

Primary hypospadias repair techniques: A review of the evidence

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Abstract

This review summarizes data regarding commonly used surgical techniques to repair distal and proximal hypospadias. We review evidence concerning indications for various procedures used in primary hypospadias repair, and their complications, urinary function and esthetic results. Available evidence suggests TIP is preferable to Mathieu for distal hypospadias correction. Current data do not identify a clear preference between TIP and onlay flap for proximal repair when there is ventral curvature $<30^\circ$, or between various flap and graft options when curvature is $>30^\circ$. A review of objective data helps clarify decision-making for distal hypospadias repair. Additional objective evidence is needed to identify preferred options for proximal hypospadias repair. Measuring glansplasty dimensions (meatal size and distance from meatus to corona) may improve urinary function assessments, and provide additional objective data for decision-making between various surgical techniques.

Key Words: Complications, evidence, hypospadias, urethroplasty

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INTRODUCTION

Surgeons agree the goal of hypospadias surgery is to create a normal penis. But what defines a normal penis, and how should the various repairs be measured against that standard?

The week before he died, John Duckett strongly admonished me during a small pediatric urology meeting in Telluride, Colorado, to “give me numbers!” He wanted to know how wide the urethral plate was before midline TIP incision, and how much wider it was afterward. He asked how far proximally and how far distally, and just how deep, I made that midline plate incision.

He wanted to know objective parameters that defined the role of the new operation. Perhaps he was motivated from his own experience with the MAGPI, which he originally described as potentially useful for a meatus as far as 1–2 cm below the corona,^[1] before later admitting the technique was best suited when the meatus was at the corona.^[2]

More than 20 years later, the optimal procedure to correct various extents of hypospadias remains ill-defined. For many surgeons decision-making among various techniques still relies on subjective analysis of the anatomy and personal preferences. Comparisons between operations are mostly based on relative

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urethroplasty complication rates. Urinary function is less often described, and then usually by maximum flow rates and uroflow curves that vary over time and do not take into account deviation and/or spraying of the stream which may be of greater consequence to the patient. Very few studies objectively report cosmetic results.

This article will summarize available data comparing the most commonly used methods to repair distal and proximal hypospadias, and propose a new objective parameter that may be useful to assess each against the standard of normal.

DISTAL HYPOSPADIAS REPAIR: TIP VERSUS MATHIEU

Indications

Both TIP and Mathieu can be used to repair any distal hypospadias. The only exceptions are uncommon cases with a distal meatus but a “thin” urethra extending toward the scrotal junction that cannot be separated from the overlying shaft skin, or ventral curvature $>30^\circ$ after degloving. These uncommon variants are best considered proximal hypospadias.

As mentioned above, in the past surgeons evaluated the appearance of the glans and meatus in selecting among a variety of technique for distal hypospadias repair. Some continue that practice to decide cases they consider unsuitable for TIP, generally those with a flat or narrow urethral plate.

However, three studies agreed that the urethral plate groove-defined as “deep” or “flat” - does not correlate with complications after distal TIP repair.^[3-5] In addition, we recently reported multivariable analysis of risk for complications based on preincision width of the urethral plate in 224 consecutive primary TIP repairs.^[6] 86% of plates measured <8 mm, with a mean of 6 mm. However, preincision width did not correlate with complications, meaning a “narrow” plate is not a contraindication for TIP.

We always use TIP to correct distal hypospadias and reported observations in 551 consecutive patients.^[5] Good outcomes in that series, in which there was no selection criteria for TIP versus other techniques, should end discussion about “unhealthy” or “unsuitable” urethral plates.

Urethroplasty complications

A systematic literature review of primary distal repairs in children using TIP and Mathieu since 1990 identified 23 publications, 15 series reporting a total of 1872 TIP repairs and 10 series describing 1496 Mathieu outcomes.^[7] Fistulas, meatal stenosis and urethral strictures were compared, finding these occurred in 6.9% of TIP and 6.7% of Mathieu repairs.

