ORIGINAL ARTICLE

Modified Mathieu's Urethroplasty V/s. Modified Onlay Island Flap Urethroplasty Based on Patient Selection Criteria for Distal Hypospadias Repair: A Prospective Cohort Study

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Abstract:

Background: Hypospadias is one of the most common congenital anomalies of the external genitalia in males. Several procedures have been described for distal penile hypospadias repair with the goal of attaining favourable results. Such large number of repair techniques shows that none is satisfactory and gold standard. This study compares Modified Mathieu's urethroplasty (MMU) with the Modified Onlay Island flap (MOIF) urethroplasty based on patient criteria for the repair of distal penile hypospadias (DPH). *Material and Methods:* A prospective cohort study was carried out from June 2016 to February 2020. 89 patients with DPH were included and repaired by single surgeon. Patients with previous repair, chordee and glanular hypospadias were excluded. Operative duration, intra/post-operative complications, functional outcome, urinary stream, and overall satisfaction were noted in each case. *Results:* The mean age at the time of repair was 71±34.2 months in MMU and 71.7±31.2 months in MOIF. Mean operative time was 53.2±6.7 minutes in MMU and 76.1±9.8 minutes in MOIF excluding the anesthesia time. Mean follow-up period was 23.5±11.9 months in MMU and 31±12.6 months in MOIF. 85.7% of MMU and 91.5% of MOIF treated patients had a single, good caliber urinary stream in forward direction. Post-operative complications were significantly low (P Value<0.001) in MMU. The overall satisfaction in both repair methods was 95~96%. *Conclusion:* Both MMU and MOIF are recommended for DPH repair. Judicious patient selection is key element for ensuring a favorable outcome.

Keywords: Distal penile hypospadias, Modified Mathieu's urethroplasty, Modified Onlay Island flap urethroplasty.

Introduction:

Hypospadias is one of the most common congenital anomalies of the external genitalia with approximately 1 in 200 to 1 in 300 boys getting affected [1]. It is caused by the arrest of urethra development between the 9th and 14th weeks of gestation [2]. It is marked by an abnormal ventral urethral meatus, an incompletely developed prepuce and an abnormal ventral penile curvature [3]. It is usually classified according to the anatomic location of the urethral orifice: anterior (distal) 70-80%, middle shaft (intermediate) 15-20% and posterior or proximal (penoscrotal, scrotal, or perineal) 13%[4].

Among anterior hypospadias, 50% are coronal, 30% subcoronal, 15% glanular and 5% are of the Megameatus intact prepuce type [5]. The main goal of any hypospadias repair is to achieve a functionally normal and aesthetic penis with lesser complications. More than 400 techniques and their modifications demonstrate that there is no ideal universal technique for hypospadias correction [6]. With proper understanding of the vascularity and healing of flaps, several newer surgical techniques have emerged during the last 50 years [7].This study compares the outcome of a Modified Mathieu's urethroplasty (MMU) with the Modified Onlay Island flap (MOIF) urethroplasty based on patient criteria for the repair of distal penile hypospadias (DPH).

Material and Methods:

In this prospective cohort study, 89 male patients underwent surgical repair of distal hypospadias, from June 2016 to February 2020. Out of these, 76 and 13 patients had subcoronal and coronal hypospadias respectively [Table 1]. In our study, the age of patients

ranged from 3 to 13.5 years. Children were at least 3 years of age, as they are more cooperative and tend to have an acceptable penile size. If the penis was relatively small then, preoperative two to three aqueous testosterone injection (1–2 mg/kg) was given at 3 weeks interval to increase its size and repair was done after 1 month of last injection. The patients with chordee, glanular hypospadias and who had undergone penile surgery (previous urethroplasty or circumcision) were excluded from the study. The patients (7 coronal and 35 subcoronal) with wide urethral plate > 6 mm, deep glanular groove with adequately sized glans, no meatal stenosis and healthy skin proximal to the meatus underwent Modified Mathieu's urethroplasty whereas patients (6 coronal and 41 subcoronal) with urethral plate width ≤ 6 mm, good prepucial skin, thin/ scarred skin proximal to meatus underwent Modified Onlay Island flap (MOIF) technique. The width of the urethral plate was measured precisely in the operating room under anesthesia. All patients were operated on by the same surgeon under combined general anesthesia and caudal block. Informed written consent was obtained from patient's parent(s) or guardian.

