Hypospadias Repair: Surgical Management and Post Operative Assessment

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Abstract:

Preoperative evaluation is an integral part of hypospadias surgery. It includes the type of hypospadias, size of urethral plate and glans, chordee and penile torque, hypoplastic urethral length and dorsal hood. Severe hypospadias should be evaluated radiologically for lower and upper urinary tract, hormonal status, and intersex disorders. Six to 18 months of age is the golden time to operate the hypospadias patients. Patients are operated on under general anaesthesia, regional and local blocks for postoperative pain. The microsurgical instruments, magnification, and gentle tissue handling help to have better results. Bladder drainage with an appropriate catheter helps in improving the outcomes. The use of local or systemic hormones is useful for improving the growth and vascularity of the urethral plate in the patients with poorly developed urethral plate. The urethral plate preservation urethroplasty results are better, and the addition of spongioplasty to TIPU reconstructs a near-normal urethra. The algorithms are proposed with a rational approach for both one- and two-stage urethroplasty. Surgical training, experience, and type of hypospadias guide the surgeon to choose one-stage or two-stage repair. Applying the basic microsurgical principles, choice of one- or two-stage in a given case, use of the magnification and fine suture material, surgery at desired age, and proper postoperative care yield good results of hypospadias repair.

Keywords: Hypospadias, HIS, GMS.

Introduction:

Indications of treating hypospadias include spraying of urinary stream, inability to urinate in standing position, curvature leading to difficulties during intercourse, fertility issues because of difficulty with sperm deposition, and dissatisfaction with genital appearance (1).

The timing of the repair should balance the potential adverse psychological effects of surgery, the anesthetic risk to the child, the degree of penile development that will facilitate a successful repair, and wound healing differences as boys age (2). The American Academy of Pediatrics suggests this time interval to limit psychological stress and subsequent behavioral problems seen in toddlers

undergoing genital surgery (3). Surgical intervention for hypospadias can be performed at any age; however, most authors recommend operative intervention at 6–18 months(4).

Preoperative androgen stimulation in the form of systemic testosterone, topical testosterone, and derivatives like dihydrotestosterone (DHT) and human chorionic gonadotropin (hCG) have been used to stimulate glans size preoperatively to allow better tubularization of the urethral plate and decrease the incidence of glans dehiscence (5). Some surgeons avoid preoperative testosterone because of a perceived increased risk for bleeding as a result of increased angiogenesis. Others believe that poor wound healing may follow androgen exposure (6, 7). Therefore, androgen use is controversial (8, 9).

A survey of pediatric urologists suggests that preoperative androgen therapy was common before hypospadias repair in boys with proximal hypospadias or in those with a small glans (10). Therapy must be stopped 1–2 months prior to surgery to avoid adverse effects during or after surgery (11).

The operative steps of hypospadias surgery involve penile degloving, correction of VC (**orthoplasty**), reconstruction of the urethra (**urethroplasty**), providing a vascularized coverage for the urethroplasty, reconstruction of the glans (**glansplasty**), and finally a cosmetic skin coverage to create accepted penile appearance. The key surgical principles to achieve optimal surgical outcomes include the use of magnification, fine instruments and sutures, minimal and atraumatic tissue-handling, careful hemostasis, and good surgical assistance (4, 5).

Regional blockade, with either a caudal or circumferential penile block, reduces narcotic requirement during the procedure and improves pain control in the immediate postoperative period (12, 13).

Curvature may result from shortened ventral skin, a short urethra, or from intrinsic curvature of the erectile bodies. The cause of curvature is difficult to assess outside of the operating room. Parents should be asked if they note a history of curvature with erections or may even document this in their son with photos, but the definitive assessment is done via artificial erection in the operating room after the penis has been degloved (14).

Donnahoo et al. (1998) divided curvature into a classification system of 4 groups: skin tethering; dysgenetic Buck and dartos fascia; corporal disproportion; and congenitally short urethra. Each component can be present to varying degrees, increasing the complexity of the defect and repair. Although this system was used to describe chordee in boys without hypospadias, its concepts are relevant to the curvature noted in hypospadias (15).

Correction of VC is a key component of hypospadias surgery to achieve a straight penis, while preserving penile length and erectile function. VC is assessed preoperatively, but the surgical decision regarding the method of VC correction is made after penile degloving (11, 16). A circumscribing incision is made and the penis is degloved as far as the penoscrotal junction, to excise dysplastic dartos tissue. Artificial erection should then be performed, typically with a tourniquet placed at the penoscrotal junction and injection of normal saline (17).
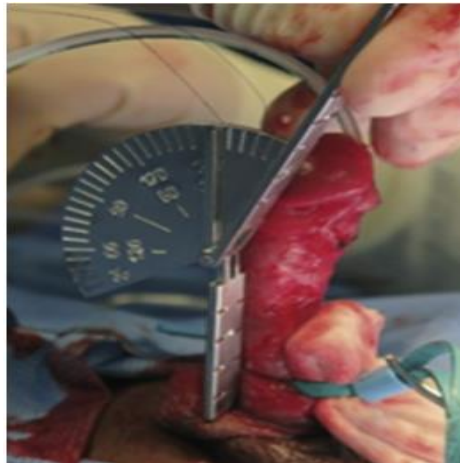
Fig 1: The goniometer with a protractor-like element presents to precisely measure the degree of penile curvature. (Quoted from Campbell-Walsh-Wein Urology 12th Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

Although no consensus exists for treatment of specific degrees of curvature, most seem to agree that a dorsal plication is sufficient for curvature less than 30 degrees (18). If curvature is more severe than 30 degrees, the next step would be to divide the urethra. Some severe cases of ventral curvature have a meatus proximal to the point of maximal bend so that urethral division is not necessary. Persistent curvature greater than 30 degrees at this point would warrant a corporal lengthening procedure, which requires transection of the corpora spongiosum distal to the urethra or transection of the urethra (19).

