

TUBULARIZED INCISED PLATE URETHROPLASTY: EXPANDED USE IN PRIMARY AND REPEAT SURGERY FOR HYPOSPADIAS

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ABSTRACT

Purpose: We evaluated the impact of tubularized incised plate urethroplasty on primary and repeat hypospadias repair.

Materials and Methods: We retrospectively reviewed the medical records of all boys who underwent hypospadias repair at our institution during a recent 3-year period. The level of the hypospadias defect, technique of repair, primary repair versus reoperation, age at surgery and complications were recorded.

Results: A total of 520 hypospadias repairs were done from May 1996 through June 1999. We began to perform tubularized incised plate urethroplasty in November 1996. During the ensuing consecutive 32 months 181 primary and 25 repeat hypospadias repairs were done using this technique. Mean patient age at surgery was 22 months (range 3 months to 30 years). During the 6 months immediately before we began to use this method the Mathieu flip-flap procedure was the most commonly performed technique, accounting for 38% of all hypospadias repairs. In contrast, during the last 6 months reviewed tubularized incised plate urethroplasty accounted for 63% of all repairs, including 41 of 65 primary operations (63%) and 4 of 6 reoperations (67%), while no Mathieu procedures were performed. Postoperative followup was 6 to 38 months for tubularized incised plate repair. Overall meatal stenosis and a urethrocutaneous fistula developed in 1 and 14 boys, respectively (7% complication rate).

Conclusions: Tubularized incised plate urethroplasty has become the preferred technique of primary and repeat hypospadias repair at our institution. The technique has few complications as well as proved success and versatility that continues to expand its applicability and popularity.

KEY WORDS: urethra, hypospadias, abnormalities

Longitudinal midline incision of the distal urethral plate was initially described by Rich et al in 1989 for improving the cosmetic result of the Mathieu and onlay island flap repairs.¹ In 1994 Snodgrass reported extension of the incision proximally to the level of the hypospadiac meatus and emphasized that deep incision of the shallow urethral plate was the most important part of tubularized incised plate urethroplasty.² Since this initial description for use in distal hypospadias repair, additional experience with tubularized incised plate urethroplasty for distal and more proximal defects has been reported by others at several centers.^{3–8} Excellent results have also been noted in repeat and complex hypospadias repairs.^{3,7}

We began to perform this procedure in November 1996, primarily for repairing coronal to mid penile shaft defects.⁷ More recently, we have expanded its role for primary, repeat and complex hypospadias as well as for more proximal defects.⁹ We report the impact of tubularized incised plate urethroplasty on primary and repeat hypospadias repair at our institution since incorporating this technique.

MATERIALS AND METHODS

We retrospectively reviewed the medical records of all consecutive boys at our institution who underwent hypospadias repair from May 1996 through June 1999. Internal review board approval was obtained. The position of the hypospadiac urethral meatus, technique of repair, primary surgery versus

reoperation, patient age at repair and complications were recorded.

The level of the hypospadiac urethral meatus was documented as the meatal position after any indicated orthoplasty, as proposed by Barcat.¹⁰ Meatal position was glanular, coronal, subcoronal (anterior or distal), distal, mid or proximal penile shaft (mid), or penoscrotal, scrotal or perineal (posterior or proximal). Repair involved meatal advancement and glanuloplasty or another distal advancement technique (dorsal meatoplasty, glans approximation, and distal urethral dissection and advancement), a Duplay or other tubularization procedure (Thiersch-Duplay or King), tubularized incised plate urethroplasty, or a Mathieu, onlay island flap, transverse preputial island flap or 2-stage procedure according to the previous original description or modification.^{9,11}

The technique of choice for a given defect varied somewhat according to the preference of the 7 pediatric urologists who participated in this study. However, generally the indication for tubularized incised plate urethroplasty was distal and mid hypospadias with a shallow glanular groove. Defects at a similar level with a deep glanular groove and a phallus with a urethral plate of sufficient breadth were repaired by a Thiersch-Duplay or King tubularization technique. The Mathieu procedure was perhaps also suitable in this situation when the proximal extent of the flap excluded hair-bearing skin, but it was not favored in more recent experience because of inferior cosmesis and flap vascularity. We preferred the onlay technique when there was a small phallus with significant curvature and breadth inadequate for tubularization only or tubularized incised plate urethro-

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plasty, and in specific cases of a conical glans with a shallow groove not amenable to tubularized incised plate repair.

