


Original Article
Clinical Investigation**Risk factors for postoperative complications in children with proximal hypospadias with severe chordee who underwent urethral plate transection**Guanglun Zhou,^{1,†} Ruifeng Wang,^{2,†} Wenbin Zhu,¹ Jianchun Yin,¹ Zhilin Yang¹ and Shoulin Li¹ ¹Department of Urology and Laboratory of Pelvic Floor Muscle Function, Shenzhen Children's Hospital, Shenzhen, Guangdong and²Department of Gastroenterology and Zhengzhou Key Laboratory of Children's Digestive Diseases, Children's Hospital affiliated to Zhengzhou University, Henan Children's Hospital, Zhengzhou Children's Hospital, Zhengzhou, Henan, China**Abbreviations & Acronyms**PH = proximal hypospadias
TIP = tubularized incised
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Objectives: To identify the risk factors associated with developing complications after transection of the urethral plate for proximal hypospadias with severe chordee.**Methods:** We used a prospective database to identify patients with proximal hypospadias and severe chordee who underwent transection of the urethral plate and primary hypospadias repair in 2011 and 2021. All patients underwent urethroplasty with a follow-up period of >12 months. The association between variables (age, surgical technique, length of urethral defect, and surgeon volume) and postoperative complications (fistulas, urethral strictures, diverticula and glans dehiscence) was analyzed.**Results:** Altogether, 493 patients were included, of whom 133 (26.9%) had postoperative complications. Univariate and multivariate analyses revealed that the preoperative proximal meatal position, one-stage repair, longer urethral defect length, and low surgeon volume were significant risk factors for postoperative complications with proximal hypospadias with severe chordee who underwent transection of the urethral plate. A urethral defect length of ≥ 4.55 cm was considered the best cutoff value for predicting postoperative complications.**Conclusions:** Preoperative proximal meatal location, one-stage repair, longer urethral defect length, and low surgeon volume were associated with postoperative complications in patients with proximal hypospadias with severe chordee who underwent transection of the urethral plate. A urethral defect length of ≥ 4.55 cm was significantly associated with the development of complications.**Key words:** hypospadias, male, postoperative complications, risk factors, treatment outcome.**INTRODUCTION**Repairing proximal hypospadias (PH) is a challenging surgery, especially in patients with severe chordee.¹ Although technical advances have improved the outcomes, postoperative complications remain high.² Some studies have reported a high PH complication rate of 30–68%.²In clinical practice, PH with severe chordee repair remains controversial.¹ Some researchers have selected preservation of the urethral plate for urethroplasty, which may lead to a high recurrent ventral curvature.³ Snodgrass et al. have reported that the treatment of PH with severe chordee by tubularized incised plate (TIP) repair can lead to a recurrent ventral curvature rate of up to 26%.³ We preferred transection of the urethral plate to correct severe chordee and observed that this technique greatly reduces curvature recurrence. However, the incidence of other complications (fistulas, urethral strictures, diverticula, and glans dehiscence) associated with this technique is relatively high. Interestingly, some patients had postoperative complications, while others had none. These conditions raise concerns regarding the management of PH in patients with severe chordee because some boys are exposed to additional unplanned risks, and minimizing the risk of developing complications is important. A few factors may increase the risk of developing complications, and identifying the possible risk factors for

complications in patients with PH with severe chordee who underwent urethral plate transection is necessary.

However, the current investigations on the particular risk factors of developing complications in the treating PH in patients with severe chordee with a transverse urethral plate are limited. In this study, we hypothesized that some evaluated risk factors could be related to the development of complications in patients with PH and severe chordee who underwent urethral plate transection. We aimed to identify the risk factors associated with developing complications after transection of the urethral plate for PH with severe chordee.

METHODS

Clinical cohort and definition

This prospective, observational study was approved by the institutional review board of our hospital. Written informed consent was obtained from the guardians or parents of all patients prior to treatment.

We collected clinical information from November 2011 to July 2021 of patients diagnosed with PH with severe chordee, who underwent surgery at our institution. The inclusion criteria were as follows: patients who underwent transection of the urethral plate for severe chordee correction at our institution and patients who had completed urethroplasty with a follow-up period of >12 months. The exclusion criteria were a history of penile surgery and disorders of sex development. PH with severe chordee was defined as a meatal position located on the midshaft, proximal shaft, penoscrotal, perineal, and curvature >30° after degloving.⁴ Altogether, 516 patients were enrolled in this study, of whom 23 were excluded because of missing data. The collected information included age at the first surgery, use of preoperative testosterone, preoperative meatal location, curvature after degloving, primary repair techniques, use of dorsal plication, length of urethral defect, duration of stenting after urethroplasty, surgeon volume, insurance, and complications. The urethral defect length was defined as from the meatus to the tip of the glans during the urethroplasty.

