ORIGINAL PAPER

TRAUMA AND RECONSTRUCTIVE UROLOGY

The role of gel-infused translabial ultrasound as a new modality in evaluation of female urethral stricture

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Introduction To investigate the role of trans-labial ultrasound study in detection of female urethral stenosis (FUS) compared to former cysto-urethroscopy as the currently available definitive diagnostic modality.

Material and methods In this cross-sectional study, 60 consecutive patients with bladder outlet obstruction diagnosed by clinical symptoms and urodynamic study, were included from 2019 to 2022. For additional assessment, all these patients underwent gel-Infused trans-labial ultrasound (GITLUS) and cystourethroscopy. Trans-labial real-time ultrasonography was performed following the insertion of 20 ml steady stream viscous jelly into the urethral meatus to assess the length of the urethra and exact location and length of the probable narrowing, as well as the presence of peri-urethral fibrosis (PUF).

Results In GITLUS evaluation, urethral stricture was found in 27 patients. Mean urethral length and stricture length were 35.63 ±4.78 and 17.04 ±10.59, respectively. All these stenosis were confirmed via cysto-urethroscopy. PUF was found in 20 of 27 patients. In cysto-urethroscopy, urethral stricture was confirmed in 40 patients: 13 in urethral meatus and 27 in other parts or pan-urethra. GITLUS could not reveal urethral stricture in 13 patients with meatal stenosis, confirmed with cystoscopy. GITLUS detected FUS less accurately when it involves pure distal urethra compared to other parts of urethra or pan-urethral stenosis (p value = 0.002).

Conclusions GITLUS is a safe, non-invasive, and valuable technique for detecting FUS. The location and the length of the stricture and probable peri-urethral fibrosis can be identified by this method. However, in meatal or pure short-length distal urethral strictures, this method should be used with caution.

Key Words: urethral stricture ‹› ultrasound ‹› female ‹› cystoscopy ‹› urodynamic ‹› urethroplasty

INTRODUCTION

Bladder outlet obstruction (BOO) is an uncommon cause of female lower urinary tract symptoms (LUTS) with an estimated prevalence of 2.7-8%. Female urethral stricture (FUS) is an even more rare condition that accounts for 4-18% of the patients with so called BOO [1, 2]. According to the low prevalence of urethral stricture in women, there is no widely accepted consensus on the definition of FUS and its diagnostic criteria in the literature. Osman NI et al defined urethral stricture as an anatomical and symptomatic narrowing of the urethra that does not accommodate urethral instrumentation and can be confirmed by visual inspection, urethral calibration, urethroscopy or imaging studies [3]. Some researchers described FUS as a fixed anatomical narrowing (<14F) between distal urethra and the bladder neck [4]. There are several causes for FUS including iatrogenic conditions, history of inflammation and urethritis, chronic cystitis, stone passage, malignancy, trauma, radiation and idiopathic. Prolonged

catheterization and repeated instrumentation are the most common causes responsible for iatrogenic urethral strictures [5].

LUTS in women is multifactorial and may result from both anatomical and functional disorders. Obstructive LUTS in women may present with several symptoms including weak urinary stream, straining, nocturia, incomplete emptying, dribbling, hesitancy, and even urinary retention as a result of BOO [6]. Women with underactive bladder may present with similar symptoms [7] and clinicians should be aware of it as a probable cause of voiding dysfunction and LUTS. Diagnosis of FUS requires clinical suspicion, obtaining detailed medical history and thorough evaluation including: physical examination and specific para-clinics including urodynamic study or cystoscopy [8]. In a systematic review of 40 studies [3], uroflowmetry, measurement of post-void residual urine (PVR), cysto-urethroscopy, voiding cysto-urethrogram (VCUG), urodynamics, video urodynamics, and magnetic resonance imaging (MRI) were utilized to diagnose FUS. In a limited case series study, Sussman et al [9] introduced a gel-infused trans-labial ultrasound (GITLUS) as a novel technique to characterize female urethral stenosis, for the first time.

In the present study, we aimed to investigate the role of trans-labial ultrasound study in detection of urethral stenosis and distinguish it from other causes of female LUTS; furthermore, evaluating the practical value of this method in comparison to former cysto-urethroscopy as the currently available definitive diagnostic modality.