Surgical Technique:

1. Modified Mathieu's urethroplasty (Image 1)

An 8 or 10 Fr silastic nasogastric (NG) tube was inserted per urethra, followed by an anchoring suture, at the midline on the glans penis. The urethral plate and perimeatal-based flap were measured (6 to 10 mm) and marked for the proximal flap. The tourniquet was applied over the base of penis. A meatal based U-shaped incision was taken, pointing towards the penile root with limbs of this incision pointing distally. The urethral plate was preserved and the penis was not degloved. The penile skin was separated from dartos fascia, distal and lateral to this incision. Proximal dissection was done, till the flap was free upwards. Two stay sutures were then applied at the end of the flap. The flap was carefully separated from the underlying tissue using fine scissors taking precautions to maintain the blood supply to the flap and its evenness. It was turned over distally to cover the urethral plate. Neourethra was formed over 8 or 10 Fr silastic nasogastric (NG) tube with continuous 6-0 polyglactin sutures on both sides of the flap. It was then covered with additional layer of dartos tissue with three to four interrupted sutures. Two proximal U-shaped sutures were taken on either side of flap at the junction and two sutures were taken at 4 and 8 o'clock position over the meatus. Deep glanular wings were dissected. It was then anastomosed to the reflected part of the flap in a tension-free manner. Skin closure in two layers with polyglactin 6-0 sutures was done in the midline ventrally. 8/10 Fr silastic NG tube was replaced by 6 Fr silastic NG tube. Tourniquet was released every 30 minutes and discarded, after the first layer of the dressing was complete. Patients who underwent this repair ended up with a hooded prepuce. Thus, for cosmetic reasons, circumcision was done after 6 months post procedure.

Modifications of the technique are [8]:

a) Only ventral dissection and prepuce remain intact, penis was not degloved completely.
b) Mobilization of the flap by introducing the blades of the scissor under the flap and by spreading the blades.
c) Two U-shaped sutures on either side of flap proximally at the junction.
d) Two sutures were taken at 4 and 8 o'clock position over the meatus.
e) Urethroplasty in two layers, first continuous and second interrupted.
f) Skin closure midline in two layers.

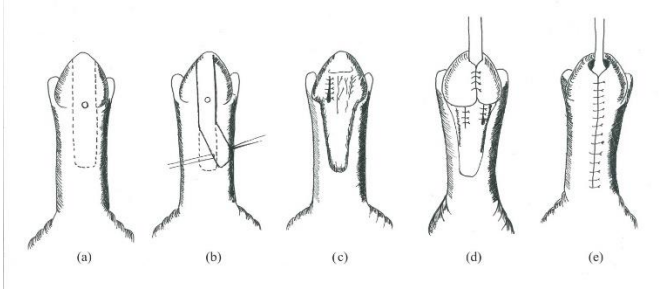

Image 1- Modified Mathieu's repair

(a) Distal penile hypospadias with adequate glans and good proximal urethral plate. (b) Elevation of perimeatal based flap. (c) Perimeatal flap sutured. (d) Glans wings are sutured over the neourethra. (e) Skin closure completed.

2. Modified Onlay Island flap (MOIF) technique (Image -2A, 2B)

Dilute adrenaline (1/100,000) with 2% lignocaine solution was injected along the marked incision lines. The ventral skin was then, incised using racket shaped incision with preservation of the urethral plate. A circumcoronal incision was performed 5 mm proximal to the coronal margin. Two vertical incisions placed 6-8 mm apart along the urethral plate were made, from the proposed site of the neourethral meatus to the ectopic urethral meatus and further extended in midline proximally. Phallus was degloved completely. For the neourethra, a rectangular flap was harvested from the dorsal inner prepucial layer. It should be equal to or more than the urethral plate. The vascular supply is based on the leash of vessels running dorsally in its mesentery. The mobilized flap was then ventrally rotated and sutured to the urethral plate with 6-0 polyglactin in a continuous fashion over an 8 Fr silastic NG tube [9]. The excess part of the flap was cut. The other end of flap was sutured to the opposite edge of the urethral plate to fashion a neourethra. Distally, the leftover part of the flap was folded proximally and incorporated in glanuloplasty. The suture line was covered with vascular prepucial mesentery. Glanuloplasty was done in 2 layers in all cases. Penile shaft was covered with penile skin flaps with lateral suture line. 8 Fr nasogastric tube was replaced with 6 Fr nasogastric silastic tube for urinary diversion. Simple penile dressing was done for all cases.

In both types of repairs, dressing was changed on the 7th postoperative day and catheter removed on the 10th postoperative day. The urethra was kept stented for 10 days postoperatively under umbrella of prophylactic antibiotics.

In the post-operative period, patients were followed up at 1 week, 2 weeks, 3 months, 6 months, 12 months and then telephonically. Those children who were not able to attend the follow up visit, were examined through voiding videos, telephonic interviews and latest pictures.

As per our protocol, routine calibration or dilatation was not done postoperatively. Stricture formation was diagnosed only by urinary complaints and urinary stream.

