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Bhat's modifications of Glassberg–Duckett repair to reduce complications in management severe hypospadias with curvature



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Inner preputial flap repair;
Tubularized incise plate
urethroplasty

Abstract

Objective: Disadvantages of two-stage hypospadias repair are the necessity of 2 or 3 surgeries, loss of time/money, complications like splaying of the stream, dribbling of urine or ejaculate and milking of the ejaculate due to a poor-quality urethra. The current article details our modifications of flap repair allowing to manage such patients in one stage and reducing the complications.

Subjects and methods: Twenty one patients (aged 2–23 years, between January 2006 and June 2012 mean 11.5 years) of severe hypospadias were managed with flap tube urethroplasty combined with TIP since June 2006 and June 2012. Curvature was corrected by penile de-gloving, mobilization of urethral plate/urethra with corpus spongiosum and transecting urethral plate at corona. Buck's fascia was dissected between the corporal bodies and superficial corporotomies were done as required. Mobilized urethral plate was tubularized to reconstruct proximal urethra up to peno-scrotal junction and distal tube was reconstructed with raised inner preputial flap after measuring adequacy of skin width. Both neo-urethrae were anastomosed in elliptical shape and covered with spongiosum. Distal anastomosis was done 5–8 mm proximal to tip of glans preventing protrusion of skin on glans. Tubularized urethral plate was covered by spongioplasty. Skin tube was covered by dartos pedicle and fixed to corpora. Scrotoplasty was done in layers, covering the anastomosis.

Results: Type of hypospadias was scrotal 10, perineo-scrotal 5, penoscrotal 4 and proximal penile in 2 cases. Chordee (severe 15 and moderate 6) correction was possible penile de-gloving with mobilization of urethral plate with spongiosum after dividing urethral plate at corona 8, next 5 cases required dissection of corporal bodies, superficial corporotomy 5 and 3 cases lateral dissection of Buck's fascia. Length of tubularized urethral plate varied from 3 to 5 cm and flap tube varied from 5.5 to 13 cm (average 7.5 cm).

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Complications were fistula 2, meatal stenosis 1, and dilated distal urethra 1 with overall success rate of 81%. None of them had residual curvature, torsion, splaying or dribbling urine in follow up of 10–36 (average 18) months.

Conclusions: TIPU with spongioplasty of proximal urethra and dartos cover on skin tube reconstructs functional urethra. Distal end skin sutured to glans mucosa 5–8 mm proximal to the tip of glans reconstructs a cosmetically normal looking meatus. An exact measurement of the width and length of the stretched dartos, fixation of the skin tube to the corpora and covering the skin tube with dartos helps in prevention of diverticula. Elliptical anastomosis covered with spongiosum prevents fistula and stricture at anastomotic site.

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Introduction

The management of severe or proximal hypospadias is still the 'Holy Grail' of hypospadiology. Numerous methods have been described for the treatment of this clinical entity with varying results. The accepted modern approach in any kind of hypospadias repair includes preservation of the urethral plate, if possible [1]. Conventionally, the urethral plate was resected to correct chordee in proximal hypospadias, and tube, flap or graft urethroplasty was done. Over the last few years, tubularized incised plate (TIP) urethroplasty has become the most commonly performed surgery for distal hypospadias [2], but its use is limited in proximal hypospadias cases due to severe ventral curvature [3]. Commonly, severe hypospadias is managed by applying two- or three-stage procedures. In many cases of perineal and perineo-scrotal hypospadias, the preputial flap falls short, forcing the surgeon to go for a two-stage repair. Disadvantages of two-stage procedures include the necessity for 2 or 3 surgeries, loss of patient's or parents' time and money, late complications like splaying of the stream, dribbling of urine or ejaculate and milking of the ejaculate due to a poor-quality urethra (devoid of support), diverticula formation, stricture and fistula at the anastomotic site, disfigurement due to a protruding skin tube, mobility of the skin tube and penile torsion. The advantages of one-stage repair on the other hand are a healthy unscarred skin in primary repair cases, cost effectiveness of the procedure, a decreased anesthesia risk, better psychological impact and decreased separation anxiety, all of which offer a greater convenience to the patient and parents, as well as to the surgeon [4,5].

