
Tubularized Incised Plate for Mid Shaft and Proximal Hypospadias Repair

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Purpose: We report outcomes from tubularized incised plate repair of mid shaft and proximal hypospadias by a single surgeon.

Materials and Methods: Chart review of all patients undergoing mid shaft and proximal hypospadias was performed. Those with tubularized incised plate were divided into 2 groups for mid shaft and proximal repairs. Group 1 underwent single layer urethroplasty using chromic catgut suture, while group 2 underwent 2-layer polyglactin subepithelial closure. All patients had a dartos barrier flap, while spongioplasty was also done in group 2 when possible.

Results: A total of 30 patients underwent mid shaft repairs, while 35 had more proximal defects. Complication rates for mid shaft repairs did not differ between the 2 groups, and averaged 13%. However, complications in mid shaft vs proximal repairs (37%) were significantly different ($p = 0.04$). Overall complications (53% vs 25%) and incidence of fistulas (33% vs 10%) decreased in proximal repairs from group 1 to 2.

Conclusions: Tubularized incised plate repair was applicable for all mid shaft hypospadias cases and for those more proximal cases when ventral curvature could be straightened without plate transection and the incised plate was grossly supple. Outcomes were improved using 2-layer subepithelial tubularization of the neourethra. Results of mid shaft vs proximal hypospadias repairs are significantly different and should be reported separately.

Key Words: hypospadias; urologic surgical procedures, male; surgical flaps; urethra

Tubularized incised plate urethroplasty for mid shaft and penoscrotal hypospadias was first reported from a multicenter experience in 1998.¹ Since then, an additional 6 publications have reviewed outcomes for this technique, extending its use to scrotal and perineal defects.²⁻⁷ Outcomes compare favorably with those from preputial flaps, resulting in increased reliance on TIP for mid shaft and proximal cases when ventral curvature does not lead to plate transection for straightening.⁸ However, there is potential selection bias in these studies, since neither the number of mid shaft and proximal cases undergoing alternative repairs nor factors in decision making favoring 1 technique over another were provided.

Our earlier study of TIP for mid shaft to scrotal hypospadias revealed complications in 33% of cases.⁴ Most of these complications were fistulas occurring despite a dartos barrier flap over the neourethra. Dehiscence and recurrent ventral curvature occurred in 1 patient each with penoscrotal defects, thought intraoperatively to have an "unhealthy" appearing incised urethral plate. Following this experience several technical modifications were made, primarily to decrease fistulas, and it was determined that patients with an unhealthy plate would not undergo TIP repair.

We report decision making for mid shaft and proximal hypospadias repair in consecutive patients by a single sur-

geon (WS). Tubularized incised plate outcomes following technical modification are compared to the original series.

MATERIALS AND METHODS

We queried the database of the senior author (WS) for all patients undergoing primary repair for mid shaft and proximal hypospadias. The intent was to perform TIP urethroplasty unless specifically contraindicated. Initially, ventral curvature judged too severe to straighten with a single dorsal plication using 6-zero polypropylene was the sole contraindication, since it resulted in urethral plate transection. Following recognition of an unhealthy appearing incised plate, the finding of grossly deficient subepithelial tissues with inelasticity of the plate constituted a second contraindication for TIP.

Patients undergoing TIP were divided into 2 groups according to variations in surgical technique. Group 1 underwent tubularization in a single layer using 7-zero chromic catgut and various suturing methods, including interrupted or running stitches placed through all layers or subepithelial (not recorded in 2 patients).^{8,18} A de-epithelialized dartos flap harvested from the dorsal prepuce and shaft was used as a barrier layer in all cases. These cases were initially reported in 2002,⁴ and recognition of a 21% fistula rate led to several modifications in group 2.

In patient group 2 plate tubularization was performed using 7-zero polyglactin in 2 layers, turning all epithelium into the lumen. For all proximal and 5 mid shaft cases the first layer was interrupted and the second running, while in the remaining 12 mid shaft repairs running closure was

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TABLE 1. Patient treatment and followup

	Mid Shaft		Proximal	
	Group 1	Group 2	Group 1	Group 2
No. pts	13	17	15	20
No. preop testosterone	0	1	5	4
No. dorsal plication	5	6	10	14
No. spongioplasty	0	10	0	16
No. urethral plate mobilization	0	0	1	1
Mean mos postop followup (range)	7.6 (1-18)	7.2 (1-21)	21.8 (1-79)	11.1 (1-37)
No. calibration	8	13	9	14
No. uroflowmetry	2	1	4	0
No. urethroscopy	3	2	11	8

performed in 2 layers. When possible corpus spongiosum alongside the urethral plate was mobilized from the surface of the corpora cavernosa and approximated over the neourethra in Y-to-I fashion,⁹ performed in 10 mid shaft and 16 proximal repairs. Next, a dartos or tunica vaginalis flap was additionally used to cover the entire neourethra before glanuloplasty and skin closure. In both groups postoperative urinary diversion with a 6Fr dripping urethral stent was maintained for 7 to 10 days, and 4 mg/kg sulfamethoxazole/trimethoprim was administered twice daily.

