Urodynamic and urethral pressure profilometry findings in women with voiding phase dysfunction treated with surgical urethrolysis

Amy D. Dobberfuhl[1], Craig V. Comiter[1], Sayantan Deb[2]
[1]Department of Urology, Stanford University School of Medicine, Palo Alto, CA, United States; [2]Massachusetts General Hospital, Boston, MA, United States

Cite as: Dobberfuhl AD, Comiter CV, Deb S. Urodynamic and urethral pressure profilometry findings in women with voiding phase dysfunction treated with surgical urethrolysis. *Can Urol Assoc J* 2023 August 03; Epub ahead of print. http://dx.doi.org/10.5489/cuaj.8342

Published online August 03, 2023

Corresponding author: Dr. Amy D. Dobberfuhl, Department of Urology, Stanford University School of Medicine, Palo Alto, CA, USA; adobber@stanford.edu

***

ABSTRACT

Introduction: Long-term urodynamic (UDS) and urethral pressure profilometry (UPP) parameters in women with voiding phase dysfunction following an anti-incontinence (AI) procedure have been poorly characterized. We report our 10-year UDS findings in women with voiding phase dysfunction after AI procedure, who underwent urethrolysis.
Methods: We identified sequential records containing urethrolysis CPT codes over a 10-year period. Records of women with preoperative UDS were reviewed for demographics, UDS tracing, and outcomes following urethrolysis.
Results: Twenty-five women (mean age 60 years) had voiding phase dysfunction and underwent urethrolysis at a mean of 47 months (interquartile range [IQR] 12–61) after AI procedure. Preoperatively, six (24%) women required intermittent catheterization. Free uroflowmetry revealed a mean: maximum peak flow (Qmax) 9.6 ml/s (IQR 7.0–11.0), voided volume 137 ml (IQR 81–169), and postvoid residual 167 ml (IQR 43–288). UDS revealed a mean: UPP length 24 mm (IQR 20–27), UPP closure pressure 78 cmH_2O (IQR 59–103), Pdet@Qmax 31 cmH_2O

KEY MESSAGES

- We report 10-year UDS findings in women with voiding phase dysfunction following an anti-incontinence (AI) procedure, who underwent urethrolysis.
- UPP length was significantly associated (Pearson correlation, $p<0.05$) with BOO index ($r=0.80$), Pdet@Qmax ($r=0.75$), and time since AI procedure ($r=-0.70$).
- UPP closure pressure was significantly associated with age ($r=-0.64$), volume of first ($r=-0.64$) and strong ($r=-0.78$) desire, and capacity ($r=-0.71$).
- UPP may help characterize outlet parameters in women with voiding phase dysfunction following an AI procedure, who ultimately undergo urethrolysis.

(IQR 19–43), Qmax 7.9 ml/s (IQR 5.0–12.0), bladder outlet obstruction index 15 (IQR 0–34), and bladder contractility index 71 (IQR 60–81). UPP length was significantly associated (Pearson correlation, $p<0.05$) with: bladder outlet obstruction index ($r=0.80$), Pdet@Qmax ($r=0.75$), and time since AI procedure ($r=-0.70$). UPP closure pressure was significantly associated with age ($r=-0.64$), volume of first ($r=-0.64$) and strong ($r=-0.78$) desire, and capacity ($r=-0.71$). Following urethrolysis, spontaneous voiding was achieved in 23 (92%) women at followup (mean 308 days).
Conclusions: UPP may help characterize outlet parameters in women with voiding phase dysfunction following an AI procedure, who ultimately undergo urethrolysis.

INTRODUCTION

The American Urologic Association (AUA) and Society of Urodynamics Female pelvic medicine & Urogenital reconstruction (SUFU) guidelines exist for the surgical treatment of female stress urinary incontinence (SUI).[1] These include bladder neck suspension (retropubic and transvaginal), and bladder neck and midurethral slings. Although the mechanism underlying voiding phase dysfunction following these anti-incontinence (AI) procedures is not completely understood, excessive scar formation, and misplacement of suspension sutures or the sling have been attributed to causing compression of the urethra and kinking of the bladder outlet.[2,3] The American Urogynecologic Society Committee on Gynecologic Practice has stated in their recommendations that "Short-term voiding dysfunction after placement of a synthetic midurethral sling is common and, if improving, can be managed expectantly for up to 6 weeks. However, retention (inability to empty the bladder) or small-volume voids with large postvoid bladder residual volume should receive earlier intervention".[4] While this guidance is helpful for acute voiding phase dysfunction, there limited guidance for women with long term voiding phase dysfunction, although urethrolysis has become one of the mainstay treatments. The urethrolysis procedure can be performed in a retropubic, transvaginal, or suprameatal fashion with or without a Martius flap, to decrease further scarring. Resuspension can be attempted at the time of urethrolysis surgery, though this is controversial. Studies have reported resolution of SUI in 70% to 80% of patients following urethrolysis, with similar rates of SUI regardless of resuspension.[5–7] In up to 20% of patients, recurrent SUI can occur, and is often treated with bulking agent injection.[8]

