Comparative Analysis of Tubularized Incised Plate Versus Onlay Island Flap Urethroplasty for Penoscrotal Hypospadias

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Purpose: Despite being the dominant technique for repair of distal hypospadias, application of the tubularized incised plate approach for penoscrotal hypospadias remains controversial. We report our experience with severe hypospadias, comparing tubularized incised plate to transverse island flap onlay urethroplasty.

Materials and Methods: We retrospectively reviewed consecutive patients with penoscrotal hypospadias presenting between 1998 and 2006. Based on surgeon preference 35 children underwent tubularized incised plate and 40 underwent onlay urethroplasty. Penoscrotal transposition and degree of ventral curvature, type of ventral curvature repair, complication rate, postoperative uroflowmetry pattern in toilet trained patients and number of reoperations were compared between the 2 groups.

Results: Mean patient age at surgery was 17 months (range 9 to 91) for tubularized incised plate urethroplasty and 17.8 months (10 to 58) for the onlay procedure. Urethroplasty was performed over an 8Fr catheter in all patients. With mean followups of 30 months (range 6 to 74) and 38.8 months (16 to 80) the overall complication rates were 60% and 45% for the tubularized incised plate and onlay procedures, respectively. Fistula occurred in 15 patients and repair breakdown in 3 patients (total 51.4%) treated with tubularized incised plate repair, compared to 8 and 2 patients, respectively (25%), treated with onlay repair ($p = 0.01$). Fistula location also differed significantly between the 2 groups, with proximal fistulas occurring in 11 of 15 tubularized incised plate repairs (73.3%) vs 2 of 8 onlay repairs (25%, $p = 0.02$). Recurrent ventral curvature was more frequent after onlay urethroplasty (5.7% vs 12.5%, not significant). At a mean age of 5.1 years a plateau uroflow curve (vs normal bell curve) was observed in 16 of 24 children (66.7%) who underwent tubularized incised plate repair and in 7 of 21 (33.3%) who underwent onlay repair ($p < 0.01$).

Conclusions: In this series the overall complication rate was similar for tubularized incised plate and onlay urethroplasty. Despite similar urethroplasty calibers, the uroflow curves and fistula positions in patients undergoing tubularized incised plate repair suggest that the neourethra distal to the fistula may be relatively narrow, creating flow resistance and leading to proximal fistula. Longer followup and close monitoring are needed before embracing one approach over the other.

Key Words: hypospadias; urologic surgical procedures, male; surgical flaps; urinary fistula; infants

Tubularized incised plate urethroplasty has been collectively accepted for repair of distal and mid shaft hypospadias, as shown by a recent survey among an international cohort of pediatric urologists.[1] Given the relative simplicity of the operative concept, low complication rate and good cosmetic result in distal hypospadias, the procedure has been progressively applied to more proximal defects.[2–4] However, to date the published experience with TIP urethroplasty for repair of penoscrotal hypospadias has been limited to a few reports with small numbers of patients.[5–8] Furthermore, most studies have not attempted to compare outcomes with other techniques, such as transverse island flap onlay urethroplasty, which many consider the preferred procedure for proximal cases.[1]

Due to the increasing popularity of the TIP repair for all types of defects, comparative studies are timely and necessary. There is a need to assess outcomes critically for the TIP and onlay techniques currently used for penoscrotal repairs. Therefore, we reviewed our experience with penoscrotal hypospadias, comparing TIP to onlay urethroplasty with regard to complications and uroflowmetry findings.

MATERIALS AND METHODS

We retrospectively reviewed the records of consecutive patients referred for treatment of penoscrotal hypospadias between 1998 and 2006. A total of 1,657 boys underwent hypospadias repair at our institution during this period. Penoscrotal hypospadias was defined based on a penoscrotal meatal position at the beginning of the urethroplasty. A total of 75 children comprised our study population, of whom 35 underwent a TIP repair and 40 underwent an onlay repair, based on surgeon preference. Patients who underwent correction with other techniques or who had proximal penile or mid shaft defects were excluded. Intramuscular testosterone was administered preoperatively at the discretion of the surgeon.

