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ARTICLE

One-year follow-up after urethroplasty, with the focus on both lower urinary tract and erectile function

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ABSTRACT

Background: Urethral stricture disease (USD) represents a complex urological problem. Urethroplasty is considered the gold standard for the treatment of USD. Most available studies report outcome data obtained from retrograde urethrography and uroflowmetry. Only a limited number of papers describe the effect of urethroplasty on erectile function and their results are inconsistent. The goal of this prospective study was to evaluate the effect of urethroplasty on both lower urinary tract and erectile function using objective parameters and standardized patient-reported outcome measurement tools.
Materials and Methods: A total of 55 consecutive patients with USD were enrolled into the study. Patients underwent ventral onlay urethroplasty, urethroplasty according to the Asopa technique, dorsal onlay urethroplasty, cutaneous flap urethroplasty using the Orandi technique or anastomotic repair. All patients were evaluated using uroflowmetry, urethrography, the PROM-USS questionnaire and the International Index of Erectile Function-5 questionnaire (IIEF-5) pre-operatively and consequently post-op, in 3-month intervals. This study presents the comparison of baseline pre-op parameters and parameters 12 months after the surgery using the Wilcoxon signed rank test, Wilcoxon rank sum test and the Kruskal-Wallis one-way analysis of variance.
Results: A significant improvement in uroflowmetry parameters, all domains of the PROM-USS questionnaire, as well as the overall score of the IIEF-5 was observed. No statistically significant differences between sub-groups were found when comparing treatment results in patients with short versus long strictures and patients with penile urethra stricture versus bulbar or membranous urethra stricture.
Conclusions: Urethroplasty yielded very good functional results with respect to both lower urinary tract and erectile functions.

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Introduction

Urethral stricture disease (USD) is a complex urological problem, which has severe significance in a patient's quality-of-life. This is frequently exaggerated by the fact that the disease often affects young and active patients. USD could be a result of urethral trauma, iatrogenic causes such as a long-term indwelling catheter, endourological procedures, inflammation or a combination of these factors. The etiology is often uncertain [1]. It is a rare disease with an estimated prevalence of 0.6% [2]. This low prevalence poses a challenge, since only a limited number of urologists have the knowledge and skills necessary to provide complex care to these patients. Management of these patients should be concentrated to specialized centers.

Patients with USD suffer from obstructive lower urinary tract symptoms (LUTS), including weak stream, straining during urination, interrupted voiding and large post-void residual. The prolonged bladder outlet obstruction often results in severe complications (e.g. structural changes of the bladder wall, recurrent urinary tract infections, cystolithiasis).

In the past, most USD cases were treated with urethral dilatations and/or internal urethrotomy. These methods are currently reserved for palliative care, while urethroplasty became the gold standard. This trend is evident, as the number of open urethroplasties performed in the United States increased more than 3-fold between 2004 and 2012 [3]. Urethroplasty is a safe surgical procedure with low incidence of perioperative morbidity and mortality [4]. Studies conducted at specialized centers with a sufficient volume of urethroplasty procedures report a success rate above 80% [5]. On the other hand, it must be recognized that a consensus on the definition of success in the US treatment is lacking. Previously, no need for re-treatment was accepted as a definition of success [6]. Today, most studies report success based on quantifiable functional outcome data obtained mostly from retrograde urethrography and uroflowmetry. The effect of urethral surgery on erectile function was first evaluated in a study by Mundy [7] published in 1993. Since then, only a limited number of studies focusing on this aspect of treatment have been published, yielding conflicting results [8].

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The goal of our study was to prospectively evaluate the effects of urethroplasty on both lower urinary tract and erectile function, using objective parameters and standardized patient-reported outcome measurement instruments.

Materials and methods

This single-center prospective cohort study was performed according to the Declaration of Helsinki and World Health Organization (WHO). The study design was approved by the Institutional Review Board of the University Hospital Ostrava (Ref. No.:301/2015). Prior to enrollment, all patients signed informed consent.

Patients

A total of 55 consecutive patients with USD were enrolled into the study between May 2015 and April 2018. One patient was lost to follow-up and is not included in the final analysis. The average age at enrollment was 58.5 (28–79) years. The average body mass index was 28.5 (18.6–45.5). Eighteen patients (33.3%) were unable to void spontaneously before treatment and instead used a suprapubic tube for bladder drainage.

