Original Article

Extent of spongiofibrosis and length of strictures: Findings at sonourethrography and urethroplasty

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Abstract

Introduction: The purpose of this study was to diagnose urethral stricture and to determine the extent of spongiofibrosis as well as the length of stricture using sonourethrography and compare it with intraoperative findings.

Patients and Methods: It was a cross sectional observational study from September 2017-August 2018. All patients who presented with urethral stricture, scheduled for urethroplasty, and consented to the study were enrolled. The extent of spongiofibrosis and length of strictures were determined at sonourethrography and subsequently at urethroplasty. Sensitivity, specificity, positive predictive value and negative predictive values of sonourethrography in the determination of length of stricture was done. Spearman correlation coefficient(r) was used to describe the association between the extent of spongiofibrosis found at sonourethrography and at urethroplasty.

Results: A total of 84 patients were evaluated during the study period. The median age at presentation was 45years. 81% of the patients had moderate spongiofibrosis on sonourethrography. There was a significant correlation of 71.4% between the extent of spongiofibrosis on sonourethrography and at urethroplasty. In evaluation for the length of strictures, sonourethrography had a sensitivity of 84.6% specificity of 82.7%, PPV of 68.7% and NPV 92.3%.

Conclusion: Sonourethrography is a valuable tool in the evaluation of urethral strictures. Its radiation free readily available even in resource-poor settings and gives a good evaluation of extent of spongiofibrosis as well as the length of strictures. It's use in the preoperative evaluation of strictures may improve the outcome of the management of strictures.

Keywords: Spongiofibrosis, sonourethrography, urethroplasty, anterior urethral strictures

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INTRODUCTION

Urethral stricture is an organic narrowing of the urethra caused by scaring of the urethral epithelium and/or spongy erectile tissue of the corpus spongiosum.[1] It is a common disease that afflicts mainly the anterior urethra, thus in the WHO consensus statement on urethral strictures, the term "urethral Stricture" is synonymous with "anterior urethral strictures." Narrowing of the posterior urethra is to be referred to variously as distraction defects, contractures,

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or stenosis. Urethral stricture is mainly acquired from infections or trauma.[2] Infections remain an important cause in developing countries where Neisseria gonorrhea, chlamydia, lymphogranuloma venereum, tuberculosis, and schistosomiasis have been implicated.[3] Traumatic strictures occur following trauma in the form of pelvic fractures, straddle injuries, or direct trauma to the phallus or perineum. Malignant strictures seen in penile and urethral tumors are relatively uncommon.[4]

Presentation is in the form of lower urinary tract symptoms and those of urinary tract infections such as prostatitis, periurethral abscess, or watering-can perineum in complicated strictures. Contrast urethrogram, urethroscopy, and ultrasonography can be used to determine the extent of narrowing to guide the choice in the modality of treatment (dilatation, urethrotomy, or urethroplasty).[5]

Retrograde urethrogram remains a good diagnostic tool for planning of urethral reconstruction; however, it has some of limitations such as static images, exposure to radiation, hypersensitivity reactions, and interpretations that may be hampered by the presence of air bubbles.[6] The paucity of information on the extent of spongiofibrosis makes treatment planning difficult. McAninch *et al*. found that urethral ultrasonography accurately defines the extent of spongiofibrosis.[7] Urethroscopy can be used in the diagnosis of stricture and determination of the extent of spongiofibrosis; however, its role is limited in complete strictures.[8,9] Magnetic resonance imaging and sonoelastography are modalities that could also give the extent of spongiofibrosis.[10-12] These are recent advances in the management of strictures and are relatively either not readily available or are expensive.

A full preoperative evaluation of any case of urethral stricture is valuable in treatment planning, and subsequent outcome of urethroplasty as the first occasion of urethroplasty is usually the best chance of success.[1]

Retrograde urethrogram produces variable results due to variation in the penile stretch, urethral distension, and patient positioning.[13] In addition to these, the fact that for most practical purposes, the urologist only has static images at his disposal; conclusions drawn might be inaccurate or not representative of the true situation.

Sonourethrography is an important imaging tool in the evaluation of male urethral stricture. The advantages include being dynamic, reproducible, and radiation-free when compared to the static images of retrograde urethrogram (RUG). It also provides information on spongiofibrosis in addition to being radiation free.

This study aims to determine the diagnostic role of sonourethrography in the management of strictures by the evaluation of the extent of spongiofibrosis and length of strictures by sonourethrography and to compare it with intraoperative findings, as a preoperative sonourethrogram may provide a better guide to patient counseling, choice of urethroplasty, and better surgical outcome.