Per the AUA/SUFU guidelines, urodynamics (UDS) may be obtained in the complicated patient when *invasive, potentially morbid or irreversible treatments are considered*,[9] and as such UDS have the potential to guide clinical decision-making in complex cases and improve surgical outcomes in the setting of storage and voiding symptoms related to outlet fibrosis, stress incontinence,[10] the large capacity bladder,[11] outlet obstruction,[12] and detrusor underactivity.[13]

Given the small number of women who undergo urethrolysis, UDS parameters prior to urethrolysis have not been sufficiently reported in the literature.

Urethral pressure profilometry (UPP) may be performed at the time of UDS by withdrawing the pressure profilometry catheter through the urethra, typically at a rate of 1 mm/s, and by measuring the shape of the UPP, length and maximum urethral closure pressure (MUCP) can be calculated. The utility of UPP in the urodynamic evaluation of women has been controversial.[14,15] Previous studies have reported the correlation of UPP parameters and incontinence symptoms.[15,16] MUCP has been noted to be higher in continent than incontinent women. Likewise, low MUCP has been associated with SUI. Urethral length and MUCP have been found to be reproducible in SUI, but more variable in patients with detrusor overactivity. Furthermore, weak correlation has been shown between UPP and bladder neck mobility.[17] There are currently no studies that have reported the use of UPP in women prior to undergoing urethrolysis.[18] The aim of our study was to describe urodynamic and UPP findings, as well as surgical outcomes in women undergoing urethrolysis at our institution over a 10 year period.

METHODS

After obtaining Institutional Review Board study protocol approval, we identified sequential patient records, which contained urethrolysis Current Procedural Terminology (CPT) codes at our institution from the years 2005 to 2015. We then identified records from this group with possible preoperative UDS CPT codes. A case-by-case retrospective chart review of each medical record was then performed. Study data were collected and managed using Research Electronic Data Capture (redcap)[19] tools hosted at our university. Data were compiled in redcap and included: demographics, prior anti-incontinence procedure, preoperative voiding characteristics, UDS parameters, urethrolysis surgical details, and postoperative outcomes. Following chart review, there were 25 women identified who had voiding phase dysfunction, with complete charts and preoperative UDS followed by urethrolysis surgery.

Demographics of clinically obstructed women included body mass index, pelvic organ prolapse quantification staging vaginal exam (POP-Q), and preoperative medications. Prior AI procedures were descriptively characterized for each patient, along with time since procedure. Preoperative storage and voiding symptoms were characterized. Urodynamic tracings were directly reviewed and validated with the reported values from the urodynamic report. Urethrolysis operative notes were directly reviewed for intraoperative technical parameters, estimated blood loss, and presence of indwelling catheter at discharge. On follow-up, all 25 patients had follow-up data available for analysis, which included time since urethrolysis surgery at longest follow-up, ability to spontaneously void, the presence and nature of urinary incontinence, and any additional treatments for overactive bladder. Data were analyzed and are presented for standard deviation (SD), inter-quartile range (IQR) and Pearson correlation coefficient. A p-value <0.05 was defined as significant.

RESULTS

Twenty-five women underwent preoperative UDS and were treated with urethrolysis for the voiding phase dysfunction indication at our institution from 2005 to 2015. The mean age of the patients was 60 years at the time of urethrolysis (Table 1). Mean BMI of patients was 28. There was minimal prolapse present on POP-Q vaginal exam whereupon 56% of patients had no anterior prolapse, 88% had no apical prolapse, and 72% had no posterior prolapse. In women with prolapse, it is our standard practice to reduce prolapse with a pessary to determine if there is a resolution of voiding phase dysfunction. Preoperatively 44% of patients were prescribed bladder medications, with 32% using anticholinergics, and 12% using alpha-blockers.