In 1987, Glassberg suggested that in situations where the skin tube falls short an augmented Duckett repair might be useful where the inner preputial tube is anastomosed to a neo-urethra fashioned from a proximal midline skin tube [6]. However, the complication rates varied from 25% to 42% as reported in the literature [7,8]. In the present work, we propose certain modifications to the Glassberg–Duckett technique, which will help to bring down the complications, and, most importantly, to provide a functional urethra up to the penoscrotal junction, thus minimizing terminal dribble of urine and squeezing of ejaculate.

Patients and methods

We reviewed the case sheets, operative photographs and videos of 21 cases of severe hypospadias treated with the modified

Glassberg–Duckett urethroplasty procedure between January 2006 and June 2012 after clearance from the institutional ethical committee. In total, 262 patients with hypospadias were operated during this period, 35 of them with proximal hypospadias. Among these, 14 had a wide urethral plate and a good spongiosum, thus enabling correction of the curvature with preservation of the urethral plate, so TIPU repair was done. Consequently, these patients were excluded from the study, thus leaving the remaining 21 cases with a narrow and/or poorly developed urethral plate and severe curvature which persisted after penile de-gloving and urethral mobilization as a patient cohort for this study. They were treated with a combined approach using proximal TIP urethroplasty and a distal Duckett tube constructed from the inner prepuce after transection of the urethral plate at the corona. The site of the meatus at the bifurcation of the spongiosum was considered for classification of the type of hypospadias. All procedures were performed by the same surgeon (ALB). The data evaluated included the patients' age, the location of the meatus, the degree of chordee and torsion, the size and quality of the urethral plate, associated anomalies, the duration of follow up and postoperative complications such as infection, hematoma, meatal stenosis, residual chordee or torsion, splaying of urine and retained ejaculate, stricture and fistula.

Surgical technique

After a circumferential circum-coronal incision, penile de-gloving was done keeping the plane of dissection at the level of tunica albuginea. The curvature was corrected by penile de-gloving, mobilization of the urethral plate and the urethra with the corpus spongiosum after transecting the urethral plate at the corona (Fig. 1A and B). The mobilized urethral plate and spongiosum were preserved for tubularization. Buck's fascia was dissected between the corpora. Superficial corporotomies were performed in patients with persisting curvature. In patients where TIP urethroplasty had been planned in the beginning and curvature correction had been attempted by mobilizing the urethra with the spongiosum, but had failed because of tethering of the urethral plate, the urethral plate was transected at the corona in order to correct the curvature (Fig. 2A and B) and flap urethroplasty was done. Correction of curvature was confirmed by Gitte's test (Fig. 1B) and residual curvature (if any) was corrected applying midline dissection and superficial corporotomies. Inner preputial flap of adequate length and width was mobilized keeping the plane of dissection at superficial layer of dartos. Proximal dissection of the vascular pedicle was done up to the root of penis to prevent torque. After stretching the flap, its size