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Tubularized Incised Plate Repair

The TIP repair was performed according to published techniques.[9,10] Briefly, the ventral skin was incised with a U-shaped incision that preserved the urethral plate. Penile degloving and excision of tethering tissues lateral to the corpus spongiosum and urethral plate were performed to correct mild ventral curvature. In cases of more severe ventral curvature radical proximal dissection down to the bulbar urethra was carried out.[11] Subsequently, an artificial erection was produced to detect residual ventral curvature, which, if present, was corrected by dorsal plication with a single incision in the albuginea at the 12 o'clock position.[12] A midline relaxing incision was made in the urethral plate, extending from the glanular groove to the most proximal point of the plate. The plate was then tubularized using 7-zero polydioxanone running suture over an 8Fr feeding tube.

In all cases dartos flap from the dorsal prepuce and spongiosal tissue (spongioplasty when available) were used to cover the neourethra as a waterproofing and vascular coverage layer. After glanuloplasty the penile shaft skin was closed with a midline suture or with a transverse island skin flap in cases of significant ventral skin deficiency, according to surgeon preference.

Transverse Island Flap Repair

Transverse island flap onlay urethroplasty was performed according to the original description.[13] The first surgical steps (incision, degloving of the penis and release of lateral attachments) were identical to those described for the TIP repair, to preserve the urethral plate and correct mild curvature. More severe ventral curvature was also corrected by dorsal plication with a single incision as described for TIP repair. No ventral grafts were used for ventral curvature correction. Next, a rectangular flap was harvested from the dorsal inner prepuce, ventrally rotated and anastomosed to the urethral plate with a 7-zero polydioxanone running suture over an 8Fr feeding tube. The vascular pedicle to the flap was used to cover the suture line. Glanuloplasty and skin closure also followed the same principles described for TIP repair, except in cases with significant ventral skin deficiency, where a double face island flap was used.

For both approaches penoscrotal transposition was corrected at the time of the first procedure. All boys received temporary urinary diversion with an 8Fr silastic stent or an 8Fr Foley catheter, which remained in place for 7 to 14 days. Patients were seen at the time of stent or catheter removal (1 to 2 weeks postoperatively), and then at 3, 6 and 12 months postoperatively. After that yearly followup was planned, with uroflowmetry in toiled trained children. Complications were documented after the first repair and after redo surgery.

Penoscrotal transposition and degree of ventral curvature, type of ventral curvature repair, overall complication rate, type of complications, available uroflowmetry results in toilet trained patients and number of reoperations were compared between the 2 groups. We defined overall complication rate as all complications after the urethroplasty, including fistula, dehiscence, recurrent ventral curvature, meatal stenosis, diverticulum and urethral stricture. Uroflow results were analyzed based on percentiles according to the uroflow nomogram described by Toguri et al.[14] Descriptive statistics were carried out with the assistance of commercially available statistics software (SPSS® version 11.0). Student's t test and Pearson chi-square test were used for comparative analysis, with $p < 0.05$ considered to indicate statistical significance.

RESULTS

Mean patient age at surgery was 17 months (range 9 to 91) for TIP procedures and 17.8 months (10 to 58) for onlay procedures. Penoscrotal transposition was found in 40% of children in both groups (14 of 35 and 16 of 40, respectively; p not significant). Preoperative testosterone was given in 22 (29.3%) of the 75 patients, with 12 in the TIP group and 10 in the onlay group receiving testosterone (p not significant). Seven of 35 boys (20%) who underwent TIP repair had severe ventral curvature (defined as greater than 45 degrees on artificial erection), compared to 18 of 40 (45%) who underwent an onlay procedure ($p = 0.02$). After penile degloving, release of lateral attachments and radical proximal dissection dorsal plication was performed in 19 (54.3%) and 27 patients (67.5%) in the TIP and onlay groups, respectively (p not significant). Mean catheter duration was similar for both groups, at 8.8 days (range 7 to 10) for the TIP group and 10.1 days (7 to 14) for the onlay group (p not significant).