Complications were defined as problems that occurred during the study period that required surgical correction. Postoperative complications included urethrocutaneous fistula, recurrent ventral curvature, urethral stricture, urethral diverticulum, and glan dehiscence. Recurrent ventral curvature was defined as >15° after initial repair. Urethral stricture was defined as urethral narrowing smaller than 6Fr and obstructive voiding symptoms.

The patients were divided into the complication group and non-complication group according to the presence of complications after urethroplasty. The surgeon determined the preoperative testosterone administration. The preoperative meatal location was classified as midshaft, proximal shaft (proximal shaft and penoscrotal), or perineal. Curvature was measured after penile degloving and was divided into 30–45° and >45°. The choice of surgical technique was based on the surgeon's experience, and the surgical repairs were classified into single-stage procedure (Duckett repair) and staged repair (Byars repair). Dorsal plication was performed when urethral plate transection was inadequate to straighten the penis. The urethral defect length was measured during the urethroplasty.

The duration of stenting was recorded as ≤14 days or ≥15 days, surgeon volume was categorized as ≤50 cases/year and ≥51 cases/year, and insurance was categorized as medical insurance, commercial insurance, or others.

Statistical analysis

Statistical analysis was performed using SPSS 22.0, and a value of $p < 0.05$ was considered significant. Continuous variables are presented as mean ± standard deviation, and continuous data were analyzed using Student's *t*-test. Categorical variables are presented as frequencies and percentages (%), and Pearson's chi-squared and Fisher's exact tests were used where appropriate. Variables with $p < 0.05$ in the univariate analysis were included in the subsequent multivariate analysis. A multivariate logistic regression analysis was performed to determine the association between various parameters and postoperative complications. To determine the optimal thresholds (cutoffs) of the urethral defect length, the point on the receiver operating characteristic curves with the maximum Youden index (sensitivity+specificity-1) was calculated. The sensitivity and specificity values were calculated based on the optimal cutoff points.

RESULTS

Study population

Overall, 493 patients were included in this study. The mean age at initial surgery in the whole cohort was 36.9 ± 20.3 months. The median follow-up period was 39 months (range 14–113 months). The initial meatal position was midshaft in 134 (27.2%) patients, proximal shaft and penoscrotal in 340 (68.9%) patients, and perineal in 19 (3.9%) patients. The degree of curvature between 30° and 45° was observed in 302 (61.3%) patients, and curvature >45° was observed in 191 (38.7%) patients. The Duckett technique and staged urethroplasty (Byars technique) were performed in 46 (9.3%) and 447 (90.7%) patients, respectively. Preoperative testosterone was administered in 76 patients, and dorsal plication was performed in 67 patients. Patient demographics are listed in Table 1.

Complications

The overall incidence of complications was 26.9% ($n = 133$). Complications included 117 fistulas, 13 urethral strictures, 13 diverticula, and eight dehiscence. Sixteen patients presented with two or more complications. No recurrent ventral curvature was noted in any of the patients.

Univariate analysis

A preoperative proximal meatal position, curvature >45°, one-stage repair, long urethral defect length, and low surgeon volume were associated with an increased risk of postoperative complications (Table 1). Patients with perineal location were associated with a higher risk of postoperative complications than those with midshaft, proximal shaft, and penoscrotal locations ($p < 0.05$). A greater degree of curvature was associated with a higher risk of postoperative complications

TABLE 1 Univariate analysis of demographic and clinical parameters

Variable	Postoperative complications group	Postoperative non-complications group	p-value
Number of patients	133	360	
Age (months)	37.56 ± 21.91	36.67 ± 20.07	0.335*
Preoperative testosterone			0.888**
Yes	20 (15.0%)	56 (15.6%)	
No	113 (85.0%)	304 (84.4%)	
Initial meatal location			0.001**
Perineal	10 (7.5%)	9 (2.5%)	
Proximal shaft and penoscrotal	101 (75.9%)	239 (66.4%)	
Midshaft	22 (16.5%)	112 (31.1%)	
Curvature			0.009**
30–45°	69 (51.9%)	233 (64.7%)	
>45°	64 (48.1%)	127 (35.3%)	
Surgical technique			0.008**
Duckett urethroplasty	20 (15.0%)	26 (7.2%)	
Staged repair	113 (85.0%)	334 (92.8%)	
Dorsal plication			0.982**
Yes	18 (13.5%)	49 (13.6%)	
No	115 (86.5%)	311 (86.4%)	
Length of urethral defect	5.01 ± 1.23	4.40 ± 0.81	0.001*
Duration of stenting (days)			0.982**
≤14	73 (54.9%)	198 (55.0%)	
≥15	60 (45.1%)	162 (45.0%)	
Surgeon volume (n)			0.001**
≤50	75 (56.4%)	125 (34.7%)	
≥51	58 (43.6%)	235 (65.3%)	
Insurance			0.978**
Medical insurance	87 (65.4%)	232 (64.4%)	
Commercial	24 (18.0%)	67 (18.6%)	
Other	22 (16.5%)	61 (16.9%)	

*t-test. **Chi-squared test.

