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A novel onlay urethroplasty for hypospadias with mild chordee after degloving: modified for complete removal of scar tissue underlying the urethral plate and for long-term outcomes

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Urethral plate (UP)-preserving urethroplasty is simple and has few complications, but it may affect the development of penis in the long term and lead to recurrent chordee. In this study, we used obliquely cut UP to repair hypospadias with mild chordee after degloving (15°–30°) and compared the results with onlay urethroplasty to explore its rationality and feasibility. Between April 2018 and October 2020, 108 hypospadias patients underwent onlay urethroplasty or modified onlay urethroplasty. Clinical data were prospectively collected, and medium-term outcomes were assessed at follow-up. The complications were compared between the two groups. Forty-four patients underwent the modified onlay procedure (Group I), with follow-up time (mean ± standard deviation [s.d.]) of 23.2 ± 4.5 (range: 17–31) months. Sixty-four patients underwent a standard onlay procedure (Group II), with follow-up time (mean ± s.d.) of 39.7 ± 3.9 (range: 32–46) months. There was no difference in age at surgery. The urethral defect length and operative time were longer in Group I. Six cases of fistula and one case each of stricture and diverticulum were reported in Group I. In Group II, 11 cases of fistula and one case each of stricture and diverticulum were reported. The complication rates were 18.2% and 20.3% in Group I and Group II, respectively ($P > 0.05$). These medium-term follow-up results demonstrate that the modified onlay procedure (oblique cut UP urethroplasty) is a safe and feasible technique for hypospadias with mild chordee after degloving. Compared with standard onlay urethroplasty, this modified procedure is conducive to the complete removal of scar tissue underlying the UP without increasing the risk of surgical complications.

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INTRODUCTION

Hypospadias is one of the most common male genital malformations in children. The incidence rate of the disease is approximately 1/300.[1] There are more than 300 kinds of reported repair methods for hypospadias.[2] These repair methods can be divided into two categories based on whether the urethral plate (UP) is preserved: UP-preserving and UP-transecting urethroplasty, and they are suitable for different types of hypospadias. For hypospadias with mild chordee after degloving, UP-preserving urethroplasty plays an important role because the UP is the most ideal material for hypospadias repair.

However, Hayashi *et al.*[3] reported that the retained UP and its underlying scar tissue are adverse factors limiting the growth of the penis and causing the penis to bend down again. To balance the influence of the two factors mentioned above, we developed a modified onlay urethroplasty: the UP is cut obliquely, and the continuity of the cut UP is restored after removing the scar tissue between the UP and corpus cavernosum. The medium-term follow-up results were compared with standard onlay urethroplasties to explore the feasibility and rationality of this modified procedure.

PATIENTS AND METHODS

Patients and study design

The clinical data of consecutive hypospadias patients with mild chordee after degloving between April 2018 and October 2020 in Children's Hospital of Nanjing Medical University (Nanjing, China) were collected. The records and follow-up outcomes of the patients were reviewed for this analysis with independent Ethics Committee of Children's Hospital of Nanjing Medical University approval (approval No. 201902128-1), and informed consent of all patient' parents was obtained.

Approximately 600 boys underwent hypospadias repair at Children's Hospital of Nanjing Medical University during this period. The subjects of the present study were patients with mild chordee after degloving who underwent repairs by the same experienced surgeon. A total of 108 children comprised our study population, of whom 44 underwent modified onlay urethroplasty (Group I) and 64 underwent standard onlay urethroplasty (Group II). The surgical technique was determined by surgeon preference and tended to favor the modified onlay procedure after July 2019, when the modified procedure was designed by our team.

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Operation methods

The procedure of Group I, modified onlay procedure, is as follows. After making two parallel incisions along the UP, circumcision was performed at 0.8 cm proximal to the coronal sulcus, and penile skin was degloved to the root (**Figure 1a** and **2a**). The UP was freed from the corpus cavernosum, and fibrous scar tissue between the UP and corpus cavernosum was fully removed (**Figure 1b**). Then, we cut the UP obliquely (**Figure 1c** and **2b**). In the case of incomplete correction of the chordee, dorsal tunica albuginea plication was applied. After the complete correction of the chordee, the continuity of the urethral plate was restored by docking the tips of the obliquely cut UP. The restored UP was fixed on the corpus cavernosum (**Figure 1d**, **1e,** and **2c**). We then used a 1.5-cm-wide transverse prepuce pedicled island flap (TPIF) and moved it to the ventral penile side (**Figure 1f** and **2d**). This was sewn to the margins of the new UP proximally and distally with 2 parallel suture lines (**Figure 2e**). The following procedures were carried out according to onlay urethroplasty (**Figures 1g**, **1h,** and **2f**). The angle of their oblique incision depends on the curvature and length of the urethral defection. If the obliquely cut UP was not long enough to restore the continuity of the UP, we used onlay-tube-onlay urethroplasty to reconstruct the urethra, and we performed this urethroplasty for 35 cases. A standard onlay procedure, the procedure of Group II, was carried out according to a previously published procedure.[4]