MATERIAL AND METHODS

Patients and setting

This cross-sectional study was conducted in our referral center from 2019 to 2022. Females with obstruc-

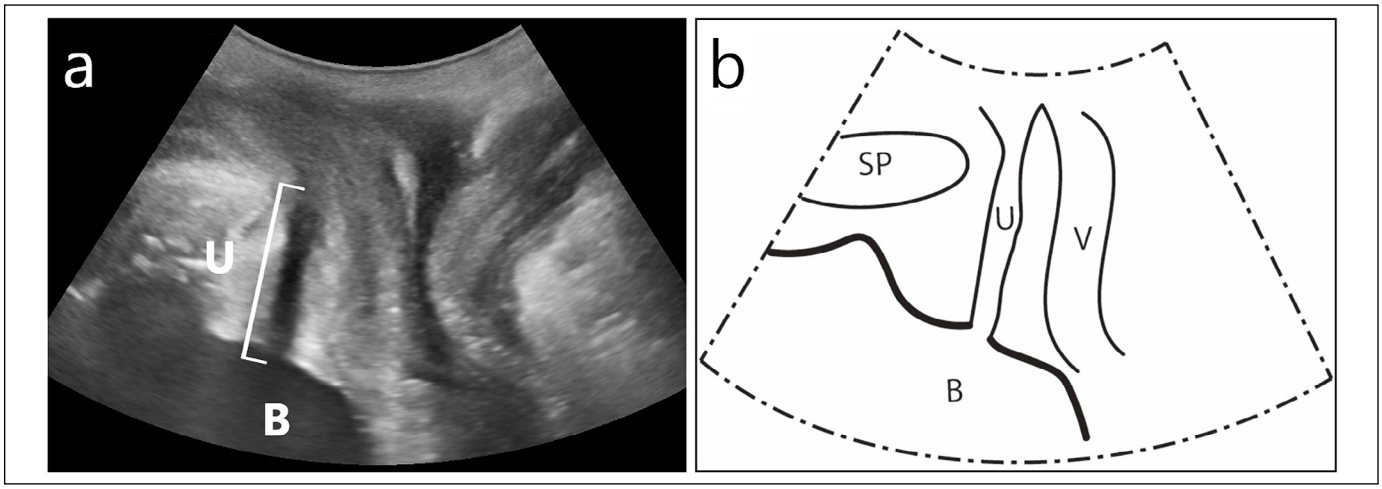

Figure 1. *Gel-infused trans-labial ultrasound of normal urethra* **(a)***; Schematic view of the same patient* **(b)***.*

U – urethral length; B – bladder; U – urethra; SP – symphysis pubis; V – vagina

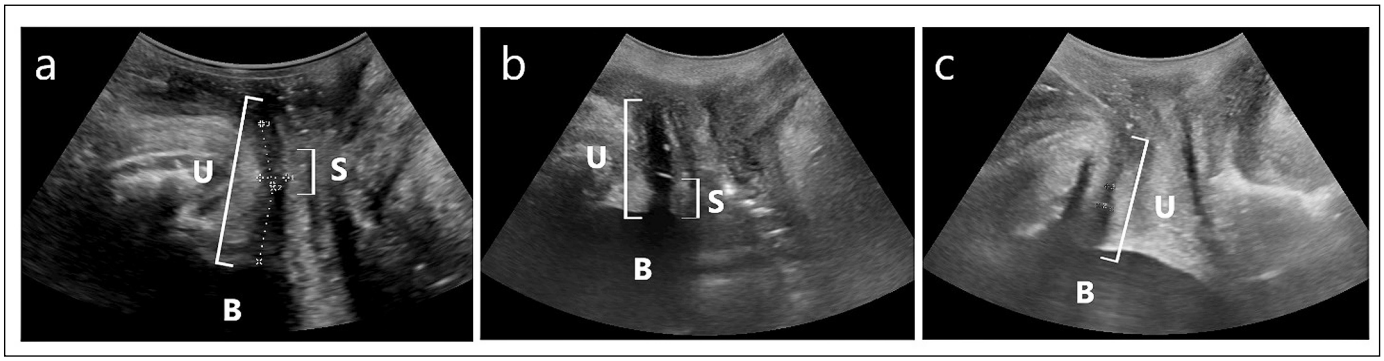

Figure 2. *Mid-urethral stricture* **(a)***; Proximal urethral stricture* **(b)***; Pan-urethral stricture and peri-urethral fibrosis demonstrating as hyper-echoic tissue surrounding the urethra* **(c)***.*

U – urethral length; B – bladder; S – stricture

tive LUTS lasting for at least 6 months and failed conservative and medical treatment were included in this study. The presence of grade 3 cystocele or rectocele, untreated urinary tract infection, para-urethral cysts, urethral prolapse, urethral diverticula, spinal cord injury or any known neurologic disease and lack of patients' consent to participate were considered as exclusion criteria. The study was approved by the research Ethics Committees of SBMU School of Medicine, (IR.SBMU.MSP.REC.1400.613). Written informed consent was obtained from all participants prior to the study which was in accordance with the ethical standards of the 1964 Deceleration of Helsinki as revised in 2000.