Prior AI procedure was performed at an average of 47 months (IQR 12-61) prior to urethrolysis (Table 1). The most common prior AI procedure was mid-urethral sling (68%). Native tissue procedures such as Burch and Marshall-Marchetti-Krantz comprised 28% of prior AI procedures. Descriptive categories for prior AI procedures were not mutually exclusive.

Preoperatively urgency incontinence (56%) was the most common lower urinary tract symptom prior to surgery (Table 2). The second most common presenting symptom was sensation of incomplete emptying (40%). The majority of patients (76%) were voiding spontaneously before surgery, while the remaining (24%) required intermittent catheterization prior to urethrolysis.

In patients who were voiding spontaneously, free uroflowmetry prior to pressure flow UDS demonstrated a mean Qmax of 9.6 ml/s (IQR 7.0-11.0), void volume of 137 ml (IQR 81-169), voiding time of 49 seconds (IQR 18-64) and post void residual (PVR) of 167 ml (IQR 43-288). In women with prolapse, it is our practice to reduce prolapse at time of urodynamics in order to standardize urodynamic assessment of the bladder and outlet. Complete preoperative UDS tracings were available on all 25 women for analysis. All women were able to void during the voiding phase of UDS testing, with a mean Pdet@Qmax of 31 cmh2o (IQR 19-43), and Qmax of 7.9 ml/s (IQR 5.0-12.0) (Table 2). Valsalva voiding was demonstrated in 36% of women prior to urethrolysis. Mean UDS PVR was 211 ml (IQR 50-315). The calculated bladder outlet obstruction index (BOOI) for patients was 15 (IQR 0-34) and bladder contractility index (BCI) was 71 (IQR 60-81).

UPP was performed in all women (Table 2). This revealed a mean urethral length of 24 mm (IQR 20-27) and MUCP of 78 cmh2o (IQR 59-103). The association between UPP parameters (length, MUCP) and continuous variables were tested with Pearson correlation coefficient. UPP length was found to positively correlate ($p < 0.05$) with increased BOOI ($r=0.80$) and increased Pdet@Qmax ($r=0.75$). UPP length was found to negatively correlate ($p < 0.05$) with time since AI procedure ($r=-0.70$), such that women with the greatest UPP length had the shortest interval between their AI procedure and subsequent urethrolysis. MUCP was inversely associated ($p < 0.05$) with age ($r=-0.64$), and as such the highest urethral closure pressures for women undergoing urethrolysis were noted in the youngest women, and likewise older women sought urethrolysis for lower MUCP. With respect to UDS filling volumes, MUCP

was inversely associated ($p < 0.05$) with volume of first ($r=-0.64$) and strong ($r=-0.78$) desire, as well as capacity ($r=-0.71$), such that those women with the greatest closure pressures were found to have the lowest UDS infusion volume thresholds.

Urethrolysis was successfully performed in all women (Table 3), where 40% underwent partial sling excision, 32% simple sling incision, and only 1 complete excision as previously described.[20,21] A 360-degree urethrolysis was performed in 48% and 32% underwent infra-meatal urethrolysis. The mean estimated blood loss was 67 ml (IQR 20-100). Majority of women (80%) had an indwelling catheter placed at completion of urethrolysis and 67% were discharged with a catheter. Most women (72%) were discharged on the day of surgery, while the remaining (28%) were discharged postoperative day 1.

The mean postoperative follow-up was 308 days (Table 3). Spontaneous voiding improved in the majority of women, with 92% ultimately able to void spontaneously, improved from 76% prior to surgery. Two patients continued to require intermittent catheterization at longest follow-up. Postoperatively, the most common bothersome symptom was urgency urinary incontinence in 36% of women, which improved from 56% prior to surgery. Three patients had mixed urgency predominant incontinence, and only 2 reported stress incontinence after surgery. Many patients (48%) did not require any additional pharmacologic or interventional treatment after surgery. Those requiring additional treatment were treated with anticholinergics (28%), alpha-blockers (12%), intradetrusor botulinum toxin A (4%), sacral neuromodulation (4%), and bladder augmentation (4%).

