



The slit-like adjusted Mathieu technique for distal hypospadias

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Abstract

Purpose: The aims of this study were to describe the slit-like adjusted Mathieu technique (SLAM) for distal and midpenile hypospadias and report the midterm follow-up.

Materials and Methods: Between January 2005 and December 2009, the SLAM technique was performed in 923 patients. The key modification is the design of a converging incision and the technique of suturing. Patient age ranged between 4 months to 30 years (mean, 1.5 years). The records of 872 patients who maintained regular follow-up were reviewed. The technique was performed in all forms of distal hypospadias, regardless of the size of the glans or the degree of glans clefting. Cutaneous chordee was corrected by skin mobilization. Follow-up period ranged from 22 months to 6 years (mean, 38 months). A transurethral catheter was used for 1 to 3 days.

Results and Complications: Satisfactory results were obtained in 848 patients (97%). Fourteen patients developed fistulae. Four patients developed meatal stenosis. Six patients had wound dehiscence.

Conclusions: The SLAM technique is a reliable technique for correction of distal and midpenile hypospadias with persistent good results. It avoids the drawbacks of the classic Mathieu (a transverse rounded meatus that is not terminal). Multiple-layer closure and careful attention to technical details contributed to a 3% complication rate in primary distal hypospadias.

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The Mathieu technique [1] has withstood the test of time for 80 years, with a study that reported a success rate of 100% in 204 consecutive patients [2]. The major drawback of the original Mathieu technique is the final appearance of the meatus (a fish-mouth meatus that is not at the tip of the glans). The technique has become less

popular during the past 15 years in favor of the tubularized incised plate (TIP) technique partly because of the slit-like meatus that could be achieved with the TIP technique [3].

The author has been performing a modification of the Mathieu technique since 1986. There has been continuous evolution and modifications through the years from Y-V modified Mathieu (1992–2002) [4,5] and inverted Y-V modified Mathieu (2003–2004) to the slit-like adjusted Mathieu (SLAM) technique, since 2005. The aim is to use the optimum operation that consistently produces good

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functional as well as cosmetic outcome (slit-like meatus) of the penis with a low complication rate.

1. Patients and methods

The SLAM technique was performed on 923 patients with distal and midpenile hypospadias from January 2005 to December 2009 after obtaining the approval of the institutional ethics committee. Fifty-one patients were lost to follow-up, and the remaining 872 patients constitute the present cohort for this report. Patients' age ranged from 4 months to 30 years (mean, 1.5 years).

For the purposes of the study, distal hypospadias includes all types of hypospadias where the meatus lies distal to the midshaft. The reason is to avoid the hair-bearing scrotal skin. The morphology of the hypospadiac penis and associated anomalies are summarized in Table 1. Patients with severe deep chordee distal to the hypospadias meatus or with complicated distal hypospadias were not included in the present study.

2. Surgical technique

Under general anaesthesia and caudal block, a 4/0 nylon traction suture is placed through the tip of the glans. A tourniquet is applied at the base of the penis, and an artificial erection test is performed (Fig. 1).

2.1. Careful assessment of the penis is performed

If the native urethral meatus is narrow, it was incised proximally to create a wide spatulated meatus (107 patients). If the urethra proximal to the meatus was thin and paper-like, it was incised to reach a healthy urethral tissue covered with corpus spongiosum.

The degree of glans clefting (grooving) is evaluated. The limits of the final meatus are marked with the aid of an appropriate catheter according to the caliber of the proximal normal urethra and the age of the patient. If the glans is clefted (grooved), the lateral borders of the groove are marked and will constitute the roof of the neourethra. If the

glans is flat or small, a narrow strip (5 mm in width) is marked, allowing an adequate width of the glanular wings. A catheter of appropriate size (according to the caliber of the proximal urethra) is introduced into the bladder.

2.2. Flap design

The boundaries of the urethral plate are outlined. In patients with a globular flat glans, special attention was given to create large glanular wings, and the urethral plate could be outlined as narrow as 3 mm in width (Fig. 1A). The narrow urethral plate was compensated by a wider flap from the parameatal flap proximal to the meatus. At the distal end of the urethral plate, the 2 incisions converge toward each other to allow free mobility of the glanular wings to wrap around the neourethra to produce a slit-like meatus free of sutures (Fig. 1A).

