Hypospadias Repair: An Overview of the Actual Techniques

Ramnath Subramaniam, F.R.C.S., F.E.A.P.U.,¹ Anne Françoise Spinoit, M.D.,² and Piet Hoebeke, M.D., Ph.D.²

ABSTRACT

Hypospadias is one of the most common congenital genital anomalies for which surgery early in life is indicated. The surgical treatment is changing progressively, often by repeating treatment strategies that have been used decades ago. Indeed, historically two-stage procedures were replaced by one-stage procedures and nowadays two-stage procedures gain new interest. The same for reconstructions using the urethral plate, which decades ago were based on the Thiersch Duplay principle. In the 1980s, preputial onlay flaps were most often used and today we see a new interest in the use of the urethral plate. The actual surgical approach to hypospadias is described and technical details are given.

KEYWORDS: Hypospadias, one-stage repair, two-stage repair

Hypospadias is one of the most common congenital defects affecting the external male genitalia.^{1,2} The incidence is ~1 in 250 male newborns, although its incidence seems to be increasing.^{3,4}

Hypospadias is defined as an insufficient development of the urethral fold and the ventral foreskin, with or without penile curvature. The urethral opening is located more proximally anywhere between the tip of the penis and the perineum.¹⁻⁴

Hypospadias classification is based on the position of the meatus, within three categories: distal or anterior hypospadias with the meatus on the glans penis, at the corona, or subcoronal. Mid-penile hypospadias with an urethral opening located on the distal penile shaft, midshaft, or on the proximal penile shaft. Proximal or posterior hypospadias have a penoscrotal, scrotal, or perineal urethral meatus location.

Distal hypospadias is the most common finding in the Western world. In Asia more proximal forms are observed.^{3,4}

There is some controversy about this classification. Some authors find that you can only classify the position after surgical deglovement of the penis. In fact, on first examination proximal hypospadias can become midpenile after dissection. In general, the technique for repair will be chosen intraoperatively with the decision-making process based on the assessment of anatomy: the native meatus location, penile curvature and size, and on the aspect of the ventral skin before and after deglovement.⁵

In trying to describe the reconstructive techniques for hypospadias repair one could state that there are as many techniques and their modifications as there are surgeons who perform hypospadias repair. Therefore, it is impossible to obtain a consensus based on outcomes and provide guidelines. Part of the problem is that well-designed prospectively controlled studies are rare.

Essentially the techniques can be classified in repair procedures based on advancement techniques, tubularization techniques, or the use of grafts and flaps (Table 1).

¹Department of Paediatric Urology, Leeds Teaching Hospitals, Leeds, United Kingdom; ²Department of Urology, Ghent University Hospital, Ghent, Belgium.

Address for correspondence and reprint requests: Piet Hoebeke, M.D., Ph.D., Ghent University Hospital, De Pintelaan 185, 9000 Ghent, Belgium (e-mail: Piet.hoebeke@ugent.be).

Aesthetic and Functional Genital and Perineal Surgery: Male;

Guest Editors, Christopher J. Salgado, M.D., and Stan J. Monstrey, M.D., Ph.D.

Semin Plast Surg 2011;25:206–212. Copyright © 2011 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662.

DOI: <http://dx.doi.org/10.1055/s-0031-1281490>.

ISSN 1535-2188.

Table 1 Classification of Techniques for Hypospadias Repair

Meatal-Based Techniques	MAGPI ARAP Modification of MAGPI
Tubularization techniques (based on the Thiersch Duplay Principle)	TIP: Tubularized incised plate
Flaps	GAP: Glandular approximation plasty Bracat and many others Mathieu repair Preputial island flaps Onlay Tubularized
Grafts	Inlay grafts Two-stage procedures

MAGPI ARAP, meatal advancement and granuloplasty

DISTAL HYPOSPADIAS REPAIR TECHNIQUES

Meatal-Based Techniques

THE MEATAL ADVANCEMENT AND GRANULOPLASTY (MAGPI) TECHNIQUE

First described in 1981 by Duckett, the meatal advancement and granuloplasty (MAGPI) technique is one of the most commonly performed hypospadias repair techniques that has withstood the stand of time.^{6,7} It has a low complication rate (1.2% overall, 0.45 fistulas, no meatal stenoses) and reoperation is very seldom needed.⁸ There are some concerns about the meatal configuration, which often fails to look split like and thus looks unnatural.