Designation as mid shaft or proximal was based on meatal position at the beginning of urethroplasty. "Cutback" to a more proximal location was only performed when overlying shaft skin could not be dissected from the formed urethra, creating the appearance of a thin distal urethral segment. Throughout the study intramuscular testosterone injections (2 mg/kg every 3 weeks for 2 or 3 injections) were given preoperatively for a subjectively small penis, especially when the glans appeared small.

Followup included office neourethra calibration with sounds approximately 6 months postoperatively, uroflowmetry in toilet trained patients and urethroscopy, usually during repair of complications. Statistical analysis of outcomes was performed using Pearson chi-square.

RESULTS

A total of 91 patients underwent primary hypospadias repair for mid shaft or more severe defects. All 35 patients with mid shaft hypospadias underwent TIP repair. Of the remaining 56 boys with proximal shaft to perineal hypospadias 36 (64%) underwent TIP repair, while 20 (36%) underwent staged urethroplasty for an unhealthy appearing incised plate¹ or for ventral curvature believed to warrant plate transection to assist in straightening.¹⁹ Of these pa-

tients undergoing mid shaft and proximal TIP repair 5 had no followup and were excluded from analysis. Proximal cases with followup included 29 proximal shaft/penoscrotal, 5 scrotal and 1 perineal instance of hypospadias. Cases managed by staged repair included 7 proximal shaft/penoscrotal, 12 scrotal and 1 perineal.

Patient characteristics for the 2 groups undergoing TIP are summarized in table 1. Ventral curvature persisting after the penis was degloved was noted overall in 11 patients (37%) of 30 with mid shaft and 24 (69%) of 35 with more proximal hypospadias. In group 1 artificial erection was done after the penis was degloved, whereas in group 2 it was deferred until after corpus spongiosum was mobilized.

A thin distal urethra was cut back proximally in 7 patients (14%), 4 with a subcoronal meatus opened to mid shaft, 1 with a distal shaft meatus incised back to the proximal shaft and 2 with a mid shaft meatus extended to the penoscrotal junction. During this time another 368 patients underwent distal shaft to glanular hypospadias repair without urethral incision proximally to the mid or proximal shaft.

Complication rates for mid shaft repairs were 15% in group 1 and 12% in group 2, averaging 13%. Overall complications for proximal repairs averaged 37%, and the difference in mid shaft vs proximal surgical outcomes was statistically significant ($p = 0.04$, table 2). For proximal hypospadias 8 of 15 patients (53%) in group 1 had complications vs 5 of 20 (25%) in group 2 ($p = 0.08$), including fistulas in 5 patients (33%) in group 1 and 2 patients (10%) in group 2 ($p = 0.11$). Although decreased overall complications and fewer fistulas were noted in proximal repairs between groups 1 and 2, approximately 60 patients would be needed for each of the 2 groups to demonstrate statistical significance. Among group 2 patients 4 had fistulas, of whom 3 had undergone spongioplasty.

DISCUSSION

Our intention was to perform TIP repair for all patients with mid shaft or more proximal hypospadias unless contraindicated, usually by ventral curvature to such an extent that plate transection appeared needed for straightening. We found all mid shaft cases could be repaired by TIP, with 36% requiring a single dorsal plication using 6-zero polypropylene. Of boys with proximal shaft to perineal hypospadias a third were judged to have ventral curvature best treated by urethral plate transection and staged urethroplasty. A single dorsal plication was done in 24 patients (69%) with proximal hypospadias repaired by TIP.

TABLE 2. Complications

Complication	No. Mid Shaft (%)		No. Proximal (%)	
	Group 1	Group 2	Group 1	Group 2
Total pts	13	17	15	20
Fistula	1*	2	5*	2
Meatal stenosis			1*	0
Neourethral stricture	1*		0	0
Dehiscence (glans or complete)	1 Glans		1 Complete	1 Glans, 1 complete
Recurrent curvature	0	0	2	1
Totals	2 (15)	2 (12), $p = 0.52$	8 (53)	5 (25), $p = 0.08$
Mean by group		4 (13)		13 (37), $p = 0.04$

* Patient(s) had both complications.

