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Comparison of short-term complications between Onlay and Duckett urethroplasty and the analysis of risk factors

Yiqing Lyu[1] · Ling Yu[1] · Hua Xie[1] · Yichen Huang[1] · Xiaoxi Li[1] · Li Sun[1] · Jiewen Bao[1] · Yan Liang[1] · Xiaocheng Zhou[2] · Fang Chen[1]

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Abstract

Aims To compare the short-term complications between Onlay and Duckett urethroplasty and to analyze the various risk factors cause the complications.

Methods The children with hypospadias who underwent treatment with Onlay or Duckett urethroplasty from November 2014 to June 2016 were followed up. The difference in complications between the two groups was analyzed. Moreover, a single-factor ANOVA was performed to analyze the length and curvature of the penis and the length of the urethral defect.

Results 40 patients were treated by Duckett, while 54 by Onlay. In comparison to the Onlay group, the Duckett group showed the initial penile length was shorter ($P=0.044$), the initial urethral defect ($P=0.024$) and after the correction of chordee was longer ($P<0.001$), and the initial penile curvature ($P<0.001$) and after degloving ($P<0.001$) was greater. Furthermore, the incidence of urethra percutaneous fistula ($P=0.041$) and urethral stenosis ($P<0.001$) in Duckett group was significantly higher. The analysis of risk factors showed that the age at the time of surgery, the initial penile curvature, the initial urethral defect, and the urethral defect after the correction of chordee were not correlated with the complications. The degree of penile curvature after skin degloving and urethra stenosis was significantly correlated ($P=0.019$).

Conclusion The incidence of complications of urethra percutaneous fistula and urethral stenosis after 1 year of Duckett was higher than that by Onlay approach. The greater the curvature of the penis after skin degloving, the more likely the occurrence of urethral stenosis after surgery.

Keywords Hypospadias · Complications · Risk factors · Pediatric urology

Introduction

The repair of hypospadias is a major concern for urologists. Due to the diversity, as well as the different factors affecting surgery, such as the variety of penile development, the degree of curvature, and the local skin conditions, the same approach cannot be used to treat all cases of hypospadias. In 1980, Professor Duckett first proposed a surgical procedure for shaping the urethra with a transverse pedicled island flap after the transection of the urethral plate to correct the ventral chordee of the penis [1]. This method was a major achievement in the field of surgery of hypospadias. Duckett also proposed a method of preserving the urethral plate and forming the urethra by covering the pedicled island flap on the urethral plate, known as "Onlay" urethroplasty [2]. With the gradual deepening of the understanding about the anatomical structure of the hypospadias, several urologists have realized that the proximal type of hypospadias can correct the penile curvature by other methods without transversing the urethral plate, thereby preserving the urethral plate as a basis for urethral reconstruction [3, 4]. Therefore, the Onlay urethroplasty is widely used. The present study aims to compare the short-term complications between Duckett and Onlay urethroplasty and to conduct a preliminary analysis of the potential risk factors that cause the complications.

Yiqing Lyu and Lin Yu have contributed equally to this work.

✉ Fang Chen
doctorchenfang@126.com

[1] Department of Urology, Shanghai Children's Hospital, Shanghai Jiao Tong University, Shanghai 200040, China

[2] Department of Bioinformatics and Biostatistics, Center for Biomedical informatics, Shanghai Jiaotong University, Shanghai Children's Hospital, Shanghai, China

Fig. 1 Measurement of the initial length of the penis and the length of the urethral defect

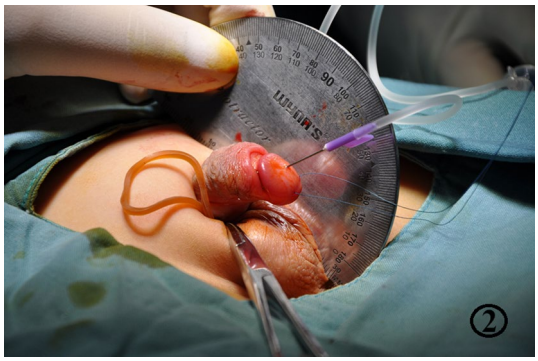

Fig. 2 Measurement of the initial ventral chordee of the penis

Materials and methods

General materials

A retrospective analysis of patients treated by Duckett or Onlay urethroplasty for hypospadias in Children's Hospital of Shanghai from November 2014 to June 2016 was carried out. All patients underwent chromosomal, urological, and cardiac ultrasound examinations before the operation to eliminate various lesions including disorder of sexual development (DSD) and other syndromes. Staged repair or 're-do' repair cases were also excluded from our study. Ethical approval was given by the medical ethics committee of Shanghai Children's Hospital.