Dorsal shortening techniques, first described by Nesbit, involve excising an ellipsoid segment of tunica albuginea and closing this defect in a transverse orientation, shortening the dorsum of the penis (20). Based on anatomic studies by Baskin *et al*, the 12 o'clock position has been found to be free of nerves. For this reason, dorsal plication is recommended at the 12 o'clock position with one or more sutures (21).

Contrary to Baskin's original description, some prefer to incise the tunica albuginea in the midline dorsally until the corporal tissue is visualized. The defect is then closed to approximate the raw edges transversely in a Heineke-Mikulicz fashion. Of particular concern is that recurrent curvature at puberty is more common after plication compared with ventral lengthening (22).
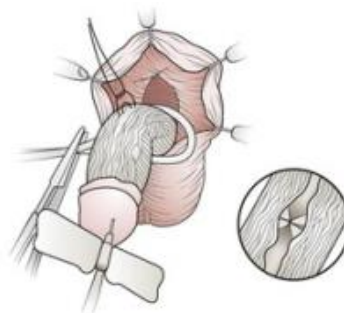

Fig 2: The midline (Baskin) plication technique, similar to the Heineke-Mikulitz approach. A single midline plication is performed in the avascular plane of the penis. (Quoted From Baskin LS: Anatomical studies of hypospadias. J Urol 160:1108–1115, 1998.)

Several options exist for **ventral corporal lengthening** procedures begins with proximal dissection of the spongiosum and distal division of the urethral plate (**23**).

Multiple superficial incisions into, not through, the tunica albuginea of corpus cavernosa to release the tension on the ventral surface of the penis are called "fairy cuts." Several (1 to 3) full thickness incisions into the tunica albuginea without grafting are referred to as transverse corporotomies and have been popularized in the STAG technique, as described in the proximal hypospadias repair (**24, 25**).
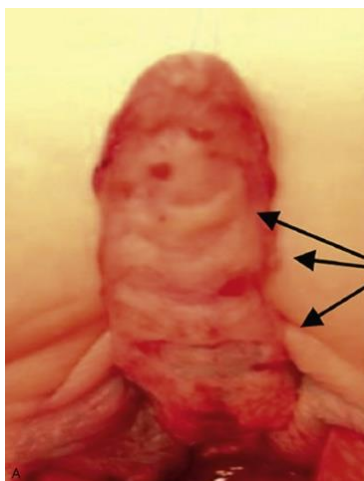

Fig 3: The multiple ventral tunica albuginea corporotomies without grafting as described in the staged tubularized autograft (STAG) repair. Arrows are pointing to the transverse corporotomies, which are made full thickness through the albuginea (From Snodgrass W: Staged tubularized autograft repair for primary proximal hypospadias. J Urol 198:680–686, 2017.)

Corporotomy can be done by incision through the tunica of the corpora cavernosum from the 3–9 o'clock position, elevating the tunica to create an ellipsoid defect (lengthening the ventral penile length) and coverage using dermal grafts, small intestinal submucosa (SIS), or a vascularized tunica vaginalis flap from the testes (**26**).

Curvature may worsen as these boys progress through puberty and undergo significant penile growth. Therefore, it is important to properly identify and correct curvature at the time of the initial repair (**27, 28**).
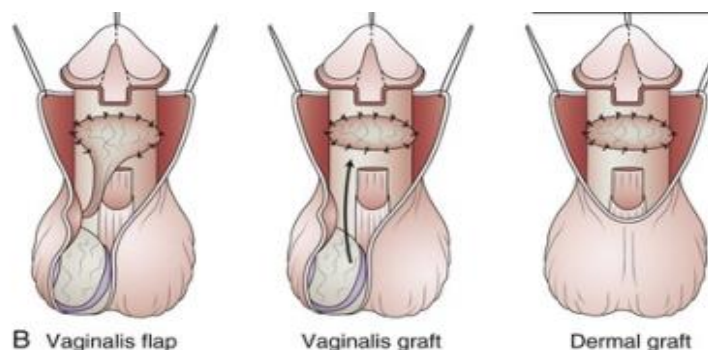

Fig 4: Three approaches to ventral penile lengthening. A tunica vaginalis flap, tunica vaginalis graft, and dermal graft are depicted after incision of the tunica albuginea (From Braga LH: Outcome analysis of severe chordee correction using tunica vaginalis as a flap in boys with proximal hypospadias. *J Urol* 178(suppl4):1693–1697, 2007.)
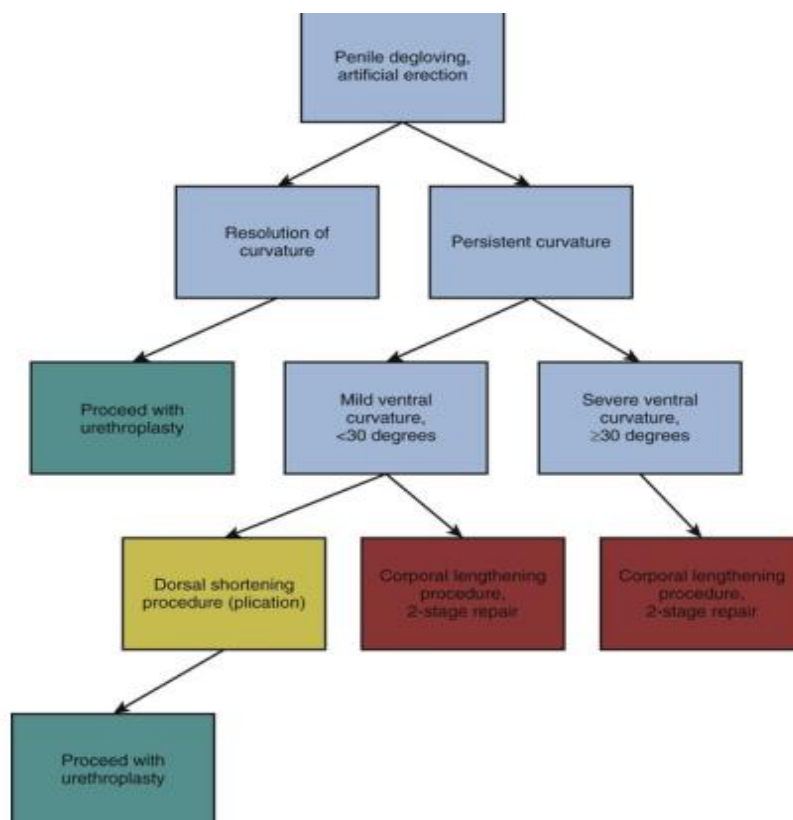
Fig 5: Algorithm for management of penile curvature. (Quoted from Campbell-Walsh-Wein Urology 12th Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

➢ **Urethroplasty:** There are multiple surgical options and several algorithms to guide **urethroplasty** decision-making (**21**). Ongoing efforts to prospectively follow surgical outcomes will hopefully lead to more standardized, evidence-based hypospadias decision-making. Surgical procedures can be divided into one- or two-stage procedures and into procedures that involve urethral plate (UP**)** **tubularization**, UP **augmentation**, and UP **replacement** (**29**).

