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Urethroplasty by Use of Turnover Flaps (Modified Mathieu Procedure) for Distal Hypospadias Repair in Adolescents: Comparison With the Tubularized Incised Plate Procedure

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Purpose: The purpose of this study was to examine whether urethroplasty with a turnover flap, as an alternative method of distal hypospadias repair in adolescents, improves the outcome of surgery.

Materials and Methods: Between January 2004 and December 2013, a total of 38 adolescents (aged 11–17 years) underwent distal hypospadias repair with either the tubularized incised plate (TIP) procedure (n=25) or the turnover flap procedure (n=13). The turnover flap procedure was performed with a proximal, ventral penile flap that was turned over to cover the urethral plate. Patient demographics, perioperative outcomes, complications, and postoperative uroflowmetry in each surgical group were analyzed retrospectively.

Results: The patient demographics were similar in the two groups. There were no significant differences in perioperative outcomes between the groups, including mean operative time, duration of hospital stay, and urethral catheterization. The number of patients with at least one complication, including wound dehiscence, urethrocutaneous fistula, meatal stenosis, and urethral stricture, was lower in the turnover flap group (1/13, 7.7%) than in the TIP group (11/25, 44%, p=0.030). The incidence of meatal stenosis was lower in the turnover flap group (0/12, 0%) than in the TIP group (6/25, 24%). In postoperative uroflowmetry, the plateau-shaped curve rate was lower in the turnover flap group (1/12, 8.3%) than in the TIP group (5/19, 26.3%); the peak flow was higher (p=0.030).

Conclusions: The turnover flap procedure is clinically useful for repairing adolescent distal hypospadias because it offers lower complication rates and better functional outcomes than TIP.

Keywords: Adolescent; Complications; Hypospadias

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INTRODUCTION

Many approaches for the surgical correction of hypospadias have been described over the past several decades. However, surgical correction of hypospadias remains difficult in pediatric urology. A recent study of an international cohort of pediatric urologists confirmed that urethroplasty by use of a tubularized incised plate (TIP) and transverse island flap onlay were the two most popular procedures of choice for hypospadias repair [1]. Owing to the relatively simple surgical concept, low complication rates, and fair cosmetic results, TIP has been increasingly adopted for repair of distal and midshaft hypospadias [2-6].

Because of psychological factors, anesthetic risk, and technical aspects of hypospadias repair, the most suitable age for performing the operation to correct hypospadias is 6 to 18 months. Sometimes, however, hypospadias are noticed later in life, when the foreskin is retracted or after a

circumcision is performed. Many of these adolescents and adults, who missed the optimal age of repair, experience complications after hypospadias surgery, including wound dehiscence, urethrocutaneous fistula, and especially meatal stenosis [7-9]. The complication rate of hypospadias repair by use of TIP is higher in adolescents than in younger children. Therefore, it is questionable whether TIP is the most appropriate surgical technique for repairing hypospadias in adolescents.

We compared the surgical outcomes of TIP with the surgical outcomes of urethroplasty by use of a turnover flap (modified Mothieu procedure) as an alternative method for distal hypospadias repair in adolescents.

MATERIALS AND METHODS

1. Patients

This study was approved by the Ethics Committee of the Kyungpook National University School of Medicine. We retrospectively reviewed the medical records of patients consecutively referred for the repair of hypospadias from January 2004 to December 2012. A total of 38 adolescents underwent distal hypospadias repair by the TIP procedure or the turnover flap procedure at our urology clinic during this period. Patients aged at least 10 years were enrolled in our study. Those enrolled between January 2004 and October 2008 underwent TIP, and those enrolled between November 2009 and December 2012 underwent the turnover flap procedure. The presence of distal hypospadias was defined at the beginning of the urethroplasty on the basis of the meatal position, which extends from the glans to the distal penile shaft. Patients were excluded if they had undergone correction with other techniques (n=4), had undergone previous attempts at hypospadia repair or chordee release (n=3), had received intramuscular testosterone injection prior to operation (n=1), or were followed up for less than 6 months (n=1).

