Article published online: 2023-06-19

Effect of Prolonging the Duration of Stenting on Urethral Stricture in Proximal Hypospadias with Severe Curvature Repair: A Prospective Cohort Study

Guanglun Zhou[1] Man Jiang[2] Xiaodong Liu[1] Jianchun Yin[1] Zhilin yang[1] Shouln Li[3] Jinjun Chen[3]

[1] Department of Urology, Shenzhen Children's Hospital, Shenzhen, Guangdong, China
[2] Department of Infectious Diseases, Shenzhen Children's Hospital, Shenzhen, China
[3] Department of Urology and Laboratory of Pelvic Floor Muscle Function, Shenzhen Children's Hospital, Guangdong, Shenzhen, China

Address for correspondence Jinjun Chen, MD, Department of Urology and Laboratory of Pelvic Floor Muscle Function, Shenzhen Children's Hospital, Futian District, Guangdong, Shenzhen 518038, China (e-mail: szcjinjun@163.com).

Eur J Pediatr Surg 2024;34:363–367.

Abstract

Introduction The aim of this study was to evaluate whether prolonged stenting reduces the risk of urethral stricture after proximal hypospadias (PH) with severe curvature (SC) repair.

Materials and Methods We prospectively studied a cohort of patients with PH with SC repair who underwent urethral plate transection and urethroplasty between January 2010 and December 2020. According to the duration of stenting, the patients were divided into 2-, 4-, and 6-week groups. Postoperative complications and time of urethral stricture occurrence were analyzed.

Results In total, 665 patients were included in the analysis. The overall incidence of complications was 26.6% ($n = 177$), including 42 cases of urethral strictures: 27 (64.3%) cases of urethral stricture occurred between 4 and 6 weeks after urethroplasty, 7 cases occurred between 7 weeks and 6 months after urethroplasty, 7 cases occurred more than 6 months after urethroplasty, and 1 case occurred at 3 weeks after urethroplasty. The incidence of urethral stricture in the 6-week group (1.8%) was significantly lower than that in the 4- (5.8%) and 2-week groups (10.9%) ($p < 0.05$).

Conclusion Prolonged stenting reduces the risk of urethral stricture in PH with SC repair. Four to six weeks after PH with SC repair may be the key period for the formation of early urethral strictures.

Keywords
- stent
- outcome
- hypospadias
- urethral stricture
- curvature

Introduction

Repair of proximal hypospadias (PH) with severe curvature (SC) remains a challenging surgical procedure.[1] The incidence of postoperative complications remains high in these patients. Postoperative complications of PH include but are not limited to urethral fistula, stricture, diverticulum, and residual chordee.[2] Correction of these complications often require reoperations.[3] The management of urethral stricture is a difficult problem, and it may require urethroplasty or multiple operations.[4]

The occurrence of urethral strictures after PH with SC repair may be associated with many risk factors, and

received
March 1, 2023
accepted after revision
May 4, 2023
article published online
June 19, 2023

DOI https://doi.org/10.1055/s-0043-1769797.
ISSN 0939-7248.

