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Comparative study of modified Koyanagi and staged Duckett for proximal hypospadias

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Abstract

Aim To compare and analyze the clinical efficacy of modified Koyanagi and staged Duckett for proximal hypospadias.

Method The clinical and prognostic data of children were treated and underwent surgery (modified Koyanagi or stage Duckett) in the Department of Urology, Kunming Children's Hospital from January 2020 to January 2023 were retrospectively analyzed. According to different surgical methods, the subjects were divided into the modified Koyanagi group and the staged Duckett group. Patients in both groups were followed up for more than 6 months after surgery. The success rate and complications of postoperative surgery in both groups were analyzed.

Result A total of 63 patients were included in this study, 34 in the modified Koyanagi group and 29 in the staged Duckett group. A total of 14 patients in the modified Koyanagi group experienced postoperative complications, the success rate of the surgery was 58.82%, and 5 among them experienced more than two kinds of complications. A total of 5 children in the staging Duckett group experienced postoperative complications, and the success rate of the operation was 82.75%. There were significant differences in the incidence of overall complications and fistula between the two surgical methods ($P=0.028$).

Conclusion Compare with modified Koyanagi, staged Duckett can significantly reduce the incidence of overall complications and urethral fistula in patients, and have obvious advantages in the treatment of proximal hypospadias.

Keywords Hypospadias, Modified Koyanagi, Staged Duckett, Surgery, Complication

Introduction

Hypospadias is one of the most common congenital malformations of the male urinary system, with an incidence of about 1/250-1/300. The main clinical manifestations of hypospadias are ectopic ventral urethral opening, ventral curvature (VC), and ventral prepuce absent [1]. Proximal hypospadias refers to the bifurcation point of the cavernous urethra or the starting point of the reconstructed urethra at or below the junction of the penile scrotum after degloving the penile. Up to now, there are more than 300 methods of surgery for hypospadias and an overall surgical success rate of about 50-80%. Proximal type of hypospadias is a risk factor affecting the success rate of surgery [2, 3].

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In the 1980s, a series of surgical reports by Duckett set a milestone for the one-stage repair of the proximal hypospadias. However, with the widespread development of one-stage surgery and the emergence of long-term follow-up results, the early and long-term adverse prognosis and influence of one-stage repair on children and their families have led clinicians to re-examine the limitations of one-stage repair and the feasibility of staged repair [4, 5]. This study analyzed the efficacy of modified Koyanagi and staged Ducket for proximal hypospadias, and further explored the advantages and disadvantages of one-stage and staged surgery of proximal hypospadias.

General information and methodology

General information

The clinical and prognostic data of patients with hypospadias admitted to the Department of Urology, Kunming Children's Hospital from January 2020 to January 2023 were retrospectively analyzed. The subjects were divided into the modified Koyanagi group and staged Duckett group according to the surgical method. All children were closely follow-up for at least 9 months after the surgery.

Inclusion and exclusion criteria

Inclusion criteria: ①Patients were diagnosed with proximal hypospadias. ② The Chromosome karyotype results of the patient were 46, XY. ③ The patients' blood clotting function were normal. ④ The patient had no serious malformations of other systems. ⑤ All treatment and follow-up of patients with hypospadias were completed in our hospital.

Exclusion criteria: ① The patients had severe malformations of other systems. ② The patient who were diagnosed with disorders of sex development. ③Patients who were transferred to hospitals or lost to follow-up.

Surgical method

Surgical method selection: The choice of surgical method was determined by the chief surgeon. Group Koyanagi: Patients' skin material were sufficient for one-stage urethral reconstruction, the procedures were performed as planned. In cases whose the urethral material were insufficient, staged Duckett were be implemented.

① Modified Koyanagi: A tractive line was sewn at the glans penis and an F6-F8 silicone catheter was placed. A circular incision was made 0.5 cm below the coronal groove (Fig. 1A). The penile was degloved to the root of the penis and the dysplastic urethral plate (UP) and fibrous band were severed to complete correction VC. If the VC cannot be completely corrected, the dorsal placation is performed. The dorsal prepuce was dissected from the middle and transferred to the ventral side (Fig. 1B), and the UP was reconstructed from the proximal to the distal suture (Fig. 1C). A U-shaped incision was made along both sides of the middle suture of the UP, and the flaps were sutured together with a continuous knock suture with 6−0 monocryl (Fig. 1D). The tunica vaginalis or scrotal dartos was dissociated to cover the new urethra (Fig. 1E). After scrotoplasty and phalloplasty, the penis was dressed (Fig. 1F).

② Staged Duckett: A tractive line was sewn at the glans penis and an F6-10 silicone catheter was placed. The penile swas degloved (Fig. 2A) and VC was completely corrected (Fig. 2B). According to the length of the urethral defect and the size of the glans, a suitable transverse preputial island flap was dissociated from the dorsal prepuce (Fig. 2C). The flap was wrapped around the F6 ~ F8 silicone catheter, sutured with 6−0 monocryl, and transferred to the ventral side of the penis. A tunnel was broken through at the head of the glans. The posterior wall of the proximal end of the urethra tube was anastomosed with the UP, and the distal end of the tube was fixed to the glans through the tunnel (Fig. 2D). The urethra tube was covered with the flap pedicle (Fig. 2E. After scrotoplasty and phalloplasty, the penis was dressed (Fig. 2F). The closure of the artificial fistula was completed after 6–12 months.

Postoperative care

All patients received continuous pain management and antibiotic therapy for five days postoperatively. Oral antibiotic treatment was initiated from the Postoperative day 6 and continued until the catheter was removed. If Incision infection occurred, the duration of antibiotic use was extended. Dressing was performed on the third day after surgery, wound packing was removed on the seventh day, and a urinary catheter was withdrawn 3 weeks after surgery.

Observation index

Perioperative and postoperative overall complications were observed, including incision infection, incision dehiscence, urethral fistula, urethral stricture, urethral diverticulum, and residual hypospadias.

Statistical analysis

SPSS 22.0 was used to complete the data analysis. Continuous variables were represented by mean ± standard. Chi-square tests or continuous correction chi-square test was used for comparisons between groups of categorical variables. Differences between continuous variables were assessed using the Mann - Whitney test. $P < 0.05$ indicated that the difference was statistically significant.

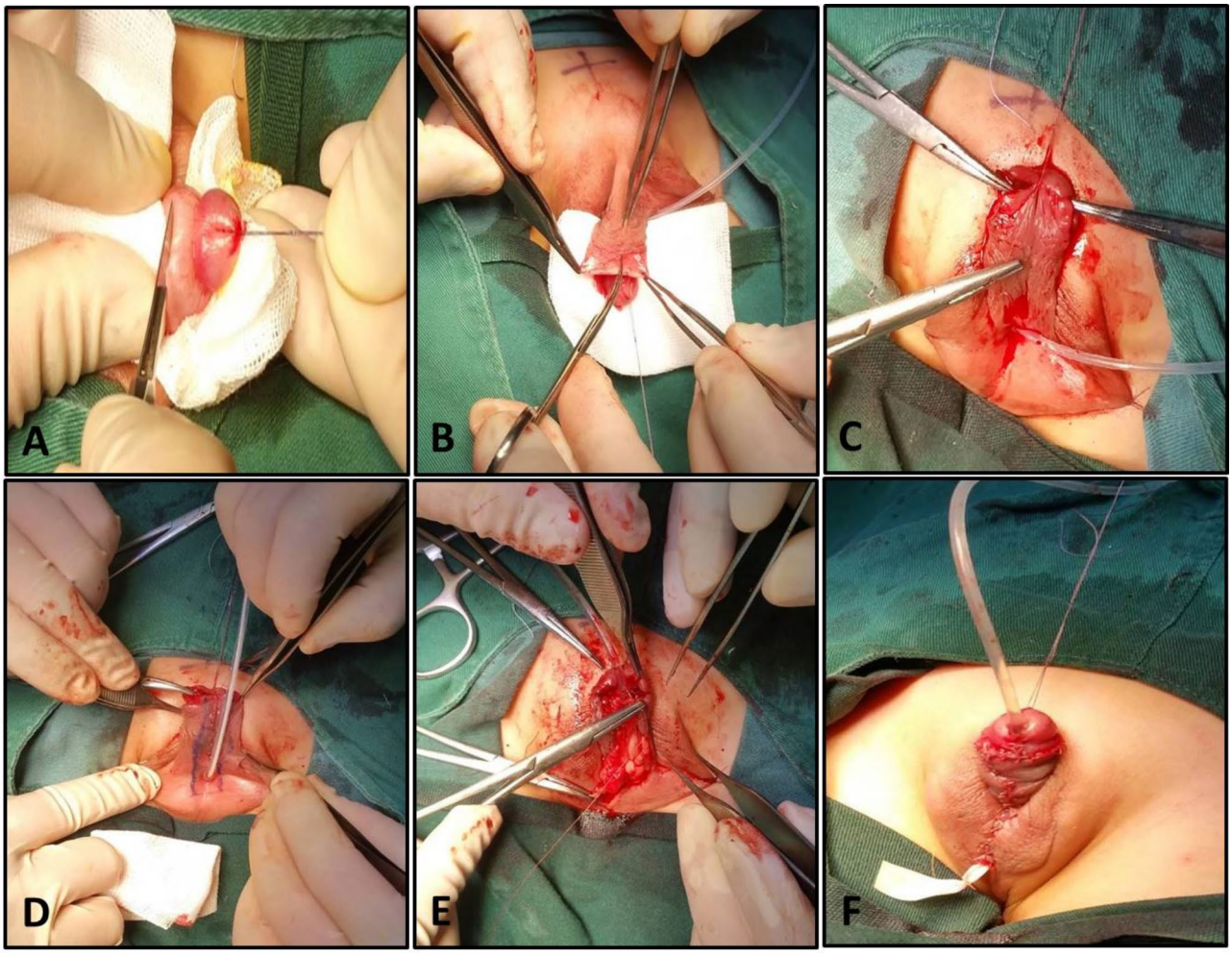

Fig. 1 **A**. A circular incision was made 0.3–0.5 cm below the coronal groove. **B**. The dorsal prepuce was dissected from the middle. **C**. the UP was reconstructed from the proximal to the distal suture. **D**. A U-shaped incision was made along both sides of the middle suture of the UP to create the new urethal tube. **E**. A tunica vaginalis or scrotal dartoswas dissociated to cover the new urethra. **F**. Postoperative appearance

Results

A total of 63 children were included in this study, including 34 in the modified Koyanagi group and 29 in the staged Duckett group. The age of patients was 16–58 months. There were no significant differences between the two groups in age, Preoperative testosterone external used, length of urethral defect, penoscrotal transposition, dorsal placation to correct VC and intraoperative indentation catheter diameter. The general information of the two groups of children is shown in Table 1.

A total of 14 patients in the modified Koyanagi group developed postoperative complications, with a success rate of 58.82%, including 7 cases of urethral fistula, 5 cases of urethral stenosis, 3 cases of urethral diverticulum, 2 cases of residual hypospadias, and 3 cases of incision infection. 7 patients suffered two or more complications. Complications occurred in 5 patients in the staged Duckett group, with a success rate of 82.76%, and no children suffered two or more complications. During the follow-up period, there was no recurrence of VC between the two groups, and there were significant differences in the overall complications (P=0.039) and urethral fistula (P=0.042). The result of postoperative complications is shown in Table 2.

Discussion

The objective of hypospadias surgery is complete correction of VC, penis with a terminal meatus can forward void, and ejaculate, and the cosmetic result is satisfying [6]. That means that the treatment of hypospadias is not only the reconstruction of the urethra but also the reconstruction of the male sexual organs [7, 8]. Although there are many surgical methods for hypospadias, no one method is perfect for all patients [9]. Proximal hypospadias is often associated with severe VC, which requires UP transection and dorsal placation to be completely corrected. As a result, the length of the urethral defect is always long, and the operation is complicated

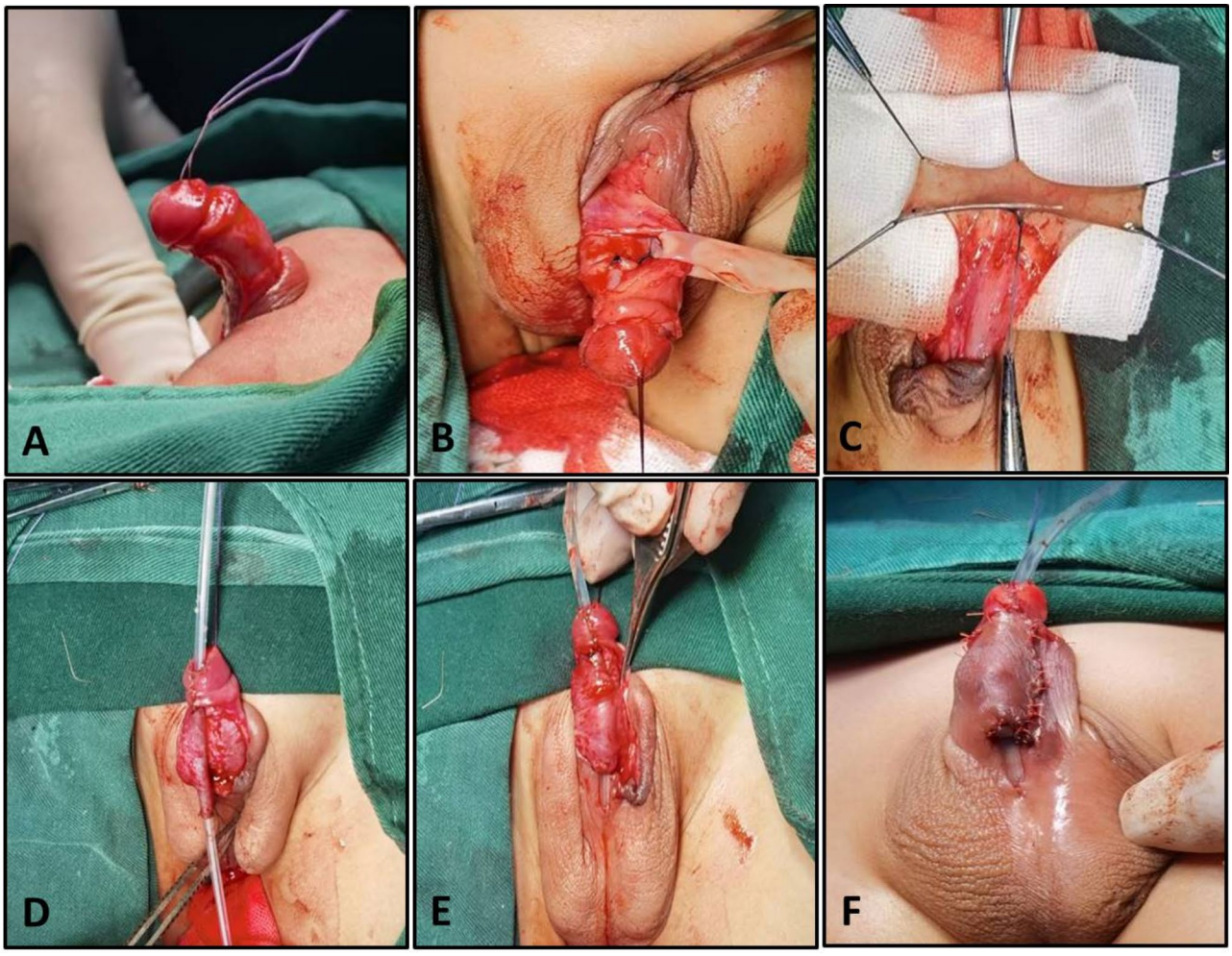

Fig. 2 **A**. There was still severe ventral curvature after penile skin was degloved to the root of the penis. **B**. Dorsal midline plication was performed to complete correction ventral curvature. **C**. A transverse preputial island flap was dissociated. **D**. The posterior wall of the proximal end of the urethra tube was anastomosed with the UP, and the distal end of the tube was fixed to the glans through the tunnel. **E**. The urethra tube was covered with the flap pedicle. **F**. Postoperative appearance of first-staged

Table 1 The general information of the two groups of children

		Modified Koyanagi	Staged Duckett	X^2	*P*
Age (Month)	/	24.52 ± 5.96	25.35 ± 8.98	/	0.825
BMI (Kg/cm^2)	/	20.48 ± 1.21	20.51 ± 1.34	/	0.972
Urethral defect length	/	5.32 ± 0.41	5.38 ± 0.38	/	0.402
PTEU	Yes	7	3	1.267	0.445
	No	27	26		
Dorsal placation	Yes	30	27	0.051	0.822
	No	4	2		
Penoscrotal transposition	Yes	24	24	1.278	0.258
	No	10	5		
Catheter diameter	F6	20	19	0.297	0.586
	F8	14	10		

Abbreviation: BMI: Body mass index, PTEU: Preoperative testosterone external used

Table 2 The result of postoperative complications

		Modified Koyanagi	Staged Ducket	X^2	*P*
Overall complications	Yes	14	5	4.257	0.039
	No	20	24		
Fistula	Yes	7	0	4.794	0.029
	No	27	29		
Stricture	Yes	1	0	0.000	1.000
	No	33	29		
Dverticulum	Yes	3	0	1.093	0.296
	No	31	29		
Residual hypospadias	Yes	2	0	0.368	0.544
	No	32	29		
Incision infection	Yes	3	0	1.093	0.296
	No	31	29		

[10]. Therefore, the treatment for proximal hypospadias has been controversial, and there are different views on staged surgery [11, 12] .

At present, the mainstream surgical methods for the primary repair of proximal hypospadias include Duckett and modified Koyanagi [13, 14]. Duckett is a preferred procedure for the initial treatment of moderate and proximal hypospadias with severe VC, because the foreskin has the advantages of good ductility and blood supply, good vasculature of the foreskin, and strong resistance to urine irritation. However, due to the insufficient width of the glans penis and blood supply caused by the excessive length of the tube, and the distortion of the urinary tube caused by unstable fixation, the success rate of Duckett was only about 62.8% [15, 16]. Wang et al. [17]. conducted a long-term follow-up of 320 children with Duckett surgery for 15 years, and the postoperative complications reached 39.1%. Even though the surgery was performed by experienced specialists, there were still high surgical complications. Modified Koyanagi firstly rebuilt the new UP with the foreskin, made a U-shaped flap on the original residual UP and the new UP, and then separated the vascularized fascial pedicle on both sides, which not only reduced the dissociation difficulty of the pedicle flap free but also narrowed the dissociation range of the flap. It helps to protect the blood supply of the pedicle flap and the residual foreskin. At the same time, a testicular sheath or scrotum to cover the new urethra tube can significantly reduce the incidence of postoperative complications compared with Koyanagi [18]. However, with the widespread application of this operation, the incidence of postoperative complications is still as high as 50-60%, mainly urinary fistula and urethral diverticulum [19, 20]. Although proximal hypospadias can be repaired in one stage, due to the severe VC, long urethral defect, penile dysplasia, poor development, lack of local repair materials, and severe penoscrotal translocation of proximal hypospadias, it is difficult to reduce the incidence of complications and achieve satisfactory cosmetic results. Especially when urethral stricture occurs in patients, multiple urethral dilation and indentation catheters are often required. Some children need to open the narrow segment, remove the scar inflammatory tissue, and perform one-stage urethroplasty or staged fistula repair. After multiple operations and long cycle repair, the cosmetic result is dissatisfactory due to local scar contracture, which brings intense economic and psychological burdens to the children and their families [13, 21, 22].

Staged hypospadias repair was the standard practice for proximal hypospadias in the 1960s and 1970s [23]. According to a worldwide survey from Springer [24], the two-stage repair is preferred by 43.3–76.6% of 68 countries' participants in the repair of proximal hypospadias.

Common stage methods include ①Byars: A Byars' flap was created and transferred to the ventral aspect of the penis to create a new UP [21]. ②Bracka: A free skin flap, which was designed on the inner layer of the preputial hood, and the size was decided by the length of the urethra defect and the width of the glans [21, 25]. ③Staged Duckett: A urethral tube was formed by a transverse preputial island flap that was dissociated from the dorsal prepuce and the inner and outer plates. The proximal end of the urethral tube was anastomosed with a UP, and the ventral side of the opening was sutured to the skin around the scrotum to form a fistula. The closure of the fistula was completed in the two-stage surgery [26].

In this study, there was no statistically significant difference in age and severity of disease between the two groups. Therefore, comparing the incidence of postoperative complications between the two surgical methods is helpful to reflect the advantages and disadvantages of the two surgical methods. According to the results, staged Duckett can significantly reduce the incidence of overall complications and urethral fistula in patients, and have obvious advantages in the treatment of proximal hypospadias: ①Postoperative urethral secretions can be drained through two openings, avoiding the retention of secretions in the newly formed urethra and reducing the chance of incision infection. ② Urine extraction from the fistula can reduce the irritation of urine on the newly formed urethra, which makes the proximal newly formed urethra heal better, and reduce the occurrence of urinary fistula. ③ The proximal urethral reconstruction was completed in the first-stage of surgery, which significantly reduced the scope and difficulty of the second-stage of surgery. It has not only achieved good function but also a satisfactory cosmetic result.

Conclusion

Indications for staging surgical repair of proximal hypospadias: ①Severe choreede>45°by fibrotic UP which requires severing the UP to achieve adequate flexure correction and cause long urethral defect;②Local skin material is insufficient for urethroplasty; ③Penile dysplasia and small penis head make it difficult to achieve entopic meatus in one stage operation. ④The dorsal prepuce is insufficient or its shape and blood supply are not suitable for the reconstruction of the urethra with a pedicled flap. ⑤It is difficult to obtain an acceptable cosmetic result after a reluctant surgery. ⑥The surgeon has little experience in the surgical correction of hypospadias.

The limitations of this study include: (1) This study is a retrospective analysis, and the control for potential confounding variables such as patient age, underlying diseases, body weight, nutritional status, and the surgeon performing the surgery inevitably leads to selection bias, which may affect the research results. (2) The number

of patients included in the study was limited, and the follow-up period was relatively short. The sample size of 63 patients was relatively small, which certainly limits the general applicability of the results and may lead to insufficient statistical evidence to detect differences between two surgical methods. (3) The surgery was performed by different surgeons, although all these doctors have qualifications for surgery, they still influenced the choice of surgical method and the outcome of surgery. In response to these limitations, future studies should aim to increase the sample size and follow-up period through multicenter cooperation, thereby enhancing the reliability and effectiveness of the research. This will help to accurately evaluate the effects of surgical methods and provide more compelling evidence for clinical practice.

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Author contributions
FMJ collected, analyzed data, and drafted the original manuscript; HYT and JJC collected data and participated in to amend the manuscript; GPY collected and analyzed data; CCZH and BY designed present study and amended the manuscript.

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Data availability
The datasets used during the current study available from the corresponding authors on reasonable request.

Declarations

Ethics approval
This study has obtained the ethical permission form the Medical Ethics Committee of Kunming Children's Hospital. (Ethical approval number: 2024-05-040-K01)

Consent for publication
No applicable.

Competing interests
The authors declare that they have no conflict of interest.

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