The first step of the operative technique is the same in all procedures, independent of the meatus location and the chosen technique: a polypropylene 4/0 traction suture is placed in the glans, and a silicone feeding tube catheter is placed in the bladder through the native meatus.

The following steps vary from one technique to another.

In the MAGPI, the next step is to perform a circumferential subcoronal incision about a centimeter proximal to the native urethral meatus. The penile shaft skin is degloved. Then in the penoscrotal junction, any chordee tissue is resected. A longitudinal incision in the dorsal aspect of the meatus where most often a mucosal web is observed is made, starting from the native meatus and following the glanular groove to the tip of the glans, although not reaching it. The dorsal aspect of the glanular groove is closed on the transverse Heineke-Mikulicz way that advances the meatus to the distal end of the glans groove. For this, resorbable sutures 6.0 or 7.0 are used. Glans wings are created in the glans and the granuloplasty is then performed with a two-layer closure of the glans wings incorporating the ventral aspect of the urethra in the most distal stitch, providing a normal glanular conical aspect. The circumferential penile skin is then closed in a traditional way.^{1,2,6-8}

The last step in hypospadias repair should be similar in all techniques and independent of the hypospadias classification: the silicone feeding tube is checked to be sure it is still correctly positioned in the bladder, and then it is secured with the first polypropylene suture. A dressing is applied and here again there are as many dressings as there are surgeons. Some surgeons will do a catheterless procedure in some cases of distal hypospadias.

When a catheter is used, different sizes between 6 French (F) and 12F have been used; the catheter remains in place for 3 to 7 days.

No comparative studies on outcome difference between different sizes of catheters, different dressings, different duration of bladder drainage have been published so there is no evidence on what would be the ideal technique.

In general MAGPI has a good cosmetic outcome and a good satisfaction rate, and thus is widely performed.⁹ With the advent of tubularization techniques the cosmetic outcome of MAGPI has been challenged as the aesthetic aim has been reset to a split-like meatus, which can be easily reached with these techniques

Tubularization Techniques

THE TUBULARIZED INCISED PLATE URETHROPLASTY (TIP)

Snodgrass first described this technique in 1994.¹⁰ Before his publications, there have been some articles published on the effect of hinging of the urethral plate on the meatal configuration. This technique is as widely used as MAGPI. In general, TIP has a slightly higher complication rate than MAGPI with overall complication rates varying between 4% in 2010 to 5.5% in 1999, the most frequent being fistula and meatal stenosis.^{11,12}

The penis is degloved after a circumferential subcoronal incision is done ~2 mm proximally to the urethral native meatus. A U-shaped incision is done along the lateral margins of the urethral plate. The glans wings are then created. A relaxing incision is made in the midline of the urethral plate to allow tension-free tubularization of the urethra. Tubularization itself is

then performed with a 6/0 running suture. A button-holed dartos flap can be transposed from the dorsal side of the penis to the ventral side allowing coverage of the tubularized neo-urethra. Glans wings approximation starts the glanuloplasty at the corona. Suture of the skin edges and of the meatus finalizes the technique.¹³

Satisfaction rates are excellent in TIP repair, aesthetic outcome being considered equal as a normal penis.^{9,14,15}

THE GAP PROCEDURE OR GLANS APPROXIMATION PLASTY

Whenever the urethral plate is wide enough to be closed without the relaxing incision in the dorsal aspect of the urethral plate the tubularization technique is called GAP repair. This was described by Zoantz long before the publication of the Tip repair and was based on the old Thiersh Duplay techniques.