TABLE 3. Studies of mid shaft to proximal TIP

References	No. Cases	No. Ventral Curvatures (%)	Mos Followup	No. Complications (%)	No. Complications				
					Fistula	Meatal Stenosis	Neourethral Stricture	Dehiscence	Recurrent Curvature
Snodgrass et al ^{1,*}	16 Mid shaft, 11 proximal	11 (69), 10 (91)	Not stated	3 (11)	1	1	0	1 Complete	Not stated
Chen et al ²	10 Mid shaft, 27 proximal	9 (24)	Mean 12.5	2 (20), 5 (19)	2† 4†	1† 3†	0 0	Not stated Not stated	Not stated Not stated
Borer et al ³	16 Mid shaft, 9 proximal	Unknown	Range 6–38	1 (6), 2 (22)	1 2	Not stated Not stated	Not stated Not stated	Not stated Not stated	Not stated Not stated
Snodgrass and Lorenzo ⁴	13 Mid shaft, 20 proximal	5 (38), 13 (65)	Mean 9	2 (15), 9 (45)	1 6†	0 1†	1 0	0 1	0 2
Cheng et al ^{5,*}	100 “Midshaft to penoscrotal”	Unknown	Range 4–66	4 (4)	3	1	0	Not stated	Not stated
Samuel and Wilcox ⁶	18 Proximal	4 (22)	Mean 4	4 (22)	1	0	0	3 Glans	Not stated
Mustafa ⁷	1 Mid shaft, 12 proximal	1 (100), 1 (8)	Not stated	4 (31)	3	1	0	Not stated	Not stated
Totals	253			36 (14)					

* Multicenter trial.

† One patient had more than 1 complication.

Although spongioplasty was incorporated to add another barrier layer against fistulas, we noted mobilization of the splayed corpus spongiosum, and in 2 cases the entire urethral plate from the underlying corpora cavernosa helped decrease the extent of curvature. Despite dissection of the urethral plate off the corpora cavernosa, incision and tubularization still were possible without completely dividing the plate into 2 longitudinal strips, and neither of these patients had postoperative complications. Our experience supports the observation of Mollard and Castagnola that the plate can be elevated without devascularization to reduce ventral curvature.¹⁰

When the urethral plate is transected options for urethroplasty include 1-stage tubularized preputial flaps or grafts, and staged Byar’s skin flaps or grafts. Following plate transection, ventral corpora grafting also is often performed, limiting urethroplasty to flaps to avoid placing a urethroplasty graft onto the corporeal patch graft. Dissatisfaction with these options recently has increased our interest in preserving the urethral plate. Accordingly, we currently elevate the entire urethral plate and mobilize the bulbar urethra proximally as 1 unit to reduce significant curvature that previously would have led to plate transection. Patients undergoing this approach were operated on after those reported in this series, and will be the subject of a future review.

There were 2 boys with proximal hypospadias in group 1 noted intraoperatively to have a straight penis but an unhealthy incised urethral plate. As previously reported, TIP in these patients resulted in complete wound dehiscence and contracture of the neourethra with recurrent curvature in 1 each.⁴ During the treatment of group 2 1 additional patient was thought to have grossly deficient subepithelial tissues and an inelastic urethral plate, which led to staged repair. Therefore, 3 of 56 patients (5%) with proximal hypospadias had this contraindication to TIP.

Our initial patients undergoing TIP for mid shaft to proximal hypospadias repair had a fistula rate of 21%.⁴ Subsequently, modifications were made in urethroplasty designed to decrease this problem, including change from chromic catgut to polyglactin, 2-layer closure, turning epithelium

into the lumen and spongioplasty. The overall rate of fistulas decreased from 21% in group 1 to 11% in group 2, and from 33% to 10% when only proximal repairs were considered. However, the number of patients was not sufficient to show statistical significance.

The fact that all patients in group 1 had a dorsal dartos barrier flap placed over the neourethra indicates this maneuver alone is not sufficient to avoid fistulas. Since several technical changes were made simultaneously, it is not possible to comment on the relative importance of any specific modification, except to note 3 of 4 fistulas in group 2 occurred after spongioplasty. Consequently, we believe subepithelial tubularization may be the most important factor to reduce fistulas.

Table 3 summarizes published reports of mid shaft to proximal TIP repairs. Incidence of ventral curvature was not mentioned in 2 articles, and varied from 8% to 91% for proximal cases in the remainder. The first multicenter experience averaged only 4.5 cases per surgeon and included an additional 7 patients in whom glanular TIP was combined with other techniques to reconstruct the penile urethra.¹ The subsequent multicenter study by Cheng et al comprised 17 mid to proximal shaft repairs per surgeon.⁵ None of the articles in table 3 differentiated patients with mid shaft to proximal hypospadias operated on during the study periods using alternative techniques. A recent survey indicated TIP was preferred by 83% of participating surgeons for mid shaft but only 43% for proximal repairs when there was no “chordee.”⁸ Together these observations suggest selection bias in choosing patients for mid shaft to proximal TIP vs other urethroplasties, which may have influenced outcomes and makes comparison to the current series difficult.