Incision of the flap begins at the coronal sulcus using a scalpel or scissors and continued distally very deep into the glans to create large glanular wings. Proximally, the flap was elevated using sharp scissors taking care to include dartos fascia and part of the corpus spongiosum with the flap (Fig. 1B). The redundant epithelial dog ear is removed from the angle of the flap to reduce the chances of fistula formation at this common fistula site (Fig. 1C).

2.3. Urethroplasty

The flap is sutured to the tip of the glans, 2 mm from the distal end of the incision in the glans (Fig. 1D). The idea is to keep the meatal edges free of any sutures and to have a smooth, near-normal meatus. A continuous subcuticular running polyglactin 6/0 suture on a cutting needle was the standard suture for urethroplasty. The subcuticular suture is continued until the distal stitch is reached, and then the surgeon returns back with same suture as a running suture approximating the flap fascia to the depth of the glans and the shaft of the penis (double breasting). Thus, there will be a single knot for the whole 2 layers (Fig. 1E). In older children and adults, the author inserts a third layer with the continuous suturing approximating the wall of the neourethra to the glanular wings.

2.4. Meatoplasty and glanuloplasty

A small V is excised from the apex of the parameatal flap (Fig. 1E), and the 2 edges of the final meatus are sutured together to the center of the V, creating a slit-like meatus using a single 7/0 polyglactin stitch (Fig. 2). No other sutures are needed in the meatus. The glanular wings are closed using interrupted polyglactin 7/0 transverse mattress sutures. The remaining wound is closed using a continuous 7/0 polyglactin mattress stitch (Fig. 1G).

Table 1 Details of 872 patients who underwent the SLAM technique between January 2005 and December 2009

Location of the meatus	No. of patients
Coronal hypospadias	289
Distal penile hypospadias	508
Midpenile hypospadias	34
Megameatus intact prepuce	41
Total	872

2.5. Urinary diversion

A transurethral bladder catheter is left for 1 to 3 days, depending on the degree of swelling and the age of the patient.

2.6. Dressing

All patients had a standard dressing using gentamicin local ointment, gauze, and adhesive tape that compresses the penis, gauze, and catheter against the lower abdominal wall and allows free mobility of the patient [6]. The dressing was removed at the time of removal of the transurethral catheter, and the penis was left exposed. If the dressing became wet with urine or blood, the dressing was changed using the same standard dressing. Broad-spectrum antibiotics (second-generation cephalosporin) were used for 1 week. Paracetamol and ibuprofen suppositories and syrup were routinely used for analgesia.

The standard follow-up protocol in the hypospadias center included examination after 3 and 12 months and every 2 years till the age of 15 years. Patients living long distances away or who failed to attend the follow-up were contacted by e-mail and telephone. The follow-up period ranged from 22 months to 6 years (mean, 38 months). Results were assessed by an independent outpatient nurse. Results were considered satisfactory when the boy achieves an apical slit-like meatus at the tip of the glans penis, single forward stream, unimpeded voiding, good cosmesis, and no need for secondary surgery for the urethra. Uroflowmetry was performed in toilet trained children. Peak flow within 2 standard deviations was considered normal. Parent feedback was considered adequate in younger children.

Early in the study, the preputial dartos fascia was used to provide a second protective intermediate layer for the neourethra. Since 2007, this has been used only when the paramental flap was thin and the corpus spongiosum was hypoplastic and underdeveloped. The remaining skin of the penis and foreskin was fashioned to provide ventral skin coverage.

2.6.1. Important technical Tips

- The caliber of the neourethra was designed to be the same size or slightly larger than the normal proximal urethra. The standard protocol is to use a 10F catheter size or larger. The aim is to have a wide neourethra and meatus that is less liable to contract with healing and cause meatal stenosis. This is suitable for most children with hypospadias. In 6 patients included in the study, the proximal "normal urethra" could only take an 8F catheter size, and in those patients, an 8F catheter size was used.
- Occasionally, the hypospadias meatus is narrower than the normal proximal urethra because of the presence of a rather circular fibrous ring and should be incised to avoid stenosis at the proximal end of the neourethra as shown in Fig. 2B.
- Care must be taken to elevate Buck fascia and part of the corpus spongiosum with the flap because this constitutes

the main blood supply to the flap. In patients with proximal bifurcation of the corpus spongiosum, part of the corpus spongiosum was elevated with the proximal flap. In patients with hypoplastic or absent corpus spongiosum, the author used preputial dartos fascia or penile dartos fascia as a protective intermediate layer.