($p < 0.05$). The Duckett technique and low surgeon volume were associated with a higher risk of postoperative complications ($p < 0.05$). The length of the urethral defect was a significant factor for the incidence of postoperative complications; the mean length of urethral defect in the postoperative complications group was 5.01 cm (range 3.4–10.1 cm), and 4.40 cm (range 3.4–8.8 cm) in the postoperative non-complications group ($p < 0.05$). In contrast, age at initial surgery, duration of stenting, insurance, preoperative testosterone, or dorsal plication were not associated with an increased risk of postoperative complications.

Multivariate analysis

In the multivariate analysis, preoperative meatal position, surgical technique, urethral defect length, and surgeon volume

TABLE 2 Multivariate analysis of clinical parameters

Variable	Adjusted OR	95% CI	p-value
Surgical technique	1.969	1.012–3.967	0.041
Length of urethral defect	2.158	2.147–4.356	0.001
Surgeon volume	2.32	1.502–3.584	0.001
Initial meatal location			0.032
Perineal	2.719	0.882–8.384	
Proximal shaft and penoscrotal	1.823	1.061–3.133	
Midshaft (referent)			

Abbreviations: CI, confidence interval; OR, odds ratio.

remained significantly associated with postoperative complications (Table 2). The best cutoff value for the length of urethral defect to distinguish postoperative complications from postoperative non-complications was 4.55 cm, which yielded a specificity of 85.1% and a sensitivity of 71.7%.

DISCUSSION

The goal of PH with severe chordee repair is functional and cosmetic normality, with low complication rates.⁴ Reducing the risk of postoperative complications can improve the quality of life of a patient.⁵ This study revealed that the initial meatal position, surgical technique, urethral defect length, and surgeon volume may be directly associated with the development of complications in children with PH with severe chordee.

Few studies have attempted to focus on the correlation between urethral defect length and postoperative complications, and the correlation between the both has been inconclusive.⁵ Huang et al. have reported that urethral length defects are not significantly associated with an increased risk of postoperative complications; the length of urethral defects in most patients is 2–3 cm.⁶ However, Sheng et al. identified that a longer urethral defect length was an independent risk factor for complications, with a mean urethral defect length of 4.11 ± 2.70 cm.⁷ Here, the mean urethral defect length was 4.56 ± 0.97 cm, and longer urethral defect length was associated with an increased risk of postoperative complications. A possible explanation is that reconstruction of a longer urethral length requires richer vascular supply and better tissue to repair, healing of tissues is relatively difficult, and higher requirements for surgical skills. Interestingly, a urethral defect length ≥ 4.55 cm was significant for the development of complications in our analysis. These data may be important for future analyses of PH with severe postoperative outcomes.

The existence of ventral curvature is an important feature of PH,⁸ the preoperative initial meatal location and existence of a severe chordee are important variables that influence not only the presence technique but also postoperative outcomes.⁹ Recurrent ventral curvature can occur after proximal TIP repair because of preservation of the urethral plate, and it is a devastating postoperative complication.³ Fortunately, the severe chordee was corrected by urethral plate transection and did not indicate recurrent ventral curvature in this study. Moreover, the degree of preoperative curvature did not significantly influence the development of complications. In this

study, most patients with PH with severe chordee achieved penile straightening through division of the urethral plate, and an additional dorsal plication procedure was performed in some patients with more severe chordee to correct the chordee thoroughly. We observed that a more proximal meatal location was an independent risk factor for postoperative complications, which is similar to the results reported by Bush et al.¹⁰ Our data revealed a positive correlation between the degree of curvature and the meatal location of hypospadias, and the length of urethral defect of a more proximal meatal location became significantly longer after thorough correction of the chordee compared to other meatal locations. In theory, the greater the length of the urethral defect, the more covering tissue is required. When a neourethra does not provide adequate local tissue coverage, the probability of postoperative complications increases significantly, especially in cases of urethral fistulas.