Patients underwent a close physical examination during follow-up at 1 month, 3 months, and 6 months after the operation. The voiding function of the patients without urethrocutaneous fistula was assessed via uroflowmetry at 6 months after surgery.

2. Operative techniques

1) TIP urethroplasty

TIP urethroplasty was performed in accordance with published techniques [10,11]. A ventral skin U-shaped incision was created, preserving the urethral plate. Penile degloving was performed, and tethering tissues were excised to correct mild ventral curvature. Next, after an artificial erection was made, remnant penile curvature was treated by dorsal plication [12]. After a relaxing incision was made along the longitudinal axis, the urethral plate was tubularized and the urethral catheter was inserted. We prepared a dartos flap from the dorsal prepuce to cover the neourethra in all cases. The penile skin closure was performed

with a midline suture, after glanuloplasty.

2) Turnover flap urethroplasty (modified Mathieu procedure)

The surgery commenced by insertion of a urethral catheter, followed by constructing a stay suture on the penile glans. Depending on the size of the urethral plate, an operative site was designed with a U-shaped marking on the mucosal edge of the exposed urethra and an appropriate site proximal to the urethral plate. The ventral skin was then incised along the marking. Unlike in TIP urethroplasty, the midsection of the urethral plate was not incised. Penile curvature with chordee was corrected by dorsal plication after penile degloving, if any. The flap containing skin and subcutaneous tissue were carefully detached, taking precautions to maintain the blood supply to the flap. The flap was turned over distally to cover the urethral plate. Subsequently, bilateral edge-to-edge anastomosis between the flap and the urethral plate was completed. The penile skin beside the flap was dissected and closed with a midline suture to cover the raw surface of the flap (Fig. 1).

3. Analyzed factors and statistical analysis

We compared demographics (age at the time of operation, body mass index [BMI], meatal position, and existence of chordee), perioperative outcomes (operation time, duration of hospital stay, and duration of urethral catheterization), postoperative complications (wound dehiscence, urethrocutaneous fistula, and meatal stenosis), and uroflowmetry findings (peak flow rate, curve shape, and postvoid residual urine volume) between the TIP and turnover flap procedures.

All statistical analyses were conducted with commercially available statistics software (PASW Statistics ver. 18.0, IBM Co., Armonk, NY, USA). The chi-square Fisher exact test and Mann Whitney U-test were used for comparative analysis, which was considered to indicate statistical significance with p < 0.05.

RESULTS

Table 1 shows the patients' characteristics, including meatal positions and existence of chordee, and the surgical techniques employed. The mean age of the patients at the time of the operation was 13.1 years (range, 11–17 years) in the TIP group and 14.2 years (range, 12–17 years) in the turnover flap group. The BMI and meatal positions were comparable in the groups. In the TIP and turnover flap groups, 7 patients and 3 patients, respectively, had chordee, and they underwent single-stage operations, with urethroplasty and chordectomy being performed simultaneously.

The perioperative outcomes and complications according to surgical techniques are shown in Table 2. The mean operative time, duration of hospital stay, and duration of urethral catheterization were similar in the groups with

no statistically significance differences (p=0.204, p=0.388, and p=0.212, respectively). The mean follow-up duration was 10.9 months and 8.7 months in the TIP and turnover flap groups, respectively (p=0.571). The main surgical out-

comes analyzed in this study were complications including wound dehiscence, urethrocutaneous fistula, and metal stenosis. The overall complication rates were 11/25 (44.0%) and 1/13 (7.7%) in the TIP and turnover flap groups, respectively, with significant differences between the groups (p=0.030). Three patients had more than one complication: two patients in the TIP group and one patient in the turnover flap group. The incidence rates of wound dehiscence according to the type of surgery were 2/25 (8.0%) for the TIP group and 1/13 (7.7%) for the turnover flap group. Some patients experienced minor wound problems, but these did not require additional surgery. The incidence rates of urethrocutaneous fistula were 6/25 (24.0%) and 1/13 (7.7%) in the TIP and turnover flap groups, respectively, without significant differences (p=0.385). All the patients with urethrocutaneous fistula underwent additional operations to correct the fistulas. Meatal stenosis in the TIP group was 6/25 (24.0%), which was higher than the 0/13 (0%) in the turnover flap group, but the difference was not statistically significant (p=0.076). All the patients with meatal stenosis underwent serial urethral dilatations at the outpatient de-

TABLE 1. Characteristics of the patients who underwent tubularized incised plate (TIP) and turnover flap urethroplasty

Variable	TIP (n=25)	Turnover flap (n=13)	p-value
Age (y)	13.1±1.8	14.2±1.9	0.085
Height (cm)	160.9±8.0	161.8±7.9	0.756
Weight (kg)	57.5±6.8	54.9±8.8	0.305
Body mass index (kg/m^2)	22.2±2.0	20.8±2.1	0.650
Meatal position			0.809
Glanular	10	4	
Subcoronal	6	3	
Distal penile	9	6	
Existence of chordate	7	3	0.744

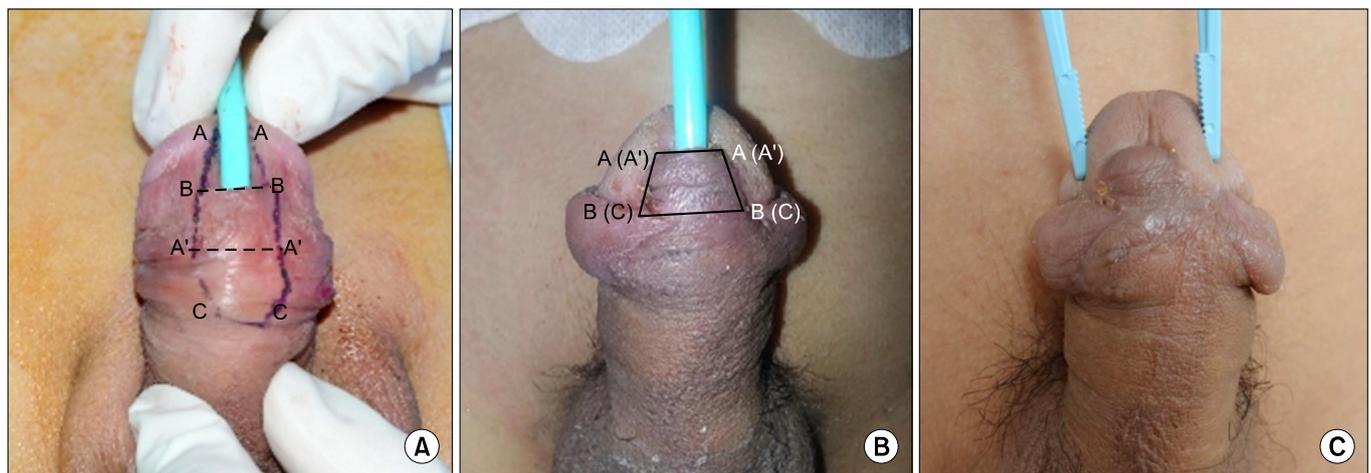Values are presented as mean±standard deviation.

FIG. 1. Images of the turnover flap technique: (A) preoperative, (B) 2 weeks after surgery, (C) 3 months after surgery.

TABLE 2. Perioperative outcomes and complications associated with the tubularized incised plate (TIP) and turnover flap urethroplasty procedures

Variable	TIP (n=25)	Turnover flap (n=13)	p-value
Operative time (min)	120.8±35.4	102.5±43.2	0.204
Duration of hospital stay (d)	10.4±2.9	11.2±2.0	0.388
Duration of urethral catheterization (d)	8.7±3.0	9.9±1.8	0.212
Follow-up (mo)	10.9±13.6	8.7±2.9	0.571
Patient with at least 1 of the complications given below[a]	11	1	0.030
Wound dehiscence	2	1	0.973
Meatal stenosis	6	0	0.076
Urethrocutaneous fistula	6	1	0.385
Urethral stricture	1	0	1.000
Requirement for additional operation	7	1	0.222

Values are presented as mean±standard deviation.
[a]: Three patients had more than 1 complication; 2 patients of TIP; 1 patient of turnover flap.