Surgical approach

Common procedure

All patients were administered general and sacral anesthesia with tracheal intubation and placed in a supine position with slightly elevated buttocks. After disinfection, the penis head was pulled with a 5–0 Prolene line; the initial penis length and urethral defect distance were measured and recorded (Fig. 1); and the penile curvature was measured after artificial erection (Fig. 2). Subsequently, the penile skin was removed from the coronal sulcus to the root of the penis, and the Dartos fascia attached to the body of the penis was also completely degloved. After degloving, the dysplasia and bifurcation of the cavernous urethral body on both sides of the urethral plate and Buck's fascia beneath it were separated for later use. Then, the penis curvature was measured (Fig. 3), and the Duckett or Onlay procedure was selected by the surgeon.

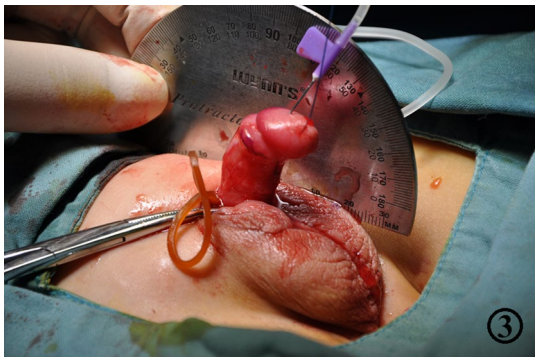

Fig. 3 Measurement of the ventral chordee of the penis after skin degloving

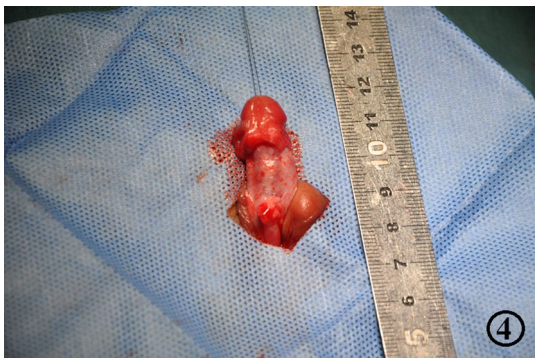

Fig. 4 Measurement of the length of the urethral defect after complete correction of the chordee

Duckett urethroplasty

The urethral plate was transverse sectioned at the point with a severe chordee, and the urethral plate and the fibrous tissues were "finely" dissected from the proximal to the distal end of the shaft until the penis was completely straightened. The penis length and the urethral defect distance were measured again after the chordee was corrected

(Fig. 4). According to the length of the urethral defect, the pedicled flap with 1.5 cm width was taken from the dorsal side of the penis. The flap was sutured with the proximal urethral meatus and urethral plate tissue. Then, the flap was coiled around an 8-Fr feed-tube, and the urethra was rebuilt to the tip of the glan. Subsequently, we mobilized the previously separated distal urethral sponge together with Buck's fascia till the distal end of the "glan wing," and these were sutured together to the ventral midline to reconstruct the glan. The pedicle flap and the remaining of the Dartos fascia were used to cover the new urethra, followed by trimming of the foreskin and suturing for penile reconstruction.

Onlay urethroplasty

In this present study, we preferred dorsal placation to straight the penis if the chordee was present even after degloving, and the distance between the length of the penis and the defect of the urethra was measured again. A minimum of 5 mm width of the urethral plate was preserved from the urethral meatus to the tip of the glan. The pedicled flap with 1.0 cm width was taken according to the length of the urethral defect. Then the flap was transferred to the ventral side of the penis followed by suturing with the urethral plate. The remaining reconstruction of the glan and penis was performed similarly to that of Duckett urethroplasty.

Postoperative treatment and follow-up

After urethroplasty, catheterization was retained for 10–14 days. The patients were followed up at 3 months, 6 months, and 1 year postoperatively, or if symptoms such as dysuria, drip, and prolonged voiding time(> 1 min) were observed that required immediate hospitalization. After 1-year post-surgery as the termination point of observation, the postoperative complications, and treatment methods of the two groups were analyzed and compared using the Chi-square test. Kaplan–Meier curve of estimated complication-free survival and fistula-free survival between two groups was also drawn. A single-factor ANOVA was conducted to analyze the relationship between penile length, penile curvature, urethral defect length, and other complications in all patients. The statistical values for the above analyses were significant at $P < 0.05$.

Table 2 Comparison of postoperative complications between the two groups ($P < 0.05$ was significant)

	Urethra percutaneous fistula (case)	Urethral stenosis (case)	Urethral diverticulum (case)
Duckett	14 (35%)	4 (10%)	1 (2.5%)
Onlay	9 (16.7%)	0 (0%)	1 (1.9%)
P	0.041	0.003	0.375

Results

A total of 40 patients, (mean age of 2.18 ± 1.15 years) were treated by Duckett urethroplasty, while 54 patients (mean age of 2.40 ± 1.70 years) were treated by Onlay urethroplasty. Any significant difference was not observed between the two groups with respect to the age at the time of surgery.

In the Duckett and Onlay groups, the number of proximal hypospadias was 35 versus 43, and distal hypospadias was 5 versus 11. The initial length of the penis was 3.94 ± 0.71 cm versus 4.25 ± 0.79 cm, while after the thorough correction of chordee, the penile length was 4.67 ± 0.71 cm versus 4.64 ± 0.71 cm, respectively. The initial urethral defect was 2.28 ± 0.61 cm versus 2.01 ± 0.52 cm, and after the thorough correction of the chordee, the urethral defect was 3.69 ± 0.87 cm versus 2.41 ± 0.71 cm, respectively. The initial penile curvature was 46.13 ± 16.67° versus 30.37 ± 18.53°, and after degloving, the curvature was 30.77 ± 9.97° versus 4.57 ± 8.15°, respectively. The comparison of the two groups demonstrated that in the Duckett group, the initial penis length was shorter ($P = 0.044$); the initial urethral defect ($P = 0.024$); the urethral defect ($P < 0.001$) after the correction of chordee was much longer; the initial penile curvature ($P < 0.001$); and the penile curvature ($P < 0.001$) after degloving was greater (Table 1) than that in the Onlay group.

The present study showed that in the Duckett and Only groups, 14 (35%) and 9 (16.7%) had urethra percutaneous fistula, 1 (2.5%) and 1 (1.9%) had urethral diverticulum, 4

Table 1 Comparison of intraoperative measurement data between the two groups ($P < 0.05$ was significant)

	Initial penis length (cm)	Initial urethral defect (cm)	Penis length after complete correction of chordee (cm)	Urethral defect after complete correction of chordee (cm)	Initial penile curvature	Penile curvature after degloving
Duckett	3.94 ± 0.71	2.28 ± 0.61	4.67 ± 0.71	3.69 ± 0.87	46.13 ± 16.67	30.77 ± 9.97
Onlay	4.25 ± 0.79	2.01 ± 0.52	4.64 ± 0.71	2.41 ± 0.71	30.37 ± 18.53	4.57 ± 8.15
P	0.044	0.024	0.875	< 0.001	< 0.001	< 0.001

(10%) and 0% had urethral stenosis, respectively. The incidence of urethra percutaneous fistula ($P=0.041$) and urethral stenosis ($P<0.001$) was significantly higher in the Duckett group than that in the Onlay group (Table 2). The Kaplan–Meier curve of estimated complication-free survival (Fig. 5) and fistula-free survival (Fig. 6) between two groups also showed the incidence of complications ($P=0.0093$) including fistula ($P=0.048$) was higher in Duckett group.

The analysis of risk factors for short-term postoperative complications showed that the age of surgery, the initial degree of curvature, and the initial urethral defect were not correlated with complications. The urethral defect was not found to be significantly correlated with urethra percutaneous fistula after thorough correction of chordee ($P=0.059$). On the other hand, the degree of penile curvature after degloving and urethra stenosis was significantly correlated ($P=0.019$).

Discussion

Since Duckett proposed the above two procedures, the use of pedicled island flaps derived from the inner foreskin to reconstruct the urethra has been greatly developed. Also, for proximal hypospadias with severe chordee, a one-stage repair can be performed with either of the procedures, which will undoubtedly reduce the cost of medical treatment as well as the anxiety and pain of the patients and their families as compared with the two-stage procedures. Furthermore, compared to the isolated grafts, the pedicled preputial inner plate has abundant blood supply and is less prone to severe complications, such as neourethra ischemic contracture and atresia [5].

During the establishment, both methods of operation were applied in different directions without crossover.

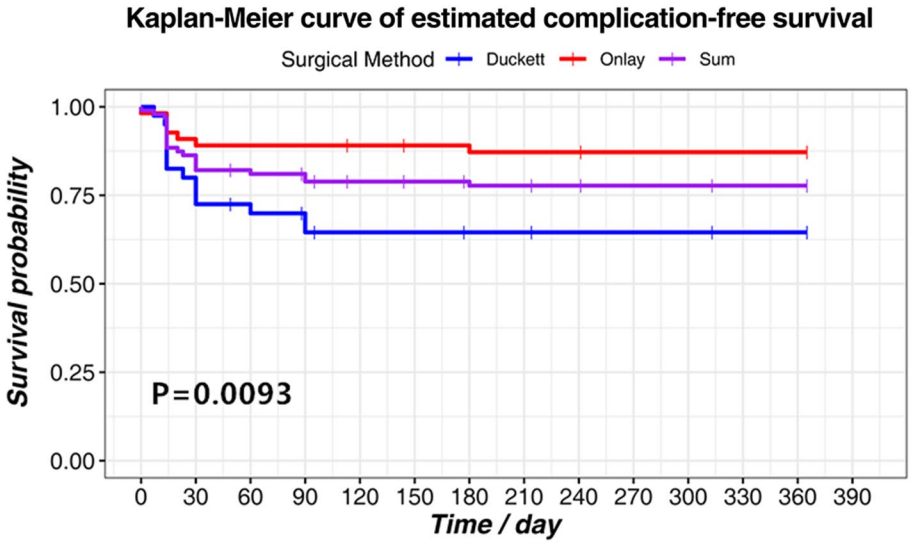

Fig. 5 Kaplan–Meier curve of estimated complication-free survival

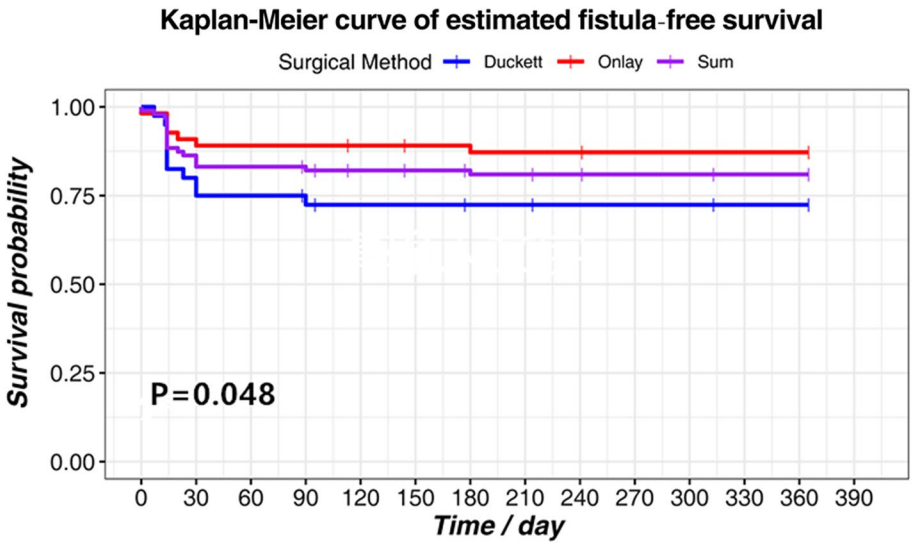

Fig. 6 Kaplan–Meier curve of estimated fistula-free survival

The Onlay approach was applied to the distal hypospadias without a severe penis curvature, while the Duckett approach was mainly used in the proximal cases. However, as mentioned above, with the continuous understanding of the causes of chordee and the increasing number of methods for correcting the curvature, the application of these two approaches is intersecting and expanding. However, in terms of doctor's preference and the characteristics of the penis of hypospadias, the Onlay approach is preferable in cases with less penile curvature, while the Duckett approach exhibits an opposite effect. The current study also showed that the cases undergoing the Duckett approach showed a relatively short initial penis length and severe penile chordee; however, the urethral defect is significantly longer after thorough correction of chordee.

After a prolonged period of accumulation and follow-up, it is speculated that the complications of Duckett urethroplasty are primarily concentrated in urethra percutaneous fistula and urethral stenosis. Reportedly, the complications of fistula can reach 66%, while the rate of stenosis is 44% [4, 6, 7], and the incidence of the urethral diverticulum is also higher than that of the other approaches [7, 8]. In order to reduce the incidence of stenosis, some surgeons deliberately only reconstruct the distal urethra or artificially form a fistula at the proximal of the shaft during the first-stage surgery to disconnect the urethra and prevent the urine from passing through the new urethra; thus, the distal new urethra can heal optimally [9]. The complications of the Onlay approach are mainly concentrated in the fistula, which ranges from 7 to 44% [6, 7, 10, 11], while the urethral stenosis and urethral diverticulum are rare. In this study, the incidence of fistula (35%) and urethral stenosis (10%) in the Duckett group was also significantly higher than that in the Onlay group (16.7% and 0%) as reported previously.

The key to short-term postoperative complications of both urethroplasty approaches was previously recognized based on the preservation of the urethral plate. Although various individual differences are detected in the quality and composition of the urethral plate, it can reliably provide support and blood supply for the new urethra, as a part of the initial urethral extension, which is critical for normal healing. Owing to the formation of the new urethra by the Duckett approach using a self-winding tube from a pedicle flap, the main blood supply is derived from the vascular pedicle; while in Onlay, a dual blood supply from the vascular pedicle and the urethral plate significantly lowers the probability of ischemia as well as necrosis of the flap. Thus, dual blood supply also reduces the probability of fistula and urethral stricture. The new urethral surface covering is also closely related to the occurrence of fistula. The covering can increase the thickness between the new urethra and the skin and enhance the impermeability. On the other hand, the healthy covering tissue benefits the new urethra by providing sufficient collateral circulation [12, 13]. Snodgrass et al. stated that Duckett surgery has inherent defects due to lack of support for new urethra and coverage of healthy tissue [14]. Although the current study did not show any significant correlation between the length of the urethral defect after chordee correction and fistula, the P value was close to statistically significant. Theoretically, the length of the urethral defect was approximately equivalent to the length of the new urethra requiring external coverage. The more defects there are, the more the outer covering tissue is needed. When the local tissue cannot provide the adequate coverage, the probability of fistula would increase significantly. In addition, the length of the urethra defect in the Duckett group is equivalent to the length of the urethra without the urethral plate support; thus, the longer the new urethra is, the higher the probability of fistula. With the subsequent replenishment of the number of cases, a distinct correlation between the incidence of fistula and the length of the urethra defect may be detected.

Besides the influence of blood supply, the occurrence of urethral stenosis is also related to penile anatomy, and the width of the flap was used to reconstruct the urethra. Nonetheless, the anastomosis between the new urethra and the original urethral meatus is prone to stenosis due to the intersection of different tissues. In addition, the glan and new meatus are also prone to stenosis as the new urethra is densely packed by the spongy tissue of the glan, which is under high pressure [13, 15]. Our correlation analysis showed that the penile curvature after skin degloving was associated with the occurrence of urethral stenosis. This phenomenon might be attributed to the correction of penile curvature, which requires the removal of the dysplasia corpus cavernosum urethrae, and the transverse section of urethral plate. The more tissue we dissected, the greater impact was caused on the blood supply of the urethral plate. Also, the possibility of new local urethral ischemia and stenosis increased. On the other hand, the large curvature of the penis prompts the application of the Duckett procedure. In the traditional Duckett procedure, because the new urethra is not supported by the urethral plate, the pressure is distinct and the probability of stenosis large. Thus, in the later stage we improved the Duckett surgery by preserving the urethral plate of the glan section, and thus, prevented postoperative stenosis [16]. Nevertheless, this study only addressed the short-term complications that occur within 1 year after hypospadias repair. The long-term complications such as recurrence of penile chordee, erectile pain, and difficulty in sexual intercourse have not been analyzed statistically due to insufficient follow-up duration. The urodynamic characteristics such as maximal urinary flow rate were also not collected for the reason of detrusor–sphincter discoordination in patients younger than 3 years old. The retrospective nature of this study rendered bias in the selection of the patients'

surgical procedures. The above limitations allowed the conclusions to be applicable only to short-term postoperative hypospadias assessment. Thus, further precise conclusions need to be summarized after a continued collection of the cases and extend follow-up.

In this study, we speculated that similar to the surgical method of the pedicled island flap in the foreskin, the Onlay urethroplasty is less likely to present urethra percutaneous fistula and urethral stenosis 1 year after surgery than the Duckett urethroplasty. Moreover, the greater the degree of penile curvature after skin degloving, more urethral stenosis will occur postoperatively.

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Author contributions YL, LY, and FC carried out the studies, participated in collecting data, and drafted the manuscript. HX, YH, XL, LS, and XZ performed the statistical analysis and participated in its design. JB and YL helped to draft the manuscript. All authors read and approved the final manuscript.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interests.

Ethical approval Ethical approval was given by the medical ethics committee of Shanghai Children's Hospital.

Informed consent All the patients and their families were informed of the study purpose of the experiment, and signed the informed consent form.

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