PATIENTS AND METHODS

Patients with lower urinary tract symptoms due to urethral stricture were consecutively recruited over 1 year (September 2017–August 2018). These were patients who came through the outpatient clinic and those who presented via the accident and emergency with complications of a urethral stricture (acute urinary retention and urosepsis) being evaluated and prepared for urethroplasty. Informed consent was obtained from the patients as well as ethical approval was obtained from the Institutional Ethical Research Committee.

Patients excluded from the study were patients not fit for urethroplasty or were scheduled for either a urethral dilation or an internal urethrotomy.

Sonourethrographic studies were performed using an ultrasound scanner (Mindray version a7.5 MHz transducer, 800 MacArthur Blvd. Mahwah, NJ 07430-0619 USA). Following adequate counseling and obtaining an informed consent, with the patient lying supine, the glans was cleansed with a 10% povidone-iodine solution, and a 12 Fr Foley catheter was introduced under strict aseptic conditions with the bulb of the catheter in the fossa navicularis. Using 2 ml of normal saline, the bulb was distended. The penis was extended over the lower abdomen and ultrasonic gel was applied generously over the ventral

Figure 1: Sonourethrography of the penile urethra

surface of the penis. 40–60 ml of normal saline was flushed into the penile urethra. The penile urethra was assessed to the penoscrotal junction by placing the transducer on the ventral penile surface, as shown in Figure 1, and the transducer was repositioned on the scrotum to assess the proximal penile and distal bulbar urethra. The proximal bulbar urethra was assessed via a transperineal approach.

Strictures were identified as segments of reduced distensibility on the injection of saline. Areas of spongiofibrosis appeared as regions of greater echogenicity in the corpus spongiosum and were classified based on the classification of degree of spongiofibrosis by Devine *et al.* as follows:

a. Mild – mucosal lesion, constriction without fibrosis (A and B)
b. Moderate – complete stricture with minimal fibrosis (C and D)
c. Severe – complete spongiofibrosis, spongiofibrosis with inflammation and fibrosis outside corpus spongiosum, and a complex stricture with fistula (E and F).[14]

Patients were subsequently prepared for urethroplasty as the definitive mode of treatment based on clinical evaluation and the findings from sonourethrography. The intraoperative length of stricture was assessed and documented, as shown in Figure 2.

The depth of spongiofibrosis was subjectively assessed and documented during dissection and exposure of the stricture at urethroplasty.

Severe spongiofibrosis was recorded in the presence of healed fistulous tracts, gritty sensation, and fibrosis of the corpus spongiosum before urethrotomy was found as well as a change in color of the urethral mucosa from pink to pale gray. A mild spongiofibrosis was documented if the only mucosal change was found and moderate spongiofibrosis was determined if the mucosal changes were accompanied with minimal spongiofibrosis with no healed fistulous tracts.

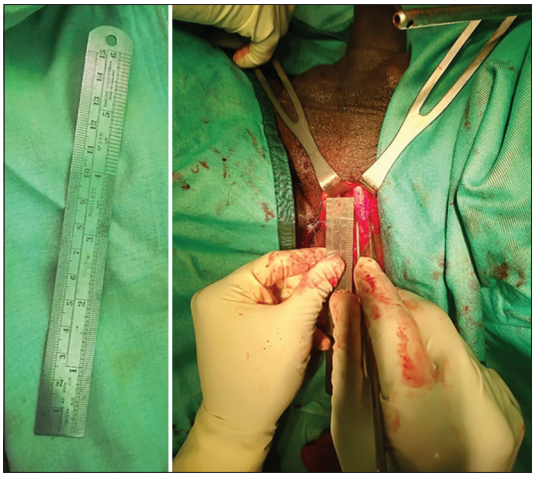

Figure 2: Intraoperative measurement of a bulbar stricture length

Data analysis

Collated data were analyzed using SPSS version 20 (IBM Armonk, NY 10504 U.S.A). The length of stricture was classified as long segments (>2 cm) or short segment (<2 cm).