Modified Onlay Island Flap Urethroplasty

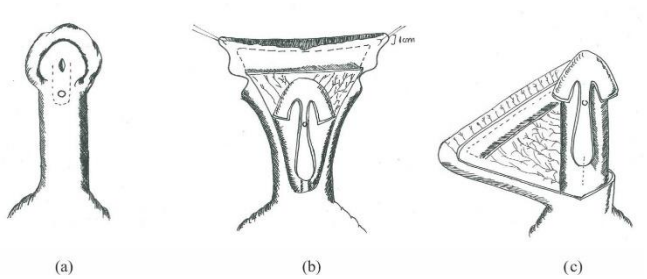

Image 2A- (a) Distal penile hypospadias without chordee with narrow urethral plate. (b) Degloving of penile skin and making of glans wings. (c) Raising onlay patch (limited mobilisation) from inner prepucial skin.

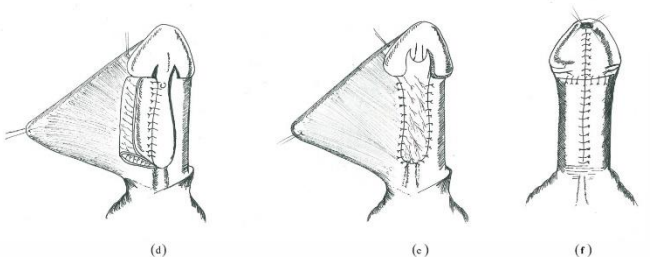

Image 2B- (d) Mobilization of vascularised prepucial patch, suturing of lateral margin of patch with narrow urethral plate. (e) Neourethral tube formed. (f) Closure of glans wings and penile skin.

Results:

The mean age at the time of repair was 71±34.2 months (range 36-160) in case of MMU and 71.7±31.2 months (range 36-156) in MOIF. In this study three doses of aqueous testosterone injection (1–2 mg/kg) was given preoperatively at 3 weeks interval in 4 cases of MOIF, and 5 cases of MMU to increase penile size and repair was done after 1 month of last injection. Mean operative time was 53.2±6.7 minutes (range 45-65) in MMU and 76.1±9.8 minutes (range 60-95) in MOIF excluding the anesthesia time. In our study, no intraoperative complications were noted in either group. In the post-operative period, all 89 patients voided spontaneously after removal of urinary catheter. Mean follow-up period was 23.5±11.9 months in MMU and 31±12.6 months in MOIF. The duration of hospital stay and duration of urethral catheterization were

similar in both groups. In MMU, 10 (23.8%) patients developed complications. The early and late postoperative complications in MMU were prepucial edema in 5 (11.8%), urethrocutaneous fistula and glanular disruption in 2 (4.8%) each, retrusive urethral meatus in 1 (2.4%) whereas meatal stenosis, proximal stricture, wound infection, flap necrosis and complete disruption were absent. In MOIF, 23 (48.9%) patients developed complications out of which majority were minor complications. The early and late postoperative complications in MOIF were mild penile torsion and wide urethral meatus in 5 (10.6%) each, hematoma in 3 (6.3%), urethrocutaneous fistula, infection, penile edema and diverticulum in 2 (4.3%) each, skin necrosis and post-operative bleed in 1 (2.1%) each whereas meatal stenosis, stricture, flap necrosis and wound dehiscence were absent.85.7% of MMU and 91.5% of MOIF treated patients had a single, good caliber urinary stream in forward direction. The overall satisfaction in both repair methods is 95~96%.In both types of repairs, a vertical slit-like meatus was not achieved, which was accepted by parents cosmetically as the functional outcome was very good.

Table No. 1: Distribution of patients in different surgical methods

Variables	Modified Mathieu's repair n (%)	Modified onlay island flap repair n (%)	p-value
Age (months) 36 to 75 76 to 115 116 to 160	 28 (66.7) 10 (23.8) 4 (9.5)	 34 (72.3) 6 (12.8) 7 (14.9)	0.346#
DPH subtype Subcoronal Coronal	 35 (83.3) 7 (16.7)	 41 (87.2) 6 (12.8)	0.826#
OT duration (min) 45 to 70 71 to 95	 42 (100) 0 (0)	 18 (38.3) 29 (61.7)	0.000#
Overall satisfaction Excellent Good Fair Poor	 28 (66.7) 9 (21.4) 3 (7.1) 2 (4.8)	 24 (51.1) 18 (38.3) 3 (6.4) 2 (4.2)	0.524#
Urinary stream Normal Spraying Dribbling	 36 (85.7) 4 (9.5) 2 (4.8)	 43 (91.5) 0 (0) 4 (8.5)	0.081#
Complications Absent Present	 32 (76.2) 10 (23.8)	 24 (51.1) 23 (48.9)	0.026#
	(Mean ± SD)	(Mean ± SD)	
Age (months)	71±34.2	71.7±31.2	0.920*
OT duration (min)	53.2±6.7	76.1±9.8	0.000*
Follow-up (months)	23.5±11.9	31±12.6	0.005*