Flap Techniques

MATHIEU PROCEDURE BASED ON A MEATAL FLAP

This procedure was first described in 1932, although it appears it was already performed earlier.¹⁶ It has since been modified many times, many centers reporting modified Mathieu techniques that offered good results, with a complication rate varying again from one center to another (0.98% for Retik to 11% for Dolatzas), according to the modification operated on using the original technique.^{17,18}

The Mathieu procedure does not begin with a penis deglovement: a penile shaft skin flap is mobilized to create the neo-urethra. The Mathieu procedure starts with measuring the length of the urethral defect from the meatus to the glans tip. An equal distance is drawn on the proximal penile shaft skin, along the urethral plate. An incision is realized along those marks. An appropriate width of typically 7 to 8 mm is measured for the proximal flap, this width being tapered to 5 to 6 mm at the distal extent of the glans. Skin and glanular incision are followed by shaft skin deglovement. Cautious dissection of the subcutaneous tissue of the flap is performed, allowing the flap to be brought to the tip of the glans. The flap is folded over at the meatus and a running suture approximates the flap to the lateral lines of the urethral plate. Meatus is matured to the glans. A dartos flap tissue is used to cover the sutures and the glans wings are approximated, and finally a traditional circumferential closure is performed.

Many variants of all those techniques are also described, each trying to bring down the reoperation rate and the complications observed, with more or less success.^{19–21} Some tried also to adapt those techniques to reconstruct an intact foreskin thereby always raising the complication rate.²²

TECHNIQUES FOR MID-PENILE HYPOSPADIAS

The most widely used techniques are those used for distal hypospadias repair except for the MAGPI and as long as the chordee is mild or moderate. The TIP technique as well as Mathieu's is commonly performed for mid-penile hypospadias. For mid-penile hypospadias, onlay flaps can be used.

The Onlay Island Flap

In 1987, Elder reported the first one-stage hypospadias repair using an island onlay, although the preputial island flap had long been performed before. It allows for repair of subcoronal and midshaft hypospadias.

A near-circumferential incision preserving the urethral plate is realized on the penile shaft. A rectangular preputial onlay is harvested, measuring as long as the urethral defect. The preputial skin is then dissected preserving its pedicle to the base of the penis. Anastomosis on the urethral plate or in case of insufficient urethral plate, tubularization of the flap is then performed. Coverage of the neo-urethra is then traditionally performed with dartos or tunica vaginalis.

PROXIMAL HYPOSPADIAS REPAIR TECHNIQUES

Chordee correction is, as any surgeon would agree, the key to the successful repair of hypospadias. Again, there are as many techniques freeing the chordee tissue satisfactorily as there are surgeons repairing hypospadias. Nevertheless, once the penis is degloved and the chordee tissue excised, the decision-making process at this stage is what sets out the difference between single and staged reconstructions.

Some pioneered the concept of preservation of the urethral plate by extensively mobilizing it underneath itself leading to a satisfactory chordee correction.^{23–25} An onlay flap was then usually applied to cover and protect the urethroplasty.

Snodgrass extended his TIP technique in repair of the distal hypospadias to the proximal hypospadias.²⁶ His technique, very popular because of its good results in distal hypospadias, became less popular in proximal hypospadias, reporting a 33% complication rate.

Although Snodgrass believes in the preservation of the plate as far as possible, he acknowledged that the urethral plate cannot be preserved in all cases of severe or proximal hypospadias.^{27,28} In a study looking at TIP repair for reoperative hypospadias, it was observed that the fistula rate was ~42% if the urethral plate was altered at the time of initial surgery compared with 0% if the plate was left unaltered.²⁹ This finding was also supported in a study by Ferro, which clearly suggests that

over enthusiastic mobilization of the urethral plate may lead to less than satisfactory outcomes.³⁰

The quality of the urethral plate is the key to a successful hypospadias repair and the real difficulty is deciding which urethral plate is of poor quality and needs to be sacrificed. It has been proven in a study using digital photography to assess the quality of the urethral plate based on a visual impression: it was clear that the interpretation on quality of urethral plate was subjective.³¹

Single-Stage Repairs

It is beyond the scope of this review to describe every single-stage repair and their modifications; therefore, we will look at the principles of some of the most popular and widely practiced techniques of repair of proximal hypospadias.

