

## Comparative Study Between Modified Koyanagi and Duckett Tube Techniques in Management of Proximal Types of Hypospadias

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### ABSTRACT

**Objectives:** To evaluate the surgical outcome of Modified Koyanagi and Transverse Preputial Island Flap (TPIF) repair for proximal penile hypospadias. **Methods:** The prospective study was conducted at the Pediatric Surgery Department, Ain Shams University Hospitals from October 2010 to September 2015. A total of 60 patients with proximal penile hypospadias in the age range of 8 months to 10 years were included. Patients with hypospadias other than proximal penile and those with a history of previous hypospadias repair were excluded. Patients were divided into two equal groups. Duckett tube (TPIF) urethroplasty was done for group A and modified Koyanagi repair for group B. The follow-up period was 12 months. SPSS 16 was used for statistical analysis. **Results:** Mean operative time was  $86 \pm 9.62$  minutes for TPIF urethroplasty, and  $91 \pm 16.45$  minutes for Modified Koyanagi repair ( $p < 0.0001$ ). In group A, 7 (23.3%) patients had complications, while in group B, 6 (20.0%) patients developed complications ( $p = 0.02$ ). Glanular disruption was observed in two patients (one in each group) (3.3%). Necrosis and sloughing of neourethra with subsequent disruption of the repair occurred in two patients (one in each group) (3.3%). Meatal stenosis occurred in 2 patients (one patient in each group) (3.3%). Urethral stricture was found in two patients (one patient in each group) (3.3%). Five patients developed urethra-cutaneous fistula, small temporary fistula in one patient (group A) (3.3%) was noticed on the 10th postoperative day, while in four patients (two in each group) (6.6%) there was more than one fistula was found. **Conclusion:** Duckett and modified Koyanagi repair techniques could be considered as acceptable and clinically equivalent as one stage procedure for primary proximal hypospadias with severe degree of chordee, small sized penis or with narrow urethral plate, provided that a good selection of cases for each type of repair was achieved.

**Key Words:** Modified Koyanagi technique, Duckett Tube technique, management of proximal types of Hypospadias, clinically equivalent results, urethra-cutaneous fistula, urethroplasty.

### INTRODUCTION

Hypospadias is one of the most common congenital anomalies occurring in 0.4 to 8.2 per 1000 live male birth. Hypospadias therefore continues to be a challenging problem for pediatric surgeons, urologists and plastic surgeons alike<sup>(1)</sup>. Proximal hypospadias is one of the most problematic conditions to correct. The multiplicity of procedures that have been described over the years is indicative of the fact that no procedure has been universally acceptable or successful. Many have chosen to perform staged procedures since this has the advantage that the varied anatomical issues can be fixed sequentially with different aspects of the problem being tackled in time. A disadvantage of this approach is that by necessity patients undergo at least two and often more procedures<sup>(2)</sup>. Controversy exists regarding the optimum

technique for the repair of proximal hypospadias<sup>(3)</sup>.

The Hodgson procedure used Skin island from the outer layer of the preputial skin for urethral tubularization<sup>(4)</sup>. In 1984 Koyanagi et al<sup>(5)</sup>, reported meatal based foreskin flap repair for proximal hypospadias. He used the inner layer of the preputial skin for urethral tubularization. In essence, the Koyanagi technique can simply be described as a two-step hypospadias repair completed in one-stage<sup>(2)</sup>. This procedure had a relatively high-complication rate, in part, because no major attempt was made to preserve the blood supply of the skin flaps. A modification of the technique was described, in which the vascularity of the flaps resulted in a reduced complication rate. The meatal based yoke is outlined and the inner incision is made first, this allows the urethral plate to be mobilized sufficiently to excise all of the lateral and ventral tissues that

contribute to the chordee. The outer incision is made but only through the skin, preserving the underlying vascular supply to the skin flaps<sup>(6)</sup>.

The transverse preputial island flap is perhaps the most popular option among hypospadiologists. Though others throughout the world helped to pioneer the technique,<sup>(7,8)</sup> it is Duckett who typically receives credit for making the technique a popular choice for proximal hypospadias<sup>(9)</sup>. Transverse preputial island flap (TPF) urethroplasty for hypospadias is based on superficial dorsal vessels of the penis and has stood test of time<sup>(10,7)</sup>.

