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| RESEARCH ARTICLE

One Stage Modified KOYANAGI-HAYASHI Technique with Tunica Vaginalis Intermediate Layer for Severe Hypospadias Surgery

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| ABSTRACT

Introduction: In recent years, the modified Koyanagi-Hayashi technique has attracted considerable interest due to its satisfactory results and low risk of major postoperative complications for the patient during surgery for severe hypospadias. The aim of this work is to evaluate this technique and compare our results with those of other research series. Materials and methods: A single-center prospective study of an inhomogeneous series of 32 children with proximal hypospadias and a mean age of 44 months was operated on by the same surgeon using the Koyanagi-Hayashi technique. Preoperative hormonal stimulation with testosterone was indicated in 17 children. The tunica vaginalis was used as the urethroplasty covering plane for all patients. Functional results were assessed, and a questionnaire was completed to evaluate the functional and aesthetic satisfaction of the parents and the surgeon. Results: Complete curvature of the penis was obtained in all patients except 2, who retained a minimal curvature, not requiring surgical correction at this time. There were 6 cases of urethral fistula, 2 cases of total urethroplasty release, 2 cases of partial release, 9 cases of glanduloplasty release, one urethrocele, and 2 meatus strictures. Overall, the success rate after the first procedure was 31.20%, rising to 74.95% after the first repeat procedure and 84.32% after the second. The result was very satisfactory for the parents at 84.37% and satisfactory at 15.62%. Conclusion: The Koyanagi technique modified by Hayashi is a good alternative for severe forms of hypospadias. Correction of the curvature of the penis is generally achieved without further procedures, and the aesthetic result is generally satisfactory. Using the tunica vaginalis as an intermediate plane to cover the urethroplasty has greatly reduced the rate of serious complications. The complication rate is high, and parents need to be aware of the risk of repeat surgeries. But these complications are always easy to manage.

| KEYWORDS

Hypospadias, Koyanagi-Hayashi, Uretroplasty, Tunica vaginalis flap.

| ARTICLE INFORMATION

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1. Introduction

Reconstructive surgery for proximal hypospadias continues to be a challenge for pediatric urologists. The surgical techniques described are numerous, and the long-term results published for each of them are inadequate, making objective assessment of hypospadias surgery difficult.

The Koyanagi technique [2018] has attracted attention over the last three decades due to its logical flap design, but it was initially not widely used due to its high complication rate. Since then, numerous modifications have been introduced with improved surgical results. However, little research has been carried out on the use of this method.

In our department, we used the modified Koyanagi-Hayashi [2024] for the single-stage repair of severe hypospadias since 2016. The aim of our work was to evaluate this technique, its indications and results in a pediatric population operated on for proximal hypospadias using the modified Koyanagi -Hayashi technique.

2. Patients and methods

This is a prospective descriptive non-randomized analytic study of an inhomogeneous series involving 32 patients hospitalized and operated on for proximal hypospadias during the period from January 15, 2017, to January 15, 2020.

2.1 Surgical technique

Hayachi's modified Koyanagi technique can be described as a two-stage repair performed in a single step.[Hayashi, 2014].

2.2 Installation

The procedure is performed under general anesthesia with a caudal block in the supine position. Careful examination of external genitalia. Measure penis size, glans width, and urethral plate width. Erection test (intra-cavernous injection of physiological serum using a grey intra-null after placing a tourniquet at the root of the penis): measurement of curvature.

2.3 Exposure of the penis

A 4/0 prolene thread is placed at the glans and acts as a tractor with two others on either side of the dorsal surface of the foreskin. In cases where the meatus is scrotal, another traction wire is added at a scrotal level to better expose the urethral plate.

2.4 Incision markers

Marking is done with a sterile dermographic pencil and begins by circumscribing the meatus at its U-shaped base and extending on either side parallel to the "virtual" scrotal median raphe, then following the preputial external border in order to have a skin flap of good width (minimum 8mm) as it will form the base of the lateral parametrial flap.[Youssef, 2018].

A circumferential marking is made at the base of the glans, leaving a 5mm mucosal flange (Figure 1). [Youssef, 2018]. A dorsal incision with an ophthalmic scalpel 5mm from the balanoprepucial groove. This incision joins the ventral part of the penis to sever the hypoplastic urethral plate.