THE TRANSVERSE ISLAND FLAP (TIF)

Duckett deserves credit for popularizing the preputial island flap.³² After degloving the penis and correcting chordee, the inner prepuce is raised as a pedicle flap and then transposed ventrally to cover the urethral plate as an onlay graft. The urethral plate constitutes the roof of the neo-urethra. The onlay avoids circular anastomosis to prevent stricture formation. It is important not to use too much of the preputial skin and to tailor it appropriately to prevent a baggy urethra causing a urethral diverticulum.

In the Asopa modification of the procedure, the inner prepuce is also used as a pedicle flap, but the neo-urethra is left attached to the underneath surface of the foreskin. Therefore, the skin and the neo-urethra share a common blood supply.³³

Duckett's experience with pedicled preputial flaps with reported 10% complication rate³² has not been consistently reproduced by others who have reported an up to 50% reoperation rate.³⁴ Many surgeons who believe in preserving the urethral plate and patching it with pedicled onlay or tubed grafts have reported up to 40% fistulas; 10% strictures; complete breakdown in 7%; anterior urethral diverticuli in 12%; and poor cosmetic outcome characterized by excessive ventral bulkiness, penile torsion, and meatal abnormalities in up to 60% cases.³⁴⁻⁴² Another study reported a reoperation rate of 90% with onlay grafts.⁵³ Singh et al in their experience with the Asopa procedure reported a 40% complication with tubed repairs (30% fistula) compared with 18% with onlay flaps.³³ They concluded that proximal hypospadias was a significant risk factor for poor outcome.

In a long-term study, 17% of adolescents who underwent the Duckett repair (early on in life) complained of a curved erection.⁴³ In another study of postpubescent boys who underwent reoperative surgery to correct chordee, all of them had undergone single-

stage repairs at the outset.⁴⁴ This is not such a problem with two-staged repairs because they allow aggressive correction of the chordee.⁴⁵

THE KOYANAGI-NONOMURA ONE-STAGE REPAIR FOR SEVERE PERINEAL HYPOSPADIAS

In the Koyanagi procedure, a long wide strip is harvested from the penile shaft skin in continuity with the preputial hood. This is then transferred ventrally and tubularized allowing a one-stage correction.^{46,47} Modifications to this procedure have since been made in an attempt to improve the blood supply.⁴⁸ The proponents believe that this is in essence a two-stage procedure completed in one stage.

The published complication rates for Koyanagi procedure ranges from 20 to 50%.⁴⁹⁻⁵² Jayanthi in a recent publication on modified Koyanagi repair for proximal hypospadias acknowledged that a sizeable number of boys will need reoperation following this procedure.⁴⁸ His argument is that 100% of the boys will have a second operation in a staged approach.

THE TUBULARIZED INCISED PLATE URETHROPLASTY (TIP)

The TIP repair as explained earlier is used in cases of proximal hypospadias in the absence of severe penile curvature with a soft and supple urethra, a somewhat contradictory situation.⁵³

The TIP is a successful repair in distal hypospadias with minimal or no chordee. However, when it comes to being used in proximal hypospadias, Snodgrass and Lorenzo have reported a complication rate of 33% with 21% incidence of fistula and persistent chordee in some patients.²⁶ Snodgrass believes in preserving the urethral plate as far as possible and only sacrifices it in extreme cases of penile curvature. However, the bottom line is that not all urethral plates can be salvaged if good outcomes are expected as acknowledged by Snodgrass in his algorithms for primary²⁷ as well as redo repairs.²⁸