## PATIENTS AND METHODS

Sixty male patients with different types of proximal hypospadias (the urethral meatus is proximal penile, penoscrotal or scrotal) were enrolled in our study; half of these patients were subjected to surgical repair using the Transverse Preputial Island Flap (TPIF) (group A, no= 30), while the other half were subjected to Modified Koyanagi repair (group B, no= 30). Surgery was performed during the period between October 2010 and September 2015 at the Pediatric Surgery Department, Ain Shams University Hospitals. Exclusion criteria: children younger than 8 months or older than 10 years, distal and mid penile hypospadias, circumcised patients and previously repaired hypospadias. Inclusion criteria: children older than 8 months and younger than 10 years, proximal hypospadias with or without chordee, and uncircumcised patients.

All patients were subjected to: detailed history taking, usually from the parents, or caregiver; subjected to thorough clinical examination, both general and local. Local examination inspected meatal site, size (wide or narrow), skin around, the urethral plate size (wide or narrow), prepuce present or absent and its shape, size of the penis, skin deficiency on ventral aspect of penile shaft and/or torsion, presence of penile chordee, presence of penoscrotal transposition, nature of the urinary stream and other associated local anomalies.

All patients were subjected to routine laboratory investigations. Prophylactic antibiotics were given to all cases intraoperative and continued through the entire hospital stay in the form of antibiotic combination (cefotaxime and ampicillin/ sulbactam) via intravenous route. All

patients were followed up for 3m to 1 yr. All operations were performed by the authors, using fine instruments and under 3.5X loupe magnification.

### Operative technique:

All patients received general anesthesia, combined with caudal anesthesia.

### Transverse Preputial Island Flap Technique: Figure 1 (A-H)

The applied technique is as described by Duckett JW (9, 11). 3\0 Prolene traction sutures were applied to the dorsum of the glans penis and artificial erection was induced by injection of 10-15 ml of normal saline by a butterfly needle in each corpus cavernosum to diagnose and assess severity of chordee. A circumferential incision was made proximal to the corona and hypospadias orifice. The urethra and shaft skin were dissected free of corpora cavernosa to release the chordee tethering. An artificial erection was induced again to re-assess the chordee. The native urethra was brought to a comfortable position without tension on the shaft and fixed by 5\0 vicryl suture to the tunica albugina.

A transverse island flap from inner layer of prepuce was outlined and dissected with the distance equal to or slightly longer than that between hypospadias orifice and the tip of glans as measured with a caliper, the width was measured based on the age of the patient, usually 8-12 mm wide and dissected with its axial vascular pedicle which was mobilized proximally to an extent that allowed ventral transposition of the flap with no tension.

Rather than rolling the tissue into a tube at this point, we first anchored the medial margin of the flap to the urethra proximally. This maneuver allowed the flap to be optimally tailored by stretching the skin to the opposite, anchored edge of the flap. The tube was fashioned to properly align the anastomosis to the native urethra and to construct a tube of ideal caliber. A second interrupted suture line by 6\0 PDS or Maxon suture then rolled the tube effectively into the glans.

The island flap was tabularized in such a manner that it was slightly loose around a suitable sized stent. A glans channel was constructed by excising central core of glanular tissue to the level that makes the glanular edges cover the neourethra which was brought through the glans and the glanular edges sutured by 5\0 PDS or

Maxon (mattress). The dorsal layer of prepuce was transported ventrally and the repair was covered with skin as cosmetically as possible. Nelaton catheter of (8 Fr, 10 Fr or 12 Fr) was placed as a way of urinary diversion and kept in situ for 10-14 days.

**Modified Koyanagi technique: Figure 2 (A-F)**

Outlines of the skin incisions were drawn with a marking pen before starting the operation. The outer skin incision was encircled proximal to the hypospadias meatus and extended laterally and dorsally to the penile foreskin until it met with its counterpart at 12 o'clock. The inner circumcoronal skin incision of the dorsal foreskin was outlined. A circumferential incision is made less than 5 mm proximal to the corona. An appropriate sized Nelaton catheter (8 Fr, 10 Fr or 12 Fr) was placed. The inner incision was made first along the full circumference of the previously defined skin marking. Dartos mobilization and chordectomy were needed with the harvesting of the flap. When it was completed, the penile shaft was almost degloved.