Sensitivity, specificity, positive predictive value, and negative predictive value of sonourethrography in the determination of length of stricture were determined. Correlation of the extent of spongiofibrosis between sonourethrography and intraoperative findings was determined using Spearman

Table 1: Clinical characteristics of the patient

Clinical data	Frequency (%)
Aetiologies of stricture	
Infective	45 (53.3)
Trauma	28 (33.3)
Iatrogenic	6 (7.1)
Catheter induced	5 (6.0)
Idiopathic	0 (0.0)
Previous interventions for stricture	
None	74 (88)
Urethroplasty	7 (8.3)
DVIU	2 (2.4)
Dilation	1 (1.2)
Complications	
AUR	70 (83.3)
None	11 (13.1)
Urethrocutaneous fistulae	2 (2.4)
Urosepsis	1 (1.2)
Physical examination findings	
SPC	72 (85.7)
Periurethral induration	14 (16.7)
Urethral discharge	8 (9.5)
None	4 (4.8)

SPC: Suprapubic cystostomy, AUR: Acute urinary retention, DVIU: Direct visual internal urethrotomy

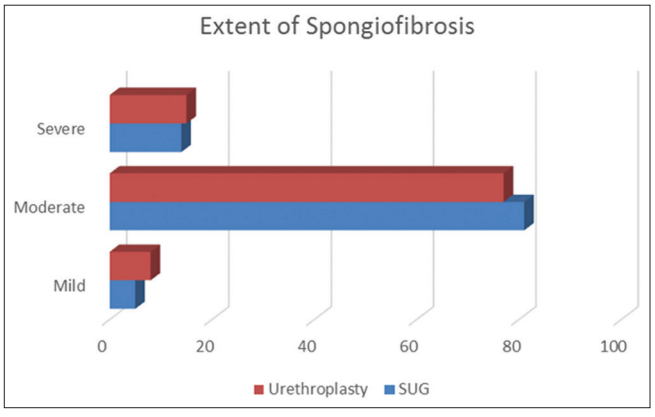

Figure 3: Extent of spongiofibrosis at sonourethrography and at urethroplasty

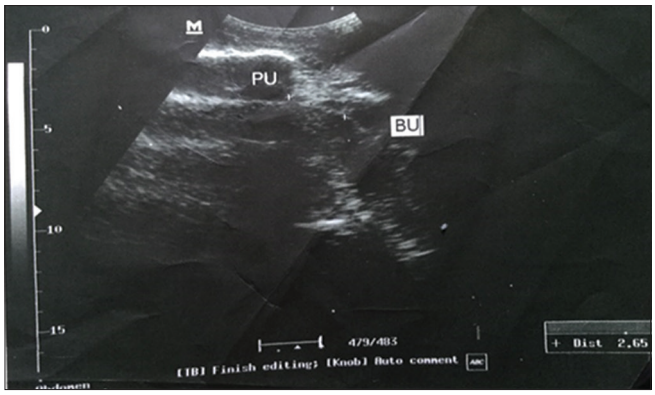

Figure 4: Sonorethrogram showing a 2.05 cm stricture with moderate spongiofibrosis. (PU: Penile urethra, BU: Bulbar urethra)

rank correlation. The results were presented in the form of tables and charts. $P < 0.05$ was considered statistically significant.

RESULTS

The median age of 45 years was found in 84 patients. The clinical characteristics of the patients studied are shown in Table 1,and Figure 3 shows the distribution and frequency of the extent of spongiofibrosis found in these patients both at sonourethrography and at urethroplasty.

Moderate spongiofibrosis was the most commont extent of spongiofibrosis. Figure 4 shows a sonourethrogram of moderate spongiofibrosis found in this study.

Using the Spearman rank correlation as this is a nonparametric data, the extent of spongiofibrosis on sonourethrography was found to have a very significant correlation with that found at urethroplasty, as shown in Table 2. Patients with mild, moderate, and severe spongiofibrosis on sonourethrography had a similar extent of spongiofibrosis at urethroplasty.

Further assessment of the findings at sonourethrography and urethroplasty was done using Kappa to show that there is an interobserver agreement. A strong agreement (74.7%) between the extent of spongiofibrosis seen using sonourethrography and at urethroplasty was found, as shown in Table 3. This was statistically significant. The sensitivity, specificity, and positive and negative predictive values of sonourethrography in the determination of the length of stricture are shown in Table 4.