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

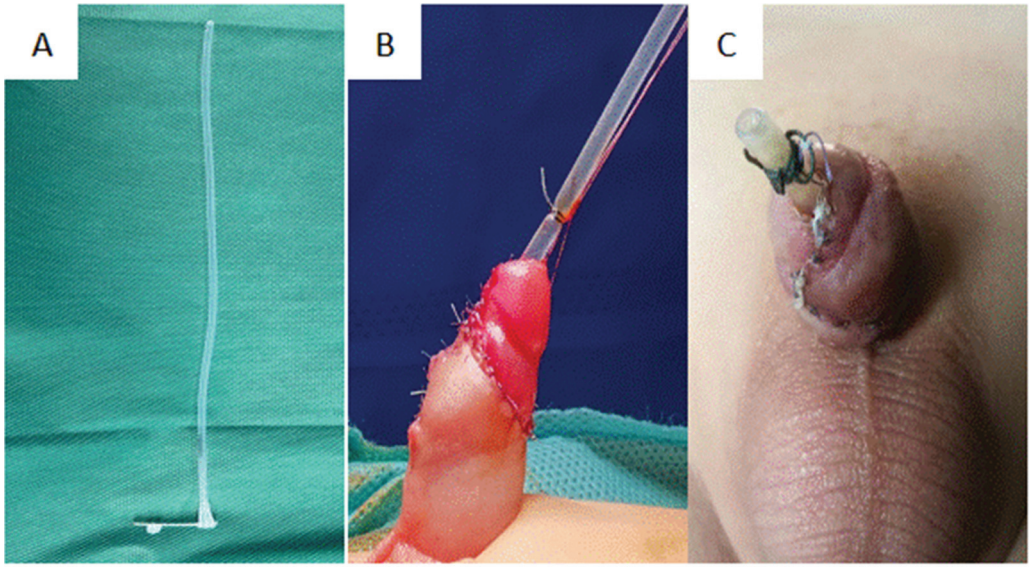

Fig. 1 View of the single-lumen silicone catheter and its placement after hypospadias repair.

Cimador et al reported that postoperative urinary drainage is an important factor for preventing urethral strictures.[3] Karakaya et al considered that urethral stenting after hypospadias repair can prevent complications, such as urethral stricture, urethrocutaneous fistula, and urinary retention.[5] However, there is no consensus regarding the duration of stenting in patients with PH with SC. Huang et al reported that urethral strictures mainly occur at the junction of the neourethra and native urethra in patients with PH.[6] Premature removal of the urethral stent may result in extravasation of urine, resulting in local scarring and urethral stricture.[7] Tang et al reported that urethral stricture mainly occurs in the early stage after hypospadias repair.[8] These patients with urethral stricture usually require transurethral treatment, and repeat transurethral manipulation may create a cumulative tissue injury.[9]

We hypothesized that prolonging the duration of stenting for PH with SC may reduce the incidence of urethral stricture without increasing other postoperative complications. In this study, we used a prospectively maintained database to test this hypothesis by documenting the incidence of postoperative urethral strictures and other complications. Moreover, we recorded the time of occurrence of urethral stricture after PH with SC repair.

Materials and Methods

Study Design and Patients

All patients diagnosed as having PH with SC were enrolled in this prospective, observational study from January 2010 to December 2020. PH with SC was defined as the urethral meatus located on the proximal shaft, penoscrotal, perineal, and curvature more than 30 degrees after penile degloving (curvature is determined at the time of surgery using an artificial erection test).[10] The inclusion criteria were as follows: 1) patients who underwent transection of the urethral plate for correct SC and urethroplasty (Duckett's or staged urethroplasty); 2) patients in whom a suitably sized single-lumen silicone catheter was passed into the bladder for bladder drainage during the operation and secured to the glans traction suture (►**Fig. 1**) patients with a follow-up period of 12 months after urethroplasty. The exclusion criteria were as follows: 1) patients with a history of penile surgery; 2) those with missing data; and 3) those in whom the stents fell out prior to the expected date of removal, stents tore, or stents were not removed at the schedule time. This study was granted by the Ethics Committee of Shenzhen Children's Hospital (2009039).

Surgical technique to correct the curvature: penile degloving was performed, and the tethered tissue in the ventral region was removed. And then the degree of curvature was reassessed, and the urethral plate was transected when SC persisted. Dorsal plication procedure was performed when the urethral plate transection was inadequate to straighten the penis.

Patients underwent stent urinary drainage for 2, 4, or 6 weeks depending on the the choice of the surgeons. According to the duration of stenting, the patients were divided into 2-, 4-, and 6-week groups. The 2-week group was defined as urethral catheters removed at postoperative week 2. The 4-week group was defined as follows: 2 weeks after urethroplasty, urethral catheters were removed from the bladder and changed to a short stent tube (►**Fig. 1C**). The proximal end of the short stent tube exceeded the level of the junction of the neourethra and native urethra, and the distal end of the short stent tube was secured to the glans traction suture for 2 weeks. Under local anesthesia (5% compound lidocaine cream), using the original glans suture to fix the short stent tube. Similarly, the 6-week group was defined as follows: 2 weeks after urethroplasty, urethral catheters were removed from the bladder and changed to a short stent tube for 4 weeks. Patients were discharged approximately 1 week after urethroplasty.