DISCUSSION

Our retrospective study finds that UPP correlated with several clinical and urodynamic parameters. We found that UPP length was significantly associated with BOOI, Pdet@Qmax and time since AI procedure. UPP closure pressure was significantly associated with age, volume of first and strong desire, and capacity prior to urethrolysis. Of the 25 women who underwent UDS followed by urethrolysis, lower urinary tract symptoms, the ability to spontaneously void and PVR improved in the majority of women following surgery.

In our cohort, 68% of women had undergone prior mid urethral sling, with the majority of these retropubic synthetic slings. The majority (56%) of women presented with urgency urinary incontinence as their most bothersome symptoms, and 40% reported a sensation of incomplete emptying. At postoperative follow-up, 92% patients were able to spontaneously void with low pvrs. Urinary symptoms also improved for many patients on postoperative follow-up.

Our study adds to the scant literature that exists regarding the utility of UDS in women undergoing urethrolysis and specifically, correlation of UPP with clinical and UDS parameters. For a condition where many women had resolution of their condition following urethrolysis, our study encompasses a relatively long duration of follow-up for women who had UDS prior to surgery. UDS tracings were directly reviewed, therefore validating the original UDS interpretation.

There are few studies which have evaluated the utility of UDS and UPP in women and their association with clinical symptoms following surgery. One study has found that even though UDS is performed regularly in women with incontinence, it does not affect clinical management of the patients, including the decision to offer surgery.[14] Another study found that there was an indirect relationship between MUCP and incontinence. Similar to our study, this study found the MUCP decreased with age.[15] Increased age was associated with increased prevalence of mixed incontinence. However, this study did not find a direct correlation between urethral pressure profilometry and incontinence. Interestingly in our study, MUCP was inversely associated ($p < 0.05$) with age ($r=-0.64$), and as such the highest urethral closure pressures for women undergoing urethrolysis were noted in the youngest women, and likewise older women sought urethrolysis for lower MUCP. In considering the context of this finding, our patients were generally older, with a mean age of 60 years and relatively narrow age range (IQR 54-68). Based on our findings there may be an association between bother, age and outlet resistance; such that younger women are more likely able to tolerate a greater MUCP without bother, whereas older women may be more bothered at the same MUCP level, and as such older women may seek urethrolysis at a lower MUCP threshold.

In patients undergoing urethrolysis, the UPP length provides valuable anatomic information which helps the surgeon determine which portion of the urethral profile may benefit the most from urethrolysis. In support of this concept we found that UPP length positively correlated ($p < 0.05$) with increased BOOI ($r=0.80$) and increased Pdet@Qmax ($r=0.75$). Regarding MUCP, we feel that the value of the closure pressure may help the surgeon determine the amount of additional mobility needed to be gained by performing urethrolysis. In our opinion, we feel that UPP helps the surgeon performing urethrolysis, which traditionally would try to identify the point of resistance intraoperatively by passing a “Bougies a Boule” through the lumen of the urethra, however when the patient is under anesthesia, resting urethral tone may be low as a result of anesthesia. In these cases, it is the actual shape of the profile, not just the MUCP alone, which may be the best indicator as to which portion of the urethra would benefit the most from the mobility gained through urethrolysis.

Following urethrolysis, we found that a subset of women report improvement of symptoms after surgery, especially the ability to spontaneously void, as reported by 92% of the women in our study, when compared to 76% prior to surgery. Postoperatively, urgency incontinence, the most common bothersome symptom after surgery, improved to 36% after surgery compared to 56% preoperatively. Our findings add to the literature, although there is a dearth of previously published studies. One case-series, reported improvement in retention and storage symptoms after surgery for 83% of the women studied, with improvement in PVR in all subjects.[6] Similarly another series found improvement in PVR in all subjects.[22] A larger cohort study found significant improvement in quality of life after urethrolysis as well as improvement in PVR.[23] Another study, reported new overactive bladder symptoms in 21% of the patients who underwent urethrolysis.[24] Although a different endpoint than our study, taken collectively these

data show that urethrolysis while improving voiding phase dysfunction, in some subjects can result in new or persistent urgency.