DISCUSSION

The extent of spongiofibrosis is an important determinant of the most appropriate choice of treatment to avoid high

Table 2: Correlation of extent of spongiofibrosis on sonourethrography and at urethroplasty

	Intraoperatively			Spearman's rank	*P*
	Mild	Moderate	Severe		
SUG					
Mild	3	1	0		<0.001
Moderate	1	64	3		
Severe	0	2	10	0.714	

SUG: Sonourethrography

Table 3: Test of agreement between the findings of sonourethrography and urethroplasty

Extent of spongiofibrosis	SUG (%)	Intraoperative (%)	Test statistic	*P*
Mild	4 (4.8)	4 (4.8)		
Moderate	68 (81.0)	67 (79.8)	χ^2=94.51	<0.001
Severe	12 (14.3)	13 (15.5)	κ=74.7%	<0.001
Total	84 (100.0)	84 (100.0)		

SUG: Sonourethrography

Table 4: Length of stricture on sonourethrography and urethroplasty

	Urethroplasty		Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
	<2 cm	>2 cm				
SUG						
≤2 cm	22	10				
>2 cm	4	48	84.6	82.7	68.7	92.3

stricture reoccurrence rates.[15] It could be assessed using a sonourethrogram, as demonstrated by McAninch *et al*. in 1988.[7] It should, however, be done using a high-resolution ultrasound with a linear probe as described by Galosi *et al*. in their recommendation for performing an ultrasound scan in urological and andrological fields.[16,17] We demonstrated mild spongiofibrosis involving mucosal tags in 5% of the study group, and 81.0% of the patients had moderate spongiofibrosis appearing as increased echogenic areas in the corpus spongiosum with loss of distensibility of the urethral lumen. This is very similar to 80.0% moderate spongiofibrosis found by Alam *et al*. at Bangladesh in 2010 when evaluating the role of sonourethrography in the management of strictures in 60 subjects.[18] This vital information is lost completely with retrograde urethrogram and may only be determined carefully intraoperatively by the change in color of the mucosa from pink to gray, thickening and induration, and gritty sensation during dissection.

Several studies have evaluated the role of sonourethrography in the management of strictures.[19,20] Most of these studies compared its findings with that of a retrograde urethrogram in the diagnosis of stricture.[19,21,22] In this study, we correlated the extent of spongiofibrosis at sonourethrography and intraoperative findings, with the latter being the standard to validate the former in its ability to determine this vital characteristic of a stricture.

Using the Pearson Chi-square at two degrees of freedom to test the relationship of the extent of spongiofibrosis found on sonourethrography and intraoperative findings, there were statistically significant findings with $P < 0.05$ ($P = 0.001$). Besides, there was also a strong positive correlation of 71.6% between the extent of spongiofibrosis on sonourethrography and at urethroplasty using Spearman's rank correlation. Alam *et al*. had a similar correlation of 67.1% between sonurethrography and intraoperatively.[18] Mandal and Bhattacharyya also had similar findings on sonourethrography in India.[23]

Similarly, in this study, sonourethrography was also found to be a good diagnostic tool in the determination of the length of the stricture. This high sensitivity in the measurement of stricture length has been reported in the literature and found to be superior to that of retrograde urethrogram.[19,24,25] Overall, these important stricture characteristics available on a sonourethrogram can guide the choice of urethroplasty and may also influence the outcome.[26] Furthermore, preoperative patient counseling will be more focused and not dependent only on intraoperative findings.

In the quest to better evaluate urethral strictures and improve outcomes, magnetic resonance urethrography was introduced and found to also give a good extent of spongiofibrosis and length and site of strictures as sonourethrography.[12,27] However, a sonourethrogram is far easier to obtain, less expensive, more readily available, and not claustrophobic as compared to a magnetic resonance urethrogram.

Christopher Chapple in his review of anterior urethral surgery prefers to use endoscopy to ultrasound in the determination of length and extent of spongiofibrosis.[28] In our environment where ultrasound is far more readily available and cheaper as compared to endoscopy, it is a valid option in the management of strictures.

The limitation of this study is the subjective assessment of the spongiofibrosis which may have interobserver variability.

CONCLUSION

Sonourethrography is a valuable tool in the evaluation of urethral strictures. It is radiation-free, readily available even in resource-poor settings, and gives a good evaluation of the extent of spongiofibrosis as well as the length of strictures.

This prospective study has validated the role of sonourethrography in the determination of two important characteristics of urethral strictures which are essential in urethroplasty: extent of spongiofibrosis and length of strictures. The former is not feasible on routine retrograde urethrogram and the latter may not be as accurate as on sonourethrography. Preoperative precise knowledge of the above features will be a useful guide to the surgeon and aid decision-making on the best approach or type of urethroplasty. We encourage the use of this tool in the routine evaluation of strictures as this may improve the outcome of the management of strictures.

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Conflicts of interest

There are no conflicts of interest.

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