An artificial erection test was done to assess the presence and extent of chordee. Classic chordectomy was also done when the urethra was mobilized enough, chordee was usually corrected and this was confirmed by another artificial erection. Glans cleavage and creation of glanular wings were done by a vertical midline incision.

Formation of the urethra: The inner edges of the flaps were sewn together with fine absorbable sutures (6-0 PDS or Maxon). By this we had created a neourethral plate well vascularized 7 to 8 mm wide flaps. The outer edges of the skin flaps were then sutured together to create the neourethra. The dartos wrap was easier to harvest but the tunica vaginalis wrap seemed more reliable. Glanulomeatoplasty was done by an approximation of the glanular wings using 5-0 PDS or Maxon mattress sutures. Byarsization of dorsal foreskin and its subcutaneous tissue were used to cover the new urethra.

Dressing by a fluffy dressing of light gauze was applied to the wound, and the penis held in

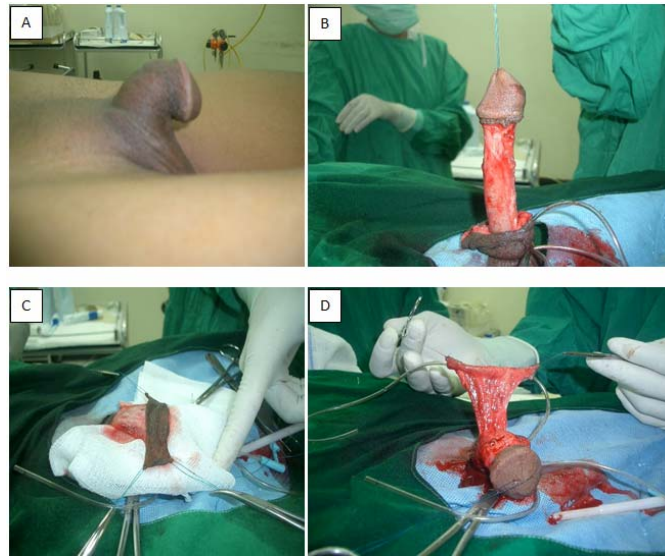
dorsiflexion against the suprapubic region under the compression coverage.

Post-operative care and follow up: Appropriate intravenous fluids were continued until oral feeding was tolerated. Cephalexin was given from the day of surgery to 2 days after urethral catheter removal to decrease the risk of complicated urinary tract infections after surgery. Garamycin ointment was applied daily around the site of emergence of the catheter. Hyosine-butylbromid 0.5 mg/kg/dose was used to prevent bladder spasm. Camphor oil syrup in the therapeutic dose was used to prevent penile erection (10 mg/kg/day orally).

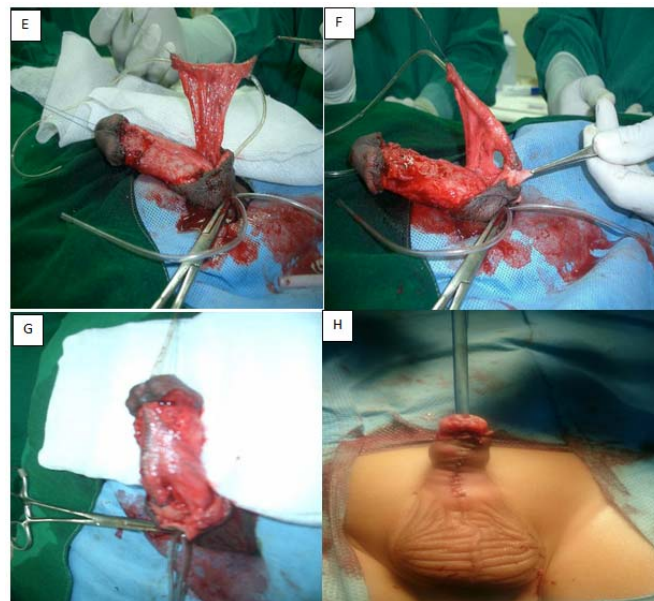
Dressing was changed at 48 hours after surgery to assess the viability of the repair and to detect for any acute postoperative complications (bleeding, hematoma and edema), and thereafter daily. The catheter was left in situ for 10-14 days according to the length of neo-urethra.