We have previously described modifications to tubularized incised plate urethroplasty.^{7,9} Briefly, the technique begins by placing a stay suture in the glans penis and outlining the urethral plate at a width of approximately 7 to 9 mm, depending on phallus size. The glans penis is injected with 1:200,000 epinephrine diluted in 1% lidocaine at the proposed incision sites. Parallel longitudinal incisions demarcating the urethral plate are made, extending from the tip of the glans to a point just proximal to the hypospadiac meatus. A transverse incision across the skin and overlying the urethra completes the U-shaped incision. A circumferential incision 5 to 7 mm proximal to the coronal margin is extended from each longitudinal incision and the penile shaft is degloved. Orthoplasty is performed as needed by dorsal tunica albuginea plication.¹²

The first critical point in this repair involves longitudinal midline incision of the urethral plate from the tip of the penis to the hypospadiac meatus (fig. 1, A). The urethral plate is then tubularized over a 6Fr silicone catheter with a running subcuticular fine polyglactin suture. The second critical point involves fashioning a wide meatus (fig. 1, B). Second layer coverage of the neourethra with a well vascularized subcutaneous dartos tissue flap harvested from the dorsal preputial and shaft skin is the third critical aspect (fig. 1, C). For more proximal repair a tunica vaginalis flap may be used for this purpose.¹³

The glans wings are then approximated under minimal tension in 2 layers, the indwelling silicone urethral catheter is secured to the glans penis and skin coverage is completed. A 6 or 7Fr silicone urethral catheter remains indwelling to drain the repair and decompress the bladder for approximately 7 to 10 days in patients who are younger than 3 years and/or not yet toilet trained. Postoperatively in older patients overnight bladder decompression is routinely provided via a 3.5Fr feeding tube passed through a 7Fr silicone urethral "splint" with a proximal tip 1 to 2 cm proximal to the repair. The "splint" is removed after 7 to 10 days. The technique is similar in previously circumcised and previously operated cases. Local subcutaneous tissue or a tunica vaginalis flap may be used for second layer neourethral coverage. Mobilized ventral shaft skin is usually sufficient for coverage.

RESULTS

In the 38 months from May 1, 1996 through June 30, 1999 we performed 520 hypospadias repairs. At our institution we began to perform tubularized incised plate urethroplasty in November 1996. During the ensuing consecutive 32 months from November 1, 1996 through June 30, 1999, 444 repairs

were done, of which 206 (46%) involved this procedure (table 1). The 206 repairs included 181 primary operations and 25 reoperations. Seven primary operations were considered complex because perineal and scrotal hypospadias repair in 4 and 3, respectively, adjunctively incorporated tubularized incised plate urethroplasty for a residual distal anomaly. Patient age at surgery was 3 months to 30 years (mean, median and mode 22, 8.5 and 6 months, respectively). Figure 2 shows the dramatic increase in the relative frequency of tubularized incised plate urethroplasty since we began performing this technique.

During the 6-month period immediately before urethroplasty use the Mathieu flip-flap procedure was the most common technique, accounting for 39% of primary and 29% of repeat hypospadias repairs. However, during the last 6 study months tubularized incised plate urethroplasty accounted for 63% of all repairs, including 41 of 65 primary operations (63%) and 4 of 6 reoperations (67%), while no Mathieu procedures were performed (tables 2 and 3). The hypospadiac meatus was classified as distal in 149 cases (72%), mid in 51 (25%) and proximal in 6 (3%) (table 4).

Postoperatively followup was 6 to 38 months. Overall there was meatal stenosis and a urethrocutaneous fistula in 1 and 14 boys, respectively (7% complication rate). A fistula developed after primary repair with tubularized incised plate urethroplasty in 9 cases (5%) and a complication developed after tubularized incised plate reoperation in 6 (24%). In patients with a urethrocutaneous fistula the initial defect was coronal, subcoronal, distal, and at the mid and proximal penile shaft in 6, 4, 1, 1 and 2, respectively. The fistula site was coronal in 9 cases, subcoronal in 3, and at the distal and mid penile shaft in 1 each. A urethrocutaneous fistula was repaired by multilayer closure without stenting in 13 cases. In 1 boy with a coronal fistula a transverse skin bridge between the glanular neomeatus and fistula site was incised longitudinally and repeat tubularized incised plate urethroplasty was done successfully. Meatal stenosis in 1 boy after primary repair of a coronal defect was managed by urethral meatotomy. Meatal stenosis or a urethrocutaneous fistula was diagnosed 2 weeks to 6 months (average 3 months) after initial tubularized incised plate urethroplasty.

The overall 7% complication rate for tubularized incised plate urethroplasty involved 9 complications after 181 primary (5%) and 6 after 25 repeat (24%) repairs. Previous unsuccessful repairs before repeat urethroplasty was performed included a Mathieu procedure in 8 cases, 2-stage repair in 6, onlay flap in 4, unknown surgery in 3, and meatal advancement and glanuloplasty, tubularized incised plate, Duplay and transverse preputial island flap (Duckett tube) in 1 each. The 6 complications, including meatal stenosis in 1

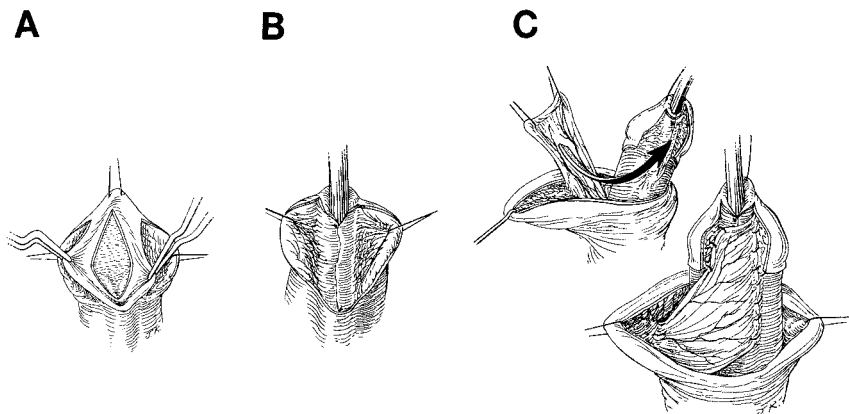


FIG. 1. Crucial steps in tubularized incised plate urethroplasty technique. A, incision of urethral plate. B, creation of wide meatus. C, second layer coverage of neourethra with repositioned subcutaneous dartos tissue.

TABLE 1. *Technique of hypospadias repair in 444 cases from November 1996 through June 1999*

| Technique | No. (%) |
|---|----------|
| Tubularized incised plate urethroplasty | 206 (46) |
| Meatal advancement and glanuloplasty* | 71 (16) |
| Mathieu | 68 (15) |
| Duplay | 41 (9) |
| Onlay | 26 (6) |
| 2-Stage | 17 (4) |
| Transverse preputial island flap | 15 (4) |

* Includes other meatal advancement procedures, such as dorsal meato-plasty, glans approximation procedure, and circumferential distal urethral dissection and advancement.

TABLE 3. *Technique and relative frequency of reoperative hypospadias repair during designated periods*

| Technique | No. Repairs/6 Mos. (%) | |
|--------------------------------------|--|---------------|
| | Immediately Before Tubularized Incised Plate Urethroplasty | Most Recently |
| Tubularized incised plate | 0 | 4 (67) |
| Duplay | 4 (57) | 2 (33) |
| Mathieu | 2 (29) | 0 |
| Meatal advancement and glanuloplasty | 1 (14) | 0 |
| Totals | 7 (100) | 6 (100) |

