



Re-Construction of an Ideal Neo-Urethral Plate: A Combination of Bracka's-Cum-Byar's Orthoplasty (BBO)

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Abstract

Purpose: To define guidelines for re-construction of an ideal neo-urethral plate in proximal hypospadias with severe chordee.

Material and Methods: Since 2006 to 2015, twenty proximal adult-hypospadias aged 16 to 25 years with severe ventral chordee underwent straightening of their penile shafts. The central part of the resultant raw area on the ventrum of penile shaft was grafted by Inner Prepuccial Full Thickness Skin Graft (IPFTSG) harvested from inner skin of prepuccial hood (Bracka's orthoplasty) and the lateral parts of the ventral raw area on either side of the IPFTSG was covered by ventralized Byar's flaps designed from the remaining outer prepuccial hood (Byar's orthoplasty).

After three months of this Bracka's-Cum-Byar's Orthoplasty (BBO), the central part of neo-urethral plate which is soft, smooth, pliable and absolutely non-hairy of IPFTSG in origin was only chosen for tabularization to re-construct neo-urethra and the laterally positioned Byar's flaps were undermined and advanced medially from either side of the tabularized neo-urethral plate to provide an axial vascular skin flap cover to the underlying neo-urethra. Only 15 mm wide strip of IPFTSG-lined neo-urethral plate was marked, incised and then tubularized to re-construct IPFTSG-lined neo-urethra, and remaining excess part of neo-urethral plate lined by IPFTSG was excised.

Results: Full take of centrally placed IPFTSG provided an ideal neo-urethral plate and the laterally positioned Byar's flaps on either side of IPFTSG provided water-proofing skin flap cover to the underlying neo-urethra during subsequent neo-urethroplasty. Only fifteen patients (75%) had reported for neo-urethroplasty. Three (20%) had mild residual chordee, which was corrected by dorsal midline tunica albuginea plication through single dorsal midline penile skin incision without disturbing neo-urethral plates and another three patients (20%) had 3 mm to 5 mm sized Urethro-Cutaneous Fistulas (UCFs) that were surgically closed after three months. Five patients were lost to follow-up because of unknown reasons. Follow-ups ranged from a minimum of one year to a maximum of three years. None developed stricture, stenosis and diverticulization in the re-constructed neo-urethra.

Conclusion: During first stage of urethroplasty, a combination of centrally placed IPFTSG and laterally placed Byar's flaps proved blessing for: (i) re-construction of an ideal neo-urethral plate purely of IPFTSG in origin, (ii) providing axially-vascularized skin-cum-dartos fascial cover (Byar's flaps in origin) to the underlying neo-urethra, thus assisting in nutrition and neo-vascularization to promote healing, (iii) preventing complications like UCFs, stricture and diverticulum in long terms of follow-ups as a result of mechanical and biological support to the neo-urethra by draping it with axial-pattern Byar's flaps and (iv) creation of ventral median raphe by midline suturing of both medially advanced Byar's flaps.

Keywords: Neo-urethral plate; Native urethral plate; Byar's flaps; Chordee; Orthoplasty

Abbreviations

IPFTSG: Inner Prepuccial Full Thickness Skin Graft; BBO: Bracka's-Cum-Byar's Orthoplasty;

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UCFs: Urethro-Cutaneous Fistulas

Introduction

Different types of hypospadias are simply the result of arrest of tabularization of native urethral plate (aborted urethra) on the ventrum of penile shaft anywhere along the line of normal urethra extending from perineum up to the tip of glans. The epithelial lining of a well-developed native urethral plate is almost similar to the lining of a normal urethra; however, it lacks underlying functional and contractile corpus spongiosum, which is represented by fibrous-atretic chordee tissue. Proximal hypospadias accounts for 20% of the hypospadiac cases [1,2]. Severe chordee is mostly seen in proximal varieties of hypospadias. Single staged repairs in proximal hypospadias have sub-optimal out-come [3-5], whereas multi-staged repairs have better results [6]. It is a great challenge for the hypospadiologists to re-construct an ideal neo-urethral plate in proximal hypospadias associated with severe chordee.

