Analysis of The Curative Effect of Tubularized Incised Plate Urethroplasty for Distal Hypospadias with The Dysplastic Corpus Spongiosum Covering Technique

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Purpose: To investigate the use of tubularized incised plate (TIP) urethroplasty for distal second- and third-degree hypospadias to free the dysplastic forked corpus spongiosum and Buck's fascia, which are used as a covering material for the new urethra, thereby reducing the incidence of urinary fistula and other complications in the coronal sulcus.

Materials and Methods: Clinical data of 113 patients with distal hypospadias treated with TIP urethroplasty from January 2017 to December 2020 were retrospectively analyzed. The study group comprised 58 patients (use of dysplastic corpus spongiosum and Buck's fascia to cover the new urethra), and the control group comprised 55 patients (use of dorsal Dartos fascia to cover the new urethra).

Results: All children were followed up for more than 12 months. In the study group, 4 patients developed urinary fistulas, 4 developed a urethral stricture, and no case developed glans fissure. In the control group, 11 patients developed urinary fistulas, 2 developed a urethral stricture, 3 developed a glans cracking.

Conclusion: Using the dysplastic corpus spongiosum to cover the new urethra increases the amount of tissue in the coronal sulcus and reduces the incidence of urethral fistula, but it may increase the incidence of urethral stricture.

Keywords: Buck's fascia; dartos fascia; corpus spongiosum; dysplasia; hypospadias; TIP operation

INTRODUCTION

Hypospadias is a common congenital malformation of the urinary system and requires early treatment. The incidence rate of hypospadias is high in boys, and it is increasing year by year.(1) TIP urethroplasty was first performed by Snodgrass in 1990 and officially reported in 1994.(2) TIP urethroplasty is a simple operation that can retain the urethral plate to the greatest extent and has a relatively low postoperative complication rate, and the urethral orifice is similar to that of the normal urethra. It has quickly become the mainstream operation for distal hypospadias. However, the incidence of urethral fistula, especially at the coronal sulcus, has been the most common in tip, which is related to the thin skin, less tissue, poor blood supply at the coronal sulcus, and the intersection of the two tissues.(3,4)

During the operation of 58 patients with distal hypospadias from January 2017 to December 2020, we dissociated the dysplastic corpus spongiosum and buck's fascia together as the covering material of the new urethra, hoping to reduce the incidence of urethral fistula and observe the incidence of other complications. We conducted a retrospective comparative study between this method and traditional tip surgery, and now the results are reported as follows.

MATERIALS AND METHODS

Study population and study design

113 cases of hypospadias were distal type (I-II°), without chordee or chordee angle <15°. TIP covered by hypoplastic corpus spongiosum and its continuous Buck's fascia was classified as the study group, and TIP covered by dorsal Dartos fascia was regarded as the control group. All patients were operated for the first time and were completed by the same surgeon. Except for other system malformations and surgical contraindications, the routine examination before operation was performed. The study has been approved by the ethics committee of the hospital.

The treatment effects of the two groups were compared quantitatively by comprehensive evaluation methods such as the incidence of complications and the questionnaire of family members' satisfaction.

Surgical technique

Pull the penis head (**Figure 1a, 2a**), and cut the membranous part of the urethral opening to the proximal end to the normal corpus spongiosum. Cut parallel along both sides of the urethral plate and extend to the front of the penis head, leaving the urethral plate about 1cm wide. Cut parallel along both sides of the urethral plate and extend to the front of the penis head, leaving the urethral plate about 1cm wide. Make a circular incision about 0.5cm from the inner prepuce plate to the coronal

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Received November 2022 & Accepted January 2023

Table 1. Comparison of basic information of two groups of patients.

Variables	Research Group	Control Group	t	*P*
Age, months; mean ± SD (range)	31.7 ± 6.76	30.7 ± 4.74	0.919	0.36
BMI, kg/m^2; mean ± SD (range)	23.8 ± 2.48	24.1 ± 2.28	-0.467	0.64

sulcus, and separate and deglove the dorsal side of the penis along the surface of buck's fascia. Pay attention not to damage the poorly developed and forked corpus spongiosum in this step. After degloving, according to the urethral inner diameter and penis development, select F8 silicone double chamber bladder urinary tube as the stent tube and drain urine, and carefully free the poorly developed corpus spongiosum on both sides of the urethral plate (**Figure 1b, 2b**), The lateral buck's fascia was dissociated together, and then the distal cavernous body was dissociated from the surface of the tunica albuginea, so that the cavernous bodies on both sides were sutured to the midline without tension to cover the new urethra. Then free the glans to fully expand both sides of the glans, and trim the tissues in the glans to achieve the effect of reducing the volume in the glans, so that when the glans is sutured, it can wrap the urethra without tension. The urethral plate is cut longitudinally in the middle, reaching the shallow surface of the white membrane of the corpus cavernosum of the penis. The urethral plate wraps around the urinary tube without tension, and the 6-0 absorbable thread is turned inward to form a new urethra. The dysplastic corpus spongiosum and buck's fascia bifurcated on both sides of the urethral plate were sutured to the midline to cover the coronal sulcus of the new urethra (**Figure 1c, 2c**). Properly cut the foreskin and then sew and wrap the penis (**Figure 1d, 2d**). The gauze was removed 5 days after operation, and the catheter was removed 2 weeks after operation on average.