Respective mean followups were 30 months (range 6 to 74) and 38.8 months (16 to 80), with similar overall complication rates for TIP and onlay repairs (60% vs 45%, p not significant). The rate of fistula and wound breakdown was significantly higher after TIP repair, occurring in 18 of 35 boys (fistula 15, breakdown 3; 51.4%), compared to 10 of 40 (fistula 8, breakdown 2; 25%) who underwent an onlay procedure ($p = 0.01$). When analyzing separately the fistula rate between the 2 procedures the difference remained statistically significant (15 of 35, or 42.9%, vs 8 of 40, or 20%; $p = 0.03$).

Furthermore, fistula location was strikingly different between the 2 groups, with a proximal fistula developing in 11 of 15 TIP repairs (73.3%) vs 2 of 8 onlay repairs (25%, $p = 0.02$). There was no difference between midline closure and double faced flaps with regard to fistula rate in either group.

There were no urethral strictures after TIP repair and 2 after onlay repair. Meatal stenosis occurred in 1 patient following each procedure, neither of whom had a fistula. Residual curvature was slightly less frequent after TIP, occurring in 2 patients, compared to onlay (5 patients; 5.7% vs 12.5%; p not significant). The 2 patients who had recurrent ventral curvature following TIP repair did not require a further procedure due to the mild degree of curvature.

Of the 5 children with recurrent ventral curvature after onlay urethroplasty 3 had mild postoperative ventral curvature due to midline skin tethering and 2 underwent redo dorsal plication. All complications of both techniques are summarized in table 1. Only 2 of 35 patients (5.7%) undergoing TIP underwent more than 2 operations (initial surgery plus complication repair), compared to 7 of 40 patients (17.5%) undergoing onlay repair (p not significant). Figure 1 demonstrates the types of complications and the number of operations required to achieve success following each technique.

TABLE 1. *Complications of TIP and onlay urethroplasty*

Complications	No. TIP Repairs (%)	No. Onlay Repairs (%)	p Value
Fistula/breakdown:	18 (51.4)	10 (25)	0.01
Fistula	15 (42.9)	8 (20)	0.03
Breakdown/dehiscence	3 (8.6)	2 (5)	—
Location (proximal-to-distal)	11:4 (73:27)	2:6 (25:75)	0.02
Stricture	0 (0)	2 (5)	NS
Meatal stenosis	1 (2.9)	1 (2.5)	NS
Recurrent ventral curvature	2 (5.7)	5 (12.5)	NS
Totals	21 (60)	18 (45)	NS

TABLE 2. *Uroflowmetry findings in toilet trained patients after TIP and onlay urethroplasty*

Variables	No. TIP Repairs	No. Onlay Repairs	p Value
Mean ml/sec av flow rate (range)	6.4 (3.1–13.2)	9.0 (3.0–16.0)	0.02
Mean ml/sec peak flow rate (range)	8.4 (3.8–17.3)	11.9 (3.0–22.4)	0.01
Plateau-shaped uroflow curve (%)	16/24 (66.7)	7/21 (33.3)	<0.01
Post-void residual greater than 10% voided vol (%)	2/24 (8.3)	2/21 (9.5)	NS

In this analysis mean patient age was 5 years.

All toilet trained patients were subjected to at least 2 flow rate studies and the last one was considered for analysis. At a mean age of 5 years mean average flow rate was 6.4 ml per second (range 3.1 to 13.2) in patients undergoing TIP repair, compared to 9.0 ml per second (3.0 to 16.0, p = 0.02) for those undergoing onlay repair. Mean peak flow rates were 8.4 and 11.9 ml per second for TIP and onlay procedures, respectively. A plateau-shaped prolonged uroflow curve was observed in 16 of 24 children (66.7%) who underwent TIP repair vs 7 of 21 (33.3%) who underwent onlay repair (p <0.01). Post-void residual greater than 10% of the voided volume for age was seen in 2 of these patients after TIP repair and in 2 after onlay repair (8.3% vs 9.5%, p not significant). Table 2 summarizes the uroflowmetry findings.

DISCUSSION

Our experience suggests that the TIP and onlay procedures are clinically equivalent for repairing penoscrotal hypospadias, since they have similar overall complication rates. Although this was a single institution consecutive patient series, a selection bias is likely to exist by virtue of retrospective limitations. On the other hand, since the preoperative patient characteristics were similar in each group (except degree of ventral curvature), this series shows an equal application of each technique to the same type of hypospadias defect. Furthermore, TIP and onlay cases were age matched, had similar types of defect and had equal rates of penoscrotal transposition, reflecting important similarities between the groups and allowing for potentially meaningful comparisons.

Although the overall complication rate was similar for both techniques, some differences became evident when the type of complication was analyzed. Fistula rate was significantly higher after TIP vs onlay repair. Furthermore, fistula location was strikingly different between the 2 techniques, with proximal fistulas occurring in 73.3% of patients following TIP and in 25% following onlay repair. This particular finding is intriguing. Despite performing urethroplasty over an 8Fr catheter in both techniques, the preponderance of proximal fistulas suggests that a "long TIP" neourethra may generate increased flow resistance (relative to a short TIP for more distal repairs). As described by Poiseuille's law, the pressure differential created by a tube is directly related to its length and inversely related to the radius. Thus, although the TIP neourethra is stricture-free, its length-to-caliber ratio may be acting as a resistance (relative to the onlay neourethra) just beyond the native meatus, giving rise to a proximal fistula in the vicinity of the original proximal hypospadiac meatus.

When analyzing uroflowmetry at last followup in both groups a difference was noted with regard to the shape of the curve, which corroborates this potential for flow related resistance. Two-thirds of TIP cases were classified as "obstructive" with a plateau-shaped curve, falling below the 25th percentile according to the uroflow nomogram proposed by Toguri[14] and Marte[15] et al. Holmdahl et al reported similar results, observing 89% of plateau-shaped uroflow curves in children with proximal hypospadias at 1 year after TIP urethroplasty.[16] The clinical implications of the plateau uroflow remain ill defined, since to date all of our patients have been asymptomatic and able to empty the bladder, and have not had urinary tract infections. However, if the intraoperative caliber and length of the neourethroplasty are similar in the TIP and

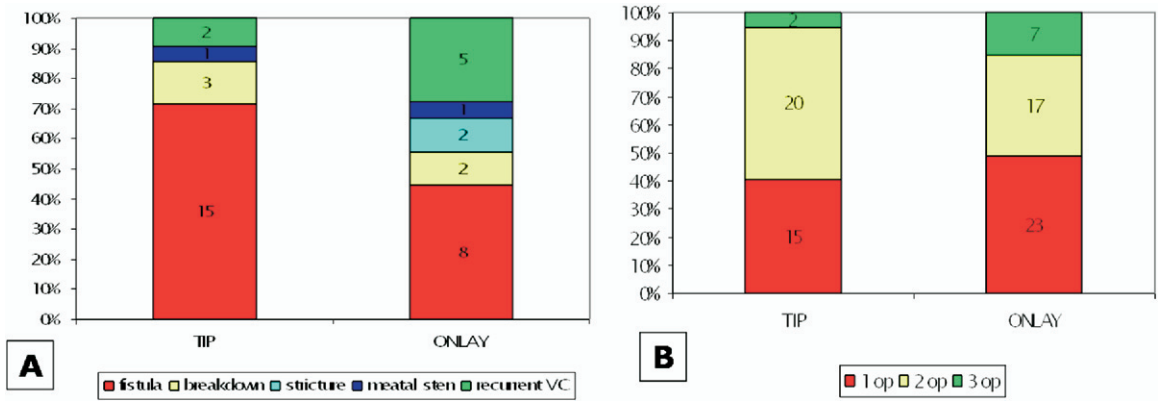

FIG. 1. *A*, distribution of findings in patients with complications of TIP and onlay techniques. *B*, number of procedures in all patients for TIP and onlay techniques.

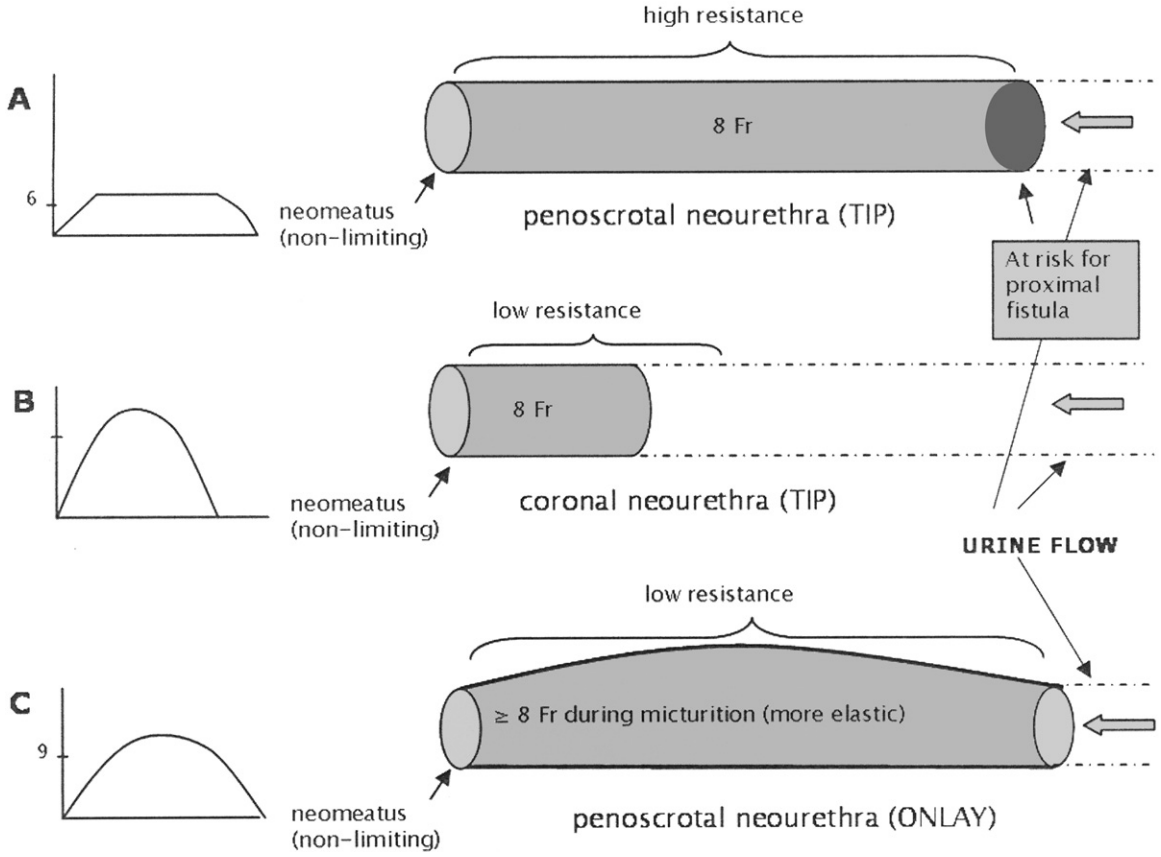

FIG. 2. Schematic representation of possible flow dynamics of neourethra following TIP vs onlay repair for penoscrotal hypospadias. *A*, penoscrotal TIP neourethra is longer than for coronal TIP repair. *B*, in absence of neomeatal stenosis (usually responsible for common distal fistulas) Poiseuille's law predicts high resistance in longer tube, and may explain proximal fistula after TIP repair. *C*, in more distensible (8Fr or greater during voiding) onlay neourethra made from skin would predict less resistance as well as bell-shaped flow curve.