The etiology of USD included iatrogenic causes in 33 patients (61%), lichen sclerosis in eight (14.8%), post-traumatic stricture in two (3.7%), failure of previous hypospadias surgery in four (7.4%) and idiopathic in seven (12.9%) patients.

All patients were indicated for urethroplasty based on the standard diagnostic algorithm considering the patient's history, urine analysis, ultrasound, uroflowmetry, urethrocystography and urethroscopy.

Procedures

entral onlay urethroplasty was performed in 22 patients with USD affecting the proximal and middle portions of the bulbar urethra [9]. After urethral dissection, a mucosal graft harvested from the cheek was implanted into the incision of the stricture at the ventral aspect of the urethra. In 17 patients with USD affecting the penile urethra, the Asopa technique was used [10]. This involved ventral, sagittal urethrotomy and transluminal implantation of the buccal mucosa graft into the dorsal urethral wall. Nine patients with proximal penile and/or distal bulbar USD underwent dorsal onlay urethroplasty according to the Barbagli technique [11]. Four patients with distal penile stricture were managed using a cutaneous flap as per the Orandi technique [12]. The remaining two patients underwent anastomotic repair [13,14]. Two stage urethroplasty was used in six patients with long strictures.

All procedures were performed by a single surgeon trained in urethral reconstructive surgery. Post-operatively, bladder drainage was secured using a urethral catheter, which was kept in place for 3 weeks. The catheter was removed following urethrocystography to exclude extravasation.

Follow-up protocol

All patients were evaluated in 3-month intervals. This study presents a comparison between baseline pre-op parameters and parameters 12 months after urethral stricture surgery (USS).

Uroflowmetry

The test was performed using the uroflowmeter MMS Solar (MMS, Enschede, The Netherlands) according to Good Urodynamic Practice [15]. A corrected cQ_{max} ($cQ_{max} = Q_{max}/2\sqrt{V}$) was used, with a corrected cQave ($cQ_{ave} = Q_{ave}/2\sqrt{V}$), to take the quadratic relationship between voided volume and peak (Q_{max}), average (Q_{ave}) flow rate into account [16].

Patient-reported outcome measures after urethral stricture surgery (PROM-USS)

PROM-USS is a robust, standardized psychometric questionnaire, used to evaluate changes in LUTS and disease-related quality-of-life (QoL) after surgical treatment of USD [17]. The first six items Q1–Q6 are adapted according to the International Consultation on Incontinence Questionnaire (ICI-Q) and focus on LUTS using the five-point Likert scale. The total score ranges between 0 (no LUTS) and 24 (most severe LUTS). Item Q7 quantifies impacts of LUTS on QoL (0 = no impact, 3 = most severe impact). Item Q8 evaluates the patient's perception of the strength of his urinary stream using a pictogram (1 = very strong urinary stream, 4 = very weak urinary stream). Patients who were unable to void prior to surgery were arbitrarily assigned a score of 5. Items Q9–Q10 evaluated the patient's satisfaction with the outcome of surgical treatment, while items Q11–Q15 assessed health-related QoL (the lower score correlated with a higher QoL). The visual analog scale (VAS) quantifies a patient's perception of his general health. A non-validated Czech translation of PROM-USS was used in this study.

International Index of Erectile Function-5 (IIEF-5)

IIEF-5 is a widely used, validated tool to evaluate erectile function using a five-point Likert scale (a lower total score denotes a higher probability of erectile dysfunction) [18].

Statistical analysis

The data were processed and a statistical analysis was performed using the Number Cruncher Statistical System (NCSS LLC 2012, Kaysville, UT). Demographic data are expressed as averages and all other data are expressed as means ± standard deviations (SD). Changes in time and differences between groups were assessed with non-parametric tests due to a non-normal distribution of the data. The Wilcoxon signed-rank test was used to compare baseline to post-operative values, the Wilcoxon rank sum test was used to compare differences in the two groups and a Kruskal–Wallis one-way analysis of variance was used to compare the three groups. A value of $p \leq 0.05$ was considered statistically significant.

Table 1. Uroflowmetry parameters before and 12 months after the surgery in the entire patient set.