Clinical assessment of the procedure was done as regards the following: final position of the meatus, urinary stream and direction, neo-urethral meatal size, skin condition & shape of the glans. The outcome was evaluated by assessing the anatomical, functional, and cosmetic results. An excellent result was defined as a cosmetically and anatomically normal-looking penis able to direct a forceful urinary stream. A minor defect that would require no further management was considered a satisfactory outcome. A complication was an anatomical or functional defect that required surgical intervention. The management was considered to have failed where there was a complication that required complete reconstruction.

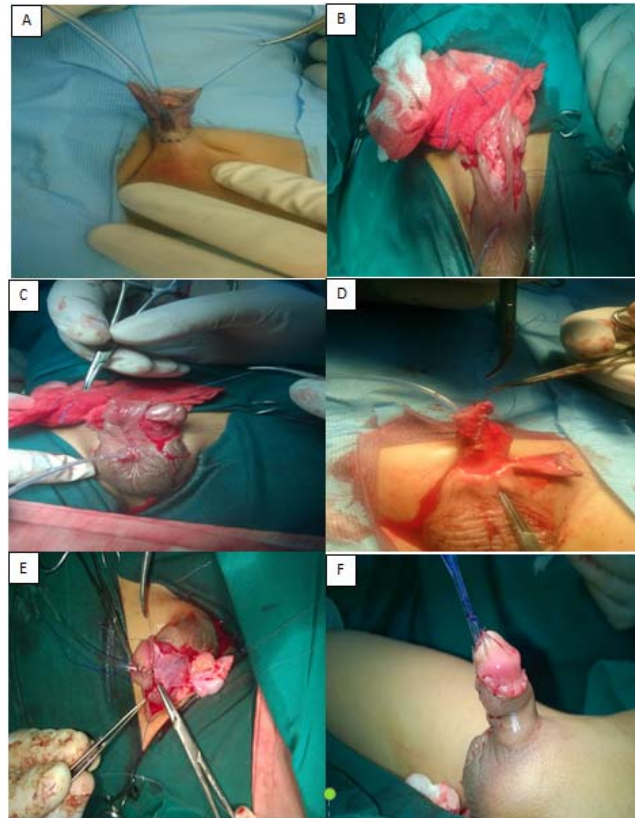
All the patients were kept on regular follow-up in the outpatient department one week after discharge then after two weeks, one, three and six months. Urethral calibration was done in selected patients having meatal stenosis and urethral stricture. Patients having persistent urethrocutaneous fistula were repaired after six months of primary surgery for hypospadias.



**Fig. (1)** (A): Proximal penile hypospadias with severe chordee, (B): Degloving and release of chordee and correction of penile curvature by surgical release of the skin and dartos fascia and ancillary straightening procedures as needed, (C): The transverse island flap is designed: a rectangle is outlined at the inner aspect of the dorsal foreskin, (D): The transverse preputial island flap is developed and tubularized over a 10-Fr catheter. The distal edges of the tube are sewn with interrupted sutures so that the edges can be trimmed to the appropriate length. The first layer consists of 6/0 PDS or Maxon sutures placed in a simple interrupted fashion at the epithelial edges.



**Fig. (1)** (E): Rotation of neo-urethra to the ventral aspect of the penis, must avoid torsion of the shaft by freeing the base of the flap adequately, (F): A proximal oblique anastomosis is made, fixing the urethroplasty to the tunica albuginea along its posterior anastomosis, (G): A wide glans channel is made underneath the glans cap against the corporal bodies by removing glans tissue within the channel and the neourethra is tacked to the corporal bodies, (H): Lateral transposition of Byar flaps of dorsal penile skin to midline and excision of the tips. The repair is stented with a 8-Fr catheter.