- When mobilizing the flap, one should hold the opposite skin edge and not the flap skin edge. This has 2 advantages, minimizing flap tissue injury and increasing the amount of subcutaneous tissue and fascia for a multilayer closure (Fig. 1B).
- The first step in the urethroplasty is to suture the distal end of the flap to the end of the glans 2 mm from the tip (Fig. 1D). This helps to have a slit-like meatus and place one stitch only at the meatus at the 6-o'clock position.
- The suturing of the urethroplasty should start few millimeters proximal to the original meatus. This helps to have the knot (a potential cause of fistula) proximal and away from the neourethra (Fig. 1E).
- Because suturing is performed in a continuous subcuticular manner, a cutting needle goes through the dermis easier as is the case with the classic subcuticular closure of skin incisions.
- The SLAM technique was used successfully in 30 patients with midpenile hypospadias. It is essential to avoid the scrotal hair-bearing skin. This was achieved by designing the flap with a curve from the midline to avoid scrotal skin (Fig. 3).

3. Results and complications

Satisfactory results were achieved in 848 patients (97%). Fourteen patients developed a fistulae; 4 were recognized within the first 2 months after surgery, 7 developed between 2 and 6 months, and 3 small fistulae developed after 2 years. The fistula was closed routinely after 6 months, and a second intermediate layer was always used to protect fistula closure. Four patients developed meatal stenosis between 2 and 6 months after surgery. Dilatation under anaesthesia and meato-plasty was performed in those 4 patients. Seven patients had wound dehiscence that was detected 2 to 3 weeks after surgery (and was associated with severe edema and infection). These 7 patients underwent a redo-SLAM after 6 to 8 months using a wider catheter and with 2 intermediate layers (Figs. 2 and 3; (Table 2)).