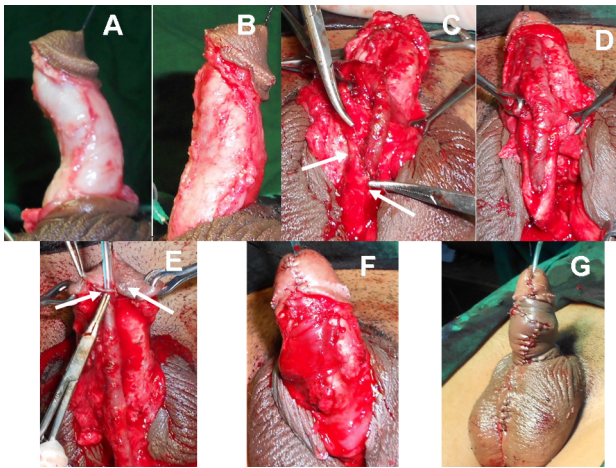


Figure 1 Showing the steps of the technique. (A) Photograph showing severe curvature after penile de-gloving. (B) Photograph showing complete correction curvature on Gittes test. (C) Arrows showing the elliptical anastomosis about 2 cm proximal to the margin of the urethral plate. (D) Photograph showing anastomosis covered by spongiosum after spongioplasty. (E) Arrows showing the wide anastomosis of the skin tube to the glans mucosa 5–8 mm proximal to glans margin. (F) Showing proximal urethra covered spongiosum, skin tube covered by dartos and glanuloplasty. (G) Showing scrotoplasty and skin closure.

was determined according to the age of the child. It is very important to stretch the skin while measuring the width. The width is measured after stretching the flap to a length of 2–3 cm to have the same width over the whole length (Fig. 3A–D). Measuring the width without stretching the flap may result in an improper width of the flap (Fig. 3C and D) which may lead to diverticulae formation. Excessive skin was trimmed to achieve an adequate width of the flap, thus preventing urethral diverticulae. The length of the flap is also measured for adequacy as per requirement in the case. Then the distal tube was constructed using the inner preputial flap. The mobilized urethral plate was tubularized in order to construct the proximal urethra up to the peno-scrotal junction. If the urethra still fell short the proximal urethra was mobilized up to the bulbar region to increase the proximal urethral length. The skin tube was brought

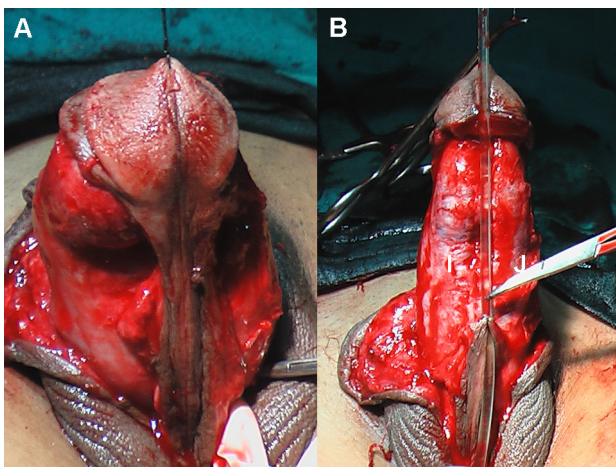


Figure 2 (A–B) Operative photograph showing correction of curvature by division of mobilized urethral plate with spongiosum at corona.

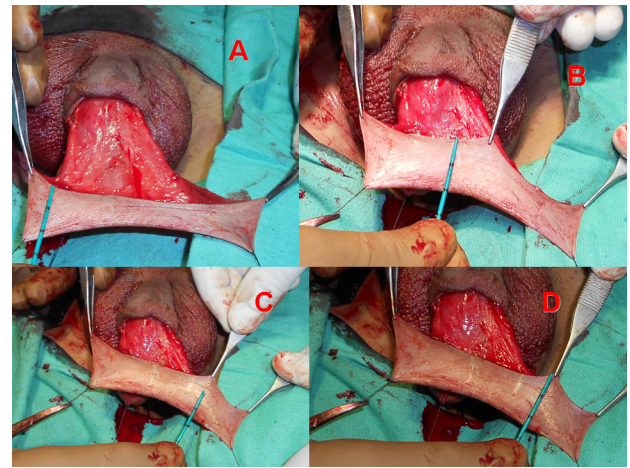


Figure 3 (A–C) Photograph showing measurement of the width of the skin flap after stretching the skin over the whole length of the flap. (D) Photograph showing the difference in stretched and un-stretched skin is approximately 1 cm.