**Fig. (2):** (A):Outlining of the skin incisions was drawn with a marking pen,(B):The outer incision and mobilization of flaps, (C):The inner edges of the flaps are sewn together then the outer edges, (D):Tubularisation of neourethra, (E):Wrapping on the neo-urethra by TV flap, (F):Glanulomeatoplasty& skin closure.

## RESULTS

Sixty male patients with different types of proximal hypospadias (the urethral meatus is proximal penile, penoscrotal or scrotal) were enrolled in the study; half of these patients were subjected to surgical repair using the Transverse Preputial Island Flap (TPIF) (group A, no= 30), while the other half were subjected to Modified Koyanagi repair (group B, no= 30). This study took place over the period between 2010 and 2015 at Pediatric Surgery Department, Ain Shams University Hospitals.

All patients were seen after 1 week, 2 weeks, one month, 3 months and 6 months. In all succeeded patients, the meatus was terminal with conical glans, straight penis, healthy mobile penile skin and straight non-turbulent forwardly directed urinary stream.

The overall mean age of the patients was  $3\pm 0.85$  years for group I and  $2\pm 0.65$  for group II ( $p < 0.0001$ ). Proximal penile hypospadias was present in 36 (60.0%) and penoscrotal in 24 (40.0%) patients.

Mean operative time was  $86\pm 9.62$  minutes for TPIF urethroplasty, and  $91\pm 16.45$  minutes for Modified Koyanagi repair ( $p < 0.0001$ ).

The repair was successful in 78.3 % (no= 47) patients. These patients had normal urinary stream without any complication, 23 out of thirty (76.7%) in group A and 24 out thirty (80%) in group B.

Mild infection was noted in three patients which appeared in the 5th post-operative day (one patient in group A (3.3%) and two patients in group B (6.6%), while three patients developed edema (two patients in group A (6.6%) and one patient in group B (3.3%). These complications settled with antibiotics and antiseptic dressings.

Overall complication rate was 20% (no= 12). Glanular disruption was observed in two patients (one in each group) (3.3%). Secondary surgery for glans closure was successful in both. Necrosis and sloughing of neourethra with subsequent disruption of the repair occurred in two patients (one in each group) (3.3%). These were treated initially with debridement and daily dressing.

Meatal stenosis occurred in two patients (one patient in each group) (3.3%).

Urethral stricture was found in two patients (one patient in each group) (3.3%). All cases of meatal stenosis and urethral stricture developed within the first post-operative month and improved by regular urethral dilatation by urethral catheter 6–8 Fr., twice weekly for 2 months.

Five patients developed urethrocutaneous fistula. A small temporary fistula in one patient in group A was noticed on the 10th postoperative day, just distal to the original meatus. Spontaneous closure of the temporary fistula occurred within one month without any other consequences, while in four patients (two in each group) (6.6%) there was more than one fistula found and patients underwent surgery for fistula closure after an interval of 6 to 9 months which was successful in the four patients.

The total number of complications in group A is seven out of thirty (23.3%) and the total number of complications in group B is six out of thirty (20%).

## DISCUSSION

Hypospadias repair is one of the most challenging problems for operating surgeons due to its high complication rate. The reported incidence of complications range from 6% to 30% depending upon severity of hypospadias<sup>(12)</sup>. The technique of repair for hypospadias kept evolving as none of the current methods is without complications even in the best of hands. The type of repair used is mostly individual preference of each surgeon.

Due to technical challenges and often poor outcome the condition has attracted attention of operating surgeons. During the past years, many techniques have developed to overcome these problems. Mostly one stage repair for hypospadias is preferred nowadays. The advantage of correcting chordee and reconstruction of neourethra in a single operative

setting and the associated low morbidity are the reason for popularity of single stage repair.

The inner preputial flap is one of the most suitable epithelial structures for creating neourethra up to 6-7cm long. Its vascular pedicle can be dissected proximally to be adopted to different types of hypospadias<sup>(11,10)</sup>. Complications after any surgical procedure are possible, but these complications are higher in hypospadias surgery when compared to any other reconstructive surgery. The most common complications following hypospadias repair are: urethrocutaneous fistula, meatal stenosis, urethral stricture, urethral diverticulum, glans dehiscence, breakdown, and cosmetic unfavorable outcome requiring redo-surgery.