Patients were examined at the time of catheter removal and 3 months, 6 months, and 1 year postoperatively. To minimize bias, complications and surgical outcomes were documented by the same surgical team. We defined the overall complication rate as all complications after urethroplasty, including fistula, dehiscence, diverticulum, and urethral stricture.

Statistical analyses

The Chi-squared test was used to compare the postoperative complication rate between the two groups. Measurement data were compared using Fisher's exact test. $P < 0.05$ was considered to indicate statistical significance. All data were processed using GraphPad Prism 5 software (Solvusoft Corporation, San Diego, CA, USA) and expressed as the mean ± standard deviation (s.d.).

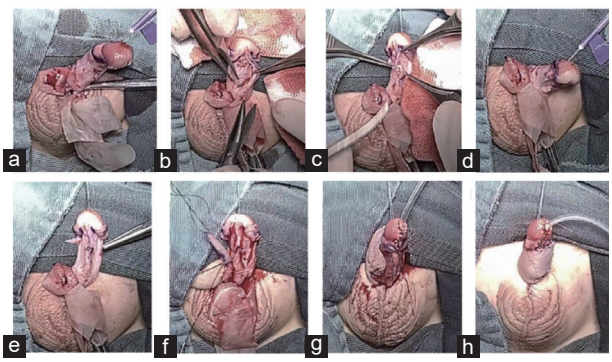

Figure 1: Key steps of the modified onlay urethroplasty. (**a**) With residual curvature after complete degloving and excising of the fibrotic tissue in the ventral aspect. (**b**) Free the UP from corpus cavernosum and fully remove fibrous and scar tissue between UP and corpus cavernosum. (**c**) Cut the UP obliquely. (**d**) Completely corrected of the chordee. (**e**) Restore the continuity of UP by docking the tips of the obliquely cut UP. (**f**) Harvest a TPIF, move it to the ventral penile side, and sew to the margins of the new UP. (**g**) Closed two wings of the glans over the tube, thus covered the neourethra. (**h**) Cosmetic result after surgery. UP: urethral plate; TPIF: transverse prepuce pedicled island flap.

RESULTS

A total of 108 consecutive patients were included in the present study. Clinical data were documented, including the patient's age, urethral defect length, dorsal tunica albuginea plication, operative time, and follow-up time. The overall complication rate and type of complications were compared between the two groups.

Forty-four patients (age [mean ± s.d.]: 32.2 ± 26.1 months, at the time of surgery) underwent modified onlay urethroplasty (Group I), and dorsal tunica albuginea plication was applied for 30 patients. Sixty-four (age [mean ± s.d.]: 30.5 ± 30.2 months, at the time of surgery) patients underwent standard onlay urethroplasty (Group II), and dorsal tunica albuginea plication was applied for 11 patients. The urethral defect length was recorded after the venture curvature was corrected completely. The urethral defects (mean ± s.d.) in Group I and Group II were 2.5 ± 0.6 cm and 2.1 ± 0.4 cm, respectively. Except for the patients with cryptorchidism or inguinal hernia, which were repaired at the same time, the operative time (mean ± s.d.) of Group I and Group II were 87.6 ± 21.3 min and 75.1 ± 12.5 min, respectively.

There were no statistically significant differences in age between the two groups ($P > 0.05$). Both the urethral defect length and operative time in Group I were longer than those in Group II, indicating a statistically significant difference between the two groups (both $P < 0.05$). In Group I, there were 6 cases (13.6%) of fistula, one case of stricture (2.3%), and one case of urethral diverticulum (2.3%). The case of urethral stricture was an external urethral stricture. In contrast, in Group II, 11 patients (17.2%) reported urinary fistula, one patient reported stricture (1.6%), and one patient reported urethral diverticulum (1.6%). No statistically significant difference was found in the incidence of complications ($P > 0.05$). The total complication rates of surgery in the two groups were 18.2% and 20.3%, respectively, with no statistically significant difference ($P > 0.05$; **Table 1**).

DISCUSSION

Hypospadias with mild penile curvature after degloving has a higher incidence than proximal hypospadias.[5] Despite the considerable

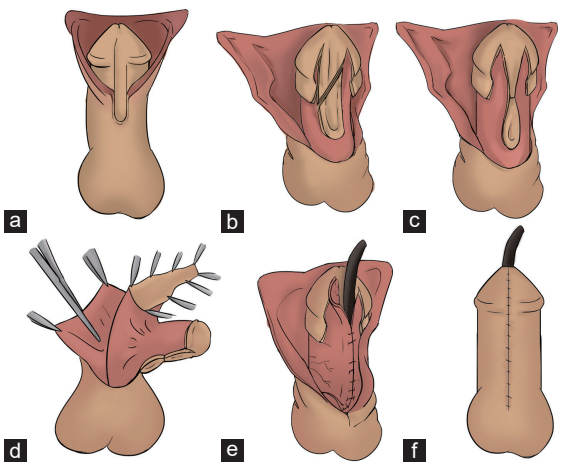

Figure 2: Maneuver of the modified onlay urethroplasty. (**a**) Penile hypospadias or distal shaft meatus with mild chordee. (**b**) Degloving the skin to the root, parallel incision onto glans and obliquely cut the UP at the point of maximum curvature. (**c**) After dissociating the obliquely cut UP, fibrous tissue and scar between the UP and corpus cavernosum is fully removed. Then, the continuity of the urethral plate is restored by docking the tips of the obliquely cut UP. (**d**) A transverse preputial flap is harvested from the inner aspect of the dorsal prepuce. (**e**) The island flap is mobilized to the ventral side and sewn to the margins of the new UP from proximally to distally with 2 parallel suture lines. (**f**) The appearance of the penis after suturing the penis. UP: urethral plate.

Table 1: Follow-up times and postoperative complications in 108 cases of hypospadias

Characteristic	*Group I (n=44)*	*Group II (n=64)*	χ^2/t	*P*
Follow-up time (month), mean±s.d.	23.2±4.5	39.7±3.9		<0.05
Complications, *n* (%)	8 (18.2)	13 (20.3)	0.102	>0.05
Urethrocutaneous fistula, *n* (%)	6 (13.6)	11 (17.2)	0.363	>0.05
Stricture, *n* (%)	1 (2.3)	1 (1.6)	0.14	>0.05
Diverticulum, *n* (%)	1 (2.3)	1 (1.6)	0.14	>0.05

The patients of Group I underwent modified onlay urethroplasty, and of Group II underwent standard onlay urethroplasty. s.d.: standard deviation

evolution of this condition and its treatment over the past 30 years, the management of this condition is still far from perfect, and this is seriously ignored and underestimated.

Hayashi *et al*.[3] reported that the retained UP and its underlying tissue are adverse factors that restrict the growth of the penis and can cause the penis to bend downward after surgical repair. However, for patients with only mild chordee after degloving, the majority of doctors choose to retain the UP and use dorsal tunica albuginea plication or ventral incision to straighten the penile curvature.

Erol *et al*.[6] found that UP is the most ideal material for urethral reconstruction, which contains an abundant blood supply, smooth muscle, glands, and nerves and has strong extensibility. The advantage of UP-preserving urethroplasty is the reduction of postoperative complications, especially urethral strictures.[7] Onlay and TIP urethroplasties, as typical representatives of UP-preserving operations, are widely used in clinical practice. Among them, 30%–57% of cases need reoperation after TIP repair,[8] while the rate of reoperation after onlay urethroplasty is much lower.[9] Additionally, onlay urethroplasty has relatively lower requirements on the condition of UP, width of glans, and technical level of the surgeon.

In 1987, Elder *et al*.[4] performed onlay urethroplasty first for patients with distal hypospadias and reported satisfactory follow-up results. Subsequently, an increasing number of pediatric urologists began to use onlay urethroplasty to repair children with distal hypospadias, and they also obtained satisfactory treatment outcomes. The procedure has a low postoperative complication rate and almost no urethral strictures. Subsequently, the indication for onlay urethroplasty is also expanding. Mollard *et al*.[10] applied an onlay procedure for patients with proximal hypospadias. Hollowell *et al*.[11] also considered that UP-preserving urethroplasty should be considered for all kinds of hypospadias patients. There are significant differences in the difficulty of hypospadias repair and the incidence of postoperative complications between UP-preserving and UP-transecting urethroplasty.[12]

All authors have performed onlay urethroplasty on hypospadias patients for more than 20 years. For patients with mild penis curvature, we straightened the penis by degloving the skin and releasing the ventral fibrous. For hypospadias patients with severe curvature, which cannot be corrected by these methods, we added dorsal tunica albuginea plication. Onlay urethroplasty has become the most widely used method in our hospital for hypospadias without or with only mild curvature after degloving.