With regards to the finding that UPP length negatively correlated ($p < 0.05$) with time since AI procedure ($r=-0.70$); while the IQR for length is relatively short, at 20-27 mm, further studies are needed to draw a direct conclusion with respect to UPP length and duration since AI procedure. Future studies may benefit from looking at not just the two rudimentary parameters of MUCP and length, but actually studying the shape of the UPP curve in the context of flow dynamics through the flow control zone. Future studies are needed which better classify the UPP shape, and not just MUCP and length, as shape may be useful to understand the flow control dynamics of the female outlet and help classify various types of voiding dysfunctions such as bladder neck obstruction, dysfunctional abdominal straining during voiding phase, pelvic floor dysfunction, outlet dysynergia, and other low or high flow situations.

We would encourage future studies which explore the utility of UPP and build upon the limitations of our study. In the context of our study, additional considerations include the lack of a comparison control group who underwent UPP but did not choose to undergo urethrolysis. Our study is a retrospective chart review reporting on UPP findings for a relatively uncommon surgical procedure. Prospectively collected data would control for recall and selection bias, however given the relative rarity of urethrolysis, a prospective study would not be as efficient as a retrospective study design given the 10 year time frame over which it took to identify the subjects in our present study. Future research into the utility of UDS to guide surgical decision making could include repeating the UPP after surgery in order to assess change in UPP parameters, albeit this would need to be purely for scientific purposes since the standard of care does not necessitate a second UDS study after a successful urethrolysis procedure.

We found that almost all women with voiding phase dysfunction benefited for the outcome of spontaneous void following urethrolysis. The purpose of UDS is typically to excludd patients who may not benefit from a surgical intervention, and as such the actual comparator that would be needed for a future study, would be to compare a group like ours against patients who underwent UDS and did not proceed to surgery. Identification of a urodynamic subgroup who were considering urethrolysis, but decided not to proceed with surgery, would be challenging, and require a prospective study design to assess physician decision making and determine how surgical decision making was altered based on urodynamic findings. We expect that our findings will help fill the gap in knowledge for physicians seeking urodynamic and UPP reference comparator measures prior to urethrolysis.

CONCLUSIONS

In conclusion, from our 10 year retrospective study of women with voiding phase dysfunction who underwent UDS prior to urethrolysis, we found that UPP length demonstrated the strongest correlation with elevated BOOI and Pdet@Qmax, consistent with an elevated degree of obstruction. Meanwhile lower MUCP was associated with older age, and women with the greatest closure pressures were found to have the lowest urodynamic infusion volume thresholds.

Overall, UPP may help characterize outlet parameters in women with voiding phase dysfunction following an AI procedure, who ultimately undergo urethrolysis.

Disclosures: *Dr. Dobberfuhl has received support from the McCormick and Gabilan Faculty Fellowship Award (SPO 272363), the National Institutes of Health (NIH 1R01DK134989, NIH 2R44DK127580, NIH 1R01CA249807) and the California Institute of Regenerative Medicine (CIRM DISC2-13205).*