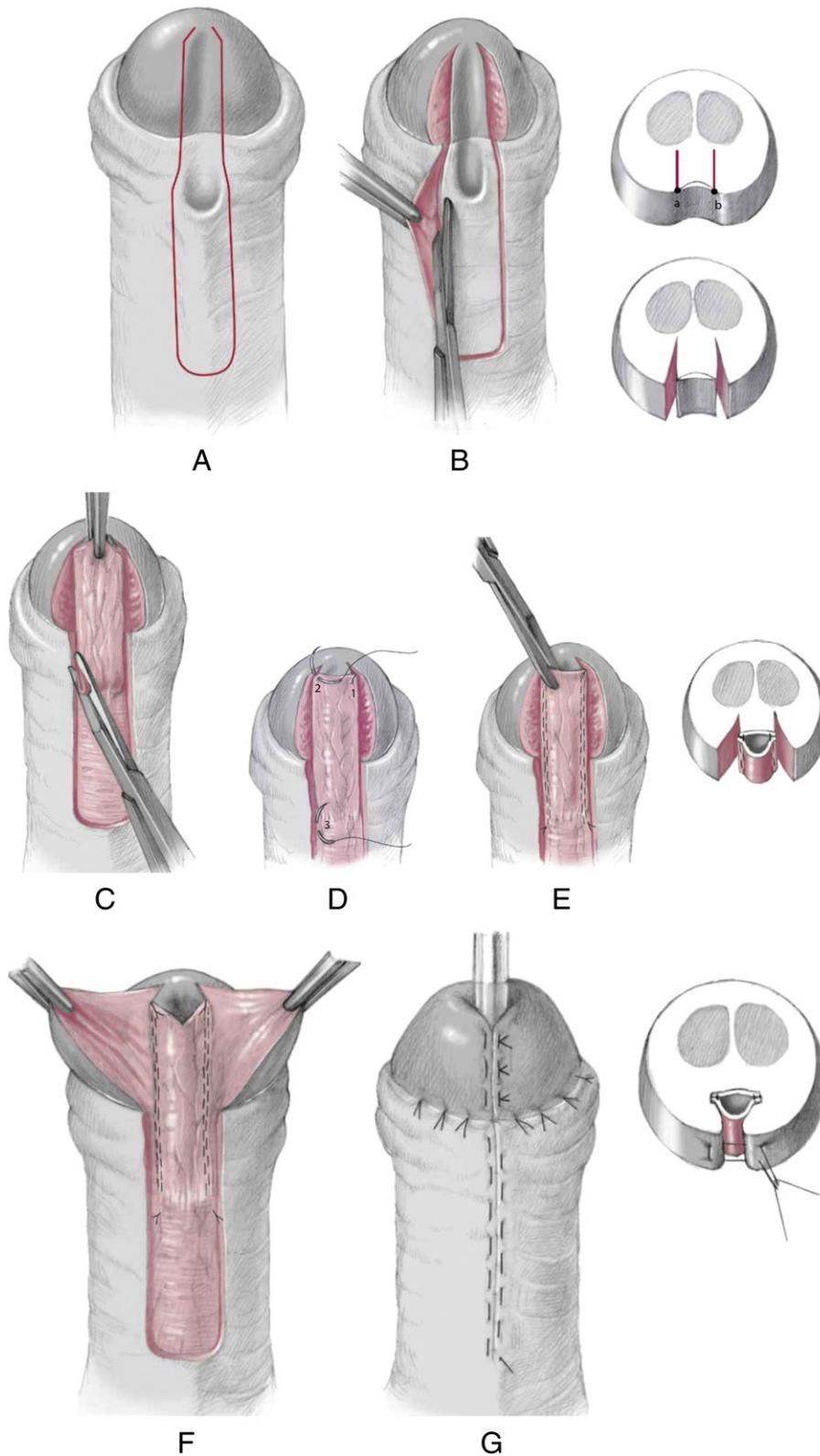
4. Discussion

The major drawback of the original Mathieu technique is the final appearance of the meatus (a fish-mouth meatus that is not at the tip of the glans). Several modifications were reported to deal with this drawback.

Barcat [7] in 1969 described the *balanic groove technique*. In addition to the classic Mathieu flap, he made a midline incision into the glans and buried the neourethra

deep into the glans trench, resulting in a slit-like meatus. He reported a complication rate of 20% in 267 patients. The technique was very popular in the 1980s and 1990s with very good results.

Rich et al [8] in 1989 described *hinging of the urethral plate* in combination of the Mathieu flap. This was modified later by Snodgrass [9] as the TIP technique. The hinging technique was revived again in 2008 by Aminsharifi et al [10].