Data Collection and Definitions

We prospectively collected patient demographics, the preoperative meatal position, degree of penile curvature, length of the neourethra, duration of stenting after urethroplasty, stent-related anomalies (stent removal, tearing, or obstruction), and postoperative complications. Complications were defined as problems that required surgical correction during the study period. Complications included urethral stricture, urethrocutaneous fistula, urethral diverticulum, recurrent ventral curvature, and glans dehiscence. Urethral stricture was defined as obstructive voiding symptoms and urethral narrowing smaller than 6 French. Recurrent ventral curvature was defined as more than 15 degrees after the initial repair.

Follow-Up

All patients were reassessed 2 weeks after urethroplasty and at 2 weeks, 4 weeks, 12 weeks, and 12 months after stent removal. In the 4-week group, stents were removed at 4 weeks after urethroplasty, whereas in the 6-week group, stents were removed at 6 weeks after urethroplasty. Follow-up visits were conducted annually. Micturition and penile erection were evaluated, and patients with stent removal underwent uroflowmetry during the follow-up period. The patient's guardian was informed that if the stent showed any abnormality, the patient should visit the outpatient clinic.

Statistical Analysis

Categorical variables are presented as frequencies and percentages (%), and Pearson's chi-square was used to analyze the data, where appropriate. Continuous variables are presented as mean ± standard deviation, and continuous data were analyzed using Student's *t*-test or covariance analysis. Statistical analyses were performed using SPSS, version 22.0, and statistical significance was set at *p*-value less than 0.05.

Results

In total, 732 patients were enrolled in this study, of which 67 patients were excluded from the study for the following reasons: 24 patients had missing data, 20 patients had their stents fall out prior to the expected date of removal, 18 patient did not have their stents removed on schedule, and 5 patients had instances of stent tearing. Thus, 665 children were included in the final analysis. The mean age of the whole cohort at initial surgery was 35.7 ± 20.4 months. The mean length of the reconstructed neourethra was 4.52 ± 0.88 cm. The median follow-up period was 46 months (range: 13–121 months). Duckett's urethroplasty and staged repair (Byars' technique) were performed in 145 (21.8%) and 520 (78.2%) patients, respectively. There were 237 patients in the 2-week group, 206 in the 4-week group, and 222 in the 6-week group. The mean ages at initial surgery, length of the neourethra, and surgical procedure in the 2-, 4-, and 6-week groups were similar. Twelve patients experienced catheter or stent obstruction and maintained stent patency after flushing.

Among the 665 patients, the overall incidence of complications was 26.6% ($n = 177$). Complications included 129 urethral fistulas, 42 urethral strictures, 15 urethral diverticula, and 9 cases of glans dehiscence. Fifteen patients had 2 complications. None of the patients had recurrent ventral penile curvature. The incidence of urethral strictures decreased with prolonged stenting duration ($p < 0.05$). The patient demographics and outcomes after urethroplasty are presented in ►Table 1.

Of 42 patients with urethral stricture (19 cases in the Duckett's group and 23 cases in the staged group), 27 (64.3%) cases of urethral stricture occurred between 4 and 6 weeks after urethroplasty (12 cases in the Duckett's group and 15 cases in the staged group), 7 cases (3 cases in the Duckett's group and 4 cases in the staged group) occurred between 7 weeks and 6 months after urethroplasty, 7 cases (3 cases in the Duckett's group and 4 cases in the staged group) occurred more than 6 months after urethroplasty (3 cases occurred > 3 years after surgery), and 1 case (in the Duckett's group) occurred at 3 weeks after urethroplasty. The times of occurrence of urethral stricture are shown in ►Table 2. All patients with urethral strictures were treated with urethral