Trend for TIP Urethroplasty

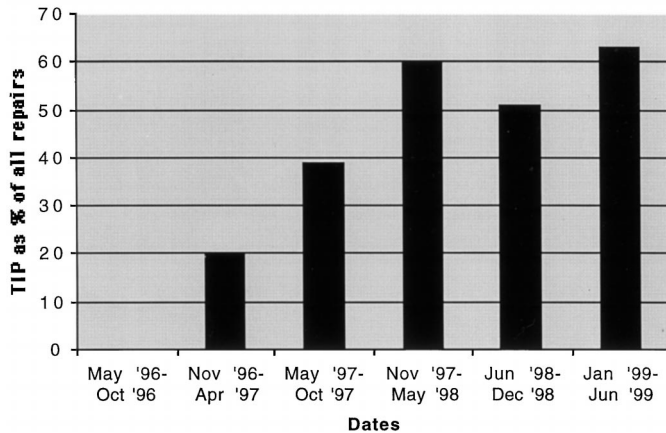


FIG. 2. Trend for frequency of tubularized incised plate (TIP) urethroplasty from November 1996 through June 1999 divided into 5 intervals of approximately 6 months each. No tubularized incised plate urethroplasties were performed before November 1996.

TABLE 2. *Technique and relative frequency of primary hypospadias repair during designated periods*

| Technique | No. Repairs/6-Mos. (%) | |
|---------------------------------------|--|---------------|
| | Immediately Before Tubularized Incised Plate Urethroplasty | Most Recently |
| Tubularized incised plate | 0 | 41 (63) |
| Mathieu | 27 (39) | 0 |
| Meatal advancement and glanuloplasty* | 27 (39) | 15 (23) |
| Duplay | 5 (7) | 4 (6) |
| Onlay | 5 (7) | 1 (2) |
| 2-Stage | 4 (6) | 4 (6) |
| Transverse preputial island flap | 1 (2) | 0 |
| Totals | 69 (100) | 65 (100) |

* Includes other meatal advancement procedures, such as dorsal meato-plasty, glans approximation procedure, and circumferential distal urethral dissection and advancement.

case after previous tubularized incised plate urethroplasty, developed after a Mathieu procedure in 2, 2-stage repair in 2 and transverse preputial island flap in 1. There was no second layer dartos or tunica vaginalis coverage of the neourethra in 4 of the 5 boys with a fistula. In our 32-month experience since we began to perform tubularized incised plate urethroplasty, there have been no significant differences in the complication rate of this procedure compared with that of the Mathieu, Duplay and onlay techniques (5%, 7%, 5% and 8%, respectively).

DISCUSSION

Tubularized incised plate urethroplasty is one of several established, successful methods of repairing anterior and

mid hypospadias.^{9,11} Since its initial description in 1994 by Snodgrass,² extensive, successful and varied experience with this technique has been reported.^{3-7,9} Further evidence of its increasing popularity was provided by the longitudinal study of Decter and Franzoni.⁸ In a review of their recent experience they indicated that tubularized incised plate urethroplasty had virtually supplanted all other methods used in the past for correcting distal hypospadias.

In our series we documented a precipitous increase in the incidence of tubularized incised plate urethroplasty relative to other techniques for primary and repeat hypospadias repair at our institution. Specifically urethroplasty was done for 20%, 39% and 60% of all repairs during the first, second and third 6-month periods that it was performed, respectively (fig. 2). This trend was true for primary and repeat hypospadias surgery. Tables 1 and 2 show the absolute impact of tubularized incised plate urethroplasty by comparing and contrasting the frequency of performing various techniques before incorporating this method and during the most recent 6 months of our experience. Urethroplasty has effectively eliminated the Mathieu procedure for primary and repeat repair. However, because of specific surgeon preference for repairing distal defects, it has not significantly altered the number of meatal advancement and glanuloplasty or other distal advancement procedures performed.

Our report incorporates the experience of 7 pediatric urologists. There was significant variability among these surgeons with regard to the technique of choice for distal hypospadias repair, particularly glanular and coronal repair. The fact that some surgeons performed only meatal advancement and glanuloplasty or another advancement procedure for glanular and coronal hypospadias is the primary reason why these techniques still accounted for almost 25% of all repairs in the most recent 6 months reviewed (table 2) and approximately 16% of all repairs in the 32 months since we began to perform tubularized incised plate urethroplasty at our institution (table 1).

In our study we observed no significant difference in the complication rate of tubularized incised plate urethroplasty, or the Mathieu, Duplay or onlay technique. Therefore, differences in the complication rates did not explain our preference for urethroplasty in specific situations. When possible, for repairing a distal or mid hypospadias defect we prefer to limit the number of incisions and suture lines, so that the Duplay technique is preferable to tubularized incised plate, Mathieu and onlay repair, and the Duplay technique and tubularized incised plate urethroplasty are preferable to Mathieu and onlay repair, respectively. In addition, we prefer to optimize cosmesis, so that tubularized incised plate urethroplasty is preferable to all other repairs. Generally our indications for urethroplasty are distal and mid hypospadiac defects with a shallow glanular groove, as described.

It is our impression that several principles are responsible for the success, versatility and preference of tubularized incised plate urethroplasty. These principles include generous vascularity of the urethral plate, relative simplicity of the technique, consistent availability of tissue necessary to com-

TABLE 4. Level of hypospadias defect in 181 primary and 25 reoperative tubularized incised plate urethroplasties, and site of eventual urethrocuteaneous fistula in 14 cases from November 1996 through June 1999

| Defect Level | No. Repairs | | No. Fistulas/Defect Site (level) | |
|---------------|-------------|-------------|----------------------------------|----------------|
| | Primary | Reoperative | Primary | Reoperative |
| Glanular | 6 | 0 | 0 | 0 |
| Coronal | 63 | 17 | 3 (coronal) | 3 (coronal) |
| Subcoronal | 58 | 5 | 3 (2 coronal, 1 subcoronal) | 1 (coronal) |
| Penile shaft: | | | | |
| Distal | 29 | 2 | 0 | 1 (subcoronal) |
| Mid | 16 | 1 | 1 (subcoronal) | 0 |
| Proximal | 3 | 0 | 2 (1 distal, 1 mid penile shaft) | 0 |
| Penoscrotal | 6 | 0 | 0 | 0 |
| Totals | 181 | 25 | 9 | 5 |

plete the repair and excellent cosmesis. Although the urethral plate is not completely normal in hypospadias, it is copiously supplied by urethral and deep dorsal arteries that furnish the corpus spongiosum and glans penis, respectively. This factor is critical to the success of the technique. The urethral plate is incised in the midline as part of this method but longitudinal incision does not interrupt or significantly change the dual blood supply to the 2 mobilized and tubularized urethral plate strips. The benefit of preserving and using the corpus spongiosum supported urethral plate has been previously discussed.¹⁴

Baskin et al performed histological studies and compared normal with hypospadiac fetal penile anatomy, which appeared to confirm a copious blood supply to the urethral plate in boys with hypospadias.¹⁵ They compared the anatomy of hypospadiac and normal fetal penises using immunostaining techniques and noted that the most striking difference involved relative vascularity. There was more extensive vascularity of the distal urethral spongiosum and glans in hypospadiac than in normal penises. With regard to hypospadias repair they proposed that incising the distal urethral spongiosum and glans, which are rich in large endothelial lined sinuses, results in the release of epithelial growth factor, encouraging tissue repair. This hypothesis may explain absent significant scar and stricture formation after tubularized incised plate urethroplasty.

With regard to stricture formation after tubularized incised plate urethroplasty Snodgrass recently reported followup of the initial 72 patients who underwent repair using this technique.¹⁶ Urethroscopy performed for a decreased urinary stream or during anesthesia for another procedure in 10% of the boys demonstrated a healthy appearing neourethra in all. Uroflowmetry was possible in 34% of toilet trained patients more than 1 year postoperatively and all results were within the 95% confidence levels of standard curves for age. He concluded that the dorsal relaxing incision of tubularized incised plate hypospadias repair did not result in neourethral stricture. There have also been no cases of urethral stricture in our experience.

Tubularized incised plate urethroplasty continues to provide excellent functional and cosmetic results with a low complication rate. Results are optimized by deeply incising the urethral plate, fashioning a wide meatus and placing a subcutaneous dartos layer of coverage over the tubularized neourethra. Our overall complication rate of 7% is similar to that of others.³ Notably all complications in our series presented within the initial 6 months of followup.

Our current preference for tubularized incised plate urethroplasty for repeat hypospadias repair is based on criteria similar to those for that procedure in primary repair. We performed repeat hypospadias repair using this method in 25 boys with a complication rate of 24%. Previous use or preservation of the urethral plate did not appear to influence the outcome of reoperation. We believe that the 3 critical aspects of primary repair with urethroplasty also apply to reoperation. Second layer dartos or tunica vaginalis coverage of the

neourethra was not done in 4 of the 5 boys with a fistula, highlighting the importance of second layer coverage in all hypospadias repairs.