Evaluations and follow-up

Recheck at 4 weeks, 8 weeks, 16 weeks and 32 weeks after operation, and then every half a year. During the period, the evaluation of the patient's family members on the penis appearance, urination, hygiene and the number of operations was collected through a questionnaire to obtain a comprehensive satisfaction evaluation.

Statistical analysis

Outcome measures: Age, BMI, complications (urinary fistula, urethral stricture, incision infection and rupture, urethral diverticulum), satisfaction pre-operation and 4, 8, 16 and 32 weeks after operation. Shapiro Wilk function was used to test the normality of measurement data, Levene test was used to test the homogeneity of variance, and independent measurement data conforming to the normal distribution was expressed in . The two groups were compared by independent sample t-test; The measurement data that do not conform to the normal distribution are expressed by the median (interquartile interval), and the independent samples are tested by Wilcoxon test of two independent samples. The counting data were expressed in percentage, and the comparison of counting variables (complication rate) was performed by $\chi 2$ test or Fisher exact test, $P < 0.05$ indicates that the difference is statistically significant.

RESULTS

113 patients in the study group and the control group were followed up for more than 1 year. There were 58 patients in the study group and 55 patients in the control group. The average age of patients in the study group was 31.7 ± 6.76 months, while that in the control group was 30.7 ± 4.74 months. There was no significant difference ($P > 0.05$). There was no significant difference

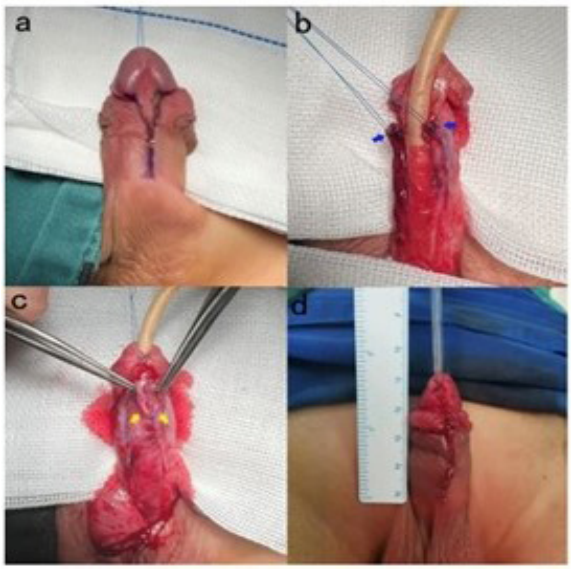

Figure 1. Pictures of key surgical steps: **1a.** Penis head traction; **1b.** Free bifurcated dysplastic corpus spongiosum and its continuous Buck's fascia after degloving penile skin (as shown by the blue arrow); **1c.** Close the cavernous body and Buck's fascia to cover the new urethra (as shown by the yellow arrow); **1d.** Penis appearance after urethroplasty.

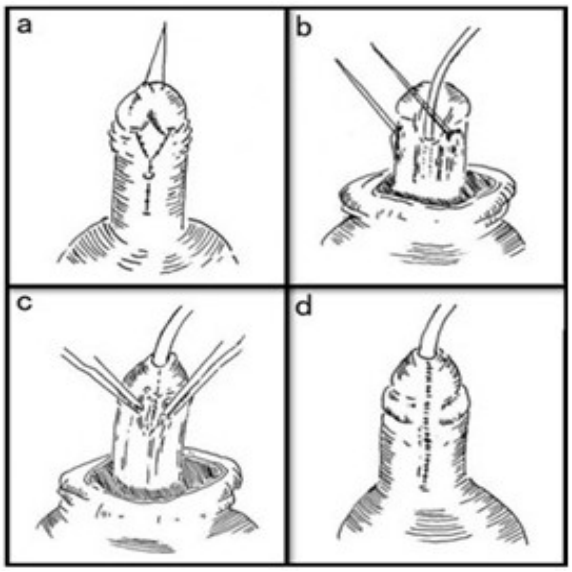

Figure 2. Hand drawing of key surgical steps: **2a.** Penis head traction; **2b.** Free bifurcated dysplastic corpus spongiosum and its continuous Buck's fascia after degloving penile skin (as shown by the blue arrow); **2c.** Close the cavernous body and Buck's fascia to cover the new urethra (as shown by the yellow arrow); **2d.** Penis appearance after urethroplasty.