In addition, two randomized trials compared these operations, both reporting no differences in urethroplasty complication rates.^[8,9]

Uroflowmetry

One study compared uroflows after distal hypospadias repair by a single surgeon in toilet trained boys without urethroplasty complications, including 19 TIP and 22 Mathieu procedures. No patient had voiding symptoms. Results were considered abnormal if Q_{max} was $<10\%$ based on the Toguri nomogram and the curve was plateau-shaped. During median follow-up of 20 months there was no difference in outcomes based on the operative technique, with 11/19 (58%) TIP and 19/22 (86%) Mathieu considered normal, $P = 0.07$.^[10]

Another report compared Q_{max} at varying postoperative time points, from <6 months to >10 years, finding no difference between Mathieu or TIP at any interval.^[11]

Esthetic appearance

Two studies used postoperative photographs judged by blinded reviewers to compare the esthetics of the glans and meatus after TIP versus Mathieu.^[12,13] Both scored TIP significantly better in appearance.

Evidence-based decision-making

Both TIP and Mathieu are versatile operations that can be used to correct all distal hypospadias, with similar risk for urethroplasty complications and similar urethral function as defined by uroflowmetry. However, TIP creates a more normal-appearing glans and meatus. Since appearance is a significant outcome, the available evidence supports use of TIP rather than Mathieu for distal hypospadias repair.

G-TIP

Grafting the dorsal TIP incision was first considered an option to fill the defect and ensure healing without stenosis, although articles from centers worldwide have reported healing without increased rates of meatal stenosis or urethral stricture with TIP. More recently, proponents report incising into glans just beyond the urethral plate and then grafting to better position the meatus at the tip.^[14] Using the foreskin to graft the incision may preclude prepucioplasty for families that prefer a natural appearance, and foreskin may not be available for megameatus intact prepuce variants diagnosed after circumcision, but G-TIP is otherwise an option for most patients with distal hypospadias. No comparative study has demonstrated a significant difference in urethroplasty outcomes between TIP and G-TIP. Similarly, there is no report comparing appearance of the meatus between these techniques.

Meatal length and the distance from the ventral lip of the meatus to the corona has been measured in normal boys.^[15] We have been recording these outcomes in patients after TIP, and suggest those doing G-TIP similarly objectively analyze results for comparison.

PROXIMAL HYOSPADIAS WITH VENTRAL CURVATURE <30°: TIP VERSUS ONLAY PREPUICIAL FLAP

Indications

Both of these operations can be used for midshaft to proximal hypospadias repair – when there is <30° ventral curvature after degloving. This is a key point, since in an earlier time Duckett encouraged dorsal plications for straightening, observing that excision of the urethral plate in patients with curvature usually did not correct the bending. He thought this curvature was due to corporal disproportion, which could be addressed by plications while preserving the urethral plate for onlay repair.^[16]

However, plications may not provide durable straightening when curvature exceeds 30°. One study that compared 1–2 dorsal plications to ventral corporotomy found recurrent curvature within 2 years in 28% versus 9%, respectively, ($P = 0.03$).^[17] We have observed that patients with recurrent fistulas or complete urethroplasty dehiscence after proximal repair often have recurrent ventral curvature originally corrected by plications.

Like Duckett, we also tried to preserve the urethral plate during penile straightening for curvature >30°.^[18] Rather than transect the urethral plate, we elevated it from the corpora, dissecting from the corona to the meatus, and then continuing under the native urethra to near the membranous urethra. Persisting curvature was then corrected by ventral corporotomies under the mobilized urethral plate, and the native urethra was gently advanced distally and sutured back to the corpora to relieve tension on the urethral plate. Finally, when the penis was straight without needing to transect the plate, TIP was done.

However, these patients have not done well. Symptomatic focal neourethral strictures developed within 1.5 years of repair in 5/29 (17%) that were not encountered in any of the 47 proximal TIP without urethral plate elevation ($P = 0.01$).^[19] In addition, three developed recurrent curvature that was >30° in one. Today we no longer perform this maneuver and instead transect the urethral plate and do a 2-stage graft repair for hypospadias with ventral curvature >30° after degloving.