Table 1 Patient demographics and outcomes after urethroplasty

Variable	2-week group	4-week group	6-week group	*p*-Value
Patients	237	206	222	
Age at initial surgery (months)	35.3 ± 18.6	36.1 ± 21.7	35.5 ± 20.9	> 0.05[a]
Repair method				> 0.05[b]
Duckett's urethroplasty ($n = 145$)	51 (35.2%)	45 (31.0%)	49 (33.8%)	
Staged repair ($n = 520$)	186 (35.7%)	161 (30.9%)	173 (33.3%)	
Complications ($n = 177$)	72 (40.7%)	57 (32.2%)	48 (27.1%)	
Urethral strictures ($n = 42$)	26 (61.9%)	12 (28.6%)	4 (9.5%)	< 0.05[b]
Urethral fistulas ($n = 129$)	45 (34.9%)	43 (33.3%)	41 (31.8%)	> 0.05[b]
Urethral diverticulum ($n = 15$)	5 (33.3%)	4 (26.7%)	6 (40%)	> 0.05[b]
Glans dehiscence ($n = 9$)	3 (33.3%)	4 (44.4%)	2 (22.2%)	> 0.05[b]

[a]Student's *t*-test.
[b]Chi-square test.

Table 2 Time of occurrence of urethral stricture

Variable		2-week group	4-week group	6-week group	*p*-Value
Patients		237	206	222	
Urethral stricture ($n = 42$)		26 (61.9%)	12 (28.6%)	4 (9.5%)	< 0.05[a]
Urethral strictures ($n = 42$)	Postoperative, 4–6 weeks	20 (76.9%)	7 (58.3%)	0 (0%)	< 0.05[a]
	Postoperative, 7 weeks to 6 months	2 (7.7%)	3 (25%)	2 (50%)	> 0.05[a]
$>$ 6 months after surgery	3 (11.5%)	2 (16.7%)	2 (50%)	> 0.05[a]	
Maximal urinary flow rate (mL/s)	2 weeks after stent removal	7.2 ± 1.8	8.3 ± 2.3	9.7 ± 2.9	< 0.05[b]
	4 weeks after stent removal	6.1 ± 2.5	7.7 ± 3.5	9.3 ± 3.3	< 0.05[b]
	12 weeks after stent removal	9.4 ± 2.6	9.5 ± 2.4	9.8 ± 2.1	> 0.05[b]
	12 months after surgery	10.1 ± 1.7	10.2 ± 2.5	10.4 ± 2.2	> 0.05[b]
	$>$ 1 year after surgery	11.4 ± 2.8	11.5 ± 2.6	11.8 ± 3.1	> 0.05[b]

Note: One case of urethral stricture occurred at 3 weeks after urethroplasty in the 2-week group.
[a]Chi-square test.
[b]Student's *t*-test.

dilatation: 29 were cured, and 13 failed treatments. Of those 13 patients (8 cases in 2-week group, 4 cases in 4-week group, and 1 case in 6-week group), 11 underwent direct vision internal urethrotomy (6 cases were cured) and 7 underwent urethroplasty (including 5 cases that failed direct vision internal urethrotomy).

The maximum urine flow rate at 2 and 4 weeks after stent removal in the 6-week group was higher than that in the 2- and 4-week groups ($p < 0.05$). The maximal urinary flow rates of the patients at different times are summarized in ►**Table 2**. The maximal urinary flow rates of the patients when diagnosing urethral stricture is 4.1 ± 2.3 mL/s.

Discussion

The goals of PH repair are to allow voids with normal velocity and laminar flow, achieve satisfactory function and cosmetic normality, and achieve low postoperative complication rates.[10] This study found a clear-cut advantage of prolonging the duration of stenting after PH with SC repair to reduce urethral stricture, and this did not increase the risk of other postoperative complications, which confirms our hypothesis.