2.5 Curvature treatment

Complete undressing of the penis with complete resection of the fibrous hypoplastic tissue usually allows correction of the penile curvature.

2.5.1 Second artificial erection test.

If the curvature persists beyond 15°, 3 transverse corporotomies are performed, according to Pippi Salle.[Pippi Salle, 2024].

2.6 Dissection of the flap and creation of a new urethral plate

A U-shaped skin incision is then made around the meatus to extend the skin along the marked line. This second incision is extended laterally and dorsally over the dorsal foreskin, approximately 8 mm parallel to the first incision. The incised line of the dorsal foreskin is joined at the 12 o'clock position. This loop-shaped skin is used to create a new urethra. Subsequently, the portion between the foreskin and the dartos is dissected dorsally. The pedicle of the neourethra is dissected sufficiently down to the base of the penis. A buttonhole is cut through the pedicle of the flap to allow the glans to pass through.

The parameatal skin and its vascular pedicle are mobilized towards the ventral side of the penis, maintaining the shape of the loop. The inner side of the loop is then closed on the midline with a 6/0 PDS thread overlock, taking up the albuginea (Figure 3).

2.7 Urethroplasty

The 2 flaps are tubularized on a siliconized bladder catheter (CH8) without ballooning by single-stitch PDS 6/0 round needle N93 (Figure 4). The glans are divided along the midline to create wings. The meatus is brought to the tip of the glans. The wings are close together. Covering the urethroplasty with an interposed vaginal flap (Figure 5).

2.8 Skin covering

Dorsal skin flaps are used to cover the penis using the Byars procedure (Figure 6).

2.9 Bladder drainage

Bladder drainage via a suprapubic catheter is recommended for perineal forms, in which case the catheter is left in place for 3 weeks.

2.10 The dressing

The penile dressing is important to keep the penis straight at rest, avoid oedema, reduce post-operative discomfort, and prevent trauma.

We have a standard dressing for any surgery on the penis, securing the penis with a stitch of 4/0 prolene thread on the anterior wall of the pubis, then applying an antibiotic-based ointment + hyaluronic acid to promote healing, followed by sterile compresses and a compression dressing.

This dressing is changed on the 5th postoperative day and removed on the 10th day. (Figure 7). This semi-compressive bandage prevents painless trauma, is easy to remove, and allows the child to move freely.

2.11 Surgical procedures associated with urethroplasty

A laparoscopic orchidopexy is used for non-palpable testicles, and a conventional inguinal approach is used for palpable testicle treatment of other pathologies of the peritoneovaginal canal.

2.12 Antibiotic therapy

A third-generation cephalosporin, such as cefotaxime, was prescribed in all cases.

2.13 Post-operative follow-up

Check-ups are carried out every day during hospitalization, at 30th days post-operatively for a primary assessment of complications, and at 6th months post-operatively for a definitive assessment and decision on repeat surgery if necessary (Figure 8).

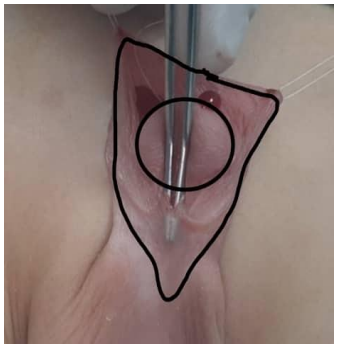

Figure 1: Incision markings

Figure 2: Appearance after internal and external incisions

Figure 3: Appearance of the two joined shutters

Figure 4: Urethroplasty

Figure 5: Vaginal coverage of urethroplasty

Figure 6: Byars skin overlay

Figure 7: Dressing

Figure 8: Final cosmetic appearance

3. Results

The present study involved 32 patients with proximal hypospadias treated surgically using the Hayachi-modified Koyanagi technique. The mean age at surgery was 43.19 months, with extremes ranging from 18 to 168 months. We noted that 46.8% of our patients (15/32) underwent surgery before the age of 3. The location of the meatus was posterior penile in 10 patients, scrotal in 16, and perineal in 6.

All patients had a curvature of the penis (100%(with deferential degrees; 6 boys (18.7%) had a curvature less than 15°, 7 boys (21.8%) had a medium curvature between 15°- 45° and 19 boys (59.3%) had a severe curvature greater than 45°. Scrotal bifdity was found in only one patient, and scrotal transposition in 10, all of which were corrected at the time of surgery.