According to authors, an ideal neo-urethral plate must have following characteristics:

- Neo-urethral plate that is well accustomed to urine.
- Neo-urethral plate that is non-keratinized, non-hairy, smooth, shiny and having no pits, elevations, depressions, wrinkling, tracts and sinuses, granulomas, fibrous plaques and contracture.
- (Neo-urethral plate that is adequate in length, breadth and thickness to facilitate its tension-free tubularization to re-construct total length of neo-urethra starting from hypospadiac meatus to the proposed site of external urethral meatus at tip of glans.
- Neo-urethral plate that is having optimal amount of sub-cutaneous tissues to permit its two layered tubularization (inner continuous and outer interrupted) around an appropriate-sized urethral tube during neo-urethroplasty.
- Neo-urethral plate that is shouldered on either side by adequate amount of peno-prepuccial skin to provide a vascular and tension-free skin cover to the underlying neo-urethra during neo-urethroplasty.
- Neo-urethral plate that is capable to produce a uniformly diametered, smooth surfaced, pliable, stretchable and collapsible neo-urethra that can withstand the normal pressure of urinary stream against its dilatation and diverticulization and also has power of spontaneous collapse to expel urine and ejaculate to some extent. The Inner Prepuccial Full Thickness Skin Graft (IPFTSG) is most ideal substitute for re-construction of neo-urethral plate and neo-urethra due to its inherited properties.

Accordingly, the present study was planned to give a brief account of the method used in re-construction of such a neo-urethral plate that will be infused with all the above-mentioned ideal characteristics by using a combination of IPFTSG (Bracka's orthoplasty) and the lateralized Byar's flaps (Byar's orthoplasty), i.e., Bracka's-cum-Byar's Orthoplasty (BBO) during first stage of adult-hypospadias with severe ventral chordee.

Material and Methods

During 2006 to 2015, in the Department of Burns & Plastic Surgery and the Hypospadias & Vesico-Vaginal Fistulas (VVF) Clinic of Postgraduate Institute of Medical Sciences (PGIMS), Rohtak, Haryana, India, twenty proximal adult-hypospadias (Figure



Figure 1: Proximal adult hypospadiac with severe ventral penile chordee.



Figure 2: Gittes and Mac Laughlin technique for assessment of chordee.



Figure 3: Marking of site of maximum chordee on the dorsum of penile shaft.

1) aged 16 to 25 years having severe ventral penile chordee underwent correction of chordee under spinal anesthesia. Consequently, the central part of the resultant raw area on the ventrum of penile shaft was grafted by IPFTSG harvested from inner prepuccial skin and remaining raw areas on either side of the IPFTSG is covered by Byar's flaps designed from the remaining outer prepuce.

Various precautions taken were: (1) creation of artificial penile erection by Gittes and Mac Laughlin technique [7] to assess severity of chordee (Figure 2) and marking the site of maximum curvature (Figure 3), (2) insertion of glans traction suture to stabilize the penile shaft during various maneuvers and procedures, (3) application of stay sutures in the prepuccial hood margins to keep it steady, marking of 25% extra of the length and breadth of the IPFTSG transversely placed



Figure 4: Smooth and shiny inner prepuccial skin displayed for harvesting.



Figure 7: Degloving of penile shaft and excision of chordee.



Figure 5: IPFTSG displayed for defatting.



Figure 8: Excision of chordee tissue results in penile straightening.



Figure 6: Repeat artificial erection after degloving shows residual chordee.



Figure 9: Designing of Byar's flaps by mid-line incision of outer prepuccial skin.