onlay approaches, it is possible that the TIP neourethra is less distensible (elastic) during voiding than the onlay neourethra comprised of preputial skin. Comparatively, less elasticity in the neourethra (in the absence of frank stricture and neomeatal stenosis) could explain the high incidence of plateau flow curve, increased resistance and proximal fistula (fig. 2).

Possible TIP modifications may be considered in the context of a comparative study. However, it would be prudent to await the long-term clinical followup of current penoscrotal TIP repair cases to determine whether technical modifications are indicated.

Finally, while fistulas occurred in half of our patients following TIP repair, most consisted of pinhole type defects that were successfully repaired at a second intervention. Indeed, only 5% of patients undergoing TIP repair required more than 2 operations, suggesting that TIP urethroplasty is a reasonable option for penoscrotal hypospadias repair despite the higher rate of otherwise minor fistulas. The TIP technique allows reconstruction of severe defects in a more conceptually straightforward way, achieving good cosmetic results with a maximum of 2 operations in 95% of the children (fig. 1, *B*). These results are comparable or even superior to those reported with 2-stage repair of virgin hypospadias using buccal mucosa grafts (15% complication rate) and in some onlay urethroplasty series.[17,18]

It was interesting to observe that urethrocutaneous fistulas and recurrent curvature accounted for more than 90% of the complications in the patients who underwent a TIP repair. In contrast, while boys who underwent an onlay urethroplasty had fewer fistulas, they had more recurrent ventral curvature as well as urethral stricture. Therefore, taking into account the type of complication found after each surgical technique, it can be inferred that although onlay urethroplasty has a slightly lower overall complication rate (including fewer fistulas), its complications are more complex, since 7 of 40 patients (17.5%) treated with onlay repair underwent more than 2 operations, compared to 2 of 35 patients (5.7%) treated with TIP.

The overall complication rate for TIP repair is not particularly different from other series involving penoscrotal hypospadias when a careful analysis is performed.[4–8] It is important to separate proximal penile and mid shaft from penoscrotal hypospadias cases, since they are likely to have different outcomes. As demonstrated in a study by El-Sherbiny et al, the type of hypospadias (posterior defect) was 1 of the 2 factors that significantly influenced the outcome of TIP repair in a multivariate analysis.[19] Samuel and Wilcox observed a 22% overall complication rate after TIP urethroplasty for proximal hypospadias.[6] This lower complication rate than the previous series might have reflected their inclusion criteria, with few or no penoscrotal cases involving severe ventral curvature, since only 20% of their proximal cases required dorsal plication, as opposed to almost 60% in the present study. Therefore, their series probably reflects a different and possibly heterogeneous popula-

TABLE 3. *Published series and respective complications of TIP urethroplasty for penoscrotal hypospadias*

References	Yr	No. "Proximal" Cases*	No. True Penoscrotal Cases†	Complication Rate (%)	
				"Proximal"	Penoscrotal
Snodgrass et al[2]	1998	16	11	11	‡
Chen et al[7]	2000	11	16	29	31
Elbakry[3]	2002	8	4	‡	‡
Snodgrass and Lorenzo[5]	2002	13	7	46	57
Cheng et al[4]	2002	100	‡	4	‡
Palmer et al[8]	2002	0	7		29
Samuel and Wilcox[6]	2003	18	‡	10	‡
El-Sherbiny et al[19]	2004	27	‡	30	‡
Snodgrass and Yucel[20]	2007	35	‡	37	‡
Present study	2007	0	35	—	60

* Based on description in respective reports from literature.
† As defined in the present study.
‡ Not stated in the study.

tion of hypospadias defects, and underscores the need for precision in defining the original defects and their management.

The same imprecision might have occurred in the series by Cheng et al, since they grouped penoscrotal cases together with all proximal and mid shaft penile hypospadias, making it impossible to compare outcome as a function of type of defect.[4] Although they reported only a 4% complication rate, all fistulas occurred with penoscrotal defects and were also proximally located, as described for TIP repair in the present series. Recently, Snodgrass and Yucel found that the results of mid shaft vs proximal hypospadias repairs were significantly different, and emphasized the need for separate reporting of outcomes according to the severity of cases.[20]

When penoscrotal defects were strictly analyzed the complication rate reported by Snodgrass and Lorenzo was similar to the present study.[5] They included 13 patients with proximal and 7 with scrotal hypospadias. Of these patients 6 (46%) with proximal and 4 (57%) with scrotal hypospadias had complications. Similarly, in the experience of Chen et al with 40 proximal hypospadias cases 16 involved penoscrotal defects, with a complication rate of 31%.[7] Finally, Palmer et al observed 2 complications in 7 cases (29%) with *long TIP* for penoscrotal hypospadias, although their series is admittedly too small for generalization.[8] Therefore, based on a careful analysis of published reports of more than 10 patients, the complication rate after TIP urethroplasty for penoscrotal hypospadias ranges from 31% to 57%, which is not strikingly different from our results (60%), as outlined in table 3. To our knowledge we report the largest number of true, accurately defined penoscrotal defects to date.

Cosmetic outcome was not objectively assessed in this series, due to the difficulty in interpreting the meaning of a "good cosmetic result" in a retrospective fashion. It has been suggested that the TIP urethroplasty provides a better cosmetic result compared to the onlay procedure, although this claim has not yet been supported by a validated measurement tool devised for such a purpose. There is an obvious balance between cosmesis, functional outcome, complication rate and reproducibility that must be considered in all hypospadias surgery. This balance is still not well defined for most surgical interventions used for proximal hypospadias correction.

While the present study is limited by the methodological constraints of a retrospective analysis, we propose that adoption of a new surgical intervention should attempt to follow a rigorous method, using standardized outcome analysis combined with properly conducted randomized trials. This approach will provide the best evidence for implementing or rejecting new surgical procedures.

CONCLUSIONS

Penoscrotal hypospadias repair remains challenging. Although the overall complication rate in our series was similar for penoscrotal TIP and onlay urethroplasty, the fistula rate was significantly higher after TIP repair. However, TIP fistulas were small and were corrected by a simple procedure in the majority of cases. While post-void residuals were not increased, more plateau-shaped TIP flow curves may suggest that TIP urethroplasty creates a more inelastic, less distensible conduit, and, thus, behaves as a relative "resistance," prompting more proximal fistula formation. Nevertheless, at present both techniques appear to be clinically and functionally equivalent approaches to correcting penoscrotal hypospadias. Longer followup may reveal more divergent outcomes for these 2 techniques.

Abbreviations and Acronyms

NS = not significant
TIP = tubularized incised plate

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EDITORIAL COMMENT

The authors compared their initial experience with proximal TIP to their current results for proximal onlay urethroplasty (an operation they have used for more than 10 years), and found the overall complication rates similar. The most common problem following TIP was fistulas, which occurred in 43% of patients. In my first series of proximal TIP repairs I also used single layer tubularization and a dartos barrier flap but observed a 33% incidence of fistulas, which diminished to 10% using 2-layer subepithelial closure (reference 20 in article). Following that report I substituted tunica vaginalis for the dartos flap, and subsequently observed no fistulas in the next 14 patients. At least in my experience technical factors appear to influence the fistula rate after proximal TIP.