	Baseline		12 months post-operatively		
Variable	*n*	Mean ± SD	*n*	Mean ± SD	*p*
V	54	193.7 ± 167.4	54	320.1 ± 136.3	0.0000
Q_{max}	54	4.7 ± 4.0	54	20.9 ± 6.8	0.0000
cQ_{max}	54	0.3 ± 0.3	54	1.2 ± 0.4	0.0000
Q_{ave}	54	2.7 ± 2.5	54	11.1 ± 4.4	0.0000
cQ_{ave}	54	0.2 ± 0.2	54	0.6 ± 0.2	0.0000

V, voided volume; Q_{max}, peak flow rate; cQ_{max}, corrected peak flow rate; Q_{max}, average flow rate; cQ_{ave}, corrected average flow rate.

Table 2. IIEF-5 and PROM-USS questionnaires score before and 12 months after the surgery in the entire patient set.

	Baseline		12 months post-operatively		
Variable	*n*	Mean ± SD	*n*	Mean ± SD	*p*
IIEF − 5	54	16.6 ± 7.1	54	17.5 ± 7.0	0.0499
Q1–Q6*	36	12.9 ± 4.8	36	4.3 ± 3.6	0.0000
Q7*	36	2.4 ± 0.8	36	1.1 ± 1.0	0.0000
Q8	54	4.0 ± 0.9	54	2.1 ± 0.9	0.0000
Q11–Q15	54	1.6 ± 1.6	54	1.0 ± 1.4	0.0044
VAS	54	64.4 ± 18.3	54	79.2 ± 17.1	0.0000

IIEF-5, IIEF − 5 questionnaire total score; Q1–Q6, PROM-USS items Q1–Q6 total score; Q7, PROM-USS item Q7 score; Q8, PROM-USS item Q8 score; Q11–Q15, PROM-USS items Q11–Q15 total score; VAS, PROM-USS visual-analog scale score.
*Applicable only in patients who were able to void pre-operatively.

Results

A significant improvement in all uroflowmetry parameters, all domains of the PROM-USS questionnaire, as well as in the overall score of the IIEF-5 was observed in the evaluation of the results in the entire group. The results are summarized in Tables 1 and 2.

Subsequently, several secondary analyses were performed. No statistically significant differences were found when comparing treatment results in sub-groups of patients with short (<20 mm, $n = 28$) and long urethral stricture (>20 mm, $n = 26$, Table 3). Similarly, when comparing outcomes in sub-groups of patients with penile urethra stricture ($n = 26$) and stricture in the bulbar or membranous urethra ($n = 28$), no statistically significant differences were found (Table 4).

When evaluating treatment outcomes in sub-groups assigned to the type and number of interventions prior to urethroplasty, we observed a significantly greater improvement in uroflowmetry parameters in the sub-group with no prior interventions ($n = 22$) compared to a sub-group of patients who underwent one urethrotomy ($n = 15$) and a sub-group of patients with multiple previous interventions ($n = 17$). In contrast, significantly less improvement in some domains of the PROM-USS questionnaire was indicated in patients who underwent one previous urethrotomy when compared to both remaining sub-groups (Table 5).

Discussion

Today, urethroplasty is considered the gold standard for urethral stricture treatment. The majority of studies published in the last two decades used the improvement of urine flow and no need for additional interventions as key parameters to define the success of treatment. In this trial, we provide data quantifying the effect of urethroplasty on lower urinary tract function and erectile function and assess the patients' perspective using standardized measurement tools.

In the present cohort we achieved statistically significant improvements in all uroflowmetry parameters and scores on the standardized PROM-USS questionnaire in all domains. At the time of the 1-year follow-up, none of the patients required additional intervention. This finding aligns well with data from high-volume, specialized centers and meta-analyses that indicate a high success rate of USS in the treatment of USD [19].

The main advantages of our study include the prospective design and the use of standardized assessment tools. In addition, to our knowledge, this is the first study using the corrected values of maximum and mean urine flow. In previous studies, non-corrected values of maximum urinary flow were used to compare pre- and post-operative lower urinary tract function, which could have led to a bias due to the known correlation between urinary flow and the voided volume [20]. The methodology used in this study enabled us to objectively compare urine flow parameters pre- and post-operatively, thereby increasing the reproducibility and reliability of the results.