Chi-square ($\chi 2$) test *Unpaired 't' test

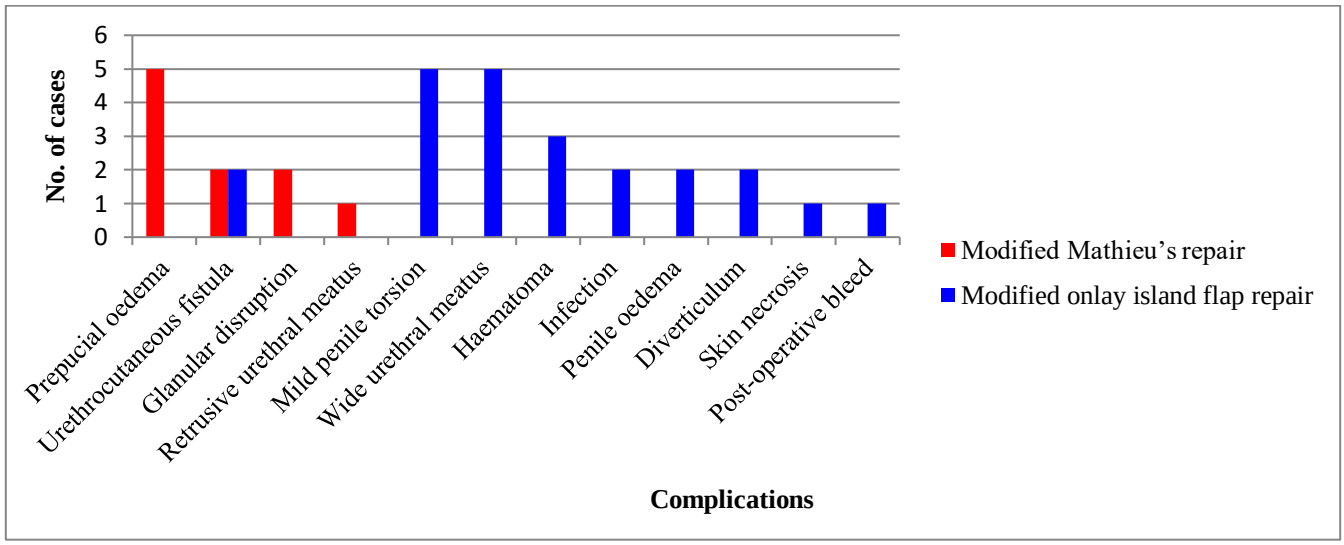

Chart No. 1: Complication-wise distribution of patients in different surgical methods

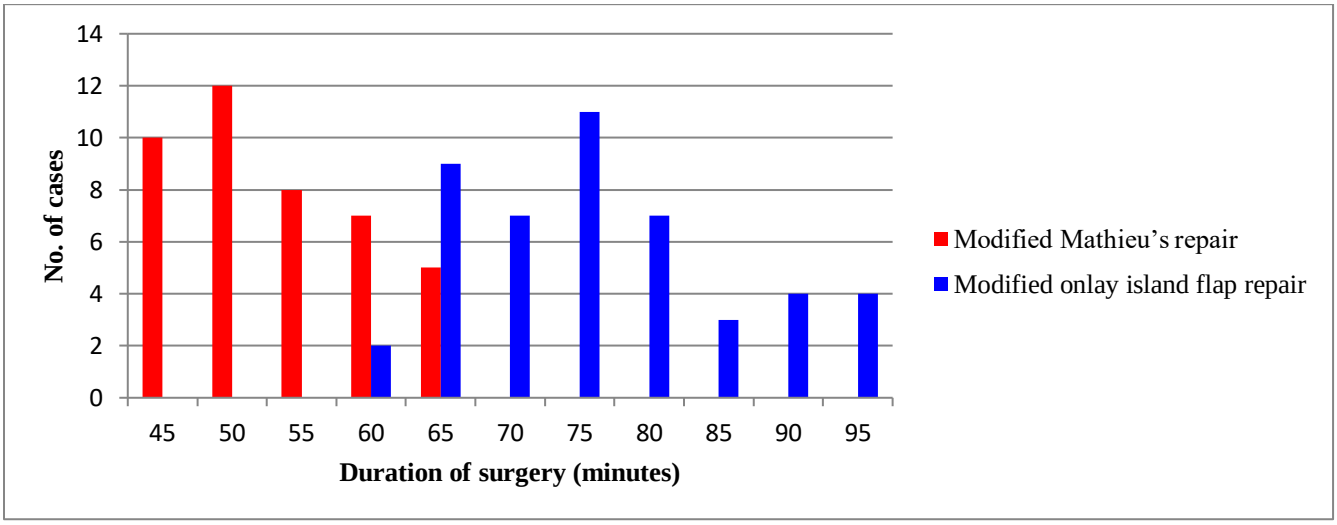

Chart No. 2: Surgery duration-wise distribution of patients in different surgical methods