The urethroplasty techniques that involve **tubularization** of the UP distal to the hypospadic meatus include The Thiersch Duplay technique (**29**). The glanular approximation procedure (**GAP**) procedure involves simple tubularization of the UP after lateral incisions circumscribing the meatus. The **TIP** procedure proposed by Snodgrass in 1994 involves a midline incision of the UP to widen it and achieve a better uretheral caliber, which is then tubularized (**30**). The superior cosmetic results and the low incidence of complications has led to wide consensus that TIP urethroplasty is the most used technique for distal hypospadias (**19**).

The glans approximation procedure (GAP) is a surgical technique designed specifically for patients with glanular/coronal hypospadias who have a wide, deep glanular groove and a noncompliant or "fish-mouth" meatus, which is often present in the MIP variant (**31**). The pyramid procedure is essentially the GAP with an intact prepuce (**32**).

The Thiersch Duplay (**TD**) repair, developed nearly 140 years ago by Thiersch and later Duplay, uses the concept of urethra tubularization of local tissue distal to the ectopic meatus (**33, 34**). The

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TIP procedure, a modification of the TD, is a popular hypospadias surgical technique used worldwide (**30, 35**).
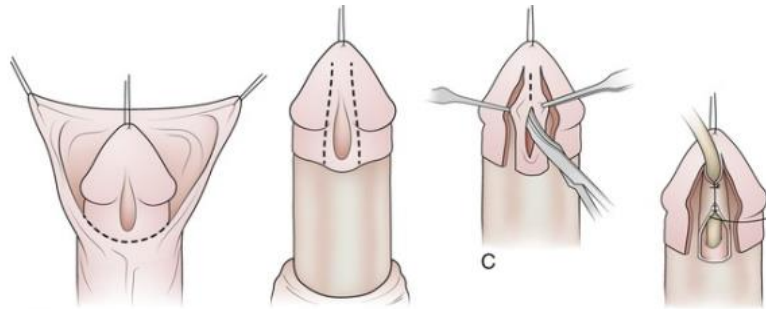

Fig 6: Distal tubularized incised plate (TIP) repair. (Modified from Snodgrass WT: Snodgrass technique for hypospadias repair. *BJU Int* 95:683–693, 2005.)

UP **augmentation** techniques can be used selectively in cases with good UP quality. An inner preputial free graft, referred to as a "**Snodgraft**" procedure places a preputial inlay graft on the incised surface of the UP with the premise that a graft covering a deep UP incision would decrease scarring (**29**). The **Mathieu** procedure flips a rectangular piece of foreskin distally, which is sutured to the edges of the UP on either side as an onlay flap to the UP (**36**). A transverse island flap, described by **Asopa** and **Duckett**, is derived from the dorsal preputial hood and can be translocated ventrally to provide an onlay flap to augment the UP (**37, 38**).

The flip-flap technique (Mathieu) is a procedure in which a parameatal-based flap proximal to the meatus is developed, advanced (flipped) onto the deficient urethral plate to augment it, (**14, 39**). This technique has been further modified to the so-called slitlike adjusted Mathieu (SLAM) procedure with good outcomes, including an improved appearance to the meatus (**40**).
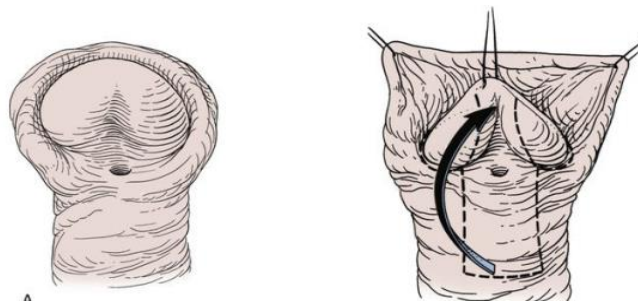

Fig 7: Parameatal skin flap (Quoted from Campbell-Walsh-Wein Urology 12th Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

The onlay island flap technique developed from the transverse preputial island flap (TPIF) technique, which was first reported in 1980(**41**). Meanwhile, the dorsal inlay graft technique aims to maintain the urethral plate and expand the healthy surface area of the epithelium (**42**).
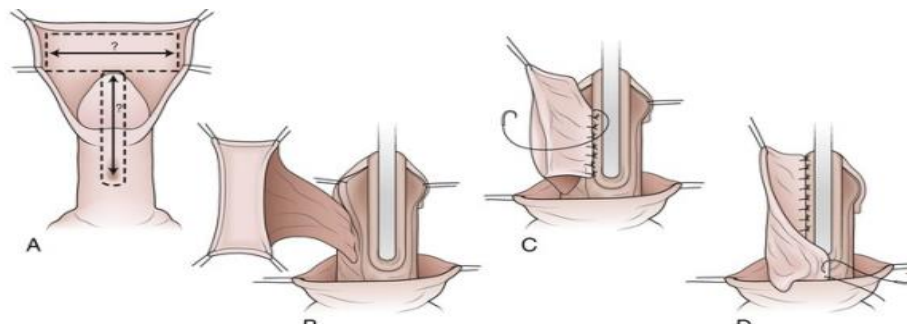
Fig 8: The onlay island flap (OIF) technique (Quoted from Campbell-Walsh-Wein Urology 12ᵗʰ Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

In the presence of significant VC, a proximal hypospadias, and a poor UP, urethral transection may be required, precluding the use of UP tubularization. There are several management options for **substitution** urethroplasty in this situation (**29**).

Despite the increasing popularity of urethral plate preservation, familiarity with a substitution urethroplasty technique is essential for any surgeon operating on proximal hypospadias, as these cases still constitute a significant proportion of repairs (**43**).

Although once a popular technique for hypospadias repair, 1-stage repairs with tubularized graft have fallen out of favor due to poor outcomes. Contemporary 1-stage substitution urethroplasty thus generally involves the use of flaps (**21**).

The most popular flap for **1-stage repair** is the tubularized preputial island flap, as popularized by Duckett (**41**). Variations of this technique include the Onlay-Tube-Onlay modification as described by Upadhyay and Khoury (**44**). Rigamonti and Castagnetti have described a modification of this technique named **Onlay on Albuginea** (**45**). Another option for 1-stage repair is the **Koyanagi** procedure (**46**).
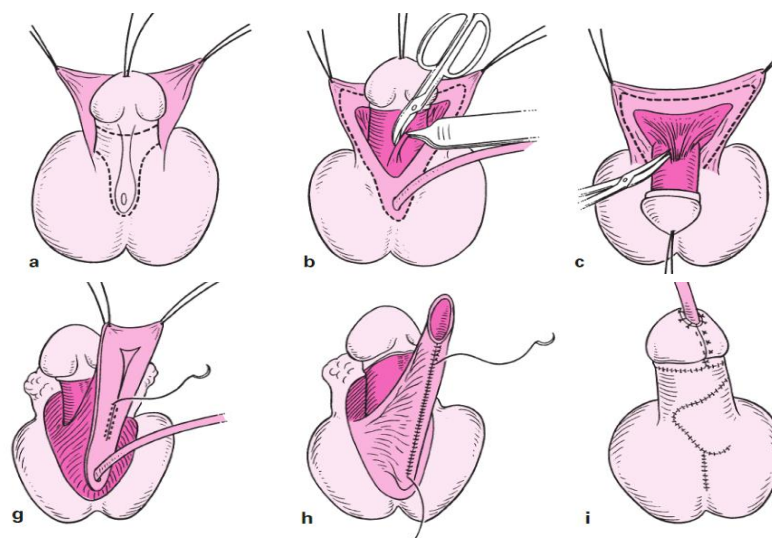

Fig 9: Modified Koyanagi repair (Quoted from Hayashi, Y., Kojima, Y., Mizuno, K., Nakane, A. and Kohri, K. (2001), the modified Koyanagi repair for severe proximal hypospadias. BJU International, 87: 235-238).

Two-stage repairs involve correction of curvature, excision of the urethral plate, and harvesting a graft or flap to create a neourethral plate in the **first** stage, the meatus remains in its proximal location. The **second** stage involves tubularization of the graft or flap that was placed during the first stage to move the urethral meatus to a location in the glans (**21**).

The Bracka two-stage repair uses a free graft, harvested from either the inner preputial skin or buccal mucosa, as a template for urethroplasty (**47**). The staged tubularized autograft (STAG) repair is a modification of Bracka's original description (**24, 25**).

Complete degloving of the penile shaft is performed till its base and The UP transected at the corona and dissected proximally to the uretheral meatus (**48**).

Once the penis is straightened, the glans is split in the midline, which enables the graft to be placed within it. Following this midline split the glans is dissected laterally off the the corpora cavernosum so it is opened like a book. The remaining UP was excised. (**48**).

The urethra is gently stretched back distally and sutured back to the corpora without tension using interrupted 6-zero polydioxanone, gaining approximately 1 cm when possible. Some of the UP is preserved and the opening is spatulated. The distal end of this proximal urethrostomy is sewn to the corpora at 12, 2 and 10 o'clock. Skin adjacent to the proximal urethrostomy is sutured to the opening at 5, 6 and 7 o'clock (**25**).

A skin graft of appropriate dimensions is now harvested from the inner layer of the preputial hood. With the prepuce stretched out, the incisions are made with scalpel, and the graft is elevated by sharp scissors dissection. The graft is then carefully thinned over the back of a finger, to remove the remaining areolar tissue and to leave just a thin translucent membrane. This is a practical method than the commonly described technique of pinning the graft out onto a board, which offers no tactile feedback. The graft is stored in a saline moistened swab until required. Usually, the inner prepuce is enough even in severe perineal hypospadias with bifid scrotum. However, if the inner prepuce is deficient (complicated hypospadias), other donor sources of skin graft can be used in conjunction with, or instead of the prepuce (**49**).
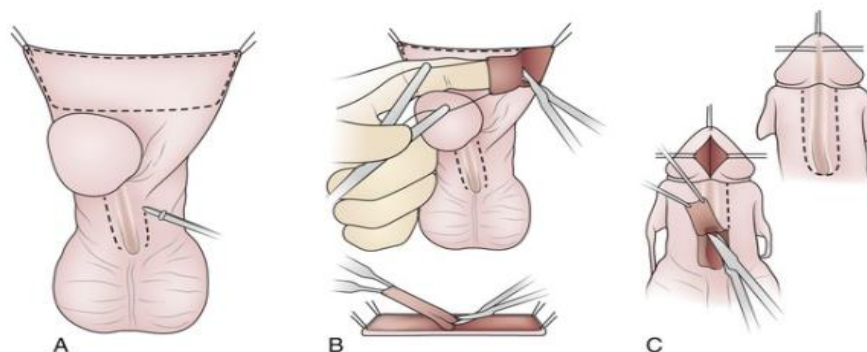

Fig 10: Bracka two-stage free graft repair A, B) Inner preputial free graft incision is marked and harvested. (C) Abnormal urethral plate is excised, and penis is degloved. Modified from Altarac S, Papeš D, Bracka A: Two-stage hypospadias repair with inner preputial layer Wolfe graft. *BJU Int* 110:460–473, 2012.)

The distal portion of the graft is first sewn to the glans using subepithelial sutures along the future meatus to avoid suture marks. The graft is next secured to shaft skin on either side. The proximal end of the graft is incised to extend to either side of the urethrostomy. The graft is quilted to underlying corpora using interrupted sutures approximately 5 mm apart. The first row extends from the urethrostomy up the midline with an additional row on either side (25).

A paraffin gauze dressing is placed on the graft and the shaft skin sutured around it to compress the graft onto the shaft of the penis. A foly catheter is placed in the bladder and the penis is coated in a pressure dressing (48).
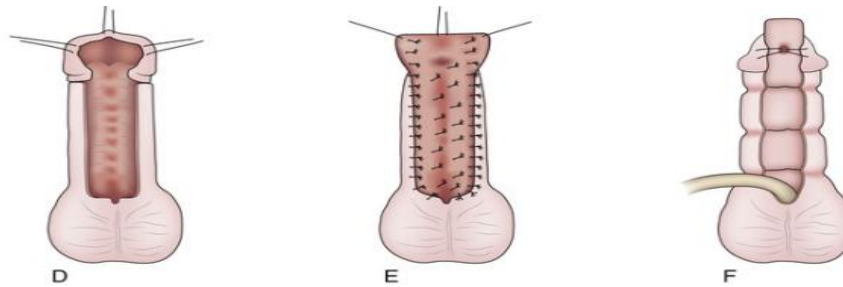

Fig 11:(D) Incision is extended into the glans, mobilizing glans wings. (E) Preputial graft is secured into place, including quilting sutures. (F) Compression dressing is sutured into place over the graft. (Modified from Altarac S, Papeš D, Bracka A: Two-stage hypospadias repair with inner preputial layer Wolfe graft. *BJU Int* 110:460–473, 2012)

The second stage should be scheduled 6 months after the first operation. An artificial erection test should confirm that chordee has been fully corrected. This is usefully deferred until after incising the new urethral plate and mobilizing the skin cover. If some curvature remains, the surgeon must decide whether to incise the tunica albuginea or incorporate a dorsal plication procedure (49).

Glans wings are injected with 1:100,000 epinephrine and then mirror image incisions are made, extending on each side down the edge of the neoplate and entering the proximal urethrostomy from 5 to 7 o'clock to exclude shaft/scrotal skin sewn there at the first stage. The incision continued down the scrotal raphe. Glans wings are dissected laterally to 3 and 9 o'clock, and then superiorly another 4 mm off the corpora on each side. A 6Fr stent is inserted, and a 2-layer subepithelial neoplate tubularization is performed. The first suture was placed distally at approximately the mid-glans level, 3 to 4 mm below the future meatus, creating an oval opening. A tunica vaginalis flap is harvested and dissected proximally to the external ring. The testicle is pexed and its hemiscrotum sutured closed. (25).

The glans is repaired over the flap with 6/0 Vicryl (for deep approximation) and 6/0 Vicryl Rapide (for the skin). Having tailored the desired shape of skin envelope, the tourniquet is released to allow for hemostasis using a bipolar coagulator. Finally, the skin is repaired with 6/0 Vicryl. The urethral catheter is usually left for 7–10 days depending on the level of postoperative edema. The catheter must be strapped securely up on the abdominal wall (49).
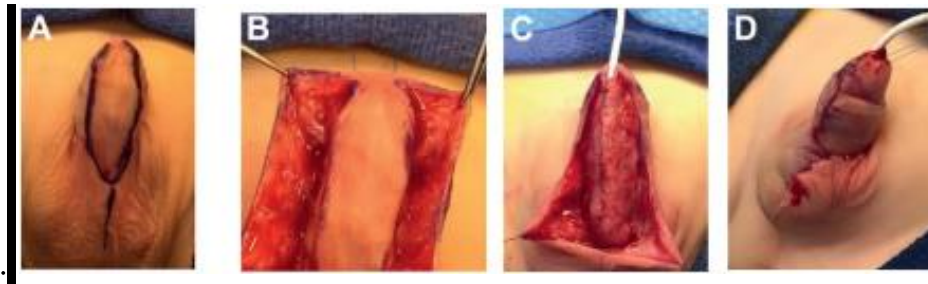
Fig 12: The staged tubularized autograft (STAG) repair. (From Snodgrass W: Staged tubularized autograft repair for primary proximal hypospadias. *J Urol* **198:680–686, 2017).**

The **Byars flap** procedure uses redundant dorsal preputial skin, which is transposed ventrally with its vascular pedicle at the first procedure, as the scaffold to form the urethra (**50, 51**).

A 4/0 prolene stitch was placed on the glans for traction and a 6 Fr silastic catheter is inserted. After infiltration with 1:100000 lignocaine and adrenaline solution a circumferential dorsal incision is made about 1/2 cm from the base of the glans. This is advanced ventrally along the urethral plate till it passes to the proximal edge of the urethral meatus. Then it extended vertically in the midline proximal to the meatus. The incision is racket shaped (**52**).
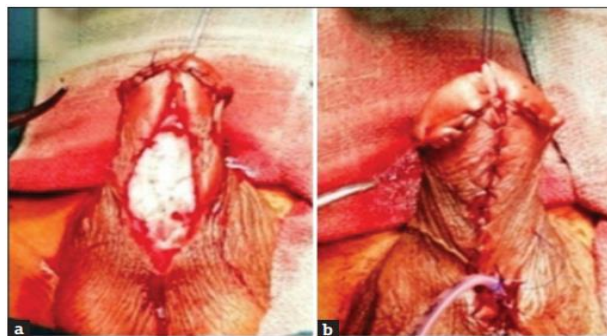

Fig 13: Two-stage hypospadias repair with Byars flap (Quoted from Shukla AK, Singh AP, Sharma P, Shukla J. Two stages repair of proximal hypospadias: Review of 700 cases. J Indian Assoc Pediatr Surg 2017; 22:158-62.

Complete degloving of the penile shaft was performed till its base. Then artificial erection was performed to demonstrate any residual chordee. If this persisted; transection of the urethral plate is done just proximal to the glans. The dorsal preputial skin was then incised in the middle and the two flaps were brought ventrally. These were sutured to the edges of the urethral plate or, if it was transected, to each other in the midline of the shaft. The catheter was removed after 3 days (*53).*
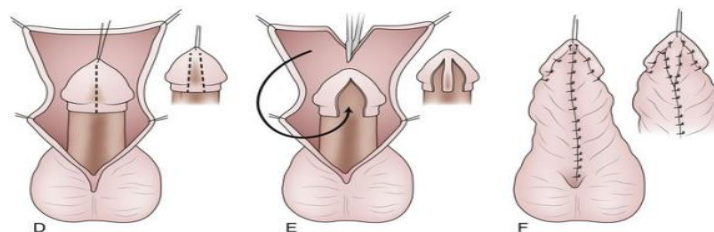
Fig 14: Two-stage hypospadias repair with Byars flap. (A) First stage: incisions are marked to allow degloving and mobilization of ventral skin. (B) The penis is degloved to the penoscrotal junction. Any dysplastic, or chordee, tissue is removed. (D) Either midline or parallel lateral glans (*inset*) incision(s) is (are) made in the glans and glans wings developed. (E) Byars flaps are developed by incising the dorsal inner preputial skin in the midline to the mucosal collar, yielding a proper skin fit dorsally. (F) The redundant dorsal skin is transposed ventrally and secured in place.

The second stage is performed 6–12 months later. A traction suture and a 8 Fr silastic catheter tube are inserted. The width of this strip is measured according to the catheter circumference. Parallel lines are marked on the ventral side of the penis. Incisions are made along these lines to the tip of the glans. The rotated skin is tabularized around the 8 Fr silastic tube to make the new urethra using inverting continuous running suture. A second layer interrupted sutures are taken from the penile adventitial tissues over the first suture line. At last, the penile skin is sutured in two layers. Simple penile dressing is applied. The dressing is changed after 5–7 days and the catheter is removed after 13 days (52)
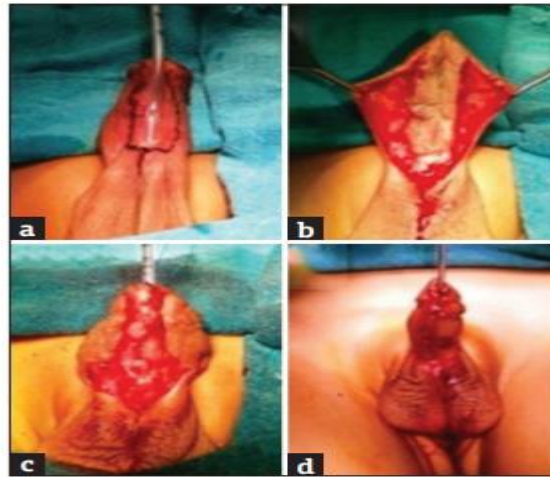

Fig 15:2nd stage of Byar repair (Quoted from Shukla AK, Singh AP, Sharma P, Shukla J. Two stages repair of proximal hypospadias: Review of 700 cases. J Indian Assoc Pediatr Surg 2017; 22:158-62).

The use of **second-layer** vascularized tissue coverage over the neourethral repair further reinforces blood supply. The use of multiple overlapping tissue layers is important in the reduction of complications so long as the additional layers do not compromise capillary flow. Dartos interposition flaps increasing the vascularized layers superficial to the urethral closure help reduce fistula formation after TIP repair (54). Snodgrass and Yucel describe the use of spongioplasty as part of their closure (55). Additional options for this barrier layer include tunica vaginalis flap, dorsal subcutaneous flap, dartos flap, or an external spermatic fascia flap (56).

Penoscrotal transposition is also commonly observed in proximal hypospadias cases and several techniques are available for its correction (56). Scrotal procedures have been described for correction of penoscrotal transposition. **Campbell**, in 1970, bisected the scrotum and sutured the two halves beneath the penis. McIlvoy and Harris (1955) placed the penis anterior to the scrotum through a subcutaneous tunnel. **Glenn** and **Anderson** (1973) performed simultaneous correction of PST and repair of hypospadias. They completely mobilized the two halves of the scrotum as rotational advancement flaps with relocation of the scrotal compartment in a normal dependent position and constructed the neourethra at the same operation **(49).**

- **Skin closure** after VC correction and urethroplasty should be symmetric and without excessive tension to prevent recurrent skin tethering and curvature. The hypospadias complex includes a redundant dorsal foreskin and ventral skin deficiency. This disproportion can sometimes make

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skin closure very challenging. If primary closure is not possible, a Byars skin flap may be utilized. In cases where a buried penis is anticipated, there may be value in suturing shaft skin at the base of the penis to Buck's fascia (21).

Post operative assessment of Hypospadias:

Although thousands of publications can be found, most if not all are limited to some extent by their retrospective nature, small cohort sizes, variations in technique, poorly defined outcomes, lack of independent outcome assessment, and patient loss to follow-up. Efforts to improve publication standards and quality collaboration across institutions are being made (57).

To capture Patient related outcome PRO, several hypospadias specific scoring systems have been developed. The Hypospadias Objective Scoring Evaluation (HOSE), Pediatric Penile Perception Score (PPS), Genital perception Score (GPS), and the Hypospadias Objective Penile Evaluation (HOPE) score are scoring systems that have been generated and validated in children (58-60).

Uroflow can be performed to further characterize a slowed urinary stream, although exact definitions of a poor flow after a hypospadias repair are not well defined and difficult to obtain in the pre–toilet-trained population. It can also be difficult to predict which child needs surgical attention because improved flow rates with aging have been reported (61).

Interview child
We will talk about several aspects of your penis. Please tell me how satisfied you are with these. There are four possible answers: Very satisfied, satisfied, dissatisfied, very dissatisfied. Please tell me which one is the most appropriate for you

	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied
a Length of your penis	□(3)	□(2)	□(1)	□(0)
b Position and shape of your urethral opening	□(3)	□(2)	□(1)	□(0)
c Shape of your glans	□(3)	□(2)	□(1)	□(0)
d Shape of your penile skin	□(3)	□(2)	□(1)	□(0)
e Penile axis (straightness upon erection	□(3)	□(2)	□(1)	□(0)
f General appearance of your penis	□(3)	□(2)	□(1)	□(0)

Fig 16: Pediatric Penile Perception Score instrument is administered to the patient and parents for assessment after hypospadias repair. Considerations include cosmetic satisfaction with the length of the penis, meatus, glans, penile skin, and straightness of the penis. (From Weber DM, Schonbucher VB, Landolt MA, et al.: The Pediatric Penile Perception Score: an instrument for patient self-assessment and surgeon evaluation after hypospadias repair. *J Urol* 180(3):1080–1084, 2008.)

Complications of Hypospadias Repair:

Postoperative complications can usually be identified early in the first few months after surgery in most cases, but long-term follow up is mandatory because delayed presentation with a urethral fistula and recurrent curvature of the penis following puberty spurt have been documented (4).

Urethrocutaneous fistula is the most common reported surgical complication after hypospadias repair, with an incidence just under 10% in short-term follow-up (62).

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Fig 17: Uretherocutaneous fistula (Quoted from Campbell-Walsh-Wein Urology 12ᵗʰ Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

The development of a fistula is multifactorial, with ischemia, infection, and/or hematoma contributing to improper healing of the neourethra. Distal urethral obstruction from meatal stenosis or urethral stricture results in high urethral pressures and turbulent flow during voiding. This places additional stress on the suture line and can decrease the perfusion of the tissues during wound healing. Technical factors such as overlapping of suture lines, inadequate inversion of the epithelium, or use of poorly absorbable suture material may also contribute (63). All these factors become even more evident as the severity of the hypospadias worsens (64, 65).

Small-caliber fistulas on the penile shaft proximal to the coronal margin can be closed primarily, taking care to excise the epithelialized tract to the urethra (66). Larger fistulas, or those that are present in areas where the tissues have thinned, require multiple layer coverage or island flap of penile shaft skin. (66-68).

Glans dehiscence is due to a combination of factors, including poor technique, tension on the glans closure, and vascular compromise. If this occurs, the meatus typically regresses back to the corona or subcoronal location. Reoperation may or may not be necessary and should be driven by the presence or absence of voiding symptoms.

Fig 18: glans dehiscence (Quoted from Campbell-Walsh-Wein Urology 12ᵗʰ Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

Definitions for **meatal stenosis** vary considerably across studies (69). Risk of narrowing increases if the urethra closure extends too distally or if the glans is closed with too much tension. Prolonging the time of postoperative stenting may decrease the risk of stenosis, although there are fewer data to substantiate this assumption (70).

Occasionally a stenotic meatus can be managed conservatively with meatal dilation with a sound and/or topical steroid cream (71). When the stenosis is refractory to dilation, a midline meatotomy can achieve patency in rare cases (72). Otherwise, a redo Meatoplasty is indicated.

Urethral Stricture is also a frequently reported complication of hypospadias repair, with rates varying depending on urethroplasty technique and length of urethroplasty (73, 74). Improper urethroplasty technique, tissue ischemia, trauma, or infection can result in narrowing of the lumen. When clinically apparent, it is best to characterize the stricture via cystoscopy to delineate the length, caliber, and location of the stricture.

Initial management depends upon the severity of the stricture. For short strictures causing minimal symptoms, urethral dilation or endoscopic incision can be attempted. In most cases, however, this will not provide a long-term solution. Direct visual internal urethrotomy in adult strictures has low success rates and risks worsening the stricture by generating more inflammation and scar (75, 76). Strictures not responding to conservative management or those with extensive disease at diagnosis require revision urethroplasty (77).

If hair-bearing skin is used for the hypospadias repair, the patient may notice hair extending from the meatus. This complication usually occurs after multiplestage procedures or complex reoperations in which there is a shortage of non– hair-bearing skin. Hair in the urethral lumen, if combined with urethral narrowing, acts as a nidus for stone formation or recurrent UTIs. Laser ablation may result in success in some cases (78, 79).

Diverticula occur more commonly in boys undergoing preputial flap repairs, two-stage repairs, and proximal repairs (80). This is in part anatomic, because of the lack of spongiosal tissue in the neourethra, which acts to reinforce the normal urethra during voiding. As mentioned earlier, the extra support of the glanular neourethra after glans closure can increase voiding pressure in the penile urethra, leading to diverticulum formation (81).

Fig 19: Uretheral diverticulum (Quoted from Campbell-Walsh-Wein Urology 12th Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

A small, localized saccular diverticulum can be excised and reduced, returningthe urethral lumen to a uniform caliber. The more commonly encountered extensive diverticula are repaired by excising redundant diverticular tissue, urethral closure, and multilayered reinforcement before skin closure (82).

Persistent penile curvature is an unfortunate complication of hypospadias repair that has severe consequences on urinary and sexual function. Residual curvature may worsen as boys grow through puberty, when penile growth surges with potentially differential growth of the dorsal and ventral portion of the corporal bodies (27). Persistent or recurrent curvature occurs when curvature is underestimated or is repaired incompletely (28). The first stage assesses the cause of curvature, with particular attention to corporal disproportion if a dorsal plication was performed previously (83).

Fig 20: Recurrant penile Curvature (Quoted from Campbell-Walsh-Wein Urology 12th Ed: Hypospadias Ch45; Christopher J. Long MD, Mark R. Zaontz MD, Douglas A. Canning, 2021)

Failed hypospadias occurs when the primary surgery does not achieve the cosmetic and functional goals of a straight penis with a glanular meatus that enables normal urinary and sexual function. Failed hypospadias includes all complicated repairs that don't fulfill patient expectations and cause dissatisfaction (84)

Risk factors affecting complications and success rate in redo hypospadias repair include factors related to the hypospadias (severity of the condition and characteristics of the urethral plate), the patient (age at surgery, endocrine environment, and wound healing impairment), the surgeon experience) and the procedure (technical details, suture materials, urethral stenting and postoperative management). The most important factors for preventing complications are surgeon expertise (number of cases treated per year), interposition of a barrier layer between the urethro-plasty and the penile skin and postoperative urinary drainage (16).

In general, the technique used for repair is determined intraoperatively after careful reassessment of the meatus location, penile curvature, final size, and the ventral aspect of the penile skin (85). However, different techniques can be used in redo hypospadias repair as TIP repair, two stage repair, onlay flap or inlay graft …. etc. (86).

- **Debate around Proximal Hypospadias management:**

Proximal hypospadias with chordee is the most challenging variant of hypospadias to reconstruct (87) The debate over the optimal treatment for severe cases of hypospadias is ongoing, and many

surgeons believe that two-stage procedure offers superior functional and cosmetic results with fewer complications (88).

One stage repair is an attractive option in that they may reduce cost, hospital stay, anesthetic risks, and time to the final result. Favorable long-term results with acceptable complication rates have been described for 1-stage repairs using the urethral plate such as proximal TIP and Onlay TVIF repairs whereas if the urethral plate is not used for the urethroplasty, 1-stage repairs may have higher complication rates, Although limited by the lack of controlled studies—a systematic review suggested that the mean complication rate with 2-stage repairs (**22.2%**) was lower than that of 1-stage repairs that did not utilize the urethral plate (**32-46%**) (**85**).

Two-stage repairs permit compartmentalization of the repair, providing the opportunity to reevaluate the situation along the way for complex hypospadias cases. The time interval between the first and second stage allows for growth of the penile structures and reveals complications that relate to recurrent VC or graft contracture. Dealing with these complications earlier can be simpler than after urethral tubularization, leading to a more successful final outcome. Problems after the second stage are then generally isolated to the urethroplasty (**21**).

Proximal hypospadias cases amenable to 1-stage urethral plate preserving techniques are rare. This is due to the predominance of unfavorable characteristics for this repair in this patient population—a narrow and inelastic urethral plate, poorly developed spongiosum, scrotal or perineal meatal location, and significant urethral plate tethering resulting in severe VC. The use of a single stage repair preserving the urethral plate in these sorts of cases may result in penile shortening, residual or recurrent VC and urethral strictures due to excessive plate mobilization and inadequate correction of curvature. In addition, the use of a 1-stage repair that discards the urethral plate increases the complexity of the single stage repair and may contribute to even higher complication rates (**21**).

Given the lack of clear high-quality evidence supporting the superiority of one approach over the others, hypospadiologists should adopt an algorithm that gives them the best outcomes in their hands. For many, this may include a 1-stage approach in cases of proximal hypospadias with "healthy" urethral plates and VC less than 45 degrees and a 2-stage approach for the more severe cases (**21**).
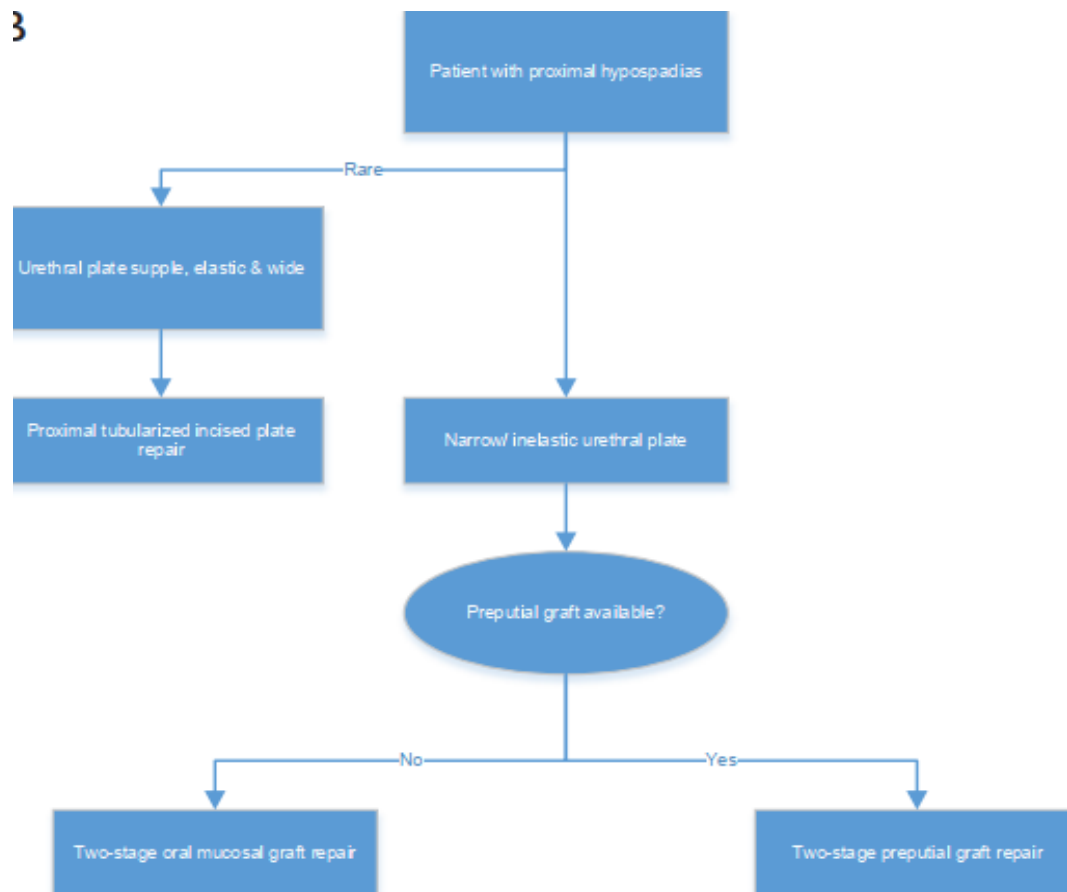
Fig 21: An algorithm for approaching ventral curvature (A) and urethroplasty (Quoted from Dason S, Wong N, Braga LH. The contemporary role of 1 vs. 2-stage repair for proximal hypospadias. *Transl Androl Urol* 2014; 3:347-58.

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