Clinical Study

Comparative study between modified Koyanagi and Snodgrass techniques in management of proximal types of hypospadias

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Abstract

Objectives: The aim of this study is to compare between the modified Koyanagi and Snodgrass techniques in the management of proximal types of hypospadias as regards operative time, hospital stay, success rate, postoperative complications and cosmetic results.

Methods: Fifty male patients with different types of proximal hypospadias (the urethral meatus is proximal penile, penoscrotal or scrotal) were enrolled in the present study; these patients underwent surgical repair using the tubularized incised plate urethroplasty and Modified Koyanagi repair. They were studied during the period between 2010 and 2012 at Pediatric Surgical Units, Al-Azhar University Hospitals (Cairo & Damietta). All patients were subjected to: detailed history taking, full clinical examination, both general and local. Fifty patients were randomized into two groups; A; (n = 30) patients underwent TIPU; B; (n = 20) patients underwent MK technique. The range of follow up period is 4 to 8 months with a mean of 6 months.

Results: Operative time was significantly decreased in group A in comparison to group B (83.30 ± 6.51 vs. 158.25 ± 22.78 min respectively). Duration of hospital stay was significantly shortened in group A in comparison to group B (9.56 ± 1.73 vs. 17.80 ± 2.26 days respectively). The success rate in group A was 70.0% compared to 60.0% in group B. The fistula was more in group A than B and mental stenosis was more in group A than B, while disruption was equal in both groups.

Conclusions: TIP and Modified Koyanagi repair techniques could be considered as acceptable and as effective as each other for hypospadias repair, provided that a good selection of cases for each type of repair was achieved. The tubularized incised plate (TIP) urethroplasty is a reliable one stage procedure in dealing with proximal hypospadias either without or with a mild degree of chordee if the urethral plate is supple and wide enough for tubularization, while MK is a reliable one stage procedure in severe degree of chordee, small sized penis or with narrow urethral plate.

Keywords: Hypospadias; Modified Koyanagi; Snodgrass techniques

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Introduction

Proximal hypospadias is one of the most challenging 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.

Controversy exists regarding the optimum technique for the repair of severe hypospadias. There has been a growing interest in one stage repair of all varieties of hypospadias including severe types.

The Hodgson procedure used skin island from the outer layer of the preputial skin for urethral tubularization.

In 1984 Koyanagi et al. 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.

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.

The reported series treated with a modified technique at many institutions showed a lower complication rate of 17–20%. The higher success rate of the modified Koyanagi technique is believed to reflect the impact of preservation of the lateral blood supply to the skin flaps and not to rely entirely on the microvasculature emanating from the region of the urethral meatus and its surrounding corpus spongiosum.

Snodgrass’ modification of the Thiersch–Duplay technique, the tubularized incised plate (TIP) urethroplasty, has gained widespread acceptance all over the world and become currently one of the most popular techniques for hypospadias repair. Since its initial description in cases of distal hypospadias, TIP urethroplasty has now been applied with notable success to both proximal and reoperative hypospadias.

The results indicate that there is a strong preference for utilizing the TIP technique, particularly in cases of distal, midshaft and proximal hypospadias without chordee. While this may have had the effect of diminishing the use of flaps and grafts in hypospadias surgery, it has by no means eliminated their use. The tubularized incised plate urethroplasty can be used for different types of hypospadias either alone or combined with other techniques when there is paucity of healthy skin flaps.

Materials and Methods

Fifty male patients with different types of proximal hypospadias (the urethral meatus is proximal penile, penoscrotal or scrotal) were enrolled in the present study; these patients underwent surgical repair using the tubularized incised plate urethroplasty (n = 30) and Modified Koyanagi repair (n = 20). They were studied during the period between 2010 and 2012 at Pediatric Surgical Units, Al-Azhar University Hospitals (Cairo & Damietta).

- Exclusion criteria: children younger than 10 months or older than 8 years, distal hypospadias, undiagnosed ambigu-
ous genitalia, circumcised patients and previously repaired hypospadias.

- Inclusion criteria: children older than 10 months and younger than 8 years, proximal hypospadias with and without chordee and hypospadias cripple with chordee, ambiguous genitalia that will be corrected to be a male and uncircumcised patients.

All patients were subjected to: detailed history taking, usually from the parents, grandfather or grand-mother; full clinical examination, both general and local. Local examination inspected meatal site, size (wide or narrow), skin around, the urethral plate size (wide or narrow) and presence of scarring, 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 and rotation, presence of penoscrotal transposition, nature of the urinary stream and other associated local anomalies. All patients underwent general anesthesia. (50 cases), 40 of them combined with caudal anesthesia.

Operative technique

Patients of group A were operated upon using TIPU technique for repair of their hypospadias deformities. Patients of group B were operated upon using MK technique for repair of their hypospadias deformities. All patients were in supine position. After removing the smegma, all patients’ skin was sterilized from the lower abdomen to the mid-thigh with povidone iodine 10%. Injection of cefoperazone sodium 50–100 mg/kg was given pre-operatively.

All operations were performed by the authors, using fine instruments and under 3.5× loupe magnification.

A 4-zero polypropylene stay sutures is placed in the dorsum of the glans for easy handling, traction and fixation of the nelaton catheter at the end of the operation. Any foreskin adhesion was gently released from the glans.

The technique of TIPU

A 6 or 8 French nelaton catheter was passed into the hypospadiac meatus to assess the skin coverage over the distal urethra and to protect the urethra. The quality of the distal portion of the urethra varies and may be quite thin and adherent to the skin (Figure 1).

A circumscribing U-shaped incision was done around the urethral plate that extended to about 2 mm proximal to the meatus. While the glans and shaft are held under fine dressing gauze (Figure 2), the penile foreskin proximal to the incision is mobilized by sharp dissection in the plane between Buck’s and

Figure 1: 2 Cases of fresh proximal hypospadias with minimal chordee.

Figure 2: The urethral plate after U shaped incision.
dartos fascia (orthoplasty). Minimal bleeding is usually encountered because all the vessels in the skin extend axially. Artificial erection was done and the chordee can be corrected if needed.

Then mid-line incision of urethral plate extending from within the meatus to its distal margin about 1–2 mm away from the glans apex and glanular wings were created. This relaxing midline incision is the key step of the procedure. Tubularization of the incized plate and neo-urethra creation were done by continuous subcuticular 6/0 vicrylsuture (Figure 3). Then the neourethra was rapped by vascularized dartosfascial flap, cremastro-tunica vaginalis flap (Figure 4). Glansplasty began at the corona and proceeded distally with about three stitches. The glans was sutured to the meatus at 5 and 7 o’clock using 6/0 Vicryl (Figure 5). Skin closure with antibiotic Vaseline gauze dressing was applied with semi tight bandage for about 5 days.

**Modified Koyanagi technique**

Outlining of the skin incisions was drawn with a marking pen before starting the operation (Figure 6). The outer skin incision 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 circum-coronal skin incision of the dorsal foreskin was outlined. A circumferential incision is made ≤5 mm proximal to the corona after noradrenaline (1: 200000) is injected subcutaneously along the proposed line of incision (Figure 7). An appropriate sized silicone Foley catheter (usually 6 or 8 F) is placed. The inner incision was made first along the full circumference of the previously defined skin marking. Dartos mobilization and chordectomy are needed with harvesting of the flap. When it was completed, the penile shaft was almost degloved. An artificial erection test was done to assess

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**Figure 3:** Tubularization of urethral plate with mid-glanular suture.

**Figure 4:** Wrapping on the neo-urethra by TV flap.

**Figure 5:** Skin closure with straight penis.

**Figure 6:** Outlining of the skin incisions was drawn with a marking pen. The arrow above refers to the inner incision. The arrow below refers to the outer incision.
the presence and extent of chordee. Classic chordecetomy was also done when the urethra was mobilized enough and chordecetomy completed, chordees were 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 are sewn together with fine absorbable suture (6–0 polydioxanone). Once this has been accomplished, one has essentially created a neourethral plate. The outer edges of the skin flaps can then be sutured together to create the neourethra (Figure 8).

The dartos wrap was easier to harvest but the tunica vaginallis wrap seemed more reliable.

Glanulomeatoplasty was done by an approximation of the glanular wings using 6-zero polyglactin mattress sutures. Byarsization of dorsal foreskin and its subcutaneous tissue can be used to cover the new urethra (Figure 9).

Skin closure and 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-N-butylbromid 0.5 mg/kg/dose can be used to prevent bladder spasm. Camphor oil syrup in the therapeutic dose was used to prevent penile erection (10 mg/kg/day orally).

Follow up is done. 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.

Results

Fifty male patients with different types of proximal hypospadias (the urethral meatus is proximal penile, penoscrotal or scrotal); these patients underwent surgical repair using the tubularized incised plate urethroplasty and Modified Koyanagi repair have been studied during the period between 2010 and 2012 at Pediatric Surgical Units, Al-Azhar University Hospitals (Cairo & Damietta). Their ages ranged from 10 to 96 months (mean age of 32 months).

We divided the patients and randomized into two groups:

Group A; 30 patients were operated upon using the tubularized incised plate urethroplasty and Modified Koyanagi repair technique for repair of their hypospadias deformities.

Group B; 20 patients were operated upon using the modified Koyanagi technique for repair of their hypospadias deformities.
As regards the shape of the penis, 10 cases (20%) had no deformity with the external meatus at levels of proximal shaft of the penis. 40 cases (80%) had chordee.

Technical considerations: One type of suture material was used for urethroplasty polyglactin 6/0 over a rounded 13 mm needle. In all cases of group A the repair was done in two layers; the first one was subcuticular and the second was interrupted sutures. In all cases of group B the repair of inner edges of flaps was done in continuous suture; the repair of outer edges of flaps was done in subcuticular suture. The second layer was dartosfascial flap in 10 cases (20%), while the second layer was cremastro-tunica vaginalis flap in 40 cases (80%). In all cases no penile rotations were encountered following ventral reflection of the flap (Dartos fascia or Cremastro-tunica vaginalis flap) toward the urethral repair. The distal meatus was formed wide enough to guard against meatal stenosis. Glanulo-meato-plasty was done in two layers by polyglactin 6/0 over 13 mm rounded needles. In TIPU the neo-meatus was sutured only by one suture on both sides at 5 and 7 o’clock to guard against crust formation (Tables 1–4).

The meatal stenosis developed in 5 cases within the first post-operative month and improved by regular urethral dilatation by urethral catheter 6–8 Fr., twice weekly for 2 months. The meatal stenosis was more in group A than B. Earlier post-operatively 4 cases (8%) had a complete failure by infection which appeared in the 5th post-operative day and was severe from the start. Fistula occurred in 18 cases (36%), small temporary fistula occurred in 2 cases (4%) and big fistula occurred in 16 cases (24%). Small temporary fistulae were noticed on the 10th postoperative day, just distal to the original meatal site, mild infection leading to the appearance of fistula. Spontaneous closure of the two temporary fistulae occurred within one month without any other consequences. The big fistulae were closed surgically without recurrence using V–Y flaps technique. The fistula rate was more in group A than B.

All patients were seen after 2 weeks, one month, 3 months and after 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 Figures 10 and 11.

Discussion

Hypospadias reconstruction remains one of the most challenging fields of surgery. The goal of hypospadias repair is to reconstruct the urethra and the penis to obtain both normal function and appearance, with as few complications as possible, while minimizing the need for multiple surgeries.12

The present study was done on 50 patients with different types of proximal hypospadias at the Pediatric Surgery Unit, Al-Azhar University Hospitals (Cairo & Damietta). These patients underwent surgical repair using the tubularized incised plate urethroplasty and Modified Koyanagi repair.

| Table 1: Comparison between group A and group B as regard age, degree of hypospadias, associated anomalies, operative time. |
|---------------------------------|---------------------------------|
| Age (mean ± SD); range | Group A (TIP) | Group B (MK) |
| Degree | (31.20 ± 13.41); 10-66 | (33.20 ± 21.82);100-96.0 |
| Proximal shaft | 12(40.0%) | 7(35.0%) |
| penoscrotal | 14(46.7%) | 10 (50.0%) |
| scrotal | 4(13.3%) | 3 (15.0%) |
| Associated anomalies | | |
| UDT | 2(6.7%) | 3(15.0%) |
| CIH | 3(10.0%) | 1 (5.0%) |
| Penoscrotal transposition | 2(6.7%) | 1(5.0%) |
| No associated anomalies | 23(76.7%) | 18(75.0%) |
| Op. time (mean ± SD); range | (83.30 ± 6.51); 60-90 | (158.25 ± 22.78) 90-190 |
| H. stay (mean ± SD); range | (9.56 ± 1.73); 7-14 | (11.18 ± 2.26) 10-14 |

| Table 2: Comparison between group A and group B as regard success rate. |
|---------------------------------|---------------------------------|
| Success rate | Group A (TIP) | Group B (MK) |
| Success | 21(70%) | 12 (60.0%) |
| Complicated | 9 (30.0%) | 8 (40.0%) |

| Table 3: Complications of TIPU repair (group A). |
|---------------------------------|---------------------------------|
| Complication | Group A |
| No | % |
| Fistula | 10 | 33.3% |
| Infection | 4 | 13.3% |
| Stenosis | 4 | 13.3% |
| Disruption | 2 | 6.7% |
| Hematoma | 1 | 3.3% |
| Contracted scar | 0 | 0.0% |
| Penile torsion | 0 | 0.0% |

| Table 4: Complications of MK repair (group B). |
|---------------------------------|---------------------------------|
| Complication | Group B |
| No | % |
| Fistula | 8 | 40.0% |
| Infection | 4 | 20.0% |
| Stenosis | 1 | 5.0% |
| Disruption | 2 | 10.0% |
| Hematoma | 1 | 5.0% |
| Contracted scar | 1 | 5.0% |
| Penile torsion | 1 | 5.0% |
The highest ages of presentation caused many postoperative difficulties in controlling the child’s activity; and his emotional disturbance caused by dressing and stent removal. These results are consistent with those of Belman 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.

Emir performed the modified repair on patients with a mean age of 12.5 months. However Koyanagi performed his repair on patients with a mean age of 3.7 years, which is higher than our group.

Hayashi and Sugita also performed Koyanagi repair on patients with severe forms of hypospadias. Elhalaby [17] performed one–Stage Repair of Severe Hypospadias: In our series, we performed the one stage modified Koyanagi repair for 20 cases with proximal forms of hypospadias. This is in agreement with all studies using this repair as it was mainly devised for severe forms of hypospadias.

As regards the hospital stay, In the series of Elder and Duckett, they believed that limiting the length of in-hospital stay not only minimizes the cost, but also decreases the cross infection with no resultant increased morbidity. In this study the patients were kept for 7–14 days as the catheter was removed after 7–10 days of surgery, to evaluate the operative sequelae and detect any complication early.

In the present work, operative time ranged between 60 and 190 min with a mean of 113.28 ± 40.02 min with a statistically significant decrease in operative time in group A in comparison to group B (83.30 ± 6.51 vs. 158.25 ± 22.78 min, respectively). In Elhalaby EA. literature the operative time was 150–210 min.

Regarding the relation between success and degree of hypospadias, it was found that, success was more associated with a proximal penile degree than the penoscrotal degree, while complications were associated with the penoscrotal, more than the proximal penile with a significant difference in total studied children. The same distribution was observed in groups A and B, but the difference was statistically insignificant.

Regarding to the success rate, the results of the present study demonstrates that there is a non-significant increase in the total number of successful repairs in patients with hypospadias who were repaired by TIP than those repaired by MK operation. the total number of successful repairs in patients repaired by TIP was 21 out of 30 (70%), while, in MK the total number of successful repairs was 12 out of 20 (60%) and this is statistically non-significant.

These results are comparable with those reported by many authors in other similar studies. TIP urethroplasty was done by Snodgrass and Lorenzo in 33 cases of fresh proximal hypospadias. Complications were noted in 11 (33%) boys 7 of whom had recurrent fistulae, and 2 patients had recurrent hypospadias with recurrent penile curvature. There was one meatal stenosis and one short neourethral structure.

Hafez reported that the overall success rates of TIP procedure were 89–94.3% in proximal hypospadias repair.

TIP urethroplasty was done by Ismail Kh in 13 cases of fresh and recurrent proximal hypospadias. Complications were noted in 5 (38%) boys.

The modified Koyanagi technique was applied over 30 cases of proximal hypospadias in Elsaied et al. series. Primary success occurred in 27 (90%) and the overall complication rate was 10% (3 cases). These results are superior to results of Koyanagi and colleagues who reported complication rates 47% [22]. Glassberg and others reported a 50% complication rate. This is attributed to the modifications of the technique which improved the blood supply to the flap and decreased complication rates.

Koyanagi performed his repair for 70 cases over a period of 10 years. 33 cases (47%) developed complications. All cases had severe hypospadias.

Emir performed the modified Koyanagi technique on 20 patients with proximal hypospadias over a period of 7 years. However they modified the technique in a brilliant manner aiming for better results. They reported a total complication rate of (30%) in 6 patients. Sugita performed a modified Koyanagi technique for 151 patients with severe hypospadias. He reported an overall complication rate of (17%), 25 cases. These relatively better results were due to the modifications devised by the authors to increase the blood supply to the neourethra.

Hayashi performed the modified Koyanagi repair on 20 patients with severe hypospadias. They reported a total complication rate (30%). Elhalaby reported that the overall success rates of modified Koyanagi procedure on patients with severe forms of hypospadias were 63.63%.
The higher success rate in both our recent group of patients and a similar series of modified Koyanagi technique is believed to reflect the impact of preservation of the lateral blood supply to the skin flaps and not to rely entirely on the microvasculature emanating from the region of the urethral meatus and its surrounding corpus spongiosum.

For reduction of fistulae in hypospadias surgery, reinforcement interposition layer is mandatory. The mechanism of action of the interposition layer is multi-factorial: acting as a mechanical barrier, preventing suture line superimposition and providing mechanical support.

Our opinion in a high percentage of complication rate is due to the presence of 2 suture lines and the long distance of the tubularized neo-urethra. To improve the surgical success rate and reduce the fistula in hypospadias surgery, it was critical to use the denuded skin, dartos or buck’s fascia or tunica-vaginalis to protect the neo-urethra as a second interposition layer according to each case.

The use of a second layer covering the urethroplasty repair was a routine maneuver in our series. The second layer was a dartosfascial flap in 10 cases (20%), while the second layer was a cremastro-tunica vaginalis flap in 40 cases (80%).

As regards regular dilatation of the neo-urethra, Snodgrass and Lorenzo suggested one calibration after 6 months from the repair in all patients who are not toilet trained and therefore unable to co-operate with uroflowmetry. The decision to calibrate at this time coincides with the last scheduled visit in our current protocol for a routine follow up and is supported by our results.

In our series, regular dilatation was done twice weekly for only 5 cases who complained of marked urethral stenosis with straining. Calibration was done for the remaining cases to assess the neo-urethral caliber by the gentle passage of a well lubricated sound.

Koyanagi stated that the indwelling urethral catheter should be left for 15 days.15 Emir and Sugita16 removed the urethral catheter after 8 days. In our study the mean catheter stay was 8.8 days. We believe as they did that the longer the catheter stay, it may induce complications rather than benefit the repair.

Conclusion

TIP and modified Koyanagi repair techniques could be considered as acceptable and as effective as each other for hypospadias repair, provided that a good selection of cases for each type of repair was achieved. The tubularized incised plate (TIP) urethroplasty is a reliable one stage procedure in dealing with proximal hypospadias either without or with a mild degree of chordee if the urethral plate is supple and wide enough for tubularization, while MK is a reliable one stage procedure in severe degree of chordee, small sized penis or with narrow urethral plate.

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