The eldest of patients caused many postoperative difficulties in controlling the child's activity; and dealing with his emotional disturbance caused by dressing and stent removal. These results are consistent with those of **Belman**<sup>(13)</sup> who operated upon children at ages of 2 and 11 months and noticed a decrease of technical complications and a decrease of anxiety.

Many reports suggested that the ideal age for genital surgery is between 6 and 12 months of age. This age range seems to insulate most children from the psychologic, physiologic, and anesthetic trauma associated with hypospadias surgery. Healing seems to occur more quickly and with fewer scars, young infants overcome the stress of surgery more easily<sup>(14)</sup>.

**Emir**<sup>(6)</sup>, performed the modified repair on patients with a mean age of 12.5 months. However, **Koyanagi et al**<sup>(15)</sup> performed their repair on patients with a mean age of 3.7 years, which is higher than the mean age in both groups of our study.

The type of urinary diversion after hypospadias surgery is still a controversial issue. In our study, transurethral urinary diversion with 8Fr or 10Fr Foley's catheter was used for 2 weeks. Transurethral catheterisation has produced more satisfactory results and patient compliance than the urethral stents. **Osifo and Azeez**<sup>(16)</sup>, reported shorter hospital stay in transurethral catheterisation compared to suprapubic urinary diversion. While, **Sigumonrong et al**<sup>(17)</sup>, reported that the type of urinary diversion after hypospadias surgery did not affect surgical outcome. **Almodhen et al**<sup>(18)</sup>, reported excellent results with stent-free TIP urethroplasty.

The ideal dressing for hypospadias repair remains elusive. In our study, sandwiched dressing was used which was removed 24 to 48 hours post-operatively. The advantages of dressing following the hypospadias repair are that of gentle compression for haemostasis and wound immobilisation while ischaemia, infection and pain during removal are some of the disadvantages. **Van Savage et al**<sup>(19)</sup>, reported that no major difference was seen in outcome in a comparative study between non-dressed and dressed hypospadias repair.

Criteria for success of any hypospadias repair is glanular meatus, single forward directed stream, unimpeded voiding, absence of penile chordae, good cosmetic and no need for secondary procedure<sup>(20)</sup>.

The results of our study demonstrate that there is no significant increase in the total number of successful repairs in patients with hypospadias who were repaired by MK than those repaired by Duckett operation, the total number of successful repairs in patients repaired by MK was 24 out of 30 (80%), while, in Duckett, the total number of successful repairs was 23 out of 30 (76.7%) and the difference is statistically insignificant.

When comparing these results with those of other similar studies, we find that 33 cases (47%) out of 70 developed complications in a study conducted by **Koyanagi, et al.**<sup>(15)</sup>, over a period of 10 years. All cases had severe hypospadias. **Glassberg, et al.**<sup>(21)</sup>, reported a 50% complication rate. **Emir, et al**<sup>(6)</sup>, performed the modified Koyanagi technique on 20 patients with proximal hypospadias over a period of 7 years and they reported a total complication rate of 30%. **Hayashi, et al.**<sup>(22)</sup>, performed the modified Koyanagi repair on 20 patients with severe hypospadias. They reported a total complication rate of about 30%. **Elhalaby EA. in 2006 (23)**, reported that the overall success rates of modified Koyanagi procedure on patients with severe forms of hypospadias were 63.63%. **Rajendra, et al.**<sup>(24)</sup>, had the overall complication rate of 35.7% & **Vepakomma, et al.**<sup>(25)</sup>, reported a complication rate of 45.8%. So, we have lower complication rate being 20%.

On the other hand, the complication rate of MK procedure in our study was higher than that reported by **Elsaied, et al.**<sup>(26)</sup>, who reported a 10% complication rate and being more than the

rate reported by **Hassan, et al.**<sup>(27)</sup>, as they had an overall complication rate of 11.4%.