Table 2. Comparison of complications between the two groups.

Complications	Research Group N (%)	Control Group N (%)	OR and 95%CI	*P*
Total complications	8 (13.79)	16(29.09)	0.39 (0.15, 1.00)	0.047
Urinary Fistula	4 (6.90)	11 (20.00)	0.30 (0.09, 0.99)	0.041
Urethral Stricture	4 (6.90)	2 (3.64)	1.95 (0.27, 22.43)	0.680
Glans fissure	0 (0.00)	3 (5.45)	- -	

between the two groups in BMI ($P > 0.05$).

The overall complication rate in the study group (13.79%) was lower than that in the control group (29.09%), with a statistically significant difference (95%CI: 0.15-1.00, OR = 0.39, $P = 0.047$). The overall incidence of urinary fistula was 6.9% and 20% respectively, with a statistically significant difference (95%CI: 0.09-0.99, OR = 0.39, $P = 0.041$); There were 1 case of coronary fistula in the study group and 8 cases in the control group. The difference between the two groups is statistically significant (95%CI: 0.01-0.83, OR = 0.10, P = 0.015). There was no statistically significant difference between the two groups in penile body fistula (95%CI: 0.12-7.39, OR = 0.95, $P > 0.05$). In the study group, urethral stricture occurred in 4 cases (6.9%), without glans dehiscence; In the control group, urethral stricture was found in 2 cases (3.64%), and glans dehiscence in 3 cases (5.45%).

The satisfaction scores of the pre-operation and 32 weeks after surgery, and the difference between satisfaction scores of 32 weeks after surgery and the pre-operation were compared. There was no significant the difference between the two groups in preoperative satisfaction scores ($P > 0.05$), but there was significant difference between satisfaction scores of 32 weeks after surgery and the difference of 32 weeks after surgery and the pre-operation in two groups ($P < 0.001$).

DISCUSSION

Hypospadias is caused by the fusion obstacle of the urethral fold at the midline, which leads to the cracking of the ventral urethra, and the absence or dysplasia of the corpus spongiosum and deep and superficial fascia at the ventral urethral orifice of the penis.[5] Surgery is the only treatment option for hypospadias.[6] Urinary fistula is one of the most common complications of hypospadias. The main reasons include poor blood supply of new urethral covering materials, high tension, less coverage levels, lack of experience of surgeons and so on.[7] Therefore, adding reliable covering materials between the new urethra and the skin is very important to reduce the incidence of postoperative complications of hypospadias.

In 2000, Yerkes first reported a bifurcation deformity of the penile corpus spongiosum in patients with hypospadias and used it as a new urethral covering material to establish the novel “Y-to-I technology,” which is considered to have the effect of reducing the incidence of urinary fistula.[8] In this study, we selected cases of distal hypospadias as the research object. There were 58 cases in the study group, and 4 cases had urinary fistula. The incidence of urinary fistula was 6.9%, which was significantly lower than 20% in the control group ($P = 0.04$). Dodat has achieved good results in the treatment of distal hypospadias with Spongioplasty.[9] He believes that this operation is applicable to all distal hypospadias, which can effectively reduce the incidence of urinary fistula and reduce the difficulty of correcting penile curvature. Bhat found that the thicker the cavernous body, the lower the incidence of urinary fistula after tip.[10] It is suggested that Cavernoplasty of penis should be taken as a necessary step. We believe that because most of the urethral cavernous bodies of the proximal hypospadias penis are stunted or missing, while most of the distal hypospadias penis has a relatively thick dysplastic corpus spongiosum (as shown in **Figure 1b**), which is Y-shaped and distributed on both sides of the urethral plate, with rich blood supply. Using it as a covering material can effectively increase the tissue thickness of the new urethra. At the same time, this method can make the repaired penis more similar to the normal penis structure and obtain a more satisfactory appearance. In the control group, the dorsal dartos fascia transfer was used to cover the new urethra. Because the blood supply of the dartos fascia flipped from the dorsal side of the penis to the ventral side was poor, and the adhere of tissue was poor, there was a high possibility of ischemic necrosis and tissue contracture after operation, which led to a high incidence of urinary fistula and glans cracking. Hafez Used the pedicled dartos fascia flap and cavernous body as the covering material when performing tip surgery on patients with scrotal hypospadias, and believed that the pedicled dartos fascia was the key to reduce postoperative complications.[11] In this regard, the operator believes that proximal hypospadias often need to cross the urethral plate, which can lead to more blood supply damage. At the same time, proximal hypospadias have high urethral orifice, early urethral development "stagnation", and poor development of corpus spongiosum, resulting in poor blood supply of covering materials and weak tissue volume.[12] Therefore, this operation is not suitable for the treatment of proximal hypospadias.

