurement remains almost perpendicular to the urethra which helps to measure the length of stricture more precisely.[4,11] Strictures are visualized as those parts of urethra which fail to stretch and expand along with the expansion of the rest of the urethra by the fluid or the jelly instilled. The length of stricture is assessed by measuring the hyperechogenic line on the urethral mucosa, whereas spongiofibrosis is estimated as the depth of fibrotic corpus spongiosum by measuring the hyperechogenic part of this tissue.[11]

In the present study, SUG provided better sensitivity and accuracy in predicting stricture length in comparison to RGU, which is in harmony with the results of previous studies. Furthermore, the mean stricture length calculated on SUG was more approximate with the operative finding than the length observed during RGU and the correlation coefficient between the length of stricture measured during SUG and during surgery was found between 0.81 and 0.93.

Better assessment of length, spongiofibrosis, and periurethral pathology: all helped in decision-making. We found that SUG provides conspicuous information which influences the surgical planning and decision-making. In this study itself, our surgical plan changed in 32% of cases when SUG assessment was considered. A prior information of spongiofibrosis is a critical determinant of treatment and the ultimate prognosis.[5,6,9] The standard RGU fails to show morphological periurethral changes and therefore does not provide a good assessment of spongiofibrosis which is always better delineated in SUG. In the present study too, SUG revealed severe spongiofibrosis in ten cases with an accuracy of 90.9%, and this added information guided us to plan for excision and anastomotic repair instead of optical internal urethrotomy.

Strictures shorter than 20 mm are usually treated with anastomotic urethroplasty, whereas those longer than 20 mm require an augmentation with a graft or flap for reconstruction.[8,12] Precise determination of true stricture length and luminal diameter preoperatively with SUG is an advantage, which guides whether to opt for excision or tissue

Figure 4: Bulbar urethral stricture in the same patient on retrograde urethrography, urethral sonography, and cystourethroscopy. SUG: Urethral sonography, RGU: Retrograde urethrography

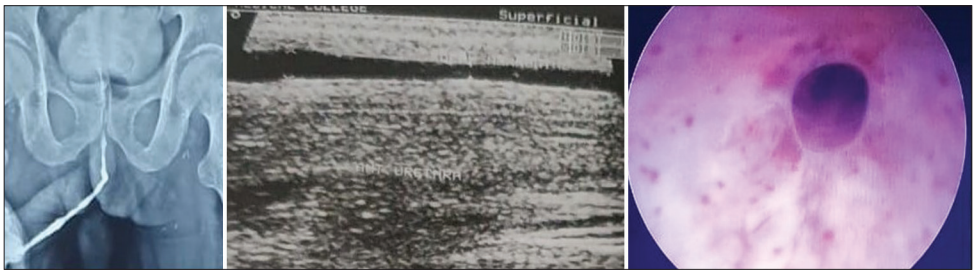

Figure 5: Pan-anterior urethral stricture in the same patient on retrograde urethrography, urethral sonography, and cystourethroscopy

Table 4: Impact of SUG in surgical decision making

Surgical Decision	Optical Internal Urethrotomy (OIU)	Resection and Anastomosis Urethroplasty	Local substitution and Augmentation Urethroplasty	Buccal Mucosa Graft Urethroplasty	Stage Procedure
Only with RGU	11	9	02	08	00
With both RGU and SUG	08	10	01	11	02

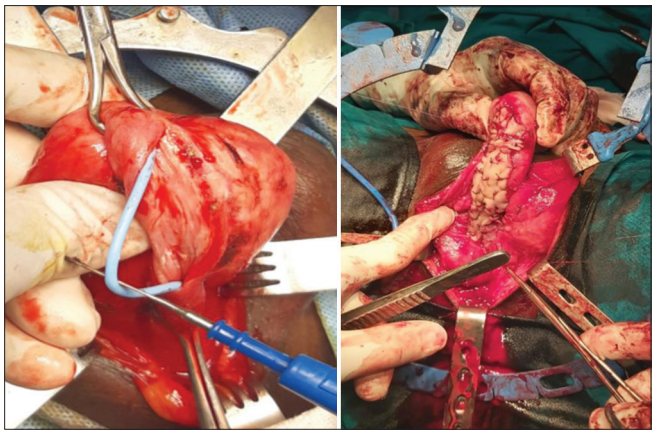

Figure 6: Laid open pan-anterior urethral stricture in the same patient followed by buccal mucosa graft quilting

Figure 8: Laid open bulbar urethral stricture

transfer. If graft or flap is planned beforehand, then sufficient flap/graft harvesting can be done in the supine position before definitive surgery in the lithotomy position. This approach helps to decrease the total time elapsed in lithotomy and its related complications.[9,12] In the present study, this favorable advantage of SUG was observed in 27.3% (6 out of 22) cases of short- and intermediate-length strictures while in 37.5% cases of long strictures [Figures 4-8].

Apart from better determination of stricture length and spongiofibrosis, SUG also recognizes other intraurethral abnormalities such as urethral stones and diverticula as well and also detects associated periurethral pathology such as hematomas, fibrous scars, abscesses, and tumor invasions.[3,7,12] In the present study, one periurethral abscess and one periurethral sinus were visualized by SUG, which were missed on RGU and helped the operating surgeon to defer the substitutional urethroplasty and to opt for an intermediate or ancillary procedure.

While dealing with penile urethral stricture cases, SUG is not as effective in decision-making as it happens with bulbar urethral strictures.[9] As the penile urethra lies in a lateral, dependent

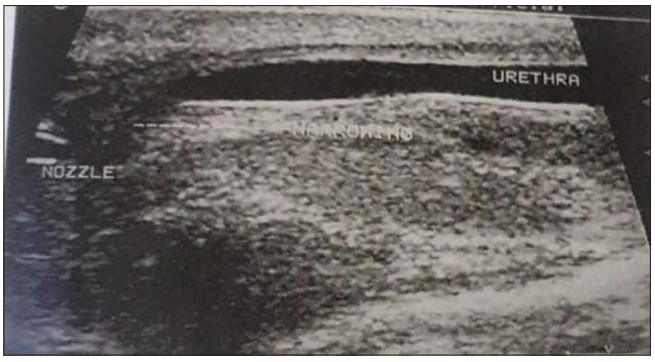

Figure 7: Distal penile stricture with dense spongiofibrosis

position during RGU, where X-ray beams fall perpendicular, radiographic and ultrasonic images provide almost equivalent information.[9,13] Furthermore, penile strictures are usually postinflammatory and diffuse; most are not curable to excision and majority require substitution urethroplasty regardless of length of stricture. Still, a prior information of periurethral tissue helps in planning of surgery and choice of substitution.[12,14] Observations of the present study are in harmony with the results of Buckley *et al*., who acknowledged the impact of SUG on decision-making in anterior urethroplasty where they found that SUG directly influenced their reconstructive surgical approach in 45% of patients.[15]

Contrary to the present study, some other researchers believe that improperly done RGUs are the main reason of their poor assessment of stricture in comparison to SUG and have demonstrated no difference between a properly performed and interpreted RGU and SUG regarding length, diameter, or severity of stricture.[16]

The major downside of SUG is its limited capability to evaluate the posterior urethra.[6,8,14] In this study too, a coexisting proximal urethral stricture was missed on SUG in one case. However, a few authors have suggested transrectal voiding cystourethrosonography for the evaluation of the posterior urethra and the bladder neck.[17] They claimed that bladder-neck opening and funneling can be studied with a good visualization of the posterior urethra up to the prostatic apex and bladder neck. However, it offers a smaller field of view, and patients under examination suffer severe discomfort who must have to void in the lateral position with a probe introduced in the rectum. Another significant drawback is interobserver variation that lies with all ultrasonographic studies. Chen *et al*. proposed three-dimensional (3D) SUG to evaluate anterior urethra which provides easily interpretable and reproducible images, especially improving fossa navicularis assessment. However, the inability to reconstruct 3D images for more than 4 cm size strictures remained its major limitation.[18]

Like any other USG procedures, SUG is also harmless. In this study too, no complications were noted.

Conclusion

SUG is an effective and safe technique that provides a reliable,

real-time, 3D assessment of anterior urethral strictures. It is more accurate in the measurement of stricture length, especially in bulbar urethra and simultaneously provides some other surgically decisive information such as spongiofibrosis and periurethral pathologies. Although it cannot substitute the conventional urethrography in a complete evaluation of the urethra and posterior urethral strictures, it can certainly work as a decisive tool in combination with conventional urethrography in preoperative assessment of anterior urethral stricture disease.

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Conflicts of interest

There are no conflicts of interest.

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