The relationship between urethral stents and postoperative complications is focused on distal hypospadias, whereas research on PH is limited.[11] Some studies have reported that there is likely no outcome difference between stented and nonstented distal hypospadias repair.[11] They considered no drainage after distal hypospadias repair as another option.[11] However, we believe that stenting still needs to be performed for PH with SC repair. This is based on the following reasons. 1) In this study, patients with PH with SC required a transverse urethral plate to correct the SC and then urethroplasty. Compared with the preservation of urethral plate repair for hypospadias, the material used for the reconstruction of the neourethra was all from the prepuce in this study. The urethral plate is well-vascularized and supple, and preservation of the urethral plate for urethroplasty can lead to decreased complications of proximal anastomosis.[12] However, the blood supply to the prepuce is unstable, which may affect wound healing and increase the incidence of urethral stricture.[13] 2) The longer the neourethral length, the greater the possibility of urethral stricture.[14] The mean length of the reconstructed neourethra was as long as 4.52 cm in this study. Therefore, for patients with PH with SC repair, preserving the stent can keep the neourethra open, prevent neourethra anastomosis, reduce urine extravasation, and avoid urethral distortion.

Although urethral stricture is a common complication after PH with SC repair, the actual incidence of urethral stricture rate is unknown.[4] In most published series, the incidence of urethral stricture after PH has been reported to be 8.0 to 16.0%.[3,13] Cimador et al reported that the risk factors for the occurrence of urethral stricture include factors related to the severity of hypospadias, surgeon, patient, and postoperative management.[3] In this study, we expected to reduce urethral strictures by changing the postoperative management (prolonging the duration of stenting) in patients with PH with SC. Our study showed a low incidence of urethral stricture (6.3%), and stent placement for 6 weeks effectively reduced the occurrence of urethral stricture (1.8%). The strictures were more common in the Duckett's urethroplasty compared to the staged urethroplasty in this study. This may due to urethral distortion that may occur in the neourethra because Duckett's tube lacks support from surrounding tissue.[13] In addition, staged urethroplasty reduces the incidence of strictures through semicircular anastomosis.

In this study, the incidence of urethral stricture in the 2-week group was significantly higher than that in 6-week group, and most urethral strictures occurred 4 to 6 weeks after repair. Similarly, Tang et al reported that most urethral strictures were found in a short follow-up period after hypospadias repair.[8] The causes of urethral stricture

occurring early after surgery are unknown and may be related to the following[13,15,16]: 1) the neourethra has a small diameter in some patients; 2) the inflammatory reaction of the neourethral anastomosis has not subsided, and the premature removal of the stent leads to blocked urine flow; 3) the neourethral anastomosis has not healed, and the premature removal of the stent may cause local urethral distortion or urine extravasation into the surrounding tissues. In this study, the maximum urine flow rate (2 and 4 weeks after stent removal) in the 2-week group was significantly lower than that in the 6-week group; additionally, the maximum urine flow rate in the 2-week group gradually decreased at 4 to 6 weeks after surgery, which is consistent with the time of early urethral stricture. Although a low maximum urine flow rate tends to improve with time, some patients without intervention may gradually show a significant decrease in the maximal urinary flow rate and obstructive voiding symptoms.[13] In the early postoperative period, the 6-week group showed a reduced incidence of early urethral stricture after the duration of stenting to keep the urethra open was prolonged. Moreover, the maximum urine flow rate in the 6-week group did not show a significant downward trend after stent removal. Therefore, we speculate that 4 to 6 weeks after PH with SC repair may be the key period for the formation of early urethral strictures. In contrast, three cases (7.1%) of urethral stricture occurred more than 3 years after urethroplasty in this study, which is consistent with the finding of another study that reported that some urethral strictures can occur many years after surgery.[4]

Many types of urethral stents have been described, including silicone, latex, silastic, polyethylene, polyvinyl chloride, and antimicrobial catheters.[16] The duration of stenting should be prolonged to reduce the occurrence of urethral strictures, and undesirable side effects related to the use of urethral stents should be eliminated. In this study, the urinary catheter was changed to a short stent 2 weeks after urethroplasty in the 4- and 6-week groups. A short stent can avoid bladder spasms and reduce catheter obstruction and infection. The use of Foley catheters was avoided in these patients. Turial et al reported that removal of Foley catheters may result in severe complications because catheter removal could potentially lead to interruption of the repair.[17] Fortunately, our data showed that stent-related complications (bleeding, infection, and stent migration) did not significantly increase when the duration of stenting was prolonged.