Therefore, proximal TIP and onlay flap are options when there is curvature <30° after degloving. We do not straighten curvature >30° by plications or other maneuvers trying to preserve the urethral plate.

Urethroplasty complications

A literature search was done to identify studies comparing TIP and onlay prepucial flaps for primary proximal hypospadias, finding 6 with a total of 262 TIP and 309 onlay procedures.^[20] Mean patient age, the proportion of penile shaft and penoscrotal cases, and the mean duration of follow-up was similar for both techniques. Meta-analysis evaluated urethroplasty complications, reporting similar overall rates (odds ratio [OR] 0.85, 95% confidence interval [CI] 0.56–1.30, $P = 0.46$), and similar odds for fistulas (OR 0.68, 95% CI 0.38–1.21, $P = 0.19$), recurrent ventral curvature (OR 1.16, 95% CI 0.43–3.12), $P = 0.76$), dehiscence (OR 0.95, 95% CI 0.33–2.74, $P = 0.92$), diverticulum (OR 1.90, 95% CI 0.53–6.78, $P = 0.32$), meatal stenosis (OR 0.74, 95% CI 0.20–2.77, $P = 0.65$), and urethral stricture (OR 1.49, 95% CI 0.41–5.50, $P = 0.54$). The authors found these two options similar for primary proximal hypospadias repair.

Uroflowmetry

The review by Xiao *et al.*^[20] found only two comparative uroflow studies, one reporting no difference in TIP versus onlay, and the other stating Qmax and Qave was significantly less after TIP in boys a mean age of 5 years.

A subsequent study compared TIP and onlay for penoscrotal repairs at multiple time points after surgery beginning at 1 year and extending to 12 years, with follow-up ≥ 10 years and into adolescence required for inclusion.^[21] TIP patients were significantly more likely to have Qmax <5th percentile during childhood, but after age 13 years Qmax increased for most patients to >5th percentile with no differences found between techniques.

Esthetic appearance

The literature review by Xiao *et al.*^[20] found two studies using the pediatric penile perception score to compare proximal TIP and onlay (meatus, glans, penile shaft, overall appearance), both stating there was no difference in results.

An earlier study took standardized photographs after repair by TIP, Mathieu or onlay which were then scored on the same factors comprising the PPPS by reviewers blinded to the technique used.^[12] Of these, 6 had a proximal TIP and 6 a proximal onlay. Mean TIP scores were all significantly higher than those from Mathieu or onlay. For example, TIP created a vertical meatus in 87.5% versus 37.5% in Mathieu and onlay patients ($P = 0.009$).

Evidence-based decision-making

Available data does not distinguish between TIP or onlay for primary proximal hypospadias repair. However, this does not necessarily mean the two operations achieve the same result. For example, patients could have a vertical meatus, similar uroflows,

and no urethroplasty complications, yet have differing rates of urine spraying. If so, then some patients with “successful” outcomes might have to sit to void – and likely would not agree their surgeries were a success.

The glansplasty done with TIP (and 2-stage grafts, discussed below) approximates the glans wings together over the neourethra, without suturing the wings to the open end of the neourethra. In contrast, flap repairs stitch the wings to the open end of the neourethra, extending around the flap. Therefore, the “glans fusion” length from the ventral lip of the neomeatus to the corona may differ between these glansplasties.

This glans fusion length has been reported in normal boys as >2 mm, averaging 4.7 mm.^[15] Therefore, results of hypospadias in both individual cases, and for cohorts of patients operated with various techniques, can be compared to normal. Simple measurement of this distance after glansplasty intraoperatively and again postoperatively would demonstrate how close to normal the glans closure is, and determine the minimum length needed to minimize spraying.