ventrally by dividing the dartos pedicle into two halves in order to prevent torque and maintaining the symmetry of penile shaft girth. Eight to 10 mm of mucosa of the urethral plate was denuded, and both neo-urethras were anastomosed in an elliptical shape (Fig. 1C). The tubularized urethral plate was covered by spongiosum to complete spongioplasty. The anastomosis was covered with spongiosum in order to prevent fistula formation (Fig. 1D). A very narrow and poorly developed urethral plate was resected while preserving the spongiosum which was used to cover the skin tube. The distal anastomosis was done 5–8 mm proximal to the tip of the glans, thus preventing protrusion of the skin on the glans, and a wide naturally marked meatus was constructed to prevent meatal stenosis (Fig. 1E). The skin tube was covered by stitching the dartos pedicle bearing vessels and skin tube was fixed to the corpora on both sides to decrease laxity of the tube (Fig. 1F). Scrotoplasty was done in layers covering the anastomosis, and then skin closure was done (Fig. 1G). A urethral stent was kept for 10–14 days.

The patients were evaluated 1, 3, 6 and 12 months after the intervention and then yearly. The results were evaluated in terms of the patients', parents' and surgeon's satisfaction regarding the meatus, the urinary stream, the cosmetic outcome and complications of any kind. During the follow-up visits at 1, 3, 6 and 12 months, the meatus was calibrated. When it was found to be narrow, this was recorded and labeled as meatal stenosis. Patients with meatal stenosis were calibrated monthly for 6 months. When the meatal stenosis persisted beyond 6 months, it was considered as not responding to meatal dilatation. In cases of ballooning of the urethra and/or post-void dribble, a urethrogram was done in order to delineate the urethra.

Results

The patients' age ranged from 2 to 23 years with a mean of 11.5 years. Hypospadias was found to be scrotal in 10, perineo-scrotal in 5, peno-scrotal in 4 and proximal penile in 2 cases. Curvature was severe in 15 and moderate in 6 cases, while 5 patients had mild torsion. Penile de-gloving with mobilization of the urethral plate enabled chordee correction in 6 patients. Two cases had initially

been scheduled for TIP urethroplasty, but correction of the curvature was not possible due to tethering of the urethral plate. Therefore, the urethral plate was transected at the corona for correction of the curvature (Fig. 2A and B). Five patients required dissection of the corporal bodies and superficial corporotomies, while 3 patients required lateral dissection of Buck's fascia. Correction of torsion was possible by applying penile de-gloving and mobilization of the urethral plate in all cases. The length of the proximal tubularized urethral plate with spongioplasty varied from 3 to 5 cm, the length of the tubularized inner preputial tube varied from 5.5 to 13 cm (average 7.5 cm). Total hospital stay ranged from 7 to 10 days. Mild preputial edema which resolved during the hospital stay was seen in 2 patients. Urethro-cutaneous fistula was seen in 2 patients (9.52%) who had undergone fistula repair after 9–12 months after the procedure. Meatal stenosis occurred in 1 patient (4.76%) and was treated by dilatation. A dilated distal urethra occurred in 1 patient (4.76%) and was treated by reduction urethroplasty. The overall success rate was 81% with two patients requiring a second surgery.

During follow up, none of the patients had residual curvature, torsion, spaying or dribbling urine, and all were satisfied with the final cosmetic outcome measured by means of a genital perception score.