In this series most of the fistulas occurring after TIP were proximal, and the authors conclude that this outcome possibly indicates increased resistance to flow. However, in my series only 25% of fistulas following proximal TIP were penoscrotal, with the remainder subcoronal. My findings of mostly distal fistulas and an overall decreasing fistula rate do not support the hypothesis of pathologically increased flow resistance. Furthermore, the authors admit that the fistulas in their series were small and were successfully closed at a 2nd operation. However, if outflow resistance were increased sufficiently to cause fistulas, one might expect them to be likely to recur.

The neourethra is never a normal urethra. Therefore, uroflowometry is of uncertain value in assessing outcomes, although postoperative results below the 5th percentile should prompt further investigation to detect meatal stenosis or urethral stricture. Otherwise, flow rates after hypospadias surgery that are within the lower range of normal most likely reflect relative inelasticity and luminal irregularity of the neourethra. The authors speculate that the differences noted in TIP versus onlay uroflow related to the more distensible preputial skin in onlays. However, a third of their patients with flap urethroplasty also had plateau curves, and in a prior report from their institution a third of the patients had peak flow below the 5th percentile after flap repair.[1]

As the authors note, current preference among hypospadiologists for proximal hypospadias repair is divided between onlay and TIP, and so their comparison is timely. They are correct that there are few reported outcomes for proximal TIP but, in fact, there are fewer reports concerning onlays specifically for proximal hypospadias. I agree that additional studies with longer followup for both techniques are needed to delineate better the relative outcomes. This study provides a needed step in that direction.

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REPLY BY AUTHORS

We agree with the importance of careful and critical appraisal of outcomes in proximal hypospadias surgery. This study emphasizes several new considerations. It is of paramount importance to define and confirm the truly proximal, penoscrotal or scrotal position of the hypospadiac meatus before embarking on aggregate analysis and reporting of clinical hypospadias outcomes.

The relatively long neourethra of a proximal repair may enter into the equation governing flow resistance as defined by Poiseuille's Law, particularly in the absence of the more familiar fixed resistance typical of a meatal stenosis or stricture. As the length of a less compliant segment (neourethra) increases, the effect on flow rate becomes more profound. This observation has been clearly confirmed by the experimental work of Idzenga et al who demonstrated that shortening a model hypospadias tube led to an increase in flow rate.[1] Holmdahl et al showed clinically that all 24 boys with well defined proximal hypospadias treated with TIP repair had plateau curves at 2 and 12 months postoperatively, similar to the findings in our present study (reference 16 in article). Therefore, experimentally and clinically, in the absence of measurable stricture (ie, normal urethral calibration), the laws of physics dictate that increased tube rigidity

or decreased biomechanical tissue compliance of the neourethra, the effect of which is amplified by neourethral length, must be considered as previously unrecognized variables in the etiology of reduced peak flow/voiding velocity.

Small proximal fistulas are easily repaired and indeed do not recur, emphasizing the more favorable tissue conditions which likely prevail at fistula repair (typically months after the initial procedure), as opposed to the seemingly chaotic wound healing processes prevalent in the early postoperative period when the tissues are perhaps least likely to resist the effects of any resistance to flow and, thus, when fistulas are most likely to occur. While the heightened resistance reflected by plateau flow curves persists even after fistula repair, it is not so profound as to create fistula recurrence. Indeed, the clinical significance of the plateau flow curve itself requires further study.

Regardless of established versus newer surgical procedures, in the hands of experienced surgeons roughly equivalent outcomes as well as not insignificant reoperation rates were observed in this series. This finding suggests that complete understanding of the correction of severe hypospadias likely includes biological considerations that lie beyond technical factors.

1. Idzenga T, Kok J, Pel JM, van Mastrigt R and Wolffenbuttel KP: Is the impaired flow after hypospadias correction due to increased urethral stiffness? J Ped Urol 2006; **2:** 299.