Two-Stage Repairs

Turner-Warwick should be credited with the original description of the two-stage procedure,⁵⁴ which was more recently popularized by Bracka.^{55,56} In essence, Bracka during the first stage creates a neo-urethral plate by clefting the glans and releasing the chordee by transecting the native urethral plate and excising any tethering chordee tissue from the corpora. A free graft is ideally taken from the inner prepuce and quilted onto the raw surface. The preferred skin for graft is excess preputial skin for all primary cases. For redo cases, when preputial skin was already sacrificed, either excess local penile skin or postauricular graft is used to cover the raw area. The graft is sieved and quilted to prevent movement and collection in the bed, which could prevent

optimum graft take. Good compression foam dressing with adequate bladder drainage is maintained for a week. A minimum of 6 months is allowed before proceeding to tubularize the urethral plate in the second stage.

Recent technical modifications of the two-staged reconstruction have been made whereby chordee is corrected more aggressively.^{45,57} Some prefer to raise a dartos flap and transpose it ventrally to allow for a wider graft bed that is well-vascularized. This allows better graft take and recurrence of chordee is rare. In addition, the dartos flaps also provide the ideal waterproofing layers, the importance of which has been emphasized by Khan et al.⁵⁸ At the second stage which is essentially tubularization of the neo-urethral plate, with eventually dorsal dartos flaps mobilization to cover the neourethra, a 1-cm strip of the plate is tubularized over an 8F or 10F silastic stent or Foley catheter and a further two or preferably three layers including skin closure is achieved.

It is generally true and well recognized that there is always sufficient preputial skin for grafting in primary cases and is still the best source for the graft.^{45,55,57} For redo cases, postauricular graft is a choice of extra genital source of graft when necessary. Local excess shaft skin following previous surgery could be used if not scarred. Manjo et al have proven the efficacy of a postauricular graft in a select group of patients with urethral stricture and oral mucosa changes.⁵⁹ Bladder mucosa is not a suitable alternative if exposed at the tip to air: it bleeds easily and scars.^{60,61}

Use of buccal mucosa is reported to have an unacceptably high complication rate.^{34,62} Snodgrass observed that glans dehiscence was higher if buccal mucosal graft were raised from the cheek compared with the lip.²⁸ The cheek mucosa is very firm and is reasonable if used as an inlay, but if left exposed for a few months in a two-stage repair tends to get firm and of poor quality. In an interesting study comparing preputial, postauricular and buccal mucosal grafts in over 200 severe hypospadias cases, it was observed that the uptake of preputial graft was over 95% compared with a 20% contractures and 11.7% graft loss with buccal mucosa.⁶³

The primary cases of proximal hypospadias when managed by two-stage repairs give the best outcome with complications between 2.5 to 6% (fistula and stricture) in most reported series with the exception of Svensson who has the highest fistula rate at 16% for two-staged correction.^{56–58,64–69} These outcomes are far superior to any published series of single-stage repair for proximal hypospadias.

In conclusion, when it comes to proximal hypospadias, the decision to preserve or sacrifice the urethral plate is the key. In a recent publication on experience with three different techniques on 194 boys with proximal hypospadias, Moursy remarked "Single-stage repair of proximal hypospadias can be successfully performed when plate preservation is possible, whereas two-stage

repair is applicable when plate transection is necessary. Functional and cosmetic outcomes are satisfactory, with no statistically significant advantage with any technique"⁷⁰. Ozturk et al reviewed their 15-year experience with one-stage repairs and have come to a similar conclusion that severe chordee and proximal hypospadias are associated with higher complication rates.⁷¹ It seems quite clear that for proximal hypospadias, two-stage hypospadias repairs provide good cosmetic and functional outcomes as compared with single-stage repairs that attempt to preserve the urethral plate.

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