TABLE 3. Uroflowmetry findings of the patients without urethrocutaneous fistula after the tubularized incised plate (TIP) and turnover flap urethroplasty procedures

Variable	TIP (n=19)	Turnover flap (n=12)	p-value
Peak flow rate (mL/s)	13.8 (5–19)	16.8 (12–21)	0.030
Plateau-shaped uroflow curve (%)	5 (26.3)	1 (8.3)	0.363
Postvoid residual > 10% voided volume (%)	5 (26.3)	1 (8.3)	0.363

Values are presented as mean (range) or number (%).

partment, and one patient with meatal stenosis after TIP repair underwent a metal urethral stent implantation for recurrent urethral stricture. The number of patients undergoing additional operations was not significantly different between the groups (p=0.222).

All of the patients in this study were toilet trained. The patients who did not experience urethrocutaneous fistula after urethroplasty (19 patients in the TIP group and 12 patients in the turnover flap group) underwent uroflowmetry after the surgery. The mean peak flow rate was 13.8 mL/s (range, 5–19 mL/s) in patients who underwent TIP, compared with 16.8 mL/s (range, 12–21 mL/s) in those who underwent turnover flap urethroplasty (p=0.030). A total of six patients had a plateau-shaped uroflow curve: five patients (26.3%) who underwent TIP and one patient (8.3%) who underwent the turnover flap procedure (p=0.363). A postvoid residual volume > 10% of voided volume was found in five patients (26.3%) after TIP and in one patient (8.3%) after the turnover flap procedure (p=0.363) (Table 3).

DISCUSSION

Hypospadias repair should focus on achieving the following three main objectives: voiding in an upright position, an appropriate voiding stream, and normal penile appearance and function. To achieve these objectives, it is crucial that the urethral meatus be positioned at the end of the glans, and that the penis be erect during the hypospadias repair. The timing of surgery is decided by the following considerations: size and development of the penis, the child's reaction to surgery, anesthetic risk, and toilet training. By the age of 6 months, infants can usually tolerate surgery and anesthesia. In addition, a child by the age of 18 months is aware of his genitalia and gets toilet trained. Therefore, the most suitable age for a hypospadias operation is from 6 to 18 months. Alternatively, the operation can be performed at 3 to 4 years of age if the earlier optimal age is missed.

Most children with hypospadias are diagnosed immediately after birth or during a physical examination before a newborn circumcision. Sometimes, the ventral foreskin seems to be normal and the hypospadias is noticed later in life after circumcision is performed or when the foreskin is retracted. Although most patients observed in our urologic clinic were infants or of preschool age, adolescents requiring hypospadias repair were also occasionally observed. They often detected the anomalies after consulting a local urologist about circumcision. Other causes of visits to our hospital at puberty were ignorance about the disease, and in rare cases, not being able to afford treatment.

Many of the adolescents or adults who visited our clinic experienced complications after hypospadias surgery. In this study, complications including urethrocutaneous fistula and wound dehiscence occurred in 7/25 (28.0%) and 1/13 (7.7%) patients in the TIP and turnover flap groups, respectively. However, in many published reports, the complication rate of TIP for distal and midshaft hypospadias repair is low. Snodgrass et al. [2] observed complications in 10/148 patients (7%) who underwent distal hypospadias repair. Retik and Borer [3] observed complications in only 1/31 patients (3%) who underwent distal and midshaft hypospadias repair. However, because studies involving adolescent hypospadias are rare, it is difficult to compare our study with other publications. Nocturnal erection and trouble building a neourethra with enough caliber for adolescents could explain the relatively high incidence of wound complications in adolescents.

In a meta-analysis of 53 published studies concerning TIP cases [13], the mean meatal stenosis rate was 2.1%, ranging from 0% to 17%. In another review of 16 studies [14], the mean meatal stenosis rate was 3.6%, ranging from 0% to 6%. The result we achieved for our TIP group exceeded the abovementioned ranges in the development of stenosis (6/25, 24.0%). As described above, our study concerned the hypospadias of adolescents; therefore, it was difficult to secure a large enough caliber of neourethra for adolescents. By contrast, there was no case of meatal stenosis in the turnover flap group (0/13, 0%).