Discussion

The transverse preputial island flap (TPIF) procedure described, named and popularized by Duckett in 1980 has been named after him (Duckett urethroplasty) and was perhaps the most frequently performed one-stage tubularized repair for proximal hypospadias throughout the eighties and nineties [9]. However, recently this time-tested procedure lost its sheen, even to the extent that in a recent round table discussion by expert hypospadiologists the tubularized Duckett tube was considered to be history [10]. But still the procedure is being done by many. A high incidence of complications such as diverticulae, fistulae, an ugly meatus with chances of balanitis xerotica obliterans (BXO) due to protruding skin at meatus, penile torsion, meatal stenosis and stricture was the reason for bringing the flap procure into disrepute. Flap procedures have been replaced by two-stage procedures such as buccal mucosal graft and skin grafts [11,12], although flaps yield better outcomes than grafts from the plastic surgeon's point of view. Second-stage urethroplasty is done with the well stretched graft fixed to the corpora. Probable factors leading to diverticulae are laxity of the dartos-based flap, a larger width and/or length of the unstretched dartos-based flap, a lack of fixation of the flap to the corpora and a lack of support to the skin tube, as well as meatal stenosis due to a circular anastomosis at the meatus. So, the width is measured after stretching the flap to its full length to ensure an adequate width of the flap. There is a significant difference in width (about 1 cm) when measuring the flap without stretching it (Fig. 3C and D). The skin tube is covered with the dartos pedicle to ensure an adequate support and is then fixed to the corpora. A wide meatus is created by anatomizing the skin 5–8 mm proximal to the glans margin, thus giving the meatus a normal appearance. Anastomosing the skin to mucosa provides better healing, resulting in good cosmetic results as well as in the prevention of meatal stenosis. Moreover, as the skin does not protrude outside the meatus, there is a reduced risk of balanitis xerotica obliterans. As the anastomosis is the most common site of stricture formation, we planned an elliptical anastomosis about 1 cm proximal to the margin after denuding the mucosa, and covered the anastomosis with spongioplasty. These two modifications prevent stricture as well as fistula formation at the

site of the anastomosis. We mobilize the urethral plate along with the spongiosum and preserve it for tubularization, spongioplasty is done have functional urethral segment up to penoscrotal junction. The proximal urethra is mobilized up to bulb (if required) to extend the functional urethra with the spongiosum up to the penoscrotal junction; this helps to maintain ejaculation and prevents post-void dribble.

The one-stage approach using TIP urethroplasty is a well standardized approach for most hypospadias cases. However, in cases with severe primary hypospadias with a poor urethral plate and marked chordee, as well as in re-operative hypospadias and in selected patients with balanitis xerotica obliterans a two-stage approach is preferable [10–12]. At the first stage, the penis is straightened if necessary, and the urethral plate is substituted with either a genital (prepuce) or extra-genital graft (buccal mucosa or post-auricular skin). The graft is tubularized to enable completing second-stage urethroplasty after 6 months. Long-term cosmetic results are good in two-stage buccal/inner preputial graft urethroplasty, but voiding and ejaculatory problems have been reported in up to 40% of the cases [13]. Sometimes, TIP urethroplasty or an inner preputial flap tube alone may not suffice in cases with proximal hypospadias. Glassberg [6] described a modification of the Duckett tube, consisting of anastomosing a proximal midline skin tube to a more distal tubularized preputial tube. In the current series, this concept was put into effect along with several other modifications in order to overcome known complications of single-stage repair. The overall complication rate of the inner preputial tube used for single-stage repair of proximal hypospadias has been reported to vary from 17% to 42% with an average of around 32% [7,14,15], while complication rates of the procedure modified by Glassberg have been reported to vary from 26% to 42% [6–8]. The complication rate in the present series was much lower (19%). The concept of using two tubes in single-stage hypospadias repair was indeed used by Glassberg, but he used the midline non-hair-bearing skin when the inner preputial flap fell short. The margins of this non-hair-bearing midline skin may contain hair-bearing areas, which may lead to hair growing into the urethra in adulthood, and secondly, this skin tubularized neourethra is not covered by spongiosum; the proximal skin tube without supporting tissue will increase the risk of diverticula as well as fistula formation. In the Glassberg modification [7] chordee correction is done by resecting the spongiosum. We mobilized, preserved and used the urethral plate and spongiosum to create a near normal urethra by tubularization of the urethral plate and spongioplasty up to the peno-scrotal junction. Skin tube to midline skin anastomosis is circular without the coverage of spongiosum in the Glassberg modification [7] but we do an elliptical anastomosis of skin tube 1 cm urethral plate margin and cover with spongiosum. Covering the anastomosis with spongiosum is described in the literature as telescoping the skin tube and urethra to prevent anastomotic fistula in one stage hypospadias repair where the urethra was mobilized, spatulated dorsally and denuded 0.5 to 1 cm to cover the anastomosis with spongioplasty [16].