REFERENCES

1. Kobashi KC, Albo ME, Dmochowski RR, et al: Surgical Treatment of Female Stress Urinary Incontinence: AUA/SUFU Guideline. *J Urol* 2017; 198: 875–883.
2. Starkman JS, Scarpero H and Dmochowski RR: Methods and results of urethrolysis. *Curr Urol Rep* 2006; 7: 384–394.
3. Dobberfuhl AD and De EJB: Female stress urinary incontinence and the mid-urethral sling: is obstruction necessary to achieve dryness? *World J Urol* 2015; 33: 1243–1250.
4. Committee on Gynecologic Practice AUS: Management of Mesh and Graft Complications in Gynecologic Surgery. *Female Pelvic Med Reconstr Surg* 2017; 23: 171–176.
5. Unger CA, Rizzo AE and Ridgeway B: Indications and risk factors for midurethral sling revision. *Int Urogynecology J* 2016; 27: 117–122.
6. Orasanu B, Marotte J, Pasko B, et al: Robotic-assisted urethrolysis for urethral obstruction after retropubic bladder neck suspension-a case series report. *J Endourol Endourol Soc* 2014; 28: 214–218.
7. Anger JT, Amundsen CL and Webster GD: Obstruction after Burch colposuspension: a return to retropubic urethrolysis. *Int Urogynecol J Pelvic Floor Dysfunct* 2006; 17: 455–459.
8. Kirchin V, Page T, Keegan PE, et al: Urethral injection therapy for urinary incontinence in women. *Cochrane Database Syst Rev* 2012; 2: CD003881.
9. Winters JC, Dmochowski RR, Goldman HB, et al: Urodynamic studies in adults: AUA/SUFU guideline. *J Urol* 2012; 188: 2464–2472.
10. Dobberfuhl AD: Evaluation and treatment of female stress urinary incontinence after pelvic radiotherapy. *Neurourol Urodyn* 2019; 38 Suppl 4: S59–S69.
11. Dobberfuhl AD, Shaffer RK, Goodman SN, et al: Urodynamic factors associated with the large capacity bladder and incomplete emptying after prolapse repair (2009-2015). *Neurourol Urodyn* 2019; 38: 1322–1331.
12. Dobberfuhl AD, Zhang X and Comiter CV: The mechanical stop test and isovolumetric detrusor contractile reserve are associated with immediate spontaneous voiding after transurethral resection of prostate. *Int Urol Nephrol* 2020; 52: 239–246.
13. Dobberfuhl AD, Chen A, Alkaram AF, et al: Spontaneous voiding is surprisingly recoverable via outlet procedure in men with underactive bladder and documented detrusor underactivity on urodynamics. *Neurourol Urodyn* 2019; 38: 2224–2232.
14. Van Leijsen SAL, Kluivers KB, Mol BWJ, et al: The value of preoperative urodynamics according to gynecologists and urologists with special interest in stress urinary incontinence. *Int Urogynecology J* 2012; 23: 423–428.
15. Valentini FA, Robain G and Marti BG: Urodynamics in women from menopause to oldest age: what motive? What diagnosis? *Int Braz J Urol Off J Braz Soc Urol* 2011; 37: 100–107.
16. Lo T-S, Tan YL, Pue LB, et al: Outcomes of urodynamic mixed urinary incontinence and urodynamic stress incontinence with urgency after mid-urethral sling surgery. *Int Urogynecology J* 2020.
17. Ling C, Shek KL, Gillor M, et al: Is urethral kinking a confounder of the association between urethral closure pressure and stress urinary incontinence? *Ultrasound Obstet Gynecol Off J Int Soc Ultrasound Obstet Gynecol* 2020.

18. Shek KL, Chantarasorn V and Dietz HP: The urethral motion profile before and after suburethral sling placement. *J Urol* 2010; 183: 1450–1454.
19. Harris PA, Taylor R, Minor BL, et al: The redcap consortium: Building an international community of software platform partners. *J Biomed Inform* 2019; 95: 103208.
20. Wu S-Y and Kuo H-C: Long-term outcomes of anti-incontinence surgery and subsequent transvaginal sling incision for urethral obstruction. *Int Urogynecology J* 2019; 30: 761–766.
21. Developed by the Joint Writing Group of the American Urogynecologic Society and the International Urogynecological Association: Joint position statement on the management of mesh-related complications for the FPMRS specialist. *Int Urogynecology J* 2020; 31: 679–694.
22. Carmignani G, Varca V and Simonato A: Transvestibular urethrolysis. *Arch Ital Urol Androl Organo Uff Soc Ital Ecogr Urol E Nefrol* 2011; 83: 207–209.
23. Giannis G, Bousouni E, Mueller MD, et al: Can urethrolysis resolve outlet obstruction related symptoms after Burch colposuspension for stress urinary incontinence? *Eur J Obstet Gynecol Reprod Biol* 2015; 195: 103–107.
24. Drain A, Enemchukwu E, Shah N, et al: Current Role of Urethrolysis and Partial Excision in Patients Seeking Revision of Anti-Incontinence Sling. *Female Pelvic Med Reconstr Surg* 2019; 25: 409–414.

FIGURES AND TABLES

Table 1. Preoperative clinical and surgical characteristics (n=25)	
Age on date of urethrolysis, years (mean ± SD, IQR)	60±14 (54–68)
Body mass index (mean ± SD, IQR)	28±5 (24–31)
Anterior prolapse (n, %)	
None	14 (56%)
Stage 1	6 (24%)
Stage 2	5 (20%)
Stage 3+	–
Apical prolapse (n, %)	
None	22 (88%)
Stage 1	3 (12%)
Stage 2	–
Stage 3+	–
Posterior prolapse (n, %)	
None	18 (72%)
Stage 1	4 (16%)
Stage 2	2 (8%)
Stage 3+	1 (4%)
Preoperative bladder medication (n, %)	
None	14 (56%)
Anticholinergic	8 (32%)
Alpha-blocker	3 (12%)
Time since prior AI procedure, months (mean ± SD, IQR)	47±49 (12–61)
Prior AI procedure characteristics (n, %)	
Mid-urethral sling	17 (68%)
Synthetic sling	15 (60%)
Retropubic sling	9 (36%)
Native tissue repair (Burch, MMK)	7 (28%)
Transobturator sling	4 (16%)
Bladder neck sling	2 (8%)
Biologic sling	2 (8%)
Autologous sling	1 (4%)

AI: anti-incontinence procedure; IQR: interquartile range: MMK: Marshall-Marchetti-Krantz; SD standard deviation.