Discussion:

Several procedures that can be used in the repair of distal penile hypospadias, with tubularised incised-plate (TIP) being the most common [10]. In the present study, careful selection of patients was done based on certain criteria like patients with wide urethral plate > 6 mm, deep glanular groove with adequately sized glans, no meatal stenosis and healthy skin proximal to the meatus underwent Modified Mathieu's urethroplasty whereas patients with urethral plate width ≤ 6 mm, good prepucial skin, thin/ scarred skin proximal to meatus underwent Modified Onlay Island flap (MOIF) technique.

Mathieu's perimeatal-based flap repair was first described in the year 1932; then Wacksman shared their experiences with this technique [11-12]. It is usually applied for correcting coronal and subcoronal defects wherein, the native urethral plate is kept intact.

Asopa was the first to describe in detail, the use of dorsal prepuce for urethral reconstruction in hypospadias [13]. This was further popularised by Duckett [13-15]. In 1987, Elder reported the first one-stage hypospadias repair using an onlay island flap for distal and mid penile hypospadias repair. For onlay urethroplasty, vascular prepucial island flap is usually harvested on inner prepuce as a transverse flap [14]. The timing of surgery is decided by various parameters

viz. size and development of the penis, the child's reaction to surgery, anesthetic risk, and toilet training. Infants can usually tolerate surgery and anesthesia by the age of 6 months and genitalia aware and toilet trained by the age of 18 months. Therefore, the most suitable age for a hypospadias repair is from 6 to 18 months. The operation can also be performed at 3 to 4 years of age if the earlier optimal age is missed [16].

In our study, the mean age at the time of repair was 71±34.2 months (range 36-160) in case of MMU and 71.7±31.2 months (range 36-156) in MOIF. This may be due to lack of awareness and education on the part of parents and delayed referral from rural healthcare centers [17].

This may be due to reservations of parents to discuss sex organ problems and this is more commonly encountered in poorly literate, low socioeconomic and conservative families.

In the present study, mean operative time was 53.2±6.7 minutes (range 45-65) in Modified Mathieu's repair, excluding anesthesia time. This is in accordance with Tawfiq NR et al. [18], where the operative time ranged from 45 to 75 minutes (mean 60±6.7 minutes). Singh AP et al. [8] also reported similar mean operative time of 52.4±5.4 minutes (range 45-60). However, in a study by Bae SH et al. [16], the operative time was 102.5±43.2, which was longer than ours. The mean operative duration in present MOIF group was 76.1±9.8 minutes (range 60-95), excluding the anesthesia time. This is not in agreement with the results of Scuderi et al. [19], who reported a range of 115–210 minutes.

The mean follow-up period for MMU and MOIF were 23.5±11.9 months and 31±12.6 months respectively. The relatively short follow-up is the limitation of this study. However, Snodgrass et al. [20] found that most complications of urethroplasty are diagnosed within the first year after repair.

For the flip-flap technique, a well-vascularized skin flap is used to augment the distal urethra [21]. This may lead to a precarious blood supply. For these reasons the most frequent complications are fistulae, meatal regression and stenosis [22] with a complication rate between 1% and 22% [23-24].

In the present study, the MMU group had complications in 10 patients, with prepucial edema occurring in 5 (11.8%), urethrocutaneous fistula and glanular disruption in 2 (4.8%) each and retrusive urethral meatus in 1 (2.4%). These results are in accordance with those of other surgeons, who reported a similar complication rate [25].

In all kind of hypospadias repairs, urethrocutaneous fistula is the most feared but expected complication. In the Mathieu technique longer flap may lead to decreased blood supply to the flap, resulting in a higher incidence of fistula [26].Careful preservation of the vasculature of the flap and avoidance of overlapping suture lines produce a watertight closure with minimal risk of postoperative fistula formation [8].

There is an increased risk of meatal stenosis as there are chances of reduced blood flow to the distal part of the flap [8]. In our study with modified Mathieu's technique, the patients had no meatal stenosis. Our technique of spreading the fine scissor blades underneath the flap to harvest an even thickness uniform flap aids in maintaining its vascularity [8].

Oswald et al. [27] observed complete repair disruption in 6.7% for Mathieu's repair. Although in our study, complete disruption was not observed, but glandular disruption occurred in 2 (4.8%).

In our study, prepucial edema was found in 5 (11.8%) patients. This was not significant as it regresses within 3-4 weeks of surgery.

One of the possible challenges of based flap is the cosmetically undesirable meatal configuration [28]. However, as the functional outcome was good, with 85.7% of children having a good caliber, single and straight urinary stream and minimal scarring, the rounded meatus was accepted by the parents. The technique of using two sutures at the 4 and 8 o'clock position over the meatus, led to cosmetically accepted meatus and with no stenosis.

The dorsal prepuce forms an integral part of the armamentarium of a hypospadias surgeon. In modified Mathieu's repair, the advantage of leaving an intact dorsal prepucial tissue is that, it can be utilized in redo surgery if needed. The disadvantage of a successful Mathieu's repair is that, the child has to again, expose

himself to anesthetic agents for circumcision. In our institution, circumcision is done 6 months of post primary repair.

In the present study the MOIF group had complications in 23 (48.9%) patients, with mild penile torsion and wide urethral meatus occurring in 5 (10.6%) each, hematoma in 3 (6.3%), urethrocutaneous fistula, infection, penile edema and diverticulum in 2 (4.3%) each, skin necrosis and post-operative bleed in 1 (2.1%) each. Various studies reported complication rates varying between 6% and 32% [14,29,30]. Scuderi et al. [19] reported early postoperative complications in 8.6% of cases, which decreased to 2% during the follow-up, with conservative or non-surgical interventions.

In onlay flap repair careful protection of the vasculature of the flap and prevention of overlapping suture lines generate a waterproof closure with minimum risk of postoperative fistula [31]. In our study, the mesentery of the optimum sized rectangular flap was sufficiently mobilized to reach the native urethral plate to get tension-free anastomosis. Also, the dartos fascia pedicle was advanced to cover suture lines on both sides of the neourethra. These techniques aid us in reducing urethrocutaneous fistula.

Fistula usually occurs within the first month of surgery may be a result of the inflammatory process associated with infection, which leads to urethral mucosal migration to suture tracts [32]. In our study 2 (4.3%) patients had post-operative infection, which was managed conservatively with antibiotics and sterile dressings, much lower than reported by Tim Jumbi et al. [33].

In MOIF, there is always a risk of using too wide flap for urethral reconstruction resulting in megalourethra, urethrocele or a diffuse diverticulum. This may also occur secondary to meatal stenosis [34]. In our study, only 2 (4.3%) of patients developed diverticulum. This is a low rate of diverticulum formation, as the rectangular flap was measured meticulously during the neourethra formation.

Meatal stenosis can occur after onlay repairs. Once meatal stenosis is developed, it leads to other complications like fistula and urethral diverticulum [33].

In our study, meatal stenosis did not occur after onlay repairs because neourethra was created over 8 to 10 Fr size of infant feeding tube. The extra anterior part of the rectangular flap was folded on itself proximally and sutured with glanuloplasty to cover the raw area leading to a wide neourethral meatus. We had no complications related to stricture formation in our study as we cut the ectopic urethral meatus back to normal urethra.

Transversely oriented island flaps from the inner prepuce have certain disadvantages like penile torsion/rotation [35]. An asymmetric rotational dartos might cause penile rotation, as the flap rotates around one side of the penile shaft [36]. In our study, 5 (10.6%) patients had mild penile torsion and required no intervention.

The major advantage of this technique is its ability to maintain good vascularity to the neourethra and the skin cover, thereby avoiding urethral or penile skin necrosis [37]. Owing to minimal mobilization of the flap, post-operative surgical site bleed occurred in 1 (2.1%), hematoma in 3 (6.3%), wound infections in 2 (4.3%) and penile skin necrosis in 1 (2.1%).We encountered penile edema in 2 (4.3%) cases. All cases were resolved with conservative management.

The urethral plate is well vascularized with a rich nerve supply and extensive muscular and connective tissue backing [23,37]. Snodgrass et al. did biopsies of urethral plate at subepithelial plane in 17 patients, resulting in no histological evidence of fibrous bands. Thus, concluded that there is no requirement of disrupting the integrity of urethral plate [38]. Urethral plate is more stable model and it provides better blood supply from adjacent spongiosal tissue. These features also explain the lower complication rate with onlay flaps. In addition, anastomotic strictures which are common in Duckett or Asopa can be prevented with the avoidance of circular suture line [23,29,30,39]. In our study, we have preserved urethral plate in all cases.

The cosmetic and functional outcomes were documented by physical examination and by confirming a good urinary stream. However, the

evaluation of the functional outcome by uroflowmetry was not done.

In the present study, the complication rates were lower and parent satisfaction was better than in the study by ElGanainy [40] wherein, random allotment of patients was done for two repair methods.

In present study duration of surgery and complication rate were significantly lower ($p<0.05$) in MMU. The judicious selection of patients aids in optimal decision-making with regard to type of hypospadias repair. This strategy offers reduced surgical time, lower complication rates, better functional outcome and acceptable cosmesis.

Conclusion:

Both modified Mathieu's repair and modified onlay island flap urethroplasty can be used in distal penile hypospadias repair. The successful outcome of both procedures depends on careful selection of patients. In our experience, candidates who fulfilled the requirements along with meticulous, modified surgical techniques had excellent cosmetic and functional results with relatively low complications. A further study with more patients, a longer follow-up and an objective evaluation of the functional outcome is recommended to confirm these early results.

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Conflict of Interest - Nil

Sources of Support - Nil

References

1. Baskin LS, Himes K, Colborn T. Hypospadias and Endocrine Disruption: Is there a Connection? *Environmental Health Perspectives* 2001;109 (11):1175-1183.
2. Baskin LS. Hypospadias and Urethral Development. *Journal of Urology* 2000; 163 (3):951-956.
3. Kojima Y, Kohri K, Hayashi Y. Genetic pathway of external genitalia formation and molecular aetiology of hypospadias. *Journal of Pediatric Urology* 2010; 6(4):346-354.
4. Duckett JW Jr. Hypospadias. *Pediatric Review* 1989;11(2):37-42.
5. Seibold J, Boehmer A, Verger A, Merseburger AS, Stenzl A, Sievert KD. The meatal mobilization technique for coronal/subcoronal hypospadias repair. *British Journal of Urology International* 2007;100(1):164-167.
6. Schroder A, Stein R, Melchior S, Fisch M, Riedmiller H, Thuroff JW. Hypospadie [in German]. *Urologe A.* 2006;45(Suppl 4):204-208.
7. Asopa HS. Newer concepts in the management of Hypospadias and its Complications. *The Annals of Royal College of Surgeons of England* 1998;80(3):161-168.
8. Singh AP, Shukla AK, Shukla R, Jyotsna S.Modified Mathieu's Surgical Procedure for Distal Penile Hypospadias—Our Institutional Experience. *Nigerian Journal of Plastic Surgery* 2017;13:12-17.
9. Singh AP, Shukla AK, Sharma P, Prasad R. One-Stage repair of Hypospadias using the Modified Prepucial Island Flap Technique: Experience with 200 cases. *Archives of International Surgery* 2016;6(2):121-126.
10. Snodgrass WT. Hypospadias. In: Wein AJ, Kavoussi LR, Novick AC, et al. editors. Campbell-Walsh Urology, 10th edition, Vol.8. Philadelphia: Elsevier, Saunders; 2012. p. 3503-3514.
11. Mathieu P. Traitement en un temps de l'hypospade balanique et juxta-balanique. *Journal de Chirurgie (Paris)* 1932;39:481-484.
12. Wacksman J. Modification of the one-stage flip-flap procedure for repair of distal penile hypospadias. *Urology Clinics of North America* 1981;8(3):527-530.
13. Asopa HS, Elhene IP, Atri SP, Bansal NK. One stage correction of penile hypospadias using a foreskin tube. A preliminary report. *International Surgery* 1971;55(6):435-440.
14. Elder JS, Duckett JW, Synder HM. Onlay Island flap in the repair of Mid and Distal penile Hypospadias without Chordee. *Journal of Urology* 1987;138 (2):376-379.
15. Duckett JW. The Island flap technique for Hypospadias Repair. *Urology Clinics of North America* 1981;8(3):503-511.
16. Bae SH, Lee JN, Kim HT, Chung SK. Urethroplasty by use of Turnover Flaps (Modified Mathieu procedure) for Distal Hypospadias Repair in Adolescents: Comparison With the Tubularized Incised Plate Procedure. *Korean Journal of Urology* 2014;55(11):750-755.
17. Chen YF, Huang WY, Chen SC, Guo YJ, Lan CF, Liu SH, et al. Factors associated with Delayed Pediatric Hypospadias surgery in Taiwan: A population-based, nationwide analysis. *Journal of the Formosan Medical Association* 2013;112(1):48-53.
18. Tawfiq NR, Saood MJ, Abdulla MH. Comparative study of two different procedures for Primary Hypospadias Repair. *International Surgery Journal* 2017;4(8):2475-2479.

19. Scuderi N, Chiummariello S, De Gado F. Correction of Hypospadias with a Vertical Prepucial Island flap: A 23 year experience. *Journal of Urology* 2006;175(3 Pt 1):1083-1087.
20. Snodgrass W, Villanueva C, Bush NC. Duration of follow-up to diagnose Hypospadias urethroplasty complications. *Journal of Pediatric Urology* 2014;10(2):208-211.
21. Ombre´danne L. Pre´cis clinique et ope´ratoire de chirurgie infantile. Paris, France: Masson and Cie; 1925. p. 654.
22. Atala A. Urethral Mobilization and Advancement for Midshaft to Distal Hypospadias. *Journal of Urology* 2002;168(4 Pt 2):1738-1741.
23. Ghali AM. Hypospadias repair by Skin flaps: A comparison of Onlay Prepucial Island flaps with either Mathieu's Meatal-based or Duckett's Tubularized Prepucial flaps. *British Journal of Urology International* 1999;83(9):1032-1038.
24. Uygur MC, Erol D, Germiyanoglu C. Lessons from 197 Mathieu Hypospadias Repairs performed at a single institution. *Pediatric Surgery International* 1998;14(3):192-194.
25. Yesildag E, Tekant G, Sarimurat N, Cenk Buyukunal SN. Do Patch procedures prevent Complications of the Mathieu technique? *Journal of Urology* 2004;171(6 Pt 2):2623-2625.
26. Boddy S, Samuel M. A Natural Glanular Meatus after 'Mathieu and a V incision sutured': MAVIS. British *Journal of Urology International* 2000;86(3):394-397.
27. Oswald J, Körner I, Riccabona M. Comparison of the Perimeatal-based flap (Mathieu) and the Tubularized Incised-plate Urethroplasty (Snodgrass) in Primary distal Hypospadias. *British Journal of Urology International* 2000;85(6):725-727.
28. Samuel M, Capps S, Worthy A. Distal hypospadias: which repair? *British Journal of Urology International* 2002;90(1):88-91.
29. Castanon M, Munoz E, Carrasco R, Rodo J, Morales L. Treatment of Proximal Hypospadias with a Tubularized Island Flap Urethroplasty and the Onlay Technique: A Comparative study. *Journal of Pediatric Surgery* 2000;35(10):1453-1455.
30. Patel RP, Shukla AR, Snyder HM 3rd. The island tube and island onlay hypospadias repairs offer excellent long-term outcomes: a 14-year follow up. *Journal of Urology* 2004;172(4 Pt 2):1717-1719.
31. Mohajerzadeh L, Mirshemirani A, Rouzrokh M, Sadeghian N, Khaleghnejad-Tabari A, Mahdavi A, et al. Evaluation of Onlay Island Flap Technique in Shallow Urethral Plate Hypospadias. *Iran Journal of Pediatrics* 2016;26(1):e660.
32. Shehata S, Hashish M. Management of Post Hypospadias Urethral Fistula. In: Donkov I, editor. Current Concepts of Urethroplasty. Shanghai, China: InTech. 2011; 47-60.
33. Jumbi T, Shahbal S, Mugo R, Osawa F, Mwika P, Lessan J. Urethro-cutaneous fistula after Hypospadia Repair: A Single Institution Study. *Annals of African Surgery* 2019;16(2):59-63.
34. Duckett JW, Walsh PC, Petik AB, Vaughan ED, Wein AJ. Campbell Urology. 7th ed., Vol. III. Hypospadias. Philadelphia: W.B. Saunders Company. 1998;2093-119.
35. Chandrasekharam VVS. Single-stage repair of hypospadias using longitudinal dorsal island flap: Single-surgeon experience with 102 cases. *Indian Journal of Urology* 2013;29(1):48-52.
36. Djordjevic ML, Perovic SV, Slavkovic Z, Djakovic N. Longitudinal Dorsal Dartos Flap for Prevention of Fistula after a Snodgrass Hypospadias Procedure. *European Urology* 2006;50(1):53-57.
37. Patil A, Sharma A, Mane N, Parab S, Andankar M, Pathak H. Hypospadias Repair using Transverse Preputial Island Flap (Modified Asopa Procedure). *Journal of Pediatric Nephrology* 2018;6(3):1-7.
38. Snodgrass W, Patterson K, Plaire JC, Grady R, Mitchell ME. Histology of the Urethral Plate: Implications for Hypospadias Repair. *Journal of Urology* 2000;164(3 Pt 2):988-989.
39. Erol A, Baskin LS, Li YW, Liu WH. Anatomical studies of the urethral plate: why preservation of the urethral plate is important in hypospadias repair. *British Journal of Urology International* 2000;85(6):728-734.
40. ElGanainy EO. A modified onlay island flap vs. Mathieu urethroplasty for distal hypospadias repair: A prospective randomised study. *Arab Journal of Urology* 2015;13(3):169-175.

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