Fistula is the commonest complication associated with hypospadias repair [17–19]. Although the exact cause of the urethral fistula has not yet been identified but there are certain risk factors predisposing to fistula formation. These include failure to invert all epithelial edges during urethroplasty, the failure to add appropriate second-layer urethroplasty coverage [5], devitalization of tissue and infection and tissue ischemia [18]. A fistula may result from or may be associated with distal stricture or meatal stenosis. The Duckett

tube is generally associated with a higher incidence of fistula [19] because the neo-urethra lies unsupported and anastomosis of the urethra and the skin tube is not covered by healthy tissue such as the spongiosum or dartos. Various types of healthy tissue (transverse island dorsal subcutaneous flaps, de-epithelialized skin flaps, lateral dartos flap, double dartos flaps, double breasted de-epithelialized penile skin flap, tunica vaginalis and corpus spongiosum) have been used to cover the neo-urethra with the aim of reducing the complication rate in TIP urethroplasty. The tubularized urethral plate is covered by spongiosum as a second layer which helps to preserve the blood supply of the urethral plate, while covering the tube with dartos provides an additional protective layer. Thus, the entire length of the two neo-urethras is covered by some tissue as a second layer. Furthermore, the whole anastomotic site is covered with spongiosum and then scrotal tissue. These measures help to prevent fistula formation. Distal anastomosis of the skin tube too far distally into the glans may lead to skin protruding outside the meatus and increases the risk of meatal stenosis. We sutured the distal preputial tube 5–8 mm proximal to the tip of the glans, thus creating a wide slit-like meatus without protruding skin which provided better cosmetic results and decreased the risk of meatal stenosis. As meatal stenosis is an important factor in fistula and diverticula formation. So prevention of meatal stenosis decreases the chances of fistula as well as divericula.

We corrected penile curvature by mobilization of the urethral plate with the spongiosum, proximal urethral mobilization, dissection of Buck's fascia laterally and between two corporal bodies and finally superficial corporotomies if needed. If the chordee still persisted we applied a single-stitch dorsal plication. Shortening of the penis is a common complaint after hypospadias repair. Dorsal plication may be a cause of shortening of the penis and, therefore, we avoided dorsal plication as far as possible. Though residual curvature is a known complication of flap procedures, we did not encounter this problem as we performed the Gittes test to confirm complete correction of curvature and had adequate required length of the neourethra after measuring both by tubularized urethral plate and inner preputial flap. Gittes test and having adequate length of neo-urethra are, therefore, important steps for the prevention of residual curvature.

Penile torque a known complication of flap repairs. The causes of torque are traction on vascular pedicle due to inadequate mobilization of vascular pedicle and improper adjustment of skin flaps during skin closure. The flap is mobilized up to root of penis and brought ventrally by dividing the dartos pedicle into two halves which release the traction on the pedicle and prevents torque. Another important step to prevent the torque is adjustment of skin flaps during skin closure [20]. The risk of encountering torsion is higher when single dartos flap (mild glanular torsion 90.7% and moderate glanular torsion 9.3%) is used as compared to the double dartos flap (0%) [21]. Since we slit the dorsal dartos pedicle in the midline to divide it into two equal parts, and bring these two parts ventrally on either side; this not only prevents torsion, but also covers the skin tube on both sides symmetrically, thus providing better esthetic appearance and more durable wound closure.

Urethral diverticulum formation is an uncommon complication of hypospadias repair presenting with post-void dribble due to drainage of pooled urine from the diverticulum and stone formation [17]. Urethral calculi can erode and eventually cause fistula formation. Similar to urethrocutaneous fistulae, urethral diverticula may be associated with distal stricture or meatal stenosis [9] which results

in dilatation of the proximal urethra and urinary extravasations into the periurethral tissues forming a diverticulum that may communicate with the urethra. A technical error in deciding the larger width of the flap may lead to diverticulae. In our series, we utilized the stretched penis length for the length of the flap and the stretched width of the flap over the whole length, thus reducing the risk of leaving redundant skin. The length of the skin tube is reduced by using the proximal segment of the urethral plate, thus reducing the turbulence of urine. In the conventional Duckett procedure, the dorsal dartos is brought ventrally from one side leaving the skin tube covered only by skin and not the dartos flap. Covering the skin tube with a dartos pedicle in our modifications supports the skin tube and fixing it to the corpora helps to prevent diverticulum formation.

The concept of extended urethra was used to increase the length of urethra (about 2–3.5 cm) to correct the curvature in hypospadias repair [22], the same is used here to bring the functional urethra up to penoscrotal junction. Furthermore, the proximal urethral segment is covered with spongiosum up to the penoscrotal junction, thus creating a functional proximal segment instead of a lax skin tube which does not propel semen and leads to milking of ejaculate. In his experience, Bracka reported a 40% rate of urine dribbling, while 33% of his patients could only have a dribble of ejaculate and 45% complained of complete retention of ejaculate [13].

One of the limitations of our series is the fact that the data were collected retrospectively and the series was not large enough to draw a definite statistical impact. Because of certain limitations we frequently used meatal calibration (instead of uroflowmetry) which is an invasive method. However, a review of the literature revealed that the current series is one of the first studies to revalidate the advantages of flap urethroplasty based on surgical principles with encouraging benefits and advantages. Further studies with a larger number of patients are required to show statistically significant differences in the final outcome.

Conclusion

The modified Glassberg–Duckett technique for the treatment of severe hypospadias is feasible with an acceptable complication rate and the technique still has an important place in management of hypospadias repair. Our modifications of the technique are as follows; the urethral plate with spongiosum is mobilized and preserved to reconstruct a neourethra with the spongiosum up to the penoscrotal junction and if this segment falls short the proximal urethra is mobilized. This segment of functional urethra helps in prevention of post void dribble and retained ejaculate. A wide elliptical anastomosis of skin tube is done after denuding 1 cm of urethral plate mucosa and covered with spongiosum to prevent anastomotic stricture and fistula. The dorsal dartos vascular pedicle is mobilized up to root of penis, splitted in midline to equal half and brought ventrally each side to cover the skin tube; which prevents torque of penis as well as fistula and gives an esthetic shape to penile shaft. Measuring width and length of the stretched skin flap, covering the skin tube with dartos pedicle and fixing it to corpora prevents divericula. Distal anastomosis of skin tube is done 5–8 mm proximal to the glans margin to create a wide slit-like normal appearing meatus and to prevent meatal stenosis.

Conflict of interest

None declared.

Source of funding

None declared.

Ethical committee approval

Approved.

Authors' contributions

Dr Amilal Bhat: Concepts, Design, Definition of intellectual content, Literature search, Clinical studies, Experimental studies, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review, Guarantor.

Dr Mahakshit Bhat: Literature search, Clinical studies, Data acquisition, Data analysis, Manuscript preparation, Manuscript editing, Manuscript review.

Dr Karamveer Sabharwal: Literature search, Clinical studies, Data acquisition, Data analysis, Manuscript preparation, Manuscript editing, Manuscript review.