strip, its hydro-dissection by sub-cutaneous injection of 1:200,000 adrenaline-normal saline solutions using 26 gauge hypodermic needle mounted on 10 cc syringe and finally making precise incisions for harvesting the graft from the inner skin of the prepuccial hood (Figure 4), (4) defatting of IPFTSG by a pair of sharp scissors (Figure 5), (5) giving a circum-coronal and circum-meatal incision for complete penile degloving till its root and repeating saline-induced artificial erection shows chordee (Figure 6), (6) atraumatic handling of tissues, (7) dissection in avascular sub-dartos fascial plane, (8) maintenance of absolute aseptic environment, (9) preservation of vasculature of all dissected tissues, (10) maximum correction of ventral chordee by excision of grossly visible and palpable chordee tissue (Figure 7), transverse scoring of outer layer of tunica albuginea to transect fine residual chordee fibers and excision of bits of palpable chordee tissues

to smoothen the recipient raw area over the exposed tunica albuginea, (11) designing of a V-shaped distally-based flap from the glans and inserting it in the V-shaped gap at the distally incised IPFTSG to prevent meatal stenosis, (12) designing of adequate glans wings for correcting distal glans chordee, to provide vertical slit like external urethral meatus at the tip of the glans and conicalization of the blunt glans penis (glansplasty) during urethroplasty, (13) dorsal meatotomy of the hypospadiac external meatus and re-surfacing the so created V-shaped gap by fitting in to it a tongue shaped graft designed at the proximal end of the IPFTSG, (14) maximum hemostasis by application of cotton gauze pieces soaked in 1:200,000 adrenaline-normal saline solutions and minimal use of sutures and electro-cautery to reduce foreign matter and dead tissues in the recipient bed to facilitate



Figure 10: Multiple incisions in IPFTSG for exit of oozing blood.

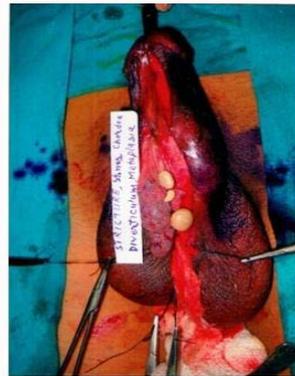


Figure 12: Multiple stones in a diverticulum of extra-genital skin re-constructed neo-urethra.



Figure 11: Velcro loop and fastener penile splint and a PVC tube in the ventral midline.



Figure 13: Stone-induced metaplasia of urethral lining.

uneventful take of IPFTSG, (15) water tight repair of incidentally breached tunica albuginea, (16) repetition of saline induced artificial erection to ascertain complete correction of chordee (Figure 8), (17) Dorsal Tunica Albuginea Plication (DTAP) for further straightening of penises was not required, (18) a 15 mm wide strip of optimally defatted IPFTSG having 20% more length than the length of neo-urethra to be re-constructed from hypospadiac external meatus to the tip of the glans is grafted in the central part of the raw area, (19) midline binarization of outer prepuce was done to design two Byar's flaps (Figure 9), and each one of the Byar's flaps is positioned on either side of the IPFTSG strip, (20) 6-0 vicryl on round-bodied needle was used for atraumatic placement of sutures between (i) IPFTSG and the tunica albuginea under optimal tension to prevent wrinkling of graft through quilting, (ii) lateral margins of the centrally placed IPFTSG and the medial margins of the Byar's flaps, (iii) proximal part of IPFTSG and the dorsal meatotomy site, i.e., future anastomotic site and distal part of IPFTSG and the distally based glans flap, i.e., future external neo-meatus site, (21) oozed blood and serum underneath the IPFTSG is permitted to drain by making multiple stab incisions in the IPFTSG (Figure 10), (22) frequent irrigation underneath the graft with 1:1 normal saline and ciprofloxacin solutions to remove blood clots, serum, tissue debris and foreign particles to minimize infection, inflammation and fibrosis, which may compromise the take of graft and also likely to produce contracture and secondary chordee, (23) application of non-adherent vaseline-gauze dressing, putting on saline soaked and squeezed fluffed cotton to achieve intimate contact between IPFTSG and the recipient bed of tunica albuginea, the tie-over dressing and finally the outer adequately padded circumferential



Figure 14: Suturing of Byar's flap in midline ventrally.

cotton gauze dressing held in place by adhesive tape for uniform compression, hemostasis and splinting of the penile shaft.

Thereafter, a vigilant post-operative care was of great concern to achieve the goals of re-construction of an ideal neo-urethral plate by: (1) use of sedatives or tranquilizers to prevent post-operative erection, (2) atraumatic primary and subsequent dressings to avoid loss of graft, (3) removal of any retained suture after three weeks to prevent unnecessary granulomas or fibrosis, (4) application of Velcro hook and fastener penile splint for three months after three weeks of full take of graft to fasten early maturation of the neo-urethral plate and (5) placement of a piece of PVC tubing in the ventral midline underneath the splint to maintain median urethral groove in between



Figure 15: Midline scar after healing of a Byar's orthoplasty.



Figure 18: Byar's flaps positioned laterally on either side. The displayed IPFTSG will be used to graft the central part of raw area.



Figure 16: Loosely placed neo-urethral plate of Byar's flaps in origin. Unevenness and scarring present.



Figure 19: IPFTSG re-constructed neo-urethral plate of optimal width.

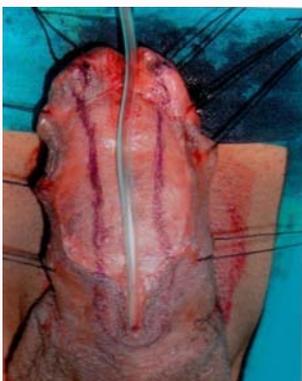


Figure 17: Neo-urethral plate of IPFTSG in origin wider than required. Extra part outside the marking will need excision.

the two corporal bodies (Figure 11). Repetition of artificial erection was done to evaluate status of chordee before contemplating the start of neo-urethroplasty. Dorsal tunica albuginea plication for correction of mild residual chordee was done in three patients (20%) through a single dorsal mid-line penile skin incision without disturbing the neo-urethral plate. Fifteen patients (75%) were undertaken for neo-urethroplasty using Thiersch-Duplay technique after a gap of three months of having done the BBO. Median urethrotomy was not required in any of the case [8]. Three patients (20%) developed 3 mm to 5 mm sized Urethro-Cutaneous Fistulas (UCFs) that were closed successfully after a gap of another three months. Rest five patients, who were lost to follow-ups due to unknown reasons.

Results and Observations

Use of inner prepuceal full thickness skin graft resulted in a well vascularized, soft, supple, smooth, pink and absolutely non-hairy ideal neo-urethral plates that could be tension-free tubularized in two layers to re-construct neo-urethras which is uniform in diameter and well adherent to the underlying tunica albuginea, whereas the lateralized Byar's flaps provided axially-vascularized skin covers to the re-constructed neo-urethras (tubularized neo-urethral plates) during urethroplasty. Out of the 15 patients who reported for second stage of urethroplasty, mild residual ventral penile chordee and UCFs measuring 3 mm to 5 mm were encountered in three patients each. Nothing could be known about five patients who did not report for urethroplasty.

Discussion

Straightening of penile shaft (orthoplasty) in adult proximal hypospadias with severe ventral chordee is ought to develop substantial raw area on the ventrum of penile shaft requiring its re-surfacing through different techniques such as: Ventralized Byar's flaps designed from prepuceal hood (genital skin) [9], extra-genital skin graft [10], buccal mucosa [11] or the bladder mucosa [12]. These techniques not only require informed consent and counseling but also warrant additional surgical procedures with inherited morbidities and complications. The carcinoma has been reported after use of bladder mucosa [13]. Most of the distal and mid-penile hypospadias are corrected using single staged urethroplasties like Snodgrass Tubularized Incised Plate Urethroplasty (STIPU) [14], Glans Approximation Procedure (GAP) [15], Meatal Advancement

and Glanuloplasty Incorporation (MAGPI) [16], Barcat's balanic groove technique [17], modified Barcat's balanic groove technique [18], Mustarde technique [19] and the urethral mobilization [20], with or without Dorsal Tunica Albuginea Plication (DTAP). The procedures such as Duckett's inner prepuccial transverse island flap (patch or tube) urethroplasty [21] and the Devine and Horton full thickness skin graft tubularization [22] done for single staged repair of proximal hypospadias with severe chordee, especially in micro-peniacs, are more prone to develop different complications like strictures, diverticulas, Urethro-Cutaneous Fistulas (UCFs) and meatal stenosis. Re-surfacing of the raw area on the ventrum of penile shaft subsequent to orthoplasty by an ideal epithelial substitute (skin/mucosa) is the most crucial step in multi-staged repairs of proximal hypospadias with severe chordee, because the ultimate quality and characteristics of the re-constructed neo-urethra will primarily depend upon the quality and characteristics of the re-constructed neo-urethral plate and only to some extent upon the experience and expertise of the treating hypospadiologist. Presently, the use of Inner Prepuccial Full Thickness Skin Graft (IPFTSG) for re-surfacing the raw area, as described by Bracka [23], is in common use, because it produces ideal neo-urethral plate suitable for re-construction of ideal neo-urethra. Further, during neo-urethroplasty, these lateralized axial Byar's flaps designed from outer prepuccial hood will provide nutrition and neo-vascularization to the relatively ischemic tubularized neo-urethral plate (neo-urethroplasty/ neo-urethral tube/ neo-urethra) to re-enforce its healing similar to the multifactorial utilities of waterproofing flaps [24].

Use of extra-genital keratinized skin for re-construction of neo-urethral plate is prone to have hair growth, infection, ulceration, scarring, contractures and stricturization, and also the destruction of collagens and elastic fibers to produce un-even neo-urethra having dilatation, sacculation and diverticulization, keratinization, de-squamations, debris collection, concretions or stone formation (Figure 12) and finally the fistulizations, metaplasia (Figure 13) or carcinomatous changes.

The IPFTSG has specially been chosen for reconstruction of neo-urethral plate because of its unique qualities such as: (i) available in plenty in same operative field, (ii) easily acclimatized to urine, (iii) non-hairy, non-keratinized, smooth, shiny, thin, soft, supple and stretchable, (iv) having extensive vascular net-work for good take, (v) easy to harvest without producing any donor site cosmetic or functional deformity, (vi) it's easy handling, defatting and positioning to re-surface the ventral raw area of the penile shaft, (vii) easy to stabilize with fine absorbable sutures and (viii) full maturation of IPFTSG produces a neo-urethral plate having characteristics almost similar to native urethral plate except for the absence of contractile power due to lack of surrounding corpus spongiosum-like tissues. Subsequent to its take, further use of Velcro hook and fastener penile-splint for three months will improve quality of neo-urethral plate by exerting compression similar to wearing of pressure garments on grafted post-burn wound. The Byarsization of the remaining outer skin of the prepuccial hood to design two Byar's flaps and their lateralization on either side of the IPFTSG will provide tension-free vascularized skin cover to the underlying tubularized neo-urethra, thus ensuring an un-eventful healing. Therefore, this combination of Bracka's and Byar's Orthoplasty (BBO) has met all the requirements of reconstruction of an ideal neo-urethral plate during orthoplasty and ideal neo-urethra during subsequent neo-urethroplasty.

1. The ventralized Byar's flaps, when sutured in midline of the

ventrum of penile shaft (Figure 14), would result in re-construction of a neo-urethral plate which is neither absolutely smooth due to central scarring (Figure 15) to come in the re-constructed neo-urethra nor firmly adherent (Figure 16) to its underlying recipient bed due to its accompanying dartos fascial tissues, thus is subjected to diverticulization and fistulizations even following mild meatal stenosis.

2. Although the use of full extent of IPFTSG alone for re-construction of neo-urethral plate will produce a wider neo-urethral plate (Figure 17), but the re-constructed neo-urethra will not have axially-vascularized skin flaps to provide a mechanical and biological cover during neo-urethroplasty.

3. The IPFTSG provided ideal lining for neo-urethra, and the lateralized Byar's flaps provided axially-vascularized skin flap cover to the underlying urethral tube, therefore, the present reported technique (Figure 18) of a combination of both the IPFTSG and the lateralized Byar's flaps is best suitable to achieve the goal of re-construction of an ideal neo-urethral plate having optimal width during orthoplasty (Figure 19).

However contractile tissues cannot be provided all around the re-constructed neo-urethra (a tissues resembling corpus spongiosum). Fifteen patients were undertaken for second stage using Thiersch-Duplay technique. Only three patients (20%) were found having residual mild penile chordee and the other three (20%) developed UCFs.

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