After verification, Bhat believed that there was no difference between the dysplastic corpus spongiosum and dartos' fascia in reducing urinary fistula.[10] Hayashi believes that Spongioplasty cannot reduce the incidence of urinary fistula in tip surgery.[13] It may be that the bifurcated corpus spongiosum fits closely with its con-

Table 4. Comparison of patients' satisfaction between the two groups.

Satisfaction score	Research Group	Control Group	Wilcoxon	*P*
Pre-operation	10.0 (8.0,11.0)	10.0 (9.0,11.0)	1621.5	0.879
32 weeks after operation	24.5 (23.3,25.0)	23.0 (20.5,24.0)	2417	< 0.001
Difference	14.0 (13.0,16.0)	13 (11.0,14.5)	2219.5	< 0.001

Table 3. Comparison of the location of urinary fistula between the two groups.

	Research Group N (%)	Control Group N (%)	OR and 95%CI	*P*
Fistula of penis	3 (5.17)	3 (5.45)	0.95 (0.12, 7.39)	0.947
Coronal sulcus fistula	1 (1.72)	8 (14.55)	0.10 (0.01, 0.83)	0.015

tinuous bucks fascia, and excessive dissociation damages the blood supply, resulting in a high incidence of urinary fistula. In this study, the overall incidence of urinary fistula in the study group and the control group were 6.9% and 20% respectively, with a statistically significant difference. It may be related to the way that we use "from far to near" to dissociate the corpus spongiosum and its successive Buck's fascia together. On the one hand, we can avoid excessive dissociation of the dysplastic cavernous body to damage its blood supply; on the other hand, because the blood supply of the corpus spongiosum moves from the proximal to the distal, this method is more in line with its blood supply direction, which can minimize the damage to the blood supply, and at the same time, we can restore the original anatomical structure as much as possible, Reduce the incidence of urinary fistula, especially at the coronary sulcus ($P = 0.015$). However, in this study, it was found that the incidence of urethral stricture in the study group was slightly higher than that in the control group, which may be related to the increased amount of tissue on the surface of the new urethra after cavernous body coverage, resulting in urethral stricture. However, the number of cases in this group is small, and more samples are needed for further analysis. At the same time, during the operation, we found that after the free anatomy of the poorly developed corpus spongiosum in most patients, its length is limited, and it can't cover all the new urethra, but only the coronal sulcus, which only increases the amount of tissue in the coronal sulcus. This may be related to the lower incidence of urinary fistula in the coronal sulcus in this experiment than in the control group (the incidence of urinary fistula in the coronal sulcus in the study group is 1.72%, and 14.55% in the control group).

In the surgical satisfaction survey, there was no difference between the two groups in preoperative satisfaction, but the satisfaction score of the study group was higher than that of the control group 32 weeks after surgery, with a statistically significant difference ($P < 0.001$). During the operation, we routinely dissociate the two wings of the glans, trim the redundant tissues of the two wings of the glans, so as to fully "reduce the volume" of the glans, make the glans wrap around the new urethra without tension, and conduct parallel tension free suture, in order to reduce the incidence of glans cracking after the operation, and obtain a more similar appearance to the normal glans, so using this operation can obtain better penile function and appearance. However, Ceccarelli believed that the short-term evaluation results could not reflect the impact of surgery on life and sexual psychology in adolescence and adulthood, so long-term follow-up and intervention were needed.[14] Murat Gul believed that the long-term follow-up cooperation rate of most patients who received early surgical treatment was low.[15] Long term follow-up data are also lacking for this surgical method. In addition, this study is a single center case study, and there may be selection bias in sample selection. As an exploratory study, the total number of samples in this study is 113, which may lead to deviation in data analysis results due to the small number of patients. There are few variables collected in this study, and there may be confounding factors that are not observed.

CONCLUSIONS

To sum up, our surgical method of covering the new urethra with free dysplastic corpus spongiosum and its continuous Buck's fascia can reduce the damage to the blood supply of the dysplastic cavernous body on the one hand, and on the other hand, while restoring the original anatomical structure, it can maintain a good blood supply of the covering material, and it is convenient to obtain materials, which effectively reduces the incidence of urinary fistula at the coronary sulcus of distal hypospadias, At the same time, the appearance of the repaired penis is more similar to that of the normal penis, which is easier to be recognized by patients and their families. However, long-term follow-up is needed to understand the impact of surgery on the life and sexual psychology of patients in adulthood.

ACKNOWLEDGMENTS

This research is supported by National Natural Science Foundation of China (82171587). We thank Angela Morben, DVM, ELS, from Liwen Bianji (Edanz) (www.liwenbianji.cn), for editing the English text of a draft of this manuscript.

CONFLICT OF INTEREST

All authors acknowledge that there is no conflict of interest.

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