Dr Akshita Bhat: Literature search, Clinical studies, Data acquisition, Data analysis, Manuscript preparation, Manuscript editing, Manuscript review.

Dr Rajiv Kumar: Literature search, Clinical studies, Data acquisition, Data analysis, Manuscript preparation, Manuscript editing, Manuscript review.

References

- [1] Upadhyay J, Shekarriz B, Khoury AE. Midshaft hypospadias. *Urol Clin North Am* 2002;29:299–310.
- [2] Manzoni G, Bracka A, Palminteri E, et al. Hypospadias surgery: when, what and by whom? *BJU Int* 2004;94:1188–95.
- [3] Snodgrass W, Bush N. Tubularized incised plate proximal hypospadias repair: continued evolution and extended applications. *J Pediatr Urol* 2011;1477–5131.
- [4] Kajbafzadeh AM, Arshadi H, Payabvash S, et al. Proximal hypospadias with severe chordee: single stage repair using corporeal tunica vaginalis free graft. *J Urol* 2007;178:1036–42.
- [5] Moursy EE. Outcome of proximal hypospadias repair using three different techniques. *J Pediatr Urol* 2010;6:45–53.
- [6] Glassberg KI. Augmented Duckett repair for severe hypospadias. *J Urol* 1987;138:380–1.
- [7] MacGillivray D, Shankar KR, Rickwood AMK. Management of severe hypospadias using Glassberg's modification of Duckett repair. *Brit J Urol Int* 2002;89:101–2.
- [8] Tiryaki T. Combination of tubularized island flap and ventral skin flap techniques in single-stage correction of severe proximal hypospadias. *Urol Int* 2010;84:269–74, <http://dx.doi.org/10.1159/000288227>.
- [9] Duckett JW. Transverse preputial island flap technique for repair of severe hypospadias. *Urol Clin North Am* 1980;7:423–30.
- [10] Snodgrass W, Macedo A, Hoebeke P, et al. Hypospadias dilemmas: a round table discussion. *J Pediatr Urol* 2011;7:145–57.
- [11] Bracka A. The role of two-stage repair in modern hypospadiology. *Indian J Urol* 2008;24:210–8.
- [12] Haxhirekha KN, Castagnetti M, Rigamonti W, et al. Two-stage repair in hypospadias. *Indian J Urol* 2008;24:226–32.
- [13] Bracka A. A long-term review of hypospadias. *Br J Plast Surg* 1989;42:251–4.
- [14] Ghali M. Hypospadias repair by skin flaps. A comparison of onlay preputial island flaps with either Mathieu's meatal-based or Duckett's tubularized preputial flaps. *Br J Urol Int* 1999;83:1032–8.
- [15] Shukla AR, Patel RP, Canning DA. The 2-stage hypospadias repair. Is it a misnomer? *J Urol* 2004;172:1714–6.
- [16] Bhat A, Saxena G, Prajapat P, et al. Telescoping of skin tube and urethra to reduce fistula rate in one stage hypospadias repair. *Br J Urol Int* 2002;90:68.
- [17] Kwon T, Song GH, Song K, et al. Management of urethral fistulas and strictures after hypospadias repair. *Kor J Urol* 2009;50:46–50.
- [18] Retik AB, Atala A. Complications of hypospadias repair. *Urol Clin North Am* 2002;29:329–39.
- [19] Snodgrass W. Hypospadias Campbell Walsh Urology. 10th ed; 2012. p. 3503–36.
- [20] Bhat A, Mandal AK. Acute postoperative complications of hypospadias repair. *Indian J Urol* 2008;24:241–8.
- [21] Kamal BA. Double dartos flaps in tubularized incised plate hypospadias repair. *Urology* 2005;66:1095–8.
- [22] Bhat A. Extended urethral mobilization in incised plate urethroplasty for severe hypospadias: a variation in technique to improve chordee correction. *J Urol* 2007;178:1031–5.