The turnover flap procedure had a lower complication rate, as described above, and also showed a functionally better outcome than the TIP procedure. In postoperative uroflowmetry, the peak flow rate for the turnover flap group was statistically higher than that of the TIP group. Also, in contrast with patients who underwent TIP (26.3%), only 8.3% of patients who underwent turnover flap urethroplasty showed a plateau-shaped curve, falling below the 25th percentile according to Toguri et al. [15] and Marte et al. [16], who proposed the uroflow nomogram.

Our study suggests that the turnover flap technique is clinically viable for repairing adolescent distal hypospadias, because it has a lower overall complication rate, including a lower incidence rate of meatal stenosis, and overall better functional outcomes. Moreover, turnover flap urethroplasty is a relatively simple technique for adolescents and can result in an operative time similar to that of TIP. This result highlights the technical simplicity of the turnover flap procedure.

Turnover flap urethroplasty is similar to a technique called the Mathieu method (perimeatal based flap ure-

throplasty) in many aspects [17-19]. However, turnover flap urethroplasty is a flap-folding procedure and is focused on simplifying the technique by minimizing incisions and reducing operative time as well as complications. Like the Mathieu method, meatal retrusion is another possible complication after turnover flap urethroplasty. In our study, however, there were not many complaints from the children or their parents about meatal retrusion because of the short follow-up periods. For this reason, a long-term follow-up study is needed.

Various modified Mathieu techniques have been reported before, and some techniques are similar to the turnover flap procedure. Nezami et al. [19] reported a "double face" Mathieu technique that was performed with glans augmentation by harvesting a longer flap and flipping back its distal portion between the glans wings. The turnover flap procedure was performed with the same technique and we observed a similar overall complication rate. The difference was that the subjects of our study were adolescent hypospadias patients.

Although this was a single-institution consecutive patient study, the chance of selection bias, especially concerning operative technique is a possible limitation. However, the fact that the preoperative patient characteristics of the groups were similar and the study had an equal application of each technique to the same type of hypospadias, may allow for potentially meaningful comparisons. On the other hand, there is another risk of selection bias in relation to time of operation between the TIP procedure (2004–2008) and turnover flap urethroplasty (2009–2012). A possible issue is that the operator's surgical technique improved with time, which led to a better result for the turnover flap urethroplasty, which was performed later. However, this can be dismissed, because a highly experienced and skilled surgeon operated on both surgical groups.

Assessment of the outcomes of hypospadias repair should include the complication rate, cosmetic appearance of the penis, functional outcomes (micturition, sexuality), and psychological factors such as quality of life and psychosexual life. However, such high-quality randomized trials are extremely challenging in pediatric urology; therefore, such studies are rarely performed. Most publications present single-center and single-surgeon retrospective case studies, with a limited follow-up period and a limited number of patients. In this study, cosmesis is an important factor because the shape of the urethral meatus can appear abnormal after the turnover flap urethroplasty owing to its transplanted skin. However, cosmetic outcomes were not assessed owing to the difficulty in interpreting cosmesis in a retrospective fashion. Sexual outcomes were not assessed for the same reason. Therefore, data were lacking on the appearance of external genitalia, penile curvature during erection, and sexual function. Carefully organized assessment scales for cosmesis and sexuality with detailed instructions to the patients and their parents will be necessary for accurate estimations in further prospective investigations.

The present study had limitations owing to the methodological constraints of a retrospective analysis. Therefore, adoption of a new surgical intervention should follow properly conducted randomized trials, combined with a rigorous method with standardized outcomes. Such an approach will show the best evidence for implementing or rejecting new surgical procedures.

CONCLUSIONS

We compared the outcomes of TIP and turnover flap urethroplasty in two comparable groups of adolescents with distal hypospadias. Our results suggest that the turnover flap procedure carries a lower overall complication rate and has significantly improved functional outcomes compared with TIP. Therefore, the turnover flap procedure can be a viable method for the repair of adolescent distal hypospadias. Further prospective studies with larger numbers of patients and an adequate assessment scoring system are needed to strengthen our findings.

CONFLICTS OF INTEREST
The authors have nothing to disclose.

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