Most previously published studies did not assess the effect of urethroplasty on erectile function. Knowledge of the topographical anatomy of structures (both vascular and neural) involved in erectile function suggests that these may be damaged during urethroplasty. Specifically, risk of damage to the terminal branches of the dorsal artery in the penis, the branches of the dorsal nerve of the penis and the pudendal nerve as has previously been addressed [21]. That is why this study also focused on the evaluation of erectile function after surgical treatment. We observed post-operative improvements in erectile function as measured by the overall IIEF-5 score. This observation has been further supported through interviews during the follow-up visits, where a clinically significant improvement in erectile function after surgery was reported by the majority of the patients. We believe that 12-month follow-up data on erectile function are valid. At this time point the healing after the surgery is completed and the patient can adequately judge the effect of USS on his erectile function. With the longer follow-up we would need to consider age-related deterioration of erectile function. Our results correlate well with previously reported data from the meta-analysis published by Feng et al. [22], indicating that USS does not lead to deterioration of erectile function.

Some limitations of our work must be acknowledged. These include the relatively small number of patients, heterogeneity in terms of USD etiology and the extent and location of the urethral stricture. On the other hand, this allowed us to perform some secondary analysis of our dataset. When comparing groups of patients with short versus long strictures, no significant differences in treatment outcomes were noted. Longer strictures usually require more extensive

Table 3. Differences between sub-groups according to the length of the stricture.

	Sub-group A1 Stricture ≤ 20 mm		Sub-group A2 Stricture > 20 mm		Sub-group A1 versus Sub-group A2
Variable	n	Difference in 12 month follow-up versus baseline mean ± SD	n	Difference in 12 month follow-up versus baseline mean ± SD	p
V	28	106.1 ± 155.9	26	145.3 ± 182.9	0.4940
cQ_{max}	28	1.0 ± 0.4	26	0.9 ± 0.5	0.6096
cQ_{ave}	28	0.5 ± 0.3	26	0.5 ± 0.3	0.8830
IIEF − 5	28	1.6 ± 5.4	26	0.5 ± 3.3	0.2009
Q1–6*	18	−7.8 ± 5.8	18	−9.3 ± 5.3	0.5043
Q7*	18	−1.3 ± 1.1	18	−1.3 ± 1.0	0.7791
Q8	28	−2.0 ± 1.2	26	−1.8 ± 1.3	0.6177
Q11–15	28	−0.5 ± 1.5	26	−0.6 ± 1.7	0.7521
VAS	28	15.7 ± 26.4	26	13.7 ± 19.7	0.5304

V, voided volume; cQ_{max}, corrected peak flow rate; cQ_{ave}, corrected average flow rate; IIEF-5, IIEF − 5 questionnaire total score; Q1–Q6, PROM-USS items Q1–Q6 total score; Q7, PROM-USS item Q7 score; Q8, PROM-USS item Q8 score; Q11–Q15, PROM-USS items Q11–Q15 total score; VAS, PROM-USS visual-analog scale score.
*Applicable only in patients who were able to void pre-operatively.

Table 4. Differences between sub-groups according to the location of the stricture.

	Sub-group B1 Stricture of the penile urethra		Sub-group B2 Stricture of the bulbar or membranous urethra		Sub-group B1 vs Sub-group B2
Variable	n	Difference in 12-month follow-up versus baseline mean ± SD	n	Difference in 12-month follow-up versus baseline mean ± SD	p
V	26	155.1 ± 184.6	28	95.5 ± 150.1	0.2909
cQ_{max}	26	0.9 ± 0.5	28	1.0 ± 0.5	0.5620
cQ_{ave}	26	0.4 ± 0.2	28	0.5 ± 0.3	0.7227
IIEF − 5	26	0.8 ± 3.7	28	1.3 ± 5.2	0.4076
Q1–6*	19	−9.7 ± 4.9	17	−7.3 ± 6.1	0.3393
Q7*	19	−1.5 ± 1.0	17	−1.1 ± 1.2	0.3810
Q8	26	−1.6 ± 1.2	28	−2.2 ± 1.2	0.1048
Q11–15	26	−0.7 ± −0.7	28	−0.5 ± 1.4	0.6489
VAS	26	16.4 ± 23.2	28	13.2 ± 23.5	1.0000

V, voided volume; cQ_{max}, corrected peak flow rate; cQ_{ave}, corrected average flow rate; IIEF-5, IIEF − 5 questionnaire total score; Q1–Q6, PROM-USS items Q1–Q6 total score; Q7, PROM-USS item Q7 score; Q8, PROM-USS item Q8 score; Q11–Q15, PROM-USS items Q11–Q15 total score; VAS, PROM-USS visual-analog scale score.
*Applicable only in patients who were able to void pre-operatively.