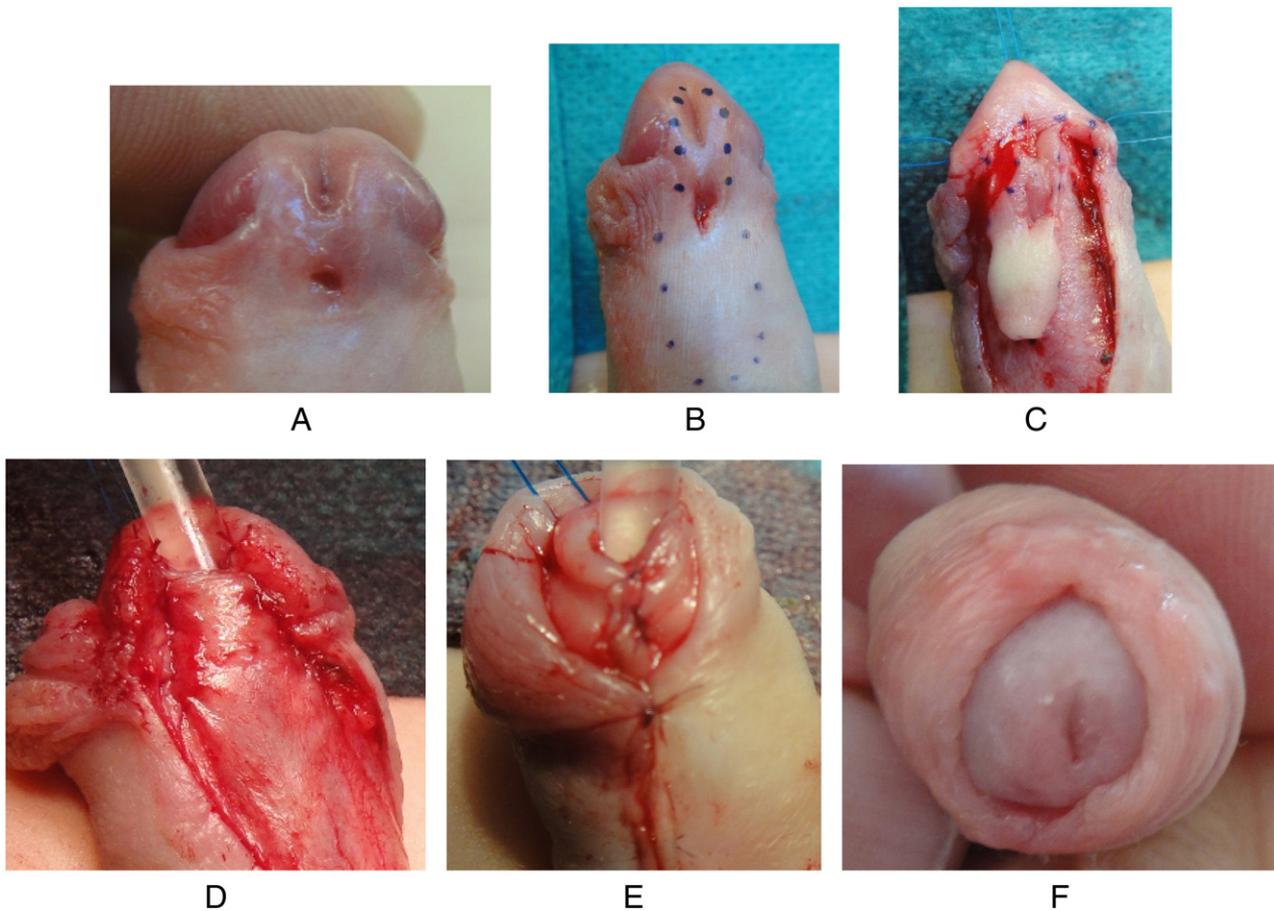


Fig. 2 Operative steps of the SLAM technique. A, Distal hypospadias: a 9-month-old child with distal hypospadias and incomplete cleft glans. B, SLAM technique design: the SLAM incision is outlined. Notice the converging lines distally and the wider flap proximal to the meatus. The stenotic meatus was incised to cut a fibrotic ring to accommodate 10F catheter. C, Flap mobilization: after deep incision of the flap, notice the large mobile glanular wings. D, Urethroplasty: the new urethra was reconstructed around a 10F catheter size, and “double-breasted” urethroplasty was performed. Notice the well-vascularized thick flap with maintained fascia and corpus spongiosum. E, Glans and skin closure: after closure of the glanular wings and penile skin. Notice that there is only a single knot at the new meatus (at the 6-o’clock position). The transurethral catheter was kept for 2 days. F, Final appearance: the final shape of the meatus and prepuce 1 year after surgery.

Hadidi in 1996 [4] described the *Y-V glanuloplasty modified Mathieu*. This technique has helped to use the Mathieu operation in all forms of hypospadiac glans in distal hypospadias and gives a wide terminal meatus at the tip of the glans. He reported a complication rate of 2% in 384 patients using this technique between 1992 and 2002 [5]. However, although the meatus was terminal, it was not slit-like.

In 2000, Boddy and Samuel [11] described the *MAVIS modification of Mathieu technique*, with 3% complication rate. In this technique, a triangle is excised from the apex of the parametalar flap. This helps to improve the appearance of the meatus. Tekant et al [12] applied the MAVIS modification to 32 patients. They reported a slit-like meatus and no fistula or stenosis in all 32 patients.

Fig. 1 The SLAM technique. A, The SLAM technique design: a U-shaped incision is outlined. The 2 parallel incisions at the glans region start along the true mucosal urethral plate to have large, wide glanular wings. At the distal end, the 2 incisions converge as shown to have a slit-like meatus and to avoid having sutures at the meatus. The 2 lateral incisions diverge near the meatus to produce a wide flap. B, Flap mobilization: using a sharp scissors, the incision is deepened starting near the coronal sulcus, the lateral skin edge (not the flap) is held with fine toothed forceps, and fascia and corpus spongiosum are included with the flap as much as possible. C, Angle epithelium excision: the epithelium at the proximal 2 angles of the flap is excised, maintaining the fascia. D, Urethroplasty: the edges of the flap are fixed to the converging edges of the urethral plate 2 to 3 mm from the distal end of the incision. Urethroplasty is carried out using 6/0 Vicryl on a sharp needle in a continuous subcuticular fashion starting 3 mm proximal to the angle of the flap. A sealing second suture line in a continuous fashion is carried out. E, V excision: a triangle is removed from the tip of the flap to help having a slit-like meatus. F and G, Glans and skin closure: the glanular wings are approximated around the new urethra, and the penile skin is closed. Notice that the new meatus has one stitch only at the 6-o’clock position. From Hadidi AT, ed. *Hypospadias Surgery*, 2nd ed. Berlin Heidelberg: Springer-Verlag. In press (with permission).