We have recorded glans fusion length in 108 consecutive patients, including 42 with proximal hypospadias repaired by TIP or 2-stage grafts. The average was 4.6 (standard deviation [SD] 1.25, 2.5–10), which is similar to that of normal boys (unpublished data).

PROXIMAL HYPOSPADIAS WITH VENTRAL CURVATURE $>30^\circ$: 1-STAGE TUBULARIZED FLAPS, 2-STAGE FLAPS, OR 2-STAGE GRAFTS

Indications

There are more options available to repair the least common, and most severe, form of hypospadias – those patients with curvature $>30^\circ$ after degloving. As discussed above, this extent of curvature is best straightened by transecting the urethral plate, and then doing ventral corporotomies when curvature persists, rather than using multiple dorsal plications to try to preserve the plate.

Ventral lengthening can be done via a single transverse incision from 3 to 9 o'clock through the point of maximum bending, stretching open the corpora and then grafting the resulting defect in the tunica albuginea with dermis, small intestinal submucosa, or other material. When this method is used, urethroplasty options are limited to 1- or 2-stage flaps to avoid placing a urethroplasty graft on top of a corporal graft.

Alternatively, three transverse corporotomies can be done from 4 to 8 o'clock. The first is made across the point of greatest bending, with another approximately 4 mm distally and a third approximately 4 mm proximally. These incisions lengthen

the ventral surface, but because each incision leaves a smaller corporal defect than a single, widely-dissected corporotomy, they are not grafted. While this method can be done with 1- and 2-stage flap urethroplasties, it also allows 2-stage graft repairs that cannot be done with single corporotomy and grafting, since re-vascularization of urethroplasty grafts placed onto corporal grafts is uncertain. This straightening technique has similar success as single corporotomy with grafting,^[22] and we reported recurrent curvature in only one of 51 (2%) patients.^[23]

Urethroplasty complications

A systematic literature review identified 69 articles published between 1990 and 2009 concerning straightening procedures and urethroplasty outcomes for “severe” hypospadias.^[24] Cumulative complication rates ranged from 15% to 46%, with no clear advantage for any given urethroplasty technique.

1-STAGE TUBULARIZED PREPUICIAL FLAP

The original “transverse island” prepuicial flap described by Duckett rolled the inner prepuce and then transferred this neourethra ventrally on a dartos pedicle. Today his successors transfer the prepuce ventrally and then suture one side of it to the meatus and along the corpora to the end of the opened glans to create a pseudo-plate. Then the remaining flap is trimmed as needed and sewn as an onlay to this pseudo-plate. Two series have been reported, comprising 12 and 22 patients, with complications within 24 months in 17% and 14%, respectively.^[25,26] To our knowledge, these are the best results published for 1-stage tubularized flap repairs for proximal hypospadias.

KOYANAGI REPAIR

One series reported outcomes for 151 penoscrotal or more proximal hypospadias repairs done from 1983 to 1999 with median 6 years follow-up.^[27] Complications developed in 17%, including fistulas, meatal stenosis, and glans dehiscence.

Another series reviewed outcomes for repairs done over a 10-year period ending in 2007 in 155 boys with primary midshaft to more proximal hypospadias operated by the same surgeon.^[28] Of these, 26 (17%) were Koyanagi procedures, with complications occurring in 16 (61.5%), including fistulas, strictures, wound dehiscence and diverticula.

2-STAGE (BYARS) PREPUICIAL FLAPS

There are three recent publications discussing outcomes after Byars flap repairs. One was a 20 years review with 134 patients, of which complications developed in from 46% (reoperation rate) to 80% (total number of complications).^[29] A second reported 56 patients operated over a 12-year period, with 66%

complications that included fistulas, meatal stenosis/urethral stricture, diverticulum and glans dehiscence.^[30]

In contrast, the third series with 128 patients found only a 12% complication rate, mostly fistulas and glans dehiscence, without diverticulum.^[31]

Reasons for such divergent outcomes are not clear, and comprise one of the difficulties trying to compare results from various operations. Snodgrass and Bush used Byars flaps, preserving the glanular urethral plate. There were 100% complications in nine patients, including fistulas, a stricture, glans dehiscence, and diverticula which occurred in 55%.^[32]

2-STAGE PREPUCCIAL GRAFTS

Aivar Bracka, who popularized this technique, initially used it to correct all hypospadias. Therefore, there are few published series specifically describing outcomes for proximal hypospadias with >30° ventral curvature.