According to a long-term follow-up study,[13] in the cases of hypospadias repaired in childhood that then experienced recurrent penile curvature in adulthood or adolescence, they found that nearly 80% of the hypospadias patients were repaired with UP-preserving urethroplasty. Braga *et al*.[14] found that the recurrence rate of penile curvature was 36.5% in the UP-preserving urethroplasty group and 20% in the UP-transecting urethroplasty group. The results of the two studies demonstrate that the preservation of dysplastic UP and underlying tissue is an adverse factor that causes the penis to bend again in adulthood or adolescence and may also restrict the growth and development of the penis after hypospadias repair. Therefore, the long-term effect of preserving UP and dorsal tunica albuginea plication for the correction of penile curvature of 10° to 30° is controversial. Because of the lack of attention to the correction of penile curvature in the first surgery, it may cause residual penile curvature or recurrent chordee in adolescence, and it will become a difficult clinical problem due to the lack of repair materials during a second correction.[15]

Mobilization of the urethral plate is a method to correct the curvature of the penis, which is caused by a dysplastic urethral plate and the underlying fibrous tissue. Koenig *et al*.[16] performed onlay urethroplasty with mobilization of the UP procedure on 83 patients with distal hypospadias. The results showed that mobilization of the urethral plate apparently contributed to the release of chordee. One case of urethral fistula occurred in that setting of patients, and no urethral stricture occurred. In 2011, Rigamonti and Castagnetti[17] reported a modified onlay on albuginea procedure with satisfying follow-up results. They corrected the chordee of the penis by transecting the UP and removing the underlying fibrous tissue. TPIF was sewn to the margins of the urethral plate proximally and distally. In the gap of the transected urethral plate, TPIF was sewn on the albuginea directly in two suture lines. The two studies suggested that the width of the UP has little effect on surgical complications.

Based on long-term clinical practice and learning from the literature, we developed a novel modified onlay urethroplasty. We cut the UP obliquely and removed the underlying fibrous and scar tissue, then we straightened the chordee of the penis completely. We finally restored the continuity of UP by docking the tips of the obliquely cut UP, and the rest of the procedure follows that for onlay urethroplasty reported by Elder *et al*.[4] We used this modified onlay urethroplasty for 44 hypospadias patients. We also achieved the same good therapeutic effect, with 8 cases (18.2%) having complications.

This procedure is a novel modified onlay urethroplasty and further extends the indications of standard onlay urethroplasty. We obtained a continuous urethral plate and fully removed the underlying fibrous tissue with this method. Compared with other modified onlay urethroplasties mentioned above, our modified procedure is more reasonable and is in line with the new concept of actively transecting the UP in hypospadias patients with chordee.[15] This continuous UP is the posterior wall of the new reconstructed urethra. It acts as a stent in the new urethra and thus reduces the incidence of urethral stricture and diverticulum. In the present study, only one patient had an external orifice stricture, which was not related to the obliquely cut UP.

Although our procedures were modified with long-term outcomes, there were several limitations of this study. The shortcomings of the present study are as follows: the most obvious was that patient allocation to each group was not randomized, and the decision regarding the surgical approach was based on the surgeon's preference. There might have been a selection bias. Due to the medium-term follow-up time in this study, no follow-up results of pubertal penis development were obtained. Additionally, the number of cases was not large. Therefore, a larger sample size and a longer follow-up time are needed to fully judge the applicability of this technique.

CONCLUSIONS

These medium-term follow-up results demonstrate that the modified onlay procedure (oblique cut UP urethroplasty) is a safe and feasible technique for repairing hypospadias with mild chordee after degloving.

Compared with standard onlay urethroplasty, this modified procedure is conducive to the complete removal of scar tissue underlying the UP without increasing the risk of surgical complications.

AUTHOR CONTRIBUTIONS

GM and YFG conceived the study and made critical revisions to the manuscript regarding important intellectual content. LQH and ZG designed the study and completed the manuscript writing. LXW, XYL, and YJD contributed to patient recruitment and follow-up. All authors read and approved the final manuscript.

COMPETING INTERESTS

All authors declared no competing interests

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