Table 2. Preoperative voiding and UDS characteristics (n=25)	
Symptoms (n, %)	
Urgency incontinence	14 (56%)
Sensation of incomplete emptying	10 (40%)
Stress incontinence	7 (28%)
Hesitancy	3 (12%)
Weak stream	2 (8%)
Mesh pain	1 (4%)
Preoperative voiding status (n, %)	
Spontaneous void	19 (76%)
Intermittent catheterization	6 (24%)
Indwelling Foley	–
Free uroflowmetry (mean ± SD, IQR)	
Qmax (ml/s)	9.6±4.2 (IQR 7.0–11.0)
Voided volume (ml)	137±74 (IQR 81–169)
Void time (s)	49±50 (IQR 18–64)
PVR (ml)	167±175 (IQR 43–288)
Urethral pressure profile (mean ± SD, IQR)	
Length (mm)	24±7 (IQR 20–27)
MUCP (cmH_2O)	78±27 (IQR 59–103)
Filling phase (mean ± SD, IQR)	
First desire (ml)	218±168 (IQR 94–286)
Strong desire (ml)	314±202 (IQR 192–388)
Capacity (ml)	402±181 (IQR 268–495)
Detrusor overactivity (n, %)	12 (48%)
Stress incontinence (n, %)	5 (20%)
Voiding phase (mean ± SD, IQR)	
Pdet@Qmax (cmH_2O)	31±18 (IQR 19–43)
Qmax (ml/s)	7.9±4.6 (IQR 5.0–12.0)
Valsalva voiding (n, %)	9 (36%)
PVR (ml)	211±182 (IQR 50–315)
Calculated indices (mean ± SD, IQR)	
BOOI (Pdet@Qmax – 2*Qmax)	15±20 (IQR 0–34)
BCI (Pdet@Qmax + 5*Qmax)	71±30 (IQR 60–81)

BCI: bladder contractility index; BOOI: bladder outlet obstruction index; IQR: interquartile range; MUCP: maximum urethral closure pressure; Pdet@Qmax: detrusor pressure at maximal flow; PVR: postvoid residual; Qmax: maximal flow, SD: standard deviation; UDS urodynamics.

Table 3. Urethrolysis procedure and postoperative outcomes (n=25)	
Urethrolysis technique (n, %)	
360-degree urethrolysis	12 (48%)
Partial sling excision	10 (40%)
Sling incision	8 (32%)
Infra-meatal urethrolysis	8 (32%)
Complete excision	1 (4%)
Surgical parameters (mean ± SD, IQR)	
Estimated blood loss (ml)	67±75 (20–100)
Foley at completion (n, %)	20 (80%)
Postoperative recovery (n, %)	
Discharge from PACU	18 (72%)
Discharge POD 1	7 (28%)
Foley at discharge	17 (68%)
Longest followup, days (mean ± SD, IQR)	308±378 (45–461)
Postoperative voiding status (n, %)	
Spontaneous void	23 (92%)
Intermittent catheterization	2 (8%)
Indwelling Foley	–
Postoperative PVR, ml (mean ± SD, IQR)	68±82 (4–88)
Postoperative incontinence (n, %)	
Urgency	9 (36%)
Mixed (urge > stress)	3 (12%)
Stress	2 (8%)
Unknown	1 (4%)
Mixed (stress > urge)	–
Postoperative treatments (n, %)	
None	12 (48%)
Anticholinergics	7 (28%)
Alpha-blockers	3 (12%)
Intradetrusor botulinum toxin A	1 (4%)
Sacral neuromodulation	1 (4%)
Bladder augment	1 (4%)

IQR: interquartile range; PACU: post-anesthesia care unit; POD: postoperative day; PVR: postvoid residual; SD: standard deviation.