This study has a couple of limitations. First, this study was not a randomized controlled trial. Second, participants should be followed up for over a longer time to identify potential long-term complications.

Conclusion

Based on our preliminary experience, early urethral stricture after PH with SC repair usually occurs 4 to 6 weeks postoperatively. This postoperative management of prolonging the duration of stenting can reduce early urethral strictures and does not increase the risk other postoperative complications. Monitoring the maximum urine flow rate may contribute to early detection of urethral strictures.

Funding

The study received funding from the Natural Science Foundation of China (U1904208) and the Shenzhen Fund for Guangdong Provincial High-level Clinical Key specialties (SZXK035).

Conflict of Interest

None declared.

References

1 Acimi S. Release of severe chordee and urethroplasty in proximal hypospadias repair. World J Urol 2021;39(06):2247–2248
2 Long CJ, Chu DI, Tenney RW, et al. Intermediate-term followup of proximal hypospadias repair reveals high complication rate. J Urol 2017;197(3 Pt 2):852–858
3 Cimador M, Vallasciani S, Manzoni G, Rigamonti W, De Grazia E, Castagnetti M. Failed hypospadias in paediatric patients. Nat Rev Urol 2013;10(11):657–666
4 Talab SS, Cambareri GM, Hanna MK. Outcome of surgical management of urethral stricture following hypospadias repair. J Pediatr Urol 2019;15(04):354.e1–354.e6
5 Karakaya AE, Doğan AB, Güler AG. Use of a stent in distal hypospadias repaired by tubularized incised plate urethroplasty: a comparative study. Urol Int 2019;102(03):336–340
6 Huang Y, Xie H, Lv Y, et al. One-stage repair of proximal hypospadias with severe chordee by in situ tubularization of the transverse preputial island flap. J Pediatr Urol 2017;13(03):296–299
7 Hadidi AT. Functional urethral obstruction following tubularised incised plate repair of hypospadias. J Pediatr Surg 2013;48(08):1778–1783
8 Tang SH, Hammer CC, Doumanian L, Santucci RA. Adult urethral stricture disease after childhood hypospadias repair. Adv Urol 2008;2008:150315
9 Horiguchi A, Shinchi M, Masunaga A, Ito K, Asano T, Azuma R. Do transurethral treatments increase the complexity of urethral strictures? J Urol 2018;199(02):508–514
10 van der Horst HJ, de Wall LL. Hypospadias, all there is to know. Eur J Pediatr 2017;176(04):435–441
11 Chua M, Welsh C, Amir B, et al. Non-stented versus stented urethroplasty for distal hypospadias repair: a systematic review and meta-analysis. J Pediatr Urol 2018;14(03):212–219
12 Baskin LS, Ebbers MB. Hypospadias: anatomy, etiology, and technique. J Pediatr Surg 2006;41(03):463–472
13 Snodgrass WT, Bush NC. Management of urethral strictures after hypospadias repair. Urol Clin North Am 2017;44(01):105–111
14 Fang C. Prevention and treatment of urethral stricture after hypospadias repair in children. Zhonghua Shiyong Erke Linchuang Zazhi 2017;32:805–807
15 González R, Ludwikowski BM. Importance of urinary flow studies after hypospadias repair: a systematic review. Int J Urol 2011;18(11):757–761
16 Ozcan S, Bagcioglu M, Karakan T, Diri MA, Demirbas A. Efficacy of using Zaontz urethral stent in hypospadias repair by the Face, Legs, Activity, Cry, Consolability (FLACC) scale: a prospective study. Can Urol Assoc J 2017;11(1–2):E15–E18
17 Turial S, Enders J, Engel V, Schier F. Stent-free tubularized incised plate (TIP) repair of distal and mid-shaft hypospadias irrespective of age. Eur J Pediatr Surg 2011;21(03):168–170