Repairing PH with severe chordee remains controversial; some surgeons prefer a one-stage repair, while others prefer a staged repair.¹¹ Compared with the staged repair, one-stage procedures may reduce the cost of medical treatment and the anxiety of patients and their families.¹² Although performing one-stage repair for hypospadias is desirable, high complication rates and poor functional outcomes were recorded in this study when this technique was used for patients with PH with severe chordee. Stanasel et al. believe that the staged technique for repair of PH with severe chordee offers superior functional results and cosmetic advantages.¹³ Moreover, the learning curve of the staged repair is relatively short, and serious complications are fewer than that of the one-stage repair.¹⁴ Therefore, the staged technique is preferred for repairing PH with severe chordee.

The relationship between surgical volume and complications is mainly focused on distal hypospadias, whereas research on PH is limited. Nguyen et al. have reported that surgeon volume and experience were not associated with the reoperation rates.¹⁵ However, Wilkinson et al. have reported that increased surgeon volume significantly decreased the need for reoperation rates.¹⁶ Similarly, this study identified a clear relationship between surgeon volume and complications after PH repair. In this population-based analysis of patients with PH with severe chordee, complications significantly declined with increasing surgeon experience in practice. PH has more complicated steps and requires a longer learning curve to master this technique than distal hypospadias.¹⁵ Hence, surgeon volume may reflect not only the practice volume but also the accumulated experience of hypospadias repair.

Data on the effects of testosterone supplementation before hypospadias repair were analyzed.¹⁷ In this study, testosterone was used for a small glans size or small-appearing penis based on the surgeon's experience, with the goal of improving surgical outcomes. Interestingly, our results indicated that preoperative testosterone use was not associated with any complications. This may be related to patient selection bias; testosterone is often used in patients who are perceived to be at risk for technically demanding hypospadias repair.¹⁷

Some studies have reported a higher number of complications after hypospadias repair with increased age.^{5,18} Bhat

et al. concluded that the complication rate after primary TIP repair was 2.5 times higher in adults than in pediatric patients.¹⁸ Moreover, they have reported that erection occurred more frequently in adults than in children, resulting in bleeding, dehiscence, and increased complications.¹⁸ However, Ru et al. have reported that age was not associated with the incidence of complications after primary repair in children.¹⁹ Our results revealed that age was not a risk factor for PH in patients with severe chordee repair. In this study, erection factors may have played a limited role because most children were young. This implied that age at initial surgery was not a risk factor for urethroplasty complications in prepubertal urethroplasty repair.

No consensus has been established on the duration of stenting after PH with severe chordee repair. The stenting was used to promote healing and prevent postoperative complications.²⁰ Here, the duration of stenting use for PH with severe chordee repair did not significantly affect the rates of complications.

To the best of our knowledge, this is the largest cohort study to analyze the potential risk factors associated with developing complications in children with PH and severe chordee. However, this study had some limitations. First, this was a single-center study. Second, data on glans size and penile length were not collected for analysis. Third, the study population had a longer follow-up period.

Preoperative proximal meatal location, one-stage repair (Duckett urethroplasty), longer urethral defect length, and low surgeon volume were identified as the risk factors for postoperative complications in children with proximal hypospadias with severe chordee following urethral plate transection. Meanwhile, performing staged techniques during repair decreases the risk of complications. A urethral defect length of ≥ 4.55 cm was the best cutoff value for predicting postoperative complications. For patients with PH and severe chordee, surgeons should assess their outcomes against such benchmarks when providing services.

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AUTHOR CONTRIBUTIONS

Guanglun Zhou: Data curation; formal analysis; investigation; methodology; writing – original draft; writing – review and editing. **Ruifeng Wang:** Data curation; formal analysis; investigation; methodology; writing – original draft. **Wenbin Zhu:** Conceptualization; data curation; software; supervision. **Jianchun Yin:** Conceptualization; project administration; resources; supervision; validation. **Zhilin Yang:** Conceptualization; formal analysis; methodology; software. **Shoulin Li:** Conceptualization; funding acquisition; project administration; resources; software; supervision; writing – review and editing.

CONFLICT OF INTEREST

None declared.

APPROVAL OF THE RESEARCH PROTOCOL BY AN INSTITUTIONAL REVIEWER BOARD

Shenzhen Children's Hospital ethics committee (2021033).

INFORMED CONSENT

Written informed consent was obtained from the guardians or parents before treatment.

REGISTRY AND THE REGISTRATION NO. OF THE STUDY/TRIAL

N/A.

ANIMAL STUDIES

N/A.