Among reports listed in table 3 descriptions of suturing techniques and use of barrier layers that could be related to specific outcomes were only provided by Cheng et al.⁵ In their multicenter study all surgeons tubularized the neourethra in 2 layers, inverting the epithelium, and then covered the neourethra with a dartos flap. They reported the lowest incidence of fistulas. However, it is unclear how many of

TABLE 4. Onlay preputial flap for proximal hypospadias

	Mollard et al ¹⁴	Barroso et al ¹³	Samuel et al ¹⁵
No. cases	22 Mid to proximal shaft	12 Mid shaft, 35 proximal	17 Proximal
No. ventral curvatures (%)	22 (100)	29 (62)	10 (59)*
Mean followup	Not stated	15.2 Mos	3.2 Yrs
No. complications (%)	0	12 (26)	10 (59)
No. complication types:			
Fistulas	0	2,† 6	10
Meatal stenosis	0	2†	2
Neourethral stricture	0	Not stated	0
Dehiscence	0	2†	0
Recurrent curvature	0	2†	0
Diverticulum	0	4†	0
Balanitis xerotica obliterans	0	0	2

* Unclear whether patients with meatal stenosis or balanitis xerotica obliterans also had fistulas, or were not counted as having complications.

† One patient had more than 1 complication.

their 100 patients had mid shaft vs more proximal hypospadias, which also impacts the fistula rate.

Our current series of TIP distal repairs has a 2.5% complication rate (unpublished data), which contrasts with 12% for mid shaft and 25% for proximal hypospadias reported herein. While it is not surprising that complications increase with the severity of the defect being corrected, this observation nevertheless is important given the tendency for reports to mix outcomes of patients with different extents of hypospadias. Similarly, we only included patients undergoing primary TIP repair, since our experience and that of others reveal a greater rate of complications in reoperations vs primary surgeries.

Despite these limitations, our experience and the available literature demonstrate there is a role for TIP repair in mid shaft and proximal hypospadias. Careful reporting of measures used to correct ventral curvature, location of the meatus, technical details regarding urethroplasty, and duration and means of evaluation during followup will better clarify use and limitations of TIP, especially in proximal cases.

Preputial flaps remain an alternative option for mid shaft and proximal hypospadias repair, with the onlay preferred when the urethral plate can be maintained. However, the majority of reports concerning onlay flaps primarily comprise patients with distal to mid shaft defects. The original publication by Elder et al included 44% distal and 54% mid shaft hypospadias.¹¹ A subsequent study from the same institution by Baskin et al showed 83% of the 374 patients undergoing onlay had mid to distal hypospadias.¹² Furthermore, an unreported number of cases designated as mid shaft presented with more distal defects that were cut back proximally. Specifically, "thin" tubularized skin distal to the intact corpus spongiosum was incised proximally to "well vascularized spongiosum."¹¹ Reasons for cutting back the distal meatus were not further explained by Elder et al,¹¹ but photographs of a representative case allow speculation that the maneuver was used to create a defect amenable to onlay repair when meatal configuration was not satisfactory for meatal advancement and glanuloplasty (also known as MAGPI). In contrast, we only used this maneuver for those cases in which it was not possible to dissect overlying shaft skin from the urethra.

Table 4 lists the only published series of which we are aware concerning onlay flap specifically for proximal hypospadias.¹³⁻¹⁵ Given that 43% of participants in a recent survey responded that onlay is their preferred option for

proximal hypospadias without significant curvature, there is a need for additional outcomes reporting for this technique when specifically applied to mid shaft and more proximal repairs.

Even if onlay and TIP have similar complication rates, the original impetus for developing TIP was to improve on the cosmetic results obtained with flip-flaps and onlay flaps. It remains our impression that TIP creates a more normal appearing penis, and we currently are administering post-operative questionnaires for surgeons and parents to validate further this justification for the procedure.

CONCLUSIONS

In this study we report expected outcomes for TIP repair in mid shaft and proximal hypospadias. Technical modifications, including use of polyglactin sutures, 2-layer urethroplasty, turning epithelium into the lumen and spongio-plasty, have reduced overall complications since our earlier series. Complication rates increase significantly as the defect progresses from mid shaft to proximal hypospadias, emphasizing the need for separate reporting of outcomes according to severity of cases. While onlay flaps remain a popular choice for surgeons correcting proximal hypospadias when the plate can be preserved during straightening maneuvers, there is a need for reporting outcomes specifically for mid shaft and proximal hypospadias repairs. In our experience TIP could be used to repair all mid shaft hypospadias, and proximal cases when the urethral plate could be maintained during straightening and appeared healthy after a midline relaxing incision.

Abbreviations and Acronyms

TIP = tubularized incised plate

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