After primary evaluation including medical history and physical examination of 79 consecutive patients complaining of obstructive urinary symptoms by an expert female urologist, all patients underwent a multi-channel urodynamic study in maximum patient dignity and privacy. Pressure-flow study during the voiding phase was performed. Maximum urinary flow rate (Qmax), PVR volume and detrusor pressure at maximum urinary flow (Pdet@Qmax) were recorded. Bladder contractility index (BCI) was used to distinguish outflow obstruction and detrusor underactivity (DU). Nineteen patients with BCI<100 were considered as DU and excluded from the study. For remaining 60 patients (mean age: 55.6 ±12.8 years), additional tests including GITLUS and cystourethroscopy were performed.

For assessment of the urethra with GITLUS, patients were asked to have a comfortably full bladder. While the participants were lying in the supine and low lithotomy position, the CA1-7A convex array probe (Samsung WS80) was placed on just off midline trans-labial region in a sagittal plane. Real-time ultrasonography was performed by an expert radiologist. Before the procedure, the inter-labial area was sterilized, and then 20 ml of steady stream viscous jelly (lidocaine 2%) was inserted into the urethral meatus using a needle-less syringe.

The goals were assessing the length of the urethra, and exact location and length of the probable narrowing, as well as presence of peri-urethral fibrosis (PUF). (Figure 1, 2)

Urethral stricture in cystoscopic evaluation was defined by failure to pass a 14-French cystoscope sheath through any part of the urethra. Since the exact border of the different parts of the female urethra could not be addressed accurately in cystourethroscopy, the location of the urethral stricture was categorized as 1/3 distal (pure distal urethral or meatal stricture) and any other parts of the urethra including the combined or pan urethral strictures.

Statistical analysis

Quantitative data are shown as mean and standard deviation (SD) for data with normal distribution. The normality of the data was tested using the Kolmogorov-Smirnov test. Categorical data were shown as frequency. We utilized SPSS version 21.0 software (IBM Corporation, Armonk, NY, USA) for statistical analysis. Two tailed P-values < 0.05 were considered for the statistical level of significance.

RESULTS

A total of 79 patients meeting inclusion criteria, were enrolled in the study. Urodynamic study revealed low bladder contractility index (BCI) in 19 patients which was compatible with DU and the patients were excluded from the study. The remaining 60 patients were candidate for GITLUS and cysto-urethroscopic evaluation. Mean patients' age was 55.6 12.8 years

Table 1. *Demographic data of the patients*

	Yes	No
History of NVD	41	19
History of C/S	19	41
History of retention	2	58
History of urethral dilatation	23	37
Diabetes mellitus	8	52
History of recurrent UTI	10	50
Cystocele grade 1 or 2	25	35
Rectocele grade 1 or 2	18	42
Menopause	35	25

NVD – normal vaginal delivery; C/S – cesarean section; UTI – urinary tract infection

Table 2. *Gel-infused trans-labial ultrasound findings in 27 patients diagnosed with urethral stricture*

Mean Urethral length (mm ±SD)	35.63 ±4.78
Mean stricture length (mm ±SD)	17.04 ±10.59
Mean length from meatus to distal part of stricture (mm ±SD)	9.33 ±7.48
Mean length from proximal part of stricture to bladder neck (mm ±SD)	8.81 ±7.41
Stricture location in urethra	
Proximal	1
Middle	10
Distal	0
Proximal and middle	1
Middle and distal	10
Pan-urethra	5
Peri-urethral fibrosis	20

SD – standard deviation

and mean BMI was 25.2 ±3.1. Demographic data is summarized in Table 1.

Urodynamic study revealed detrusor over-activity in 12 patients. In patients with bladder outlet obstruction index (BOOI) of more than 40, the mean Qmax and Pdet@Qmax were 9.6 ±4.06 and 47.3 ±.3, respectively. Twenty-two patients had PVR ≥150cc, 17 participants had PVR ≤100cc and in remaining 21, PVR was between 100–150 cc. In GITLUS, urethral stricture was found in 27 patients. Mean urethral length and mean stricture length were 35.63 ±4.78 and 17.04 ±10.59 respectively (Table 2). All of these stenoses were confirmed through cysto-urethroscopy. PUF was found in 20 out of 27 patients with stenosis. During cysto-urethroscopy, urethral stricture was confirmed in 40 patients: 13 in urethral meatus or distal urethra and 27 patients with strictures located in other parts of the urethra including proximal, mid, combined parts or pan urethra. Fixed urethra, pale mucosa and bladder wall trabeculation were seen in 30, 36 and 14 patients, respectively. Twenty participants did not have urethral stricture. GITLUS was able to correctly report all 20 patients with normal cystoscopic evaluation. However, ultrasound studies were unable to detect urethral strictures in 13 patients with meatal stenosis or short-length pure distal strictures, as confirmed by cystoscopy. GITLUS, on the other hand, proved to be more accurate in detecting urethral strictures that did not involve the urethral meatus or pure distal urethra ($p = 0.002$).