A retrospective review included 34 patients with proximal shaft to perineal hypospadias, described as having “significant chordee” corrected by “corporoplasty,” which was not defined but likely was dorsal plication.^[33] Complications developed in 26%, comprising glans dehiscence, fistulas, a diverticulum and a stricture.

We reported outcomes in consecutive patients operated from 2008 to 2015, divided into 2 cohorts based on a glansplasty modification that was introduced in November 2012.^[23] Initial patients had glans wings opened laterally to near 3 and 9 o’clock, whereas more extensive dissection was done in the 2nd group opening the wings laterally as before, but then further mobilizing them superiorly off the underlying corpora another 4 mm at 3 and 9 o’clock. Urethroplasty complications, primarily glans dehiscence, occurred in 17 (31%) of 55 total patients with follow-up, 11/22 (50%) in Group 1 versus 6/33 (18%) of Group 2 ($P = 0.017$).

Uroflowmetry

Few studies report uroflow results after repair of proximal hypospadias using these techniques. Our review found no uroflowmetry reports for Byars flaps or Koyanagi repairs.

From a total of 125 patients who underwent either tubularized or onlay prepucial repairs in childhood, 11 with a tubularized flap repair had uroflowmetry at a mean of 14 years later.^[12-21,34] Tanner stage was not reported. Mean Qmax was 17cc/s.^[15-21]

We reported results in 12 patients at mean age 8.9 years (SD 5.5) after 2-stage graft repairs, with mean Qmax 10.6cc/s (SD 4.9) and Qave 8.0 (SD 3.0).^[35]

Esthetic appearance

No study reports objective assessment of appearance after these repairs.

Evidence-based decision-making

As this summary indicates, there is insufficient data regarding function, appearance, and complications for the different repairs used to correct proximal hypospadias with ventral curvature >30°. We have shown a significant reduction in urethroplasty complications by more extensive glans wings mobilization in 2-stage graft repairs, but similar technical modifications to other procedures to improve outcomes have rarely been published.

Similar to the discussion with proximal TIP and onlay prepucial flap repairs, the operations described in this section for the most severe primary cases would also benefit from glans fusion measurements to help determine those most likely to achieve normal glans appearance and function.

PROGRESS IN HYOSPADIAS REPAIR

This review summarizes the most commonly used techniques for varying extents of hypospadias. We correct all primary cases using only two procedures: TIP and 2-stage grafts. Whether other surgeons choose these same options or other techniques reviewed above, one step toward improving outcomes is limiting the number of procedures used so that individual surgeons gain greater expertise performing the key steps. Our use of two techniques is not “forcing” an operation on the patient, but adapting the procedure to the specific anatomy encountered.

It is also necessary for surgeons to know their individual results. We suggest the 3Ps for practice improvement: Prospective data collection, Periodic outcomes review, and Practice changes based on results and the best available evidence. A simple spreadsheet listing patient name, meatal location, surgical procedure done, primary versus reoperative repair, and complications is sufficient to inform a surgeon of his or her results. This data entry requires only a few moments after surgery or clinic to keep current.

Finally, we need to refer proximal hypospadias, especially those with obvious ventral curvature, to hypospadias specialists. Self-reported case logs by US pediatric urologists to the American Board of Urology found the median number of proximal hypospadias repairs done annually was 2,^[36] which is not sufficient to achieve and maintain expertise. We have found that working as a surgical team of two experienced hypospadiologists reduces complications and most ensures that we get it right the 1st time!

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Conflicts of interest

There are no conflicts of interest.

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