REFERENCES

- Acimi S. Release of severe chordee and urethroplasty in proximal hypospadias repair. *World J Urol.* 2021;**39**(6):2247–8.
- Long CJ, Chu DI, Tenney RW, Morris AR, Weiss DA, Shukla AR, et al. Intermediate-term Followup of proximal hypospadias repair reveals high complication rate. *J Urol.* 2017;**197**(3 Part 2):852–8.
- Snodgrass W, Bush N. Recurrent ventral curvature after proximal TIP hypospadias repair. *J Pediatr Urol.* 2021;**17**(2):222.e1–5.
- Horst VD, Wall D. Hypospadias, all there is to know. *Eur J Pediatr.* 2017;**176**(4):435–41.
- Duarsa G, Tirtayasa P, Daryanto B, Nurhadi P, Renaldo J, Utomo T, et al. Risk factors for urethrocutaneous fistula following hypospadias repair surgery in Indonesia. *J Pediatr Urol.* 2020;**16**(3):317.e1–6.
- Huang LQ, Ge Z, Tian J, Ma G, Lu RG, Deng YJ, et al. Retrospective analysis of individual risk factors for urethrocutaneous fistula after onlay hypospadias repair in pediatric patients. *Ital J Pediatr.* 2015;**24**(41):35.
- Sheng X, Xu D, Wu Y, Yu YJ, Chen JH, Qi J. The risk factors of Urethrocutaneous fistula after hypospadias surgery in the youth population. *BMC Urol.* 2018;**18**(1):64.
- Sennert M, Wirmer J, Hadidi AT. Preoperative glans & penile dimensions in different hypospadias grades. *J Pediatr Urol.* 2022;**18**(1):47–53.
- Dokter EM, Mouës CM, Rooij IALM, Biezen JJ. Complications after hypospadias correction: prognostic factors and impact on final clinical outcome. *Eur J Pediatr Surg.* 2018;**28**(2):200–6.
- Bush NC, Holzer M, Zhang S, Snodgrass W. Age does not impact risk for urethroplasty complications after tubularized incised plate repair of hypospadias in prepubertal boys. *J Pediatr Urol.* 2013;**9**(3):252–6.
- Babu R, Chandrasekhar VVS. Meta-analysis comparing the outcomes of single stage (foreskin pedicled tube) versus two stage (foreskin free graft & foreskin pedicled flap) repair for proximal hypospadias in the last decade. *J Pediatr Urol.* 2021;**17**(5):681–9.
- Lyu YQ, Yu L, Xie H, Huang Y, Li X, Sun L, et al. Comparison of short-term complications between Onlay and Duckett urethroplasty and the analysis of risk factors. *Int Urol Nephrol.* 2019;**51**(5):783–8.
- Stanasel I, Le H-K, Bilgutay A, Roth DR, Gonzales ET Jr, Janzen N, et al. Complications following staged hypospadias repair using transposed preputial skin flaps. *J Urol.* 2015;**194**:512–26.
- Chen C, Yang TQ, Chen JB, Sun N, Zhang WP. The effect of staged transverse Preputial Island flap urethroplasty for proximal hypospadias with severe chordee. *J Urol.* 2016;**196**(5):1536–40.
- Nguyen S, Durbin-Johnson B, Kurzrock EA. Reoperation after hypospadias repair: long-term analysis. *J Urol.* 2021;**205**(6):1778–84.
- Wilkinson DJ, Green PA, Beglinger S, Myers J, Hudson R, Edgar D, et al. Hypospadias surgery in England: higher volume centres have lower complication rates. *J Pediatr Urol.* 2017;**13**(5):481.e1–6.
- Chua ME, Gnech M, Ming JM, Silangcruz JM, Sanger S, Lopes RI, et al. Preoperative hormonal stimulation effect on hypospadias repair complications: meta-analysis of observational versus randomized controlled studies. *J Pediatr Urol.* 2017;**13**(5):470–80.
- Bhat A, Bhat M, Kumar V, Kumar R, Mittal R, Saksena G. Comparison of variables affecting the surgical outcomes of tubularized incised plate urethroplasty in adult and pediatric hypospadias. *J Pediatr Urol.* 2016;**2**(2):108.e1–7.
- Ru W, Tang D, Wu D, Tao C, Chen G, Wei J, et al. Identification of risk factors associated with numerous reoperations following primary hypospadias repair. *J Pediatr Urol.* 2021;**17**(1):61.e1–5.
- Ritch CR, Murphy AM, Woldu SL, Reiley EA, Hensle TW. Overnight urethral stenting after tubularized incised plate urethroplasty for distal hypospadias. *Pediatr Surg Int.* 2010;**26**(6):639–42.