Applicability and advantages of tubularized incised plate urethroplasty for repeat hypospadias repair include the use of local supple tissue with well established vascularity for urethroplasty and skin coverage as well as a cosmetically superior result. Urethroplasty is ideal for repair after a failed Mathieu, onlay island flap or tubularization procedure because theoretically the native vascularity of the urethral plate has not been changed. Absent preputial skin in previously circumcised and repeat cases also makes tubularized incised plate urethroplasty an ideal option. With this technique additional skin flaps are not necessary for urethroplasty or for penile shaft skin coverage since mobilized ventral penile shaft skin is usually sufficient. Based on tissue availability issues it is our experience that the onlay island flap is rarely a feasible option for repeat hypospadias repair. However, Simmons et al reported the effectiveness of using local skin flaps and preserving the urethral plate in complex hypospadias reoperations.¹⁷ In their series the onlay island flap technique was successful in 31 of 36 reoperations (86%).

While to our knowledge there is no single, universally applicable technique for repairing all types of hypospadias, command of a technically straightforward repair with few complications and proved success for a considerable range of defects is a desirable goal. Several well established techniques exist for repairing all hypospadias defects presenting to surgeons. Tubularized incised plate urethroplasty, which is a recent contribution to the armamentarium of hypospadias repairs, has become popular for primary and repeat repair of mid and anterior hypospadias due to its exemplary early results.

CONCLUSIONS

Tubularized incised plate urethroplasty has become the preferred technique for primary and secondary hypospadias repair at our institution. It is a relatively straightforward technique with few complications that continues to expand in applicability and popularity due to its proved success and versatility.

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EDITORIAL COMMENT

The authors provide a large series of tubularized incised plate urethroplasties that supports the premise that this technique is presently done ubiquitously by pediatric urologists. The results are laudable except for a higher than expected fistula rate for distal hypospadias repair. However, they correctly point out the importance of the de-epithelialized pedicle flap by noting that 4 of the 6 fistulas occurred in boys who did not have a second vascularized flap over the neourethral repair. Regardless of the surgical technique of hypospadias repair the de-epithelialized pedicle flap has clearly been

shown to decrease substantially fistula formation and it should be a part of any hypospadias repair when possible. The authors demonstrate the usefulness of the tubularized incised plate urethroplasty technique for repeat or failed hypospadias repair performed by other means. They also reaffirm the observation of others of the rich blood supply beneath the posterior urethral plate and the excellent healing that occurs.

An area in which my technique of tubularized incised plate urethroplasty differs from that of the authors and Snodgrass in his original description is the order of urethral incisions. The authors start by making parallel incisions outlining the urethral plate at a width of 7 to 9 mm. depending on the size of the phallus. Then they perform the midline incision of the urethral plate from the tip of the penis to the hypospadiac meatus. I make these incisions in reverse order. I incise the urethral plate in the midline first to gauge the amount of achievable width before determining the ultimate width of the parallel U-shaped incision that becomes the neourethra. Contrary to the experience of Snodgrass, I have not always achieved uniform width by incising the urethral plate, which has all shapes and sizes. Hence, some urethral plates only minimally open up while others provide outstanding width. In addition, the whole urethral plate from the tip of the glans to the hypospadiac meatus does not necessitate incision if the luminal width is not compromised for the whole length. Once I determine the ultimate width of the posterior urethral plate after incision I may more easily judge the width needed to make the parallel incisions. Thus, neourethral luminal size is not compromised, as it may have been if I had made the parallel incisions first.

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REPLY BY AUTHORS

Our complication rate of 5% for primary hypospadias repair is similar to other multicenter/surgeon reports for the tubularized incised plate urethroplasty technique (reference 3 in article). One must bear in mind that our report represents 7 different pediatric urologists, not all of whom incorporated subcutaneous, second layer tissue coverage of the neourethra early in their experience. We would agree with emphasis on the importance of this adjunctive step for decreasing the urethrocutaneous fistula rate. We would also agree that incision of the entire length of the urethral plate may not be necessary in all cases.