Table 5. Differences between sub-groups according to previous interventions.

	Sub-group C1 No prior intervention		Sub-group C2 Max. 1 optimal urethrotomy		Sub-group C3 Multiple prior interventions		Sub-group C1 versus Sub-group C2 versus Sub-group C3
Variable	n	Difference in 12-month follow-up versus baseline mean ± SD	n	Difference in 12-month follow-up versus baseline mean ± SD	n	Difference in 12-month follow-up versus baseline mean ± SD	p
V	22	97.8 ± 158.9	15	140.6 ± 197.7	17	150.9 ± 162.4	0.6169
cQ_{max}	22	1.1 ± 0.5	15	0.8 ± 0.3	17	0.8 ± 0.5	0.0456
cQ_{ave}	22	0.6 ± 0.3	15	0.4 ± 0.1	17	0.4 ± 0.2	0.0472
IIEF − 5	22	1.2 ± 5.3	15	0.3 ± 2.6	17	1.6 ± 4.8	0.4851
Q1–6*	13	−6.4 ± 5.7	9	−8.8 ± 6.4	14	−10.5 ± 4.3	0.1816
Q7*	13	−1.1 ± 1.1	9	−0.7 ± 0.7	14	−1.9 ± 1.0	0.0265
Q8	22	−2.0 ± 1.4	15	−1.8 ± 1.1	17	−1.9 ± 1.2	0.9535
Q11–15	22	−0.8 ± 1.1	15	−0.3 ± 1.6	17	−0.6 ± 2.1	0.6331
VAS	22	18.5 ± 16.6	15	1.0 ± 23.3	17	22.1 ± 26.4	0.0492

V, voided volume; cQ_{max}, corrected peak flow rate; cQ_{ave}, corrected average flow rate; IIEF-5, IIEF − 5 questionnaire total score; Q1–Q6, PROM-USS items Q1–Q6 total score; Q7, PROM-USS item Q7 score; Q8, PROM-USS item Q8 score; Q11–Q15, PROM-USS items Q11–Q15 total score; VAS, PROM-USS visual-analog scale score.
*Applicable only in patients who were able to void pre-operatively.

dissection during surgery, leading to a higher potential risk of damage to structures involved in an erection. Therefore, one would expect a higher probability of post-operative erectile dysfunction. In light of this assumption, the fact that the change in the IIEF score did not differ among the sub-groups is positive, though unexpected.

We also did not observe a difference in the change in IIEF score or any other parameters between the patients undergoing penile vs bulbar or membranous reconstructions, which contradicts data published previously by Xie et al. [23].

The results of the sub-analysis with respect to the number of previous interventions indicate that urethroplasty should be performed as soon as possible, to minimize repeated tissue injury and scar formation. However, the small number of subjects in the individual sub-groups of our current study warrant analysis of a larger sample size to confirm this conclusion.

A validated Czech version of the PROM-USS is not yet available. We used a Czech version of this questionnaire translated by investigators and reviewed by a medical editor, a speaker native in both languages. We plan to continue using the PROM-USS in the future, therefore our next step will be to perform the validation of the Czech version.

Another limitation is the fact that we did not evaluate the esthetic outcome and the change in self-esteem of patients after urethroplasty. Although these are very important components of overall patient satisfaction, no standardized tools to allow for adequate evaluation of these domains are yet available. Given the growing emphasis on comprehensive patient satisfaction it is highly desirable to develop these tools in the future and to use them as an integral part of assessing the outcome of all reconstructive procedures in urology.

Conclusion

Urethroplasty is an effective treatment method for urethral strictures. This study confirms that it yields very good functional results with respect to the lower urinary tract and erectile functions, leading to a significant improvement in quality-of-life.

Disclosure statement

The authors have nothing to disclose.

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