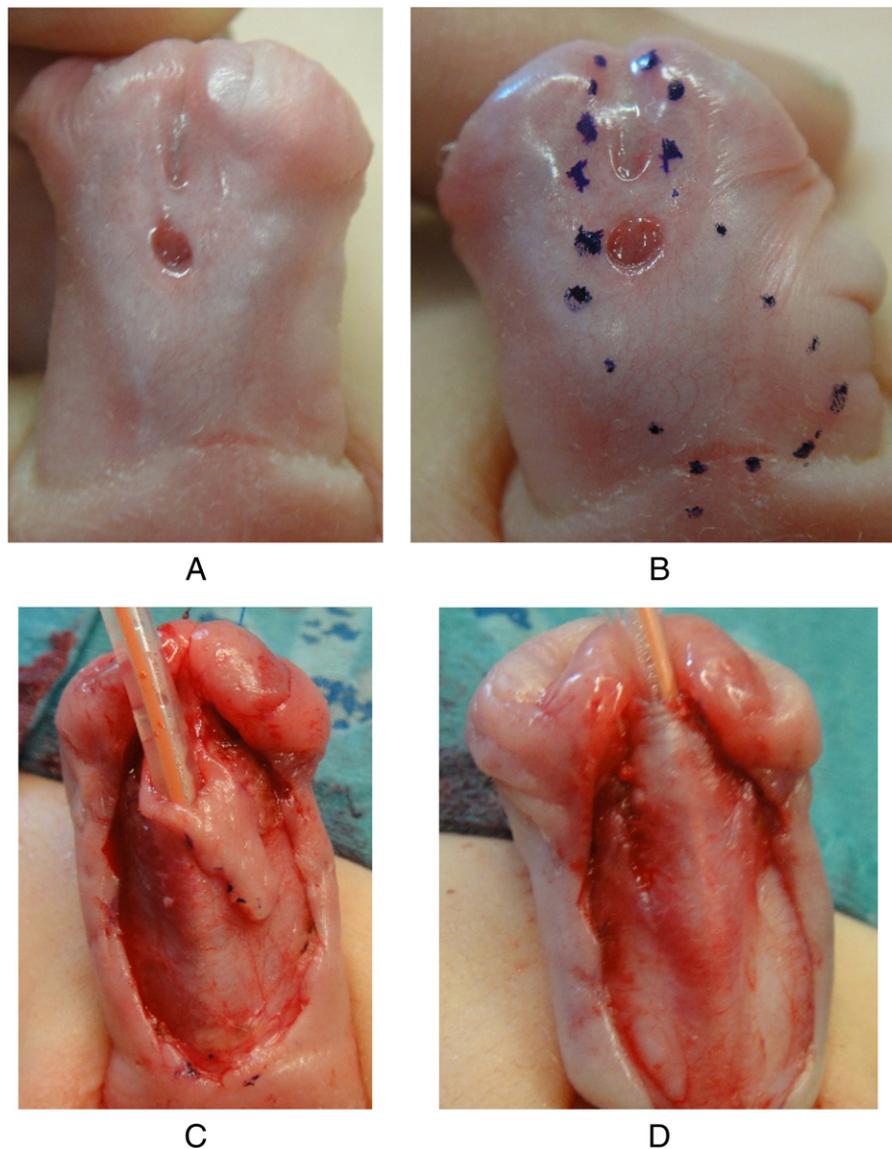


Fig. 3 The SLAM technique in midpenile hypospadias. A, Midpenile hypospadias: a 9-month-old child with midpenile hypospadias and incomplete cleft glans. B, SLAM technique design: the SLAM incision is outlined. Notice the converging lines distally and the wider oblique proximal flap curved to the left. C, Flap mobilization: after deep incision of the flap, notice the large mobile glanular wings. D, Urethroplasty: the new urethral was reconstructed around a 10F catheter size, and double-breasted urethroplasty was performed. Notice the well-vascularized thick flap with maintained fascia and corpus spongiosum. The transurethral catheter was kