9 Single Stage Repair in Proximal Hypospadias

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9.1 Introduction

Hypospadias is a diverse condition with a wide spectrum of clinical phenotypes ranging from a glanular meatus to a perineal meatus with varying degrees of chordee, glanular configurations, and penile skin coverage. It is estimated that approximately 25% of all hypospadias cases will have a proximal meatus and its associated findings, i.e. significant ventral curvature +/− penile torsion, with ventrally deficient shaft skin, a flattened hypoplastic glans, and penoscrotal transposition.

The management of proximal hypospadias has undergone significant evolution over the past few decades based on understanding the results, complications, and long-term clinical outcomes. The treatment strategies evolved based on data and information from expert opinions and retrospective case reports to incorporating more evidence-based medicine into the care algorithms that determine surgical management. From 1960 through the 1970s, there was a preference for two-stage repairs, and then Dr. Duckett popularized urethral substitution with a single-stage repair using a preputial flap tube urethroplasty. Procedures also evolved from urethral substitution (tube urethroplasty) to urethral augmentation (onlay flap urethroplasty), with improved clinical outcomes.

The goals of surgery in the management of a patient with proximal hypospadias include addressing the various components of the clinical phenotype and achieving sustainable optimal functional and cosmetic outcomes; this includes:

- Normalization of penile anatomy.
  - Correction of penile chordee and any associated penile torsion.
  - Address the location of the meatus to enable proper voiding.
  - Achieve normal glans configuration.
  - Achieve proper skin coverage of the penis—with either circumcision or preservation of the foreskin if possible, in accordance with the parental request.
  - Address penoscrotal relationship with correction of any transposition.
- Enable the proper function of the reconstructed urethra.
- Anticipate and prepare for changes related to physiological growth and erectile function from infancy to adulthood. There is, on

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average, a 320% change in flaccid penile length during this period [1].
- Ensure optimal sexual function to permit painless, penetrative intercourse.
- Allow for optimal body image perception by the patient.

The preference for managing proximal hypospadias has swung from a choice for single-stage repair to most pediatric urologists (76.6%) preferring the two-stage repair over the past decade [2, 3].

There are certainly some significant benefits of a single-stage hypospadias repair as they decrease the burden of care, reduce the cost of treatment, diminished anesthetic risk and therapy duration. However, these benefits may come at the cost of a higher complication rate than two-stage repairs.

A review published in 2010 demonstrated that the complication rates for proximal hypospadias repairs were:

- Single-stage repairs that involved urethral substitution—32-46%.
- Single-stage repairs that involved urethral augmentation or reconfiguration—24.2%.
- Two-stage procedures—22.2%.

9.2 General Principles of Repair

There is no age beyond which it is not safe to undertake the hypospadias repair. However, there is a minimum age at which it is safe to proceed with the repair, and most surgeons would recommend waiting till the child is at least six months old.

The minimal age for undertaking surgery is based on the following patient factors:

- Anesthetic risk [4, 5].
- Anatomy—vascularity improves after mini-puberty [6–8].
- The psychological impact of surgery on the parents of infants [9].

When undertaking the repair of a proximal penile shaft hypospadias, the surgeon has to consider the following:

- Degree of chordee.
- Whether to perform urethral reconstruction, augmentation, or substitution.
- Glansplasty.
- Penoscrotal transposition.
- Skin coverage.

9.3 Proper Assessment of the Chordee

The assessment of penile curvature/chordee is critically important as this is a crucial determinant in the decision to proceed with either a single-stage procedure or a multi-staged procedure.

The intra-operative artificial erection test with injectable saline is the preferred test used to assess the chordee's degree, originally described by Gittes and McLaughlin [10].

There is a consensus among pediatric urologists that chordee greater than 20 degrees is clinically significant and warrants repair [11]. In cases when the proximal hypospadias is associated with greater than 30 degrees of ventral chordee, and the degree of chordee is unchanged after degloving, it is the opinion of this author that these patients should be diverted into a staged repair pathway [12, 13].

I would direct the reader to the chapter dedicated to issues related to Chordee in this textbook for a more comprehensive review of this very important aspect of caring for a child with hypospadias.

9.4 Urethroplasty

The urethroplasty can be achieved with one of the three techniques:

- Tubularization of the existing urethral plate with or without need for incision of the back wall of the urethral plate.
- Augmentation of the existing urethral plate:
  - Grafting the existing urethral plate to permit tension-free tubularization.
  - Transverse island onlay preputial flap (TIOF).
  - Double onlay preputial flap (DOPF).
- Substitution of the existing urethral plate:

  - Duckett Procedure (TVIF).
  - Asopa-I urethroplasty.
  - Koyanagi-Nonomura urethroplasty.

The source of tissue for urethral augmentation or substitution for single-stage repairs of proximal hypospadias includes the following:

- Urethral mobilization, by dissecting and elevating the existing urethra and distal advancement to permit a glanular meatus. The main disadvantage of this option is a bias towards the inadequate treatment of chordee. If the chordee does recur, it will cause the urethroplasty to fail [14].
- Penile shaft skin distal to the existing meatus.
- Skin proximal to the existing meatus.
- Preputial skin.

  - Skin graft to form neourethra [15].
  - Skin flap to form neourethra [14, 16–27].

Surveys of practicing Pediatric Urologists and Pediatric Surgeons indicate that when caring for a patient with less than 30 degrees of ventral chordee, 51% prefer a single-stage procedure to preserve the urethral plate. Among the single-stage procedures, 43% would perform a TIP procedure, and 10–30% of them would use the TVIF procedure to correct a proximal hypospadias [2, 3].

9.5 Urethral Tubularization Procedures

9.5.1 TIP Procedure (Figs 9.1a–i)

In a few cases of proximal hypospadias where there is minimal chordee (<30 degrees) and a healthy urethral plate that extends into the glans, an extended TIP procedure can be considered [28]. After an initial enthusiasm for this procedure as a single-stage repair for such cases, this was tempered by the long-term results that showed recurrent chordee and fistulas [29].

In the instance where the anatomy is conducive, one may perform a TIP repair following the distal TIP repair principles.

- Degloving of the penis using a circumcising incision and preservation of the dorsal blood supply. The incision may be modified in those cases where the family has requested foreskin preservation (Fig. 9.1a–c).
- Mobilization of the divergent spongiosal tissue along the length of the urethral plate for later use in the spongioplasty to cover the tubularized urethral plate (Fig. 9.1d, e).
- Assessment of ventral chordee with artificial erection test and if less than 30 degrees, proceed with single-stage repair and correction of the chordee with dorsal plication(s). If more than two plications are required to achieve an orthotopic penis—the surgeon may have to reconsider the choice of a single-stage repair.
- Creation of glans wings—the spongiosal flaps should be mobilized so that they create a 90-degree angle with the urethral plate; this will permit tension-free closure of the glans (Fig. 9.1e).
- Deep midline incision of the urethral plate to permit two-layer tubularization of the urethra in a tension free manner. It is important to stop the tubularization approximately 2–3 mm from the distal end of the urethral plate to reduce risk of meatal stenosis (Fig. 9.1f).
- The urethral plate's tubularization is performed with interrupted sutures for the initial layer and running sutures for the second layer. This should be performed around a stent (caliber depends on the age of the patient at the time of surgery - I typically use a 6 Fr stent in infants).
- Spongioplasty, reconfiguration of the divergent spongiosum ventral to the reconstructed urethra—Y to I reconfiguration [30–34] (Fig. 9.1g).
- Glanuloplasty: Suturing the glans wings to reapproximate them in the ventral midline with adequate space between the neourethra and glans wings (Fig. 9.1h).
- Harvesting of a tunica vaginalis flap from one of the testis and reinforcement of the urethroplasty as a vascularized barrier flap. It is important to mobilize the tunica vaginalis along the spermatic cord adequately, otherwise, it can cause penile torsion.

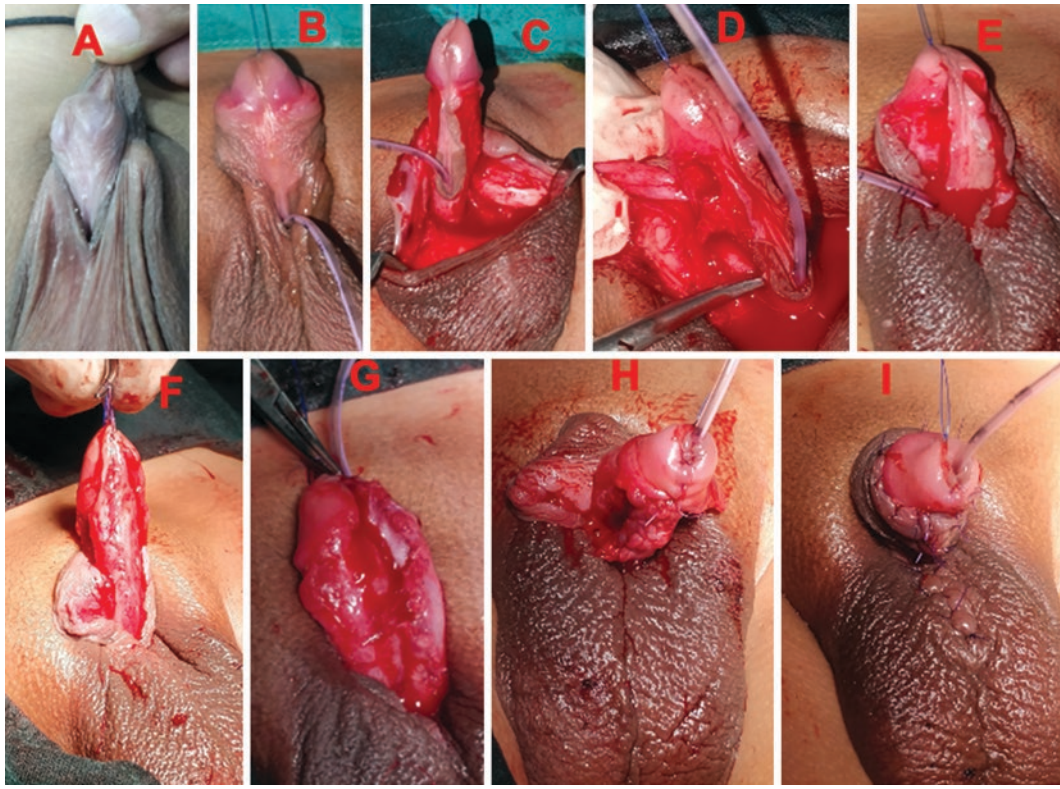

Fig. 9.1 Demonstrates the TIP urethroplasty technique for treating proximal hypospadias. (**a** & **b**). Penoscrotal hypospadias. (**c**). Penile degloving. (**d**). Incising the urethral plate. (**e**). Mobilization of urethral plate into glans. (**f**). Tubularization of urethral plate. (**g**). Spongioplasty. (**h**). Glansplasty. (**i**). Skin closure

- Skin coverage, this is an often over looked aspect of hypospadias surgery, it is important to bear in mind that attention to detail and ensuring an aesthetically pleasing skin coverage of the reconstructed penis will result in high patient and parental satisfaction as the child grows (Fig. 9.1i).

- The use of intermediate protective barrier layers between the urethra and the skin has been shown to reduce the risk of complications, in particular the occurrence of fistulae. The principles to be followed with respect to this layer, whether it be spongiosal tissue, local dartos tissue, or a tunica vaginalis flap are that it: (1) provides mechanical support to the reconstructed urethra, (2) brings neovascularity that aids in healing and (3) prevents directly overlapping suture lines. Snodgrass has shown that by incorporating a tunica vaginalis barrier flap, spongioplasty, and a two-layer closure for the urethroplasty, he has significantly reduced his fistula rate for proximal TIP procedures [28]. The initial reports of outcomes after the TIP procedure for proximal hypospadias demonstrated a complication rate of approximately 24.2%; this included a 20% incidence of fistula/dehiscence and a 3% rate of stricture/meatal stenosis.

9.6 Urethral Augmentation Procedures

9.6.1 Grafted-Tubularized Incised Plate (G-TIP) [35] Also Known as Single Primary Stage Dorsal Inlay Urethroplasty (Fig. 9.2a–h)

This procedure is performed in the same manner as a regular Tubularized Incised Plate (TIP)

repair, with one additional step, using either a prepucial or buccal mucosa graft to augment the existing urethral plate after incising it dorsally [35]. This modification of the TIP procedure has expanded the indications for a TIP repair in proximal hypospadias cases, to even include cases where previously the existing urethral plate may have been deemed to be too narrow to permit a tension-free tubularization <8 mm [36].

Steps of the procedure:

- Degloving of the penis using a circumcising incision and preservation of the dorsal blood supply. The incision may be modified in those cases where the family has requested foreskin preservation and prepucial reconstruction (Fig. 9.2a, b).
- Mobilization of the divergent spongiosal tissue along the length of the urethral plate for later use in the spongioplasty to cover the tubularized urethral plate.
- Assessment of ventral chordee with artificial erection test and if less than 30 degrees, proceed with single-stage repair and correction of the chordee with dorsal plication(s). If more than two plications are required to achieve an orthotopic penis—the surgeon may have to reconsider the choice of a single-stage repair (Fig. 9.2b).
- Creation of glans wings—the spongiosal flaps should be mobilized so that they create a 90-degree angle with the urethral plate; this will permit tension-free closure of the glans.
- Deep dorsal midline incision of the entire urethral plate, that stops approximately 3 mm from the distal end to reduce the risk of meatal stenosis. As shown in Fig. 9.2c, it is important to make a deep incision in the urethra plate such that the two halves of the ure-

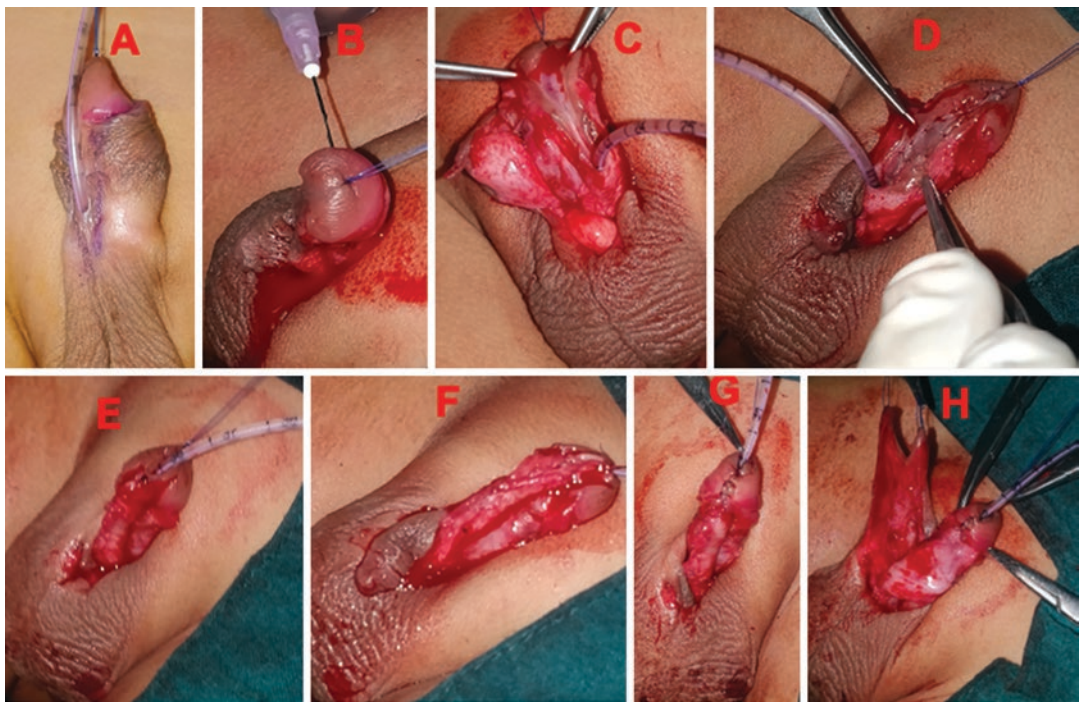

Fig. 9.2 Demonstrates the dorsal inlay graft technique. (**a**). Proximal penile hypospadias. (**b**). Checking the degree of chordee after penile degloving and mobilization of the existing urethra. (**c**). Incising the urethral plate. (**d**). Dorsal inlay graft. (**e**). Tubularization of the augmented urethral plate. (**f**). Spongioplasty. (**g**). Glanuloplasty. (**h**). Covering the tubularized urethra with dorsal dartos flaps

thral plate can be easily drawn apart—this dissection and the gap are dependent on the width of the existing urethral plate, need at least 14–16 mm total width (urethral plate + graft) to permit an adequate tension-free urethroplasty.

- Measure the length of the defect in the urethral plate and harvest an adequate sized graft from either the inner layer of the prepuce or from the inner aspect of the lip in cases where the child has been circumcised, or the family has requested a foreskin preserving procedure.
- The graft is laid into the defect in the urethral plate, the lateral edges of the graft are secured to the urethral plate with monofilament interrupted sutures, and the graft is quilted to the underlying corporal tissue (Fig. 9.2d).
- The grafted urethral plate is then tubularized with interrupted sutures for the initial layer and running sutures of the 2nd layer. This should be performed around a stent (caliber depends on the age of the patient at the time of surgery, in infants, I usually will perform this portion of the procedure around a 8 Fr feeding tube, but replace it with a 6 Fr stent that will remain during the post-operative healing) (Fig. 9.2e).
- Spongioplasty, reconfiguration of the divergent spongiosum ventral to the reconstructed urethra—Y to I reconfiguration (Fig. 9.2f) [30–34].
- Glanuloplasty: Suturing the glans wings with adequate space between the neourethra and glans wings (Fig. 9.2g).
- Harvesting dorsal dartos flap to cover the neourethra (Fig. 9.2h) or harvesting of a tunica vaginalis flap from one of the testis and using this to reinforce the urethroplasty as a vascularized barrier flap. It is important to mobilize the tunica vaginalis along the spermatic cord adequately, failure to do so can cause penile torsion.
- Skin coverage.

9.6.2 Onlay Transverse Island Preputial Flap (TVIF)

In instances where there is favorable anatomy for a single-stage repair, i.e. healthy skin, less than 30-degree ventral chordee, and an intact urethral plate, one can consider the onlay transverse island flap (TVIF) [17, 37] using prepucial skin to augment the existing urethral plate. This is a useful technique where the urethral plate is not wide enough or healthy enough (i.e., elastic) to permit a TIP procedure. The technique evolved as a modification of the tubularized transverse island flap described by Duckett.

Steps of the procedure:

- Degloving of the penis with a circumcising incision—preserve the dorsal blood supply and also the urethral plate—allow for a minimum of 8 mm of the urethral plate to be left intact.
- Intra-operative artificial erection test, if less than 30 degrees ventral chordee, correct with dorsal plication (if greater than 30 degrees, optimal results may be achieved with a staged procedure).
- Apply the tourniquet at the base of the shaft and create glans wings.
- In patients that have a prominent lip at the distal end of the glanular groove, this can be addressed with a Heineke-Mikulicz maneuver that eliminates the lip, deepens the glans groove, and extends the neourethra to the tip of the glans.
- Cut back on the existing urethra till a healthy urethra with healthy supporting corpus spongiosum is encountered. This ensures a wide proximal anastomosis and reduces the risk of an anastomotic stricture.
- Harvest a rectangular flap from the inner prepucial tissue along with its vascular pedicle. The length of the longer side is determined by the length of the urethra to be reconstructed.
- The flap is rotated to the ventrum and anastomosed to the urethral plate. The rethrocutaneous suture line is covered with a second layer

that incorporates the vascular pedicle of the flap (Fig. 9.3a–c).
- Closure of the glans wings and glansplasty, as shown in Fig. 9.3d, e.
- Skin coverage (Fig. 9.3f).

9.6.3 Double Onlay Preputial Flap (DOPF)

Holland and Smith reported that when the urethral plate is less than 8 mm in width, there is a higher complication rate when such a plate is tubularized, i.e. fistulae and wound dehiscence [36]. The Double Onlay Preputial Flap (DOPF) [38] technique of hypospadias repair can be utilized in cases of proximal hypospadias that meet the following criteria:

- Have minimal chordee.
- Have healthy penile skin and have not been circumcised.
- Urethral plate is <8 mm in width.
- Conical or flat glans penis.

Steps of the procedure:

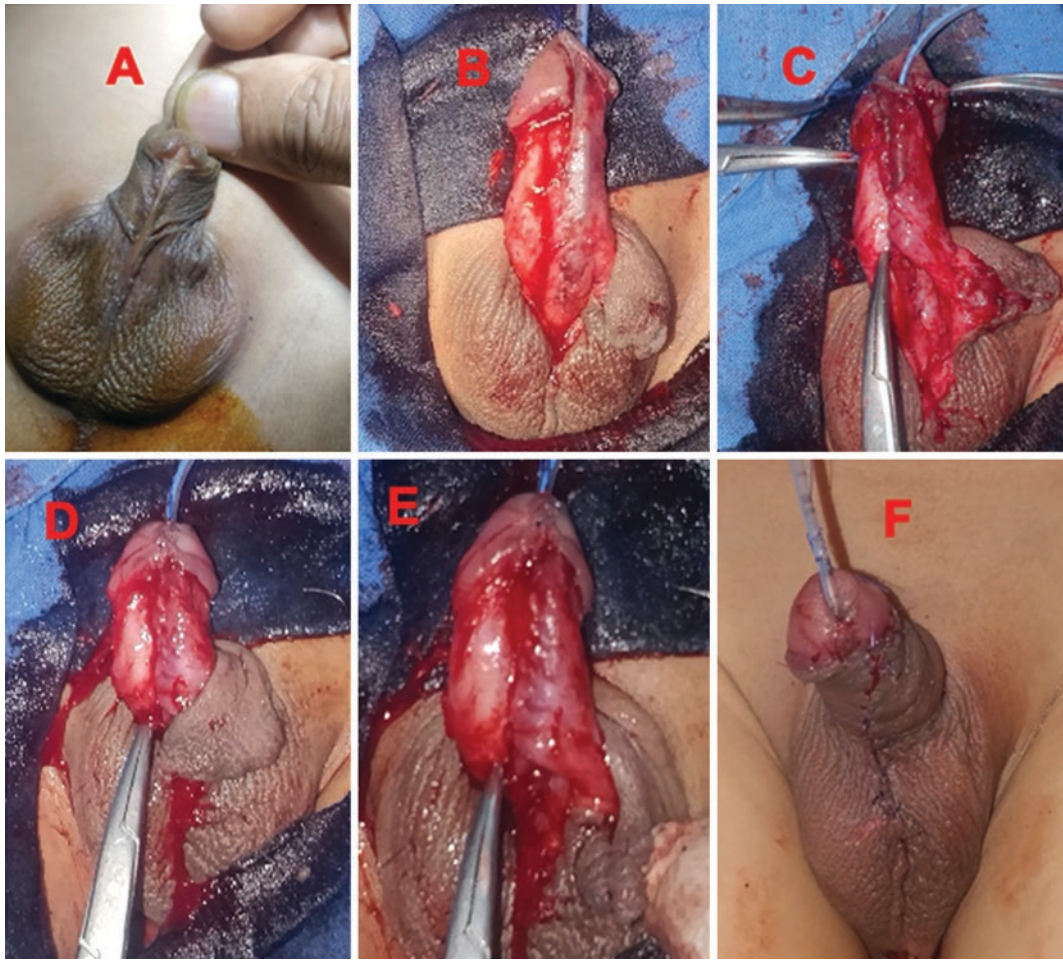

Fig. 9.3 Demonstrates the dorsal transverse island onlay flap technique. (**a**). Proximal penile hypospadias Narrow urethral plate. (**b**). Penile degloving and partial sutured island flap. (**c**). Onlay flap sutured up to meatus. (**d**). Glansplasty. (**e**). Covering the neourethra with dorsal dartos flap taking few sutures in the pedicle. (**f**). skin closure and final intra-operative result

- Place a traction suture through the glans penis.
- Make a "U" shaped incision around the existing urethral plate and the current meatus.
- Circumcising incision is performed, leaving a 5 mm glans cuff.
- The penis is then degloved down to the penopubic and penoscrotal junctions.
- Artificial erection test (Gittes test) is performed, and if any significant chordee present (between 10–30 degrees), this is corrected with dorsal plications or Nesbit procedure, (if the chordee is greater than 30 degrees, optimal results may be achieved with a staged procedure).
- A tourniquet is then applied, and glans wings are then created, ensuring a urethral plate of uniform width from the original meatus to the location of the neomeatus in the glans penis.
- The prepuce is then divided vertically into two transverse segments (one being 2/3rd the width of the prepuce and the other being 1/3rd the width).
- The larger prepucial segment (2/3rd of the prepuce) is rotated around the right side of the penile shaft to the ventral aspect and oriented vertically. It is then trimmed to the desired dimensions, and a two-layer anastomosis of the flap to the urethral plate is performed around a urethral catheter.
- The glans wings are then approximated over the neourethra distally, leaving a 2–3 mm gap at the proximal aspect of the glans.
- The 1/3rd segment of the prepucial flap is now rotated around the left side of the penile shaft and trimmed to a triangle-shaped flap that is sutured to the glans over the neourethra.
- Skin coverage.

9.7 Urethral Substitution Procedures

9.7.1 The Duckett, Transverse Preputial Island Flap Technique [Figs. 9.4a–g and 9.5a–i, 9.6a–g]

In 1980, Duckett published his technique for a single-stage procedure intended to treat those patients in whom 2–6 cm of urethra needed to be created after the release of chordee and excision of the original urethral plate [17–19, 39].

Steps of the procedure:

- Circumcising incision is performed leaving a 5 mm glans cuff and circumscribes the existing urethral meatus on the ventral aspect of the penis.
- The penis is then degloved down to the penopubic and penoscrotal junctions (Figs. 9.4a, b, 9.5a, b).
- The native urethral tissue and any ventral chordee tissue are sharply excised (Fig. 9.4b, 9.5c).
- Artificial erection test (Gittes test) is performed (Fig. 9.6a, b) and if any significant chordee present (between 10 and 30 degrees), this is corrected with dorsal plications or Nesbit procedure.
- Required length of urethra and inner prepucial flap length are measured (Figs. 9.5d, e, 9.6c).
- The creation of a vascularized neourethra is undertaken. Holding sutures are placed in the dorsal prepuce's skin, and tension maintained on the ventral aspect of the prepuce. The neourethral flap is marked out to be 15 mm wide, and as long as the defect from the existing meatus to the tip of the glans.
- The outlined flap is dissected, maintaining the blood supply intact, and then rolled into a urethra over a 10 or 12 Fr catheter (depending on the age of the patient), a combination of running sutures in the middle of the flap and interrupted sutures on the ends to permit trimming of the tube as needed (Figs. 9.4c, 9.5f).
- Dissection between the dorsal prepucial skin and the tubularized flap ensuring a generous vascularized pedicle to the flap is carried about 2/3rd of the way down the penile shaft to enable transposition of the flap to the ventrum of the penile shaft (Fig. 9.4d).
- The flap is then transposed to the ventrum by wrapping around one side of the penile shaft (usually on the right side, based on surgeon preference) (Figs. 9.5h, 9.6c) Alternatively, this can be achieved by carefully creating a buttonhole in the vascular pedicle and passing the glans penis and shaft through this opening

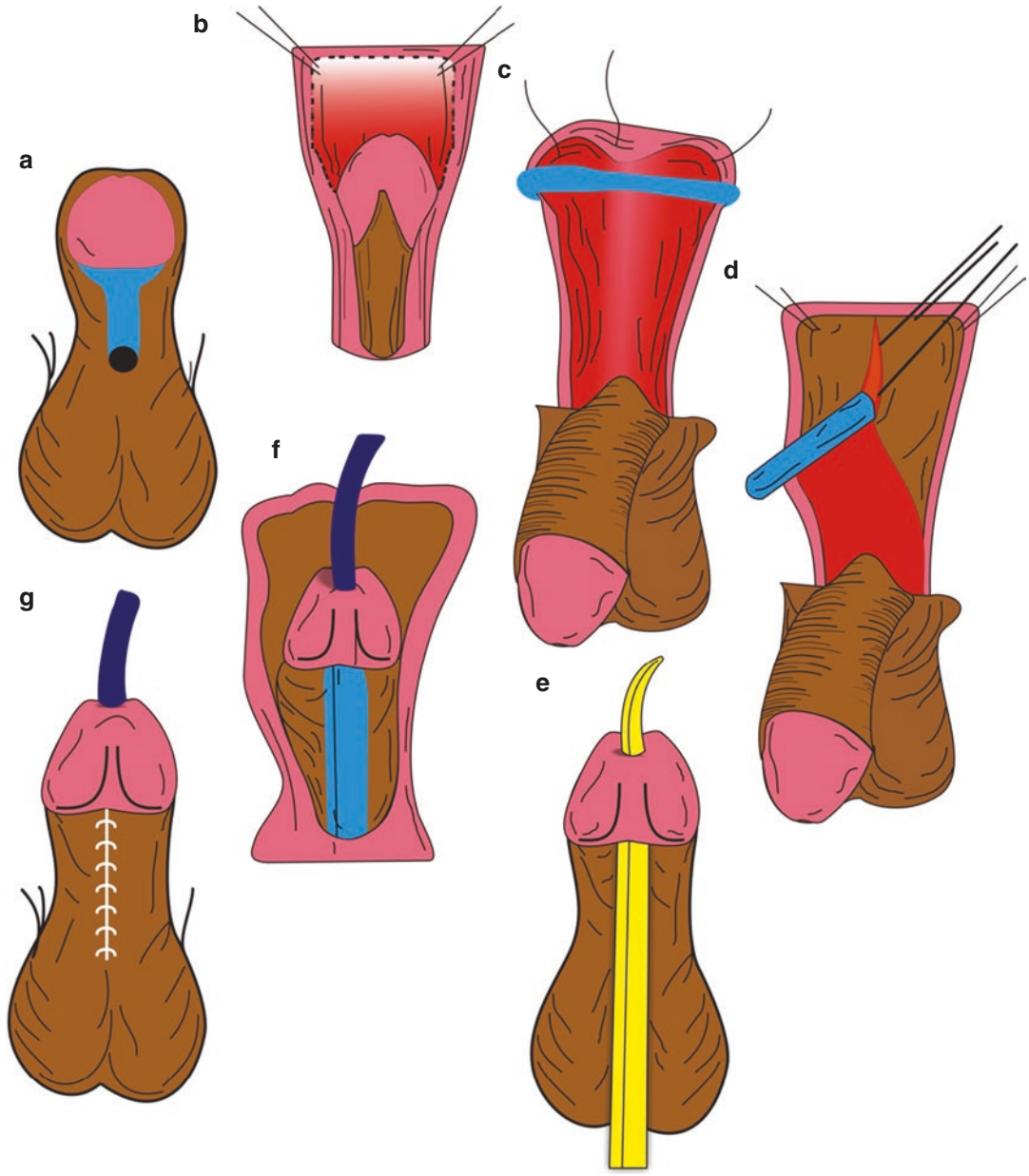

Fig. 9.4 Demonstrates the inner prepucial flap repair for severe hypospadias. (**a**). Proximal hypospadias. (**b**). Penile degloving and correction of chordee. (**c**). Mobilization of inner prepucial flap. (**d**). Tubularization of prepucial flap. (**e**). Creating a Tunnel in the glans. (**f**). Proximal and distal anastomosis of skin tube with stent in situ. (**g**) Skin closure

to allow for ventral transposition of the tubularized neourethra.

- The flap is then anastomosed to the proximal urethral meatus, ensuring that the spongiosum is included in the anastomosis (Figs. 9.5g, 9.6e).
- A glans penis channel is then created by sharply dissecting into the glans, such that the

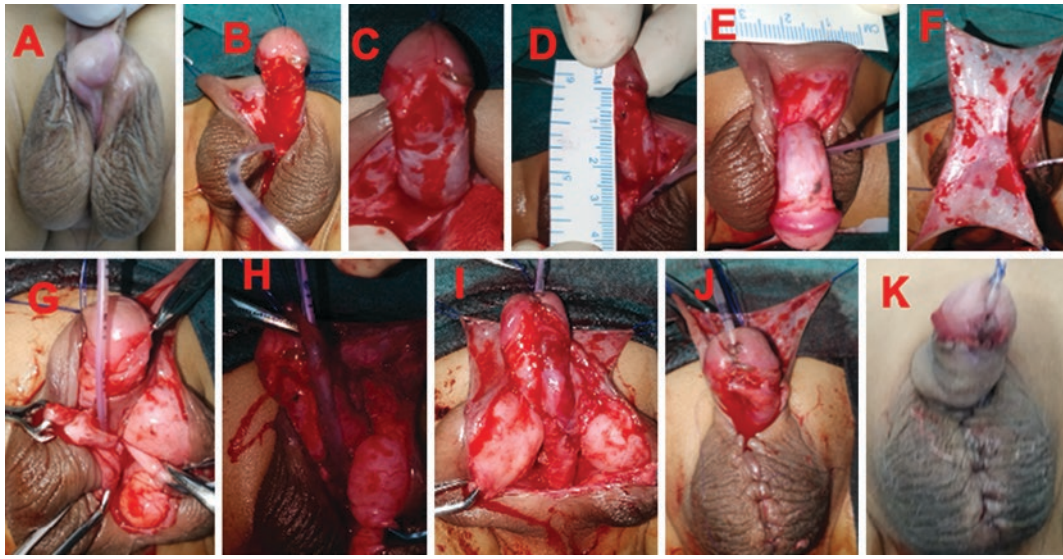

Fig. 9.5 Demonstrates the inner prepucial flap repair in scrotal hypospadias. (**a**). Scrotal hypospadias. (**b**). Penile degloving. (**c**). Correction of chordee. (**d**). Measuring the required urethral length. (**e**). Measuring the length of inner prepucial flap. (**f**). Mobilization of inner prepucial flap. (**g**). Anastomosis of skin flap with the urethra. (**h**). Tubularization of inner prepucial skin flap. (**i**). Anastomosis of skin tube to glans, covering the skin tube with dartos. (**j**). Glansplasty. (**k**). Skin closure

neomeatus is just superior to the level of the blind-ending glanular pit. A button of glanular tissue is then sharply excised (Fig. 9.4e).

- The glanular channel is calibrated with a 14 Fr urethral sound.
- The tubularized neourethra is pulled through the glans channel and gently pulled taut to avoid any kinking in the neourethra (avoid pulling too hard as this can result in secondary chordee). The excess tube is then excised, and the tube is anastomosed to the glans with interrupted sutures (Fig. 9.3f). Alternatively glans wing are raised and skin tube is sutured to the margins of the glans and then glansplasty is done (Figs. 9.4i, 9.5e, f).
- Skin coverage, in the majority of cases, adequate skin is available for penile resurfacing (Figs. 9.4g, 9.5k & 9.6g) but in patients where there is a paucity of penile shaft skin, the Cecil–Culp maneuver has been utilized with satisfactory results.

9.7.2 The Asopa-I Repair

Asopa initially described the Asopa technique in 1971 [16, 40]. Similar to results with other techniques that deployed vascularized pedicle tube repairs, long-term follow-ups of patients managed with this procedure were noted to have diverticula formation. The tubularized preputial repairs do not provide a stable foundation for the neourethra on the underlying tunica albuginea. During voiding, there is some mobility of the entire neourethra, resulting in turbulent flow of urine within the neourethra, the eddy currents created result in varying degrees of tension being exerted on the wall of the neourethra and result in diverticula formation. In 2010, the modified Asopa-I repair was proposed [41]. The modifications included fixation of the neourethral edges to the underlying tunica albuginea, to reduce the risk of diverticula formation.

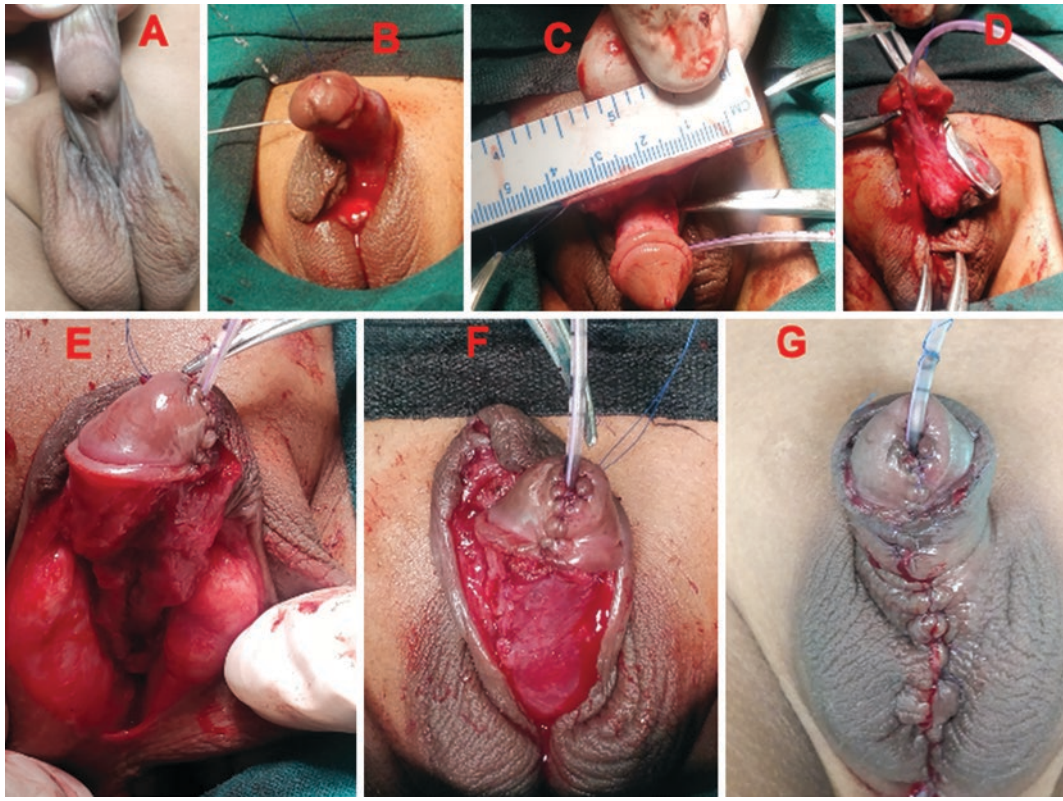

Fig. 9.6 Demonstrates the inner prepucial flap repair in penoscrotal hypospadias. (**a**). Penoscrotal hypospadias. (**b**). Gittes test after penile degloving and resection of chordee tissue. (**c**). Measuring the length of inner prepucial flap. (**d**). Anastomosis of skin flap with the urethra. (**e**). Anastomosis of skin tube to glans and glansplasty. (**f**). Covering the skin tube with dartos; Tubularized inner prepucial skin tube brought ventrally from left side. (**g**). Skin closure

Steps of the procedure:

- A subcoronal, racquet-shaped incision down the ventral aspect of the penis is created incorporating the existing meatus.
- The penis is then degloved down to the penopubic and penoscrotal junctions.
- Artificial erection test (Gittes test) is performed, and if any significant chordee present (between 10 and 30 degrees), this is corrected with dorsal plications or Nesbit procedure.
- A tourniquet is then applied, and glans wings are then created.
- An inner prepucial flap based on the superficial dorsal penile vessels is marked out and then separated from the outer preputial skin by sharp dissection.
- An oblique cut at the junction of the right-sided (2/3rd) and left (1/3rd) segments of the penile shaft skin, being careful to preserve the blood supply.
- The cranial margin of the inner prepucial flap is dissected from the vascular pedicle—this margin will function as a free graft.
- The caudal margin of the inner prepucial flap is circumferentially anastomosed to the proximal urethra, and then the flap is anchored to the penile shaft using absorbable sutures along the entire length of the neourethra into the glans.
- The flap is then tubularized over a stent.
- An additional row of sutures between the dartos of tubularized preputial flap and the tunica is now placed to ensure secure attachment of

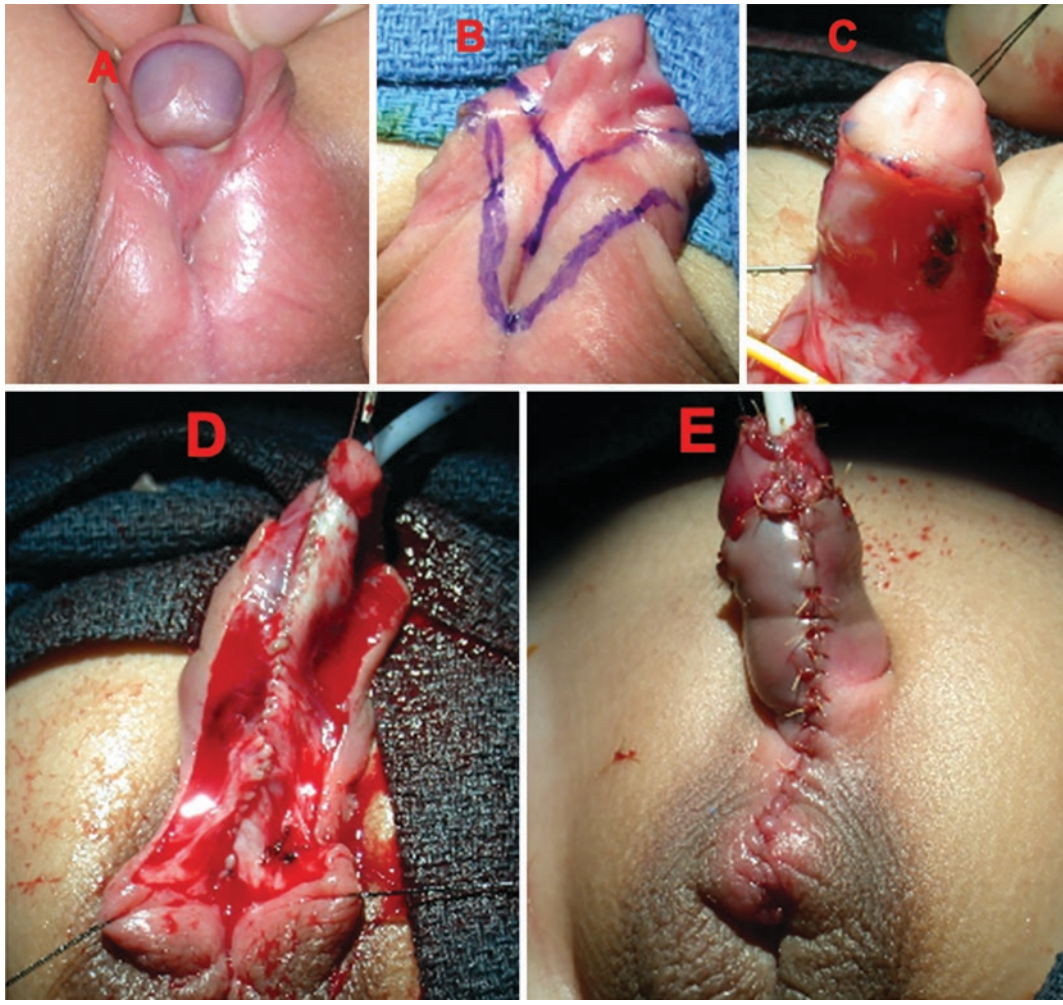

Fig. 9.7 Demonstrating the Koyanagi–Nonomura urethroplasty in proximal hypospadias. (**a**). Scrotal hypospadias and chordee. (**b**). Skin markings for Koyanagi–Nonomura urethroplasty. (**c**). Correction of chordee by excision of urethral plate and chordee tissue on ventrum of the penis. (**d**). Urethroplasty completed. (**e**). Completed Koyanagi–Nonomura hypospadias repair with orthotopic penis and distal glanular meatus

the neourethra to the underlying penile shaft (this is to reduce the risk of sacculation and diverticula formation).
- The glans wings are then approximated over the neourethra.
- Skin coverage.

9.7.3 The Koyanagi–Nonomura 1 Stage Bucket Repair

The repair initially described by Koyanagi and Nonomura has been modified to optimize the clinical outcomes [24, 42–44]. The steps of the modified procedure include the following:

- Create a circumferential incision around the glans, approximately 0.8 cm from the coronal sulcus (Fig. 9.7a, b).
- The existing urethral plate is proximally circumscribed in a "U" shaped manner.
- The incision around the urethral plate is carried parallel to the initial circumcising incision; when the flap of skin is freed up, it has the appearance of a bucket handle.
- The penile shaft skin is now degloved.

- Create glans wings.
- Correct the chordee (Fig. 9.7c).
- The medial aspects of the two limbs that make up the bucket handle are sewn together (7–0 PDS) and create a neourethra (Fig. 9.7d).
- The neourethra is formed by the skin tube.
- The glans wings are closed around the neourethra (Fig. 9.7e).
- Correct any penoscrotal transposition (Glenn and Anderson technique).
- Skin closure using Byar's flaps (Fig. 9.7e).

9.7.4 Skin Coverage

Planning for and ensuring adequate skin coverage at the culmination of the repair is important and has to be something that is proactively considered when making the initial incisions. In cases of proximal hypospadias, there is typically redundant dorsal hooded foreskin and ventral deficiency of skin. When achieving penile shaft skin coverage at the end of the procedure, ensuring a tension-free closure with the symmetric distribution of skin will reduce the risk of acquired penile curvature from skin tethering as the repair heals. In most cases, ventral midline skin closure can be achieved; however, if this cannot be accomplished, Byar's skin flaps can be used.

Preserving the foreskin as part of the hypospadias repair can be either due to parental preference or cultural practice. In single-stage repairs for proximal hypospadias, the foreskin can be preserved; however, this has to be determined at the onset of the procedure as foreskin preserving incisions are different to an incision that accounts for a circumcision to be performed as part of the procedure [Fig. 9.8a–e]. The actual parental satisfaction and complication rate of preserving the foreskin in these cases remains unknown due to infrequent reports in the literature.

9.7.5 Penoscrotal Transposition

The penoscrotal transposition associated with proximal penile shaft hypospadias is almost always partial but can be extensive in some cases. This can be corrected at the time of the single-stage repair or undertaken as a separate procedure after healing the hypospadias repair. The repair consists of creating rotational skin flaps encompassing the scrotal skin and rotating them inferior to the penile shaft. The technique described by Glenn and Anderson provides an excellent cosmetic result [45]. The Koyanagi–Nonomura single-stage bucket repair is also an option as it permits the correction of the penoscrotal transposition at the hypospadias repair time [46]. Postoperative results show meatus at the tip and good cosmetic results (Fig. 9.9a–c).

9.7.6 Stents/Dressings

Urinary diversion after a single-stage repair is the norm. When performing this procedure in children who are not yet toilet trained, we place a fenestrated urethral stent into the bladder and secure it to the glans with stay stitches. One can choose to cut the stent short as a drip stent, have it drip into the diaper, or leave it longer and teach the parents the double diaper technique. I recommend that the parents apply Vaseline as a barrier cream to protect the skin from an infection resulting in dehiscence.

For those children who are already toilet trained, we prefer to place a suprapubic tube at the time of the repair and continuously drain the bladder. We do leave a stent across the repair but do not place it proximal to the sphincter, thereby avoiding the need to place the older child in a diaper. The catheter is left in place for 10–14 days and is usually removed in the clinic after assessing the wound.

The nature of dressings after hypospadias is as varied as the number of operations. I have been using Cyanoacrylate dressing (Dermabond) for the past ten years and reinforcing this with a Coban wrap [47, 48]. The wrap is removed after 24 hrs, and the Dermabond is allowed to dissolve and separate (usually 4–7 days).

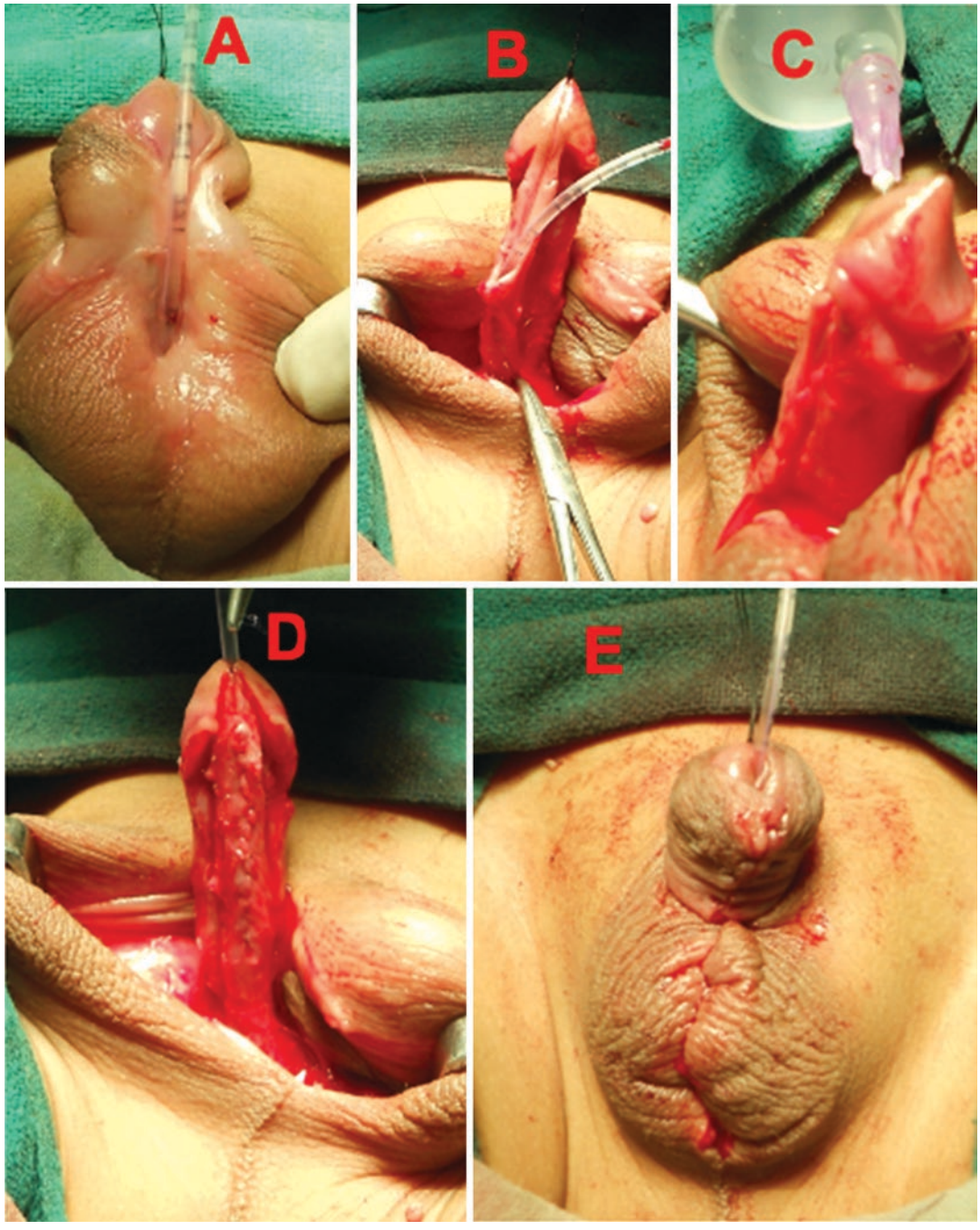

Fig. 9.8 Techniques for preservation of prepucial skin and preputioplasty. (**a**). Scrotal hypospadias. (**b**). Penile degloving and mobilization of the urethral plate and spongiosum. (**c**). Gittes test to assess for any residual chordee that might need to be corrected. (**d**). Tubularization of urethral plate. (**e**). Glanuloplasty and Prepucioplasty.

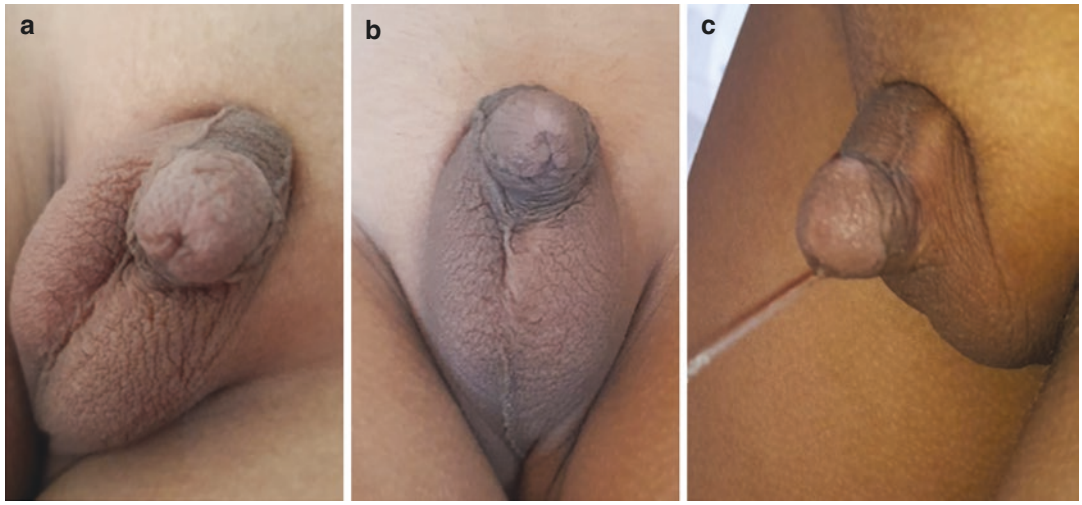

Fig. 9.9 Postoperative photograph of scrotal hypospadias after inner prepucial flap repair. Meatus at tip with conical glans, well-formed scrotum, and a single laminar urinary stream

9.7.7 Perioperative Care

Intra-operative antibiotics are administered. Typically Cefazolin (Clindamycin for those with Penicillin allergy).

Post-operatively they are sent home on Bactrim BID (if they have a Sulfa allergy, consider Keflex TID) until the urethral catheter is removed.

Oxybutynin (Ditropan—0.6 mg/kg in three divided doses) is prescribed as needed for bladder spasms.

9.7.8 Why Consider a One-Stage Procedure

Management of distal hypospadias is well established and uniformly agreed upon, but the dilemma still continues whether to perform a one-stage repair or multi-stage repair in cases of proximal hypospadias. One-stage repair is an attractive option because of reduced cost, hospital stay, anesthetic risks, and time to the final result.

Badawy and Fahmy (2013) reported similar complication rates in single-stage and two-stage techniques including mostly minor complications in the form of fistula, meatal stenosis, partial glans dehiscence, and urethral diverticulum, with their surgical technique. The 2-stage repair is versatile and has satisfactory outcomes, but necessitates a second procedure. There is a paucity of high-quality evidence supporting the superiority of one approach over the other [49–51]. Gonzalez R et al. in 2018 published their results of *one*-stage repair in mid and proximal hypospadias preserving the urethral plate and using a TPF for the urethroplasty and coverage of the ventral penis with a success rate of 77.5%. Compared to a planned two-stage approach, the technique described in this report resulted in significantly fewer procedures till complete resolution of the problem [52].

The results of the single-stage repair can be improved with modifications of the double faced flap. In a recent report, Daboos et al. present their five year experience using the double faced tubularized preputial flap for penoscrotal hypospadias repair in a prospective randomized study. 152 of 160 children (95%) had good clinical urinary functional outcomes (short micturition time, good urinary stream without straining or post voiding dribbling, and satisfactory cosmetic results) obtained by parents' interview at follow-up visits. They proposed the double faced tubularized preputial flap technique as a superior option compared to two-stage repairs with reported fewer complications (15% VS 25%),

Table 9.1 Showing complications of single-stage repair in proximal hypospadias

Complication rates of single-stage repair					
Author	Year	Technique	No. of cases	Complication No	Complication rate
Castagnetti [59]	2013	Transverse preputial island flap TIPU OIFA	31 26 18	5 7 4	16% 27% 22%
Bhat et al. [60]	2015	TIPU	14	3	21.42%
Singhal et al. [61]	2015	Transverse preputial island flap	92	16	17%
Huang et al. [62]	2017	Preputial onlay flap	32	6	18.7%
Elemam et al. [63]	2017	Transverse preputial island flap Double face	40 40	10 6	25% 15%
Bhat A et al. [55]	2017	TIPU+ TOIF	21	4	19.04%
Gonzalez et al. [52]	2018	Preputial onlay flap	49	11	22.5%
Patil et al. [64]	2018	Transverse preputial island flap	30	6	20%
Badaway et al. [51]	2018	Inner prepucial flap	40	18	45%
Daboos et al. [53]	2020	Double face Duckett	80 80	12 20	15% 25%
Cui et al. [65]	2020	Transverse preputial island flap	155	92	59.35%
Total			748	220	29.41%

Table 9.2 Complications of two-stage repair in proximal hypospadias

Complication rates of two-staged repair					
Author	Year	Technique	Total cases	Complications No	Complication rate
McNamara et al. [66]	2015	Inner prepucial flap	134	71	53%
Stanasel I et al. [67]	2015	Inner prepucial flap	56	38	68%
Manasherova [68]	2020	PSG (Free Graft) BMG	108 112	33 23	31% 20%
Misra et al. [69]	2020	BMG/prepucial grafts	36	11	30.6%
Castagnetti [59]	2013	Prepucial graft	18	5	28%
Pippi Salle [70]	2015	Prepucial graft	60	19	32%
Snodgrass [13]	2017	Prepucial graft or labial mucosa	43	10	23%
Total			567	210	37%

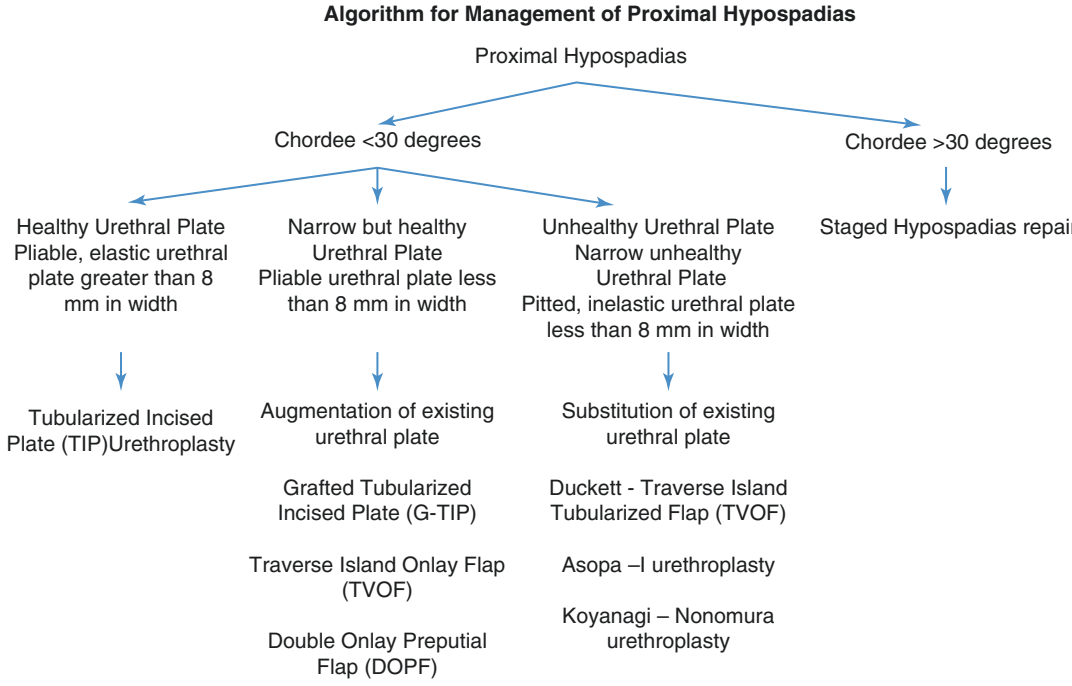

Fig. 9.10 Algorithm in proximal hypospadias repair

better urinary function, and good cosmetic results [53]. In cases where inner prepucial skin flap fails to cover the required urethral defect, midline nonhair bearing skin may be used to cover the remaining length with the technique proposed by Glassberg-Duckett. Tiryaki (2010) reported the success rate of 74% in cases where they utilized a combination of Duckett's preputial tube and the Thiersch–Duplay procedure in 34 patients with a mean follow-up of 4.1 years in severe hypospadias [54]. Similar results were reported by Bhat et al. 2017 where they tubularized the mobilized & preserved urethral plate as a proximal segment of urethra with a success rate of 80.06% [55].

Hensle et al. reported 32% long-term complications after a two-stage repair. Graft contracture and slough was noted in 46% and 54% had meatal stenosis and fistula. They reported that their complications in first 3 years of their experience were 60%. This decreased to19% in last 7 years of the reporting period indicative of a definitive learning curve in two-stage repairs [56]. Hueber et al. (2016) reported that the obstructive urinary flow pattern observed in patients early on is a frequent finding after proximal hypospadias surgery, and that the flow rates become comparable with those of normal unoperated males on follow-up to adulthood. They advocated that because of the remarkable improvement observed at puberty a watchful waiting approach is proposed in order to avoid unnecessary intervention [57]. Similarly Rynja SP (2018) published long-term results of proximal and distal hypospadias as compared to control with a mean age of 20.6 years and found that in their cohort of TPIF patients, long-term urinary, sexual, and cosmetic outcomes were similar to those in patients with distal hypospadias repairs and controls [58].

We reviewed the recent published literature reporting on the clinical outcomes of one-stage and two-stage repairs for proximal hypospadias. The data are presented in Table 9.1 (single-stage repair) and Table 9.2 (two-stage repair). The literature would suggest that the clinical outcomes are comparable whether one chooses a single-stage repair or a staged option. Longer-term follow-up is going to be very important to demonstrate if this remains true or if one strategy

is better than the other, especially since the data for the long-term outcomes for the contemporary two-stage repairs are not yet available for review.

We strongly recommend that each surgeon who undertakes hypospadias repairs should develop their own personal approach based on their training, experience, and clinical outcomes. In order to ensure best practice, they should track their own clinical outcomes with frequent and periodic reviews, and make evidence-based adjustments to their treatment algorithm.

It is the personal preference of the authors to undertake a two-stage repair in cases of proximal hypospadias with ventral chordee that is greater than 30 degrees, we propose the following algorithm to be considered (Fig. 9.10).

9.8 Conclusion

Proximal hypospadias continues to be a challenging clinical phenotype to repair. Choosing between a single-stage versus a staged hypospadias repair depends on the degree of chordee (< 30 degrees will permit a single-stage procedure) and the surgeon's experience. There are a number of surgical techniques to choose from, and it is advisable to master a technique from each of the various strategies in managing a child with proximal hypospadias, i.e. tubularization of the urethral plate, augmentation of the urethral plate, and substitution of the urethral plate. It is critical as a surgeon to track your personal clinical outcomes and complications proactively to assess your own performance objectively.

When assessing the outcome of hypospadias repair, it is vitally important to keep in mind that the patient and his family's reporting may be very different from what is noted and reported by the surgeon [71]. While as a surgeon, one might be willing to accept a complication rate of >30%, please remember for our patients that we are so privileged to be caring for, it is either "All or None," they either have a complication or do not. For patients who develop complications, the burden of care and cost of ongoing care can significantly impact the family and the mental well-being of the affected patient.

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