DISCUSSION

Urethral stricture as a rare cause of female voiding dysfunction is likely underestimated and underreported. FUS has a broad spectrum of clinical manifestations and a high index of suspicion is needed to look for further evaluation [10]. Lack of a universally accepted definition and diagnostic criteria for FUS is another issue in female urology era. Previously, several techniques have been reported to evaluate FUS, including MRI, VCUG, uro-flowmetry study, urethral calibration and cysto-urethroscopy. In the evaluation of 70 male patients with LUTS, Choudhary S et al [11] found that ultrasound study is as effective as retrograde urethrogram (RUG) in diagnosis of anterior urethral strictures. In addition, ultrasound study had more accuracy in detection of fibrosis, length and diameter of the stenosis; and when compared to RUG, it was associated with less discomfort, pain and bleeding. In a small case series, Sussman et al (9) introduced GITLUS as a novel technique to identify FUS. In their study, 8 patients with previous history of urethral stricture whom were diagnosed by uroflowmetry, PVR, video urodynamics, and cystoscopy, underwent GITLUS. They found GITLUS as a safe, valuable and accurate tool in diagnosis of FUS.

In our study, all the strictures limited to the proximal, middle parts or pan urethra as well as distal plus mid urethra were detected by GITLUS. However, 13 out of 40 patients with strictures involving the pure distal part of the urethra or urethral meatus were missed by this method. We believe this could be due to a technical problem; when the syringe was inserted into the urethra, it may bypass the meatus or short-length distal urethral strictures causing false-negative results. Considering the above, in patients complaining of persistent obstructive LUTS, even with normal GITLUS, pure distal or meatal strictures should be re-evaluated with cysto-urethroscopy and direct visual examination.

Although cysto-urethroscopy is a relatively invasive test, it brings us the opportunity for localization and treatment of the probable FUS at the same time. However, if we are not careful

enough, passing the cystoscope through the short strictures can cause false-negative results. Moreover, in case of inability to pass the stricture during cystoscopy, estimating the length of the stricture would not be possible. Ultrasound study and detection of the location and length of the stricture would be very helpful for surgical planning. Evaluating the peri-urethral tissue and detecting the probable PUF is another special feature of ultrasound study in comparison to other diagnostic tests including cysto-urethroscopy or urodynamic study.

Sussman et al [9] found PUF in all 8 cases with urethral stricture, but due to the small sample size, they could not confirm the role of this finding in predicting prognosis. Vashishtha S et al [12] in evaluation of 52 patients up to 18 years old, concluded that PUF, stricture length, associated para-urethral abscess and etiology of the stricture would have a great impact on overall prognosis and success rate of the urethroplasty. In the present study, we found PUF in 20 of 27 patients diagnosed with urethral stricture by ultrasound study. Fifteen (75%) patients with PUF had history of at least two times previous urethral dilatations which may indicate PUF as a prognostic factor for treatment failure. However, a well-designed study with larger sample size would be required to prove the claim. The ability of GITLUS to identify the normal urethra is of particular importance. It can be used as the first diagnostic modality to rule out FUS in selected patients in order to prevent unnecessary invasive tests.

GITLUS has some benefits over transvaginal ultrasound study including the ability to perform it in pediatric, pregnant, and virgin patients. Moreover, in TV-US un intentional pressure to the urethra may

cause false positive results. GITLUS is also safer in terms of radiation exposure and anesthesia risk in pregnant or high-risk patients, when compared to other diagnostic techniques such as VCUG, RUG or cysto-urethroscopy. However, a limitation of this method could be the need to a trained, expert and experienced radiologist in evaluating the female urethra. We recommend performing GITLUS only in tertiary referral centers with high patient volume. The strength of this study is its relatively large sample size, which is rare for FUS. However, in order to address the pitfall of GITLUS in detecting meatal and distal urethral strictures, it is strongly suggested that the technique be re-evaluated and solutions be found for better visualization of the entire female urethra.

CONCLUSIONS

GITLUS is a safe, non-invasive, and valuable technique for detecting FUS. The strengths of this modality include the lack of need for anesthesia, ionizing radiation, and urethral catheterization.
It can accurately identify the location and length of the stricture. Additionally, it can evaluate peri-urethral pathologies such as PUF, which can be important for surgical planning and outcome. However, in meatal or pure short length distal urethral strictures, this method should be use with caution.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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