The complication rate of Duckett tube in this study was 23.3% which is more than that reported by **Hayashi, et al.**<sup>(28)</sup>, as they reported a 9% complication rate, while it came lower than the complication rates reported by **Wiener, et al.**<sup>(29)</sup>, whose study included 74 patients who underwent a Duckett procedure with a 36% complication rate, **Ghali**<sup>(30)</sup> had a reported complication rate of 32%, **Demirbilek, et al.**<sup>(31)</sup>, who reported 90% and 38% complication rates using double faced tubularized island flap and tubularized island flap techniques consecutively for repair of proximal penile hypospadias, **MacGillirray, et al.**<sup>(32)</sup>, who used Glassberg's modification of Ducketts for repair of proximal penile hypospadias and reported a 42% complication rate, together with **Khan and Ahmed**<sup>(33)</sup>, who got a 36% complication rate, and still lower than that reported by **Jehangir**<sup>(34)</sup>, who had a 37.7% complication rate & **Safaa**<sup>(35)</sup>, who got a 55% complication rate,

Urethrocutaneous fistula after hypospadias repair remains one of the most frustrating complications with a variable rate in the different studies conducted by **David**<sup>(36)</sup>, **Martinez, et al.**<sup>(37)</sup> & **Massimo, et al.**<sup>(38)</sup>. It has been recorded in 5 cases (8%) in the current study (3 cases in group A and 2 cases in group B). Despite improvements in surgical techniques, fine surgical instruments and monofilament absorbable suture material, avoiding suture line overlap, and the transposition of additional tissue layers, urethrocutaneous fistula still occurs in 5% to 20% of all hypospadias repairs<sup>(39,40)</sup>.

When a fistula is diagnosed, whether as a perioperative or delayed complication, at least 6 months should be allowed to elapse prior to surgical intervention. This interval allows inflammation and edema to resolve, and enables an accurate assessment of the viability and suitability of local tissues to be incorporated during re-operation. While a small proximal fistula may be approached by excising the fistula tract to the urethra and performing an inverting closure with additional adjacent tissue. A larger fistula or multiple small fistulae often require a preputial or dartos-based skin flap for an on lay closure. Transposition of considerable dorsal tissue to the ventrum with an originally completed



repair provides enough tissue for a primary closure at reoperation<sup>(41)</sup>.

Various techniques have been described to prevent fistula formation after transverse preputial island flap urethroplasty. **Chuang and Shieh**<sup>(42)</sup>, found that two layered closure of neourethra decreased complication rate of urethrocutaneous fistula from 34% to 13%, as it resulted in improved healing of the neourethra and decreased chances of ischemic necrosis. **Hayashi et al.**<sup>(28)</sup>, noted urethrocutaneous fistula in one patient out of thirteen with two-layer closure of the neourethra, additionally the portion of anastomosis between native urethra and the neourethra was wrapped with the tissue of corpus spongiosum.

Perhaps the largest series of tubularized flaps is the one reported by **Liem, et al. in 2006 (43)**. The technique used was a modification of the original Duckett transverse island flap. In this series of 176 patients, a longitudinal island flap was harvested using preputial and penile skin. Patients were described as having proximal hypospadias. The authors reported a significantly low 7.4% fistula rate.

Technical problems such as creating a narrow lumen meatus or too tight glanuloplasty may be the cause of meatal stenosis, recorded in 2 cases (3.3%) in the present study (one in each group). Early calibration and dilation of the neourethra is a useful method for treatment of meatal stenosis after hypospadias repair<sup>(44)</sup>.

Stricture formation at native meatus and neourethra anastomotic site is a common complication of hypospadias surgery. Optical internal urethrotomy or dilatation is the primary therapy but many cases may require open urethroplasty based on a study conducted by **Mathur, et al.**<sup>(45)</sup>.

## CONCLUSION

Duckett and modified Koyanagi repair techniques could be considered as acceptable and clinically equivalent as one stage procedures for the repair of primary proximal hypospadias with severe degree of chordee, small sized penis or with narrow urethral plate, if a good selection of cases for each type of repair was achieved. Great care should be given to meticulous dissection, optical magnification, use of fine sutures and

delicate instruments. We also believe that the use of tunica vaginalis wrap as a cover for the urethroplasty improves the results.

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