In our series, there were 11 cases of cryptorchidism, 8 cases of bilateral cryptorchidism, 2 cases of left cryptorchidism, and only 1 case of right cryptorchidism. None of the patients had previously undergone hypospadias surgery. All patients underwent genetic, hormonal, and radiological investigations.

The etiological investigation was in favour of a normal hormone dosage in 14 cases, partial androgen insensitivity in 10 cases, partial gonadal dysgenesis in 4 cases, and suspected 5α reductase deficiency in 4 patients, hence the interest in molecular biology. Hormone therapy was indicated in 17 patients with micropenis (penis size less than 2.5 DS according to the Schönefeld curve for age).

The molecule used was testosterone enanthate (intramuscular injection of 100 mg/m^2 every month for 3 to 4 months, depending on response). The surgical procedure lasted 120 and 210 minutes, with an average of 145.29 minutes. Total length of stay ranged from 7 to 13 days, with an average of 10.9 days.

3.1 Post-operative evaluation (6 months)

Severe complications are defined as those requiring total or partial revision of the urethroplasty.

The overall rate of severe complications in our series was 40.63% (13/32) of patients, divided into 2 cases of total urethroplasty release,2 cases of partial release,1 single case of urethral diverticulum and 2 cases of residual curvatures. Simple complications in our series were urethral fistulas observed in 6 cases and 2 cases of urethral meatus stenosis.

In all, after the first operation, repeat surgery was indicated in 22 cases (68.75%). (Table 1)

Table 1: Distribution of patients by indication for revision

Indication of trade-in	Workforce	Percentage (%)
Isolated fistula	6	8.7%
Glanduloplasty release	9	28.1%
Partial release	2	6.25%
Total release	2	6.25%
Meatus stenosis	2	6.25%
Ureterocele+ diverticulum	1	3.1%
Total	22	68.75%

3.2 Final result

In our series, the overall success rate after the first operation was 32.20%. This rate rises to 71.82% after the first repeat and reaches 84.32% after the second repeat. The location of the meatus was apical in 59.37% of cases, proximal glandular in ,%25and balanoprepucial in 15. %62(Table 2).

Cosmetic appearance was highly satisfactory in all patients (Figure 7)

Table 2: Distribution of patients according to the location of the meatus.

Seat of the meatus	Workforce	Percentage (%)
Apical meatus	19	59.37%
Proximal glandular meatus	8	25%
Balanoprepucial meatus	5	15.62%
Total	32	100%

3.3 Residual curvature

Total curvature of the penis was achieved in 30 patients, although two patients retained a residual curvature estimated by the operator to be minimal <10° and not requiring revision surgery.

3.4 Urinary stream abnormalities

Two (2) patients with a balanoprepucial meatus retained a slightly dispersed urine stream.

4. Discussion

Hypospadias is one of the most common congenital malformations [Yoo, 2024] of neonatal diagnosis, affecting between 0.3% and 0.8% of new male births[Hadidi, 2003; Loane, 2011].

The European Surveillance Of Congenital Anomalies (EUROCAT) revealed that the incidence of hypospadias increased in Europe between 1999 and 2008 [Loane, 2011].

Proximal hypospadias account for 15-20% of hypospadias cases [Loane, 2011]. In our series, the rate of proximal hypospadias was 23. %11compared with all types of hypospadias seen in consultation.

In Algeria, it seems difficult to give even an approximate figure for the frequency of hypospadias. A multicentric study based on data from systematic examinations of all newborns would give an idea of the incidence of this malformation.

In 1984, Koyanagi et al. [2018] reported their technique, which seemed applicable to all types of proximal hypospadias. This description was innovative and fulfilled many of the criteria for predictable surgical results.

It is highly applicable for severe proximal hypospadias, as it ensures that there will always be enough skin for the neourethra. This is a one-stage procedure, mobilizing all the tissues forming the sapper apron on the ventral and lateral aspects of the penis.

Primary evaluation at 1 to 6 months revealed a complication rate of 68.%75, close to that of SB Youssef [2018] and De Mattos [2009] and lower than Arnaud [2011] but still a long way from the rate described in the El seid series [2010].

Meatus recoil was the most frequent complication in our series, with a rate of 43.75%, secondary to either glanduloplasty loosening or partial or total urethroplasty loosening.

Arnaud et al. [2011] reported that the meatus recoil rate was 33% in his series, while De Mattos e Silva [2008] revealed that 42.3% of his patients (n=26) had partial urethroplasty release.

The modified Koyanagi technique appears to be less prone to uretroplasty release, as shown by Catti et al. [2009] in their comparative study, where the release rate was 19.35% in the modified technique versus 42.5% in the original technique.

The receding meatus can be corrected by repeat urethral reconstruction using the Duplay technique (4 cases in our series) or the Mathieu technique (5 cases in our series).

Among patients who developed complications, 21.87% were found to have a urethral fistula at primary assessment.

This rate is higher than that found by Elsaied et al. [2010] in their study of 30 patients operated on for proximal hypospadias using the Koyanagi technique.

Catti et al. [2009], in their comparative study of patients operated on using the original (G1) and modified (G2) Koyanagi technique, showed that the fistula rate was higher in group 2 (38.7%) than in group 1 (19.2%), with a more distal location.

Our therapeutic approach to urethro-cutaneous fistulas has always been to resect the fistulous pathway, then to avivate the edges of the fistula and close it in two or three planes.

If available, it is better to cover with a flap of the tunica vaginalis to avoid recurrence. The urethral diverticulum was found in only 1 case (2.85%) in our series associated with a urethrocele; this rate is significantly lower than that published by De Mattos e Silva 26.9% (7/26 cases) [2009] and Catti et al. 21[2009].%1.

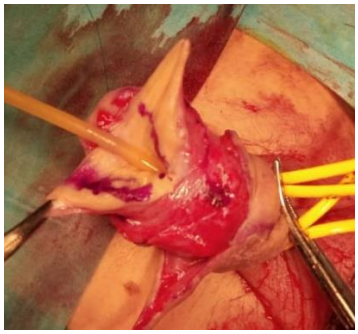

Figure 9: Uretrocele resection

It is recommended that the urethroplasty be performed using a highly vascularised tissue such as the tunica vaginalis. The tunica vaginalis helps to limit mucosal distension and prevent diverticula formation since the length of the neourethra and variations in compliance between the original urethra and the neourethra could explain this complication.[E-Silva, 2009]. (Figure 9).

Catti et al. [2009] consider that Koyanagi's original technique is less prone to urethral diverticulum, as the strip of skin left between the ectopic meatus and the glans constitutes a solid plane, whereas the modified technique results in a richly vascularized cover flap, but with a superfluity that makes coverage of the urethra much looser.

In our work, the tunica vaginalis is the intermediate plane of choice and was used in all 32 cases. In this group, only one patient developed a fistula, with no cases of partial or total release. On the other hand, glanduloplasty release was still significant on 9/32. Lei Kang [2016] published in 2016 a series of 24 patients with severe hypospadias operated on between February 2012 and January 2015 using the modified Koyanagi technique, and he used the tunica vaginalis as an intermediate plane to cover the urethroplasty.

There were 5 patients (20.8%) who developed complications: 4 patients (16.7%) developed a fistula, and 1 patient (4.2%) developed urethral dehiscence. No urethral stenosis, meatal stenosis, or urethral diverticulum were reported. Additional coverage of the neourethra with a pedicled flap of the tunica vaginalis significantly reduced the rate of fistulas and discharges.

Whatever the cause of the reconstruction failure, the principles of revision surgery remain identical to those of the initial surgery. The three essential stages of this surgery are:

-Correction of residual curvature.
-Urethroplasty to obtain an apical meatus.
-Reconstruction of the ventral surface of the penis.

There is no standard technique for this type of surgery. It all depends on the anatomical situation [Helfaer, 2024]. In our series, the overall success rate after the first operation was 32.20%. This rate is close to that reported by Catti et al. (38.5%).[2009] and De Mattos Silva et al. (38.5%) [2009]. This rate rises to 71. %82after the first repeat and reaches 84. %32after the second repeat. Hassen et al. [2014] reported a fairly high first-time success rate of 88.6% (39 cases).

5. Conclusion

The modified Koyanagi technique is one of a multitude of procedures available for surgery of proximal hypospadias and has made it possible to perform two-stage surgery in a single operation. Correction of the curvature of the penis is usually achieved without further procedures, and the aesthetic result is generally satisfactory. The complication rate is high, and parents need to be made aware of the risk of revision surgery. But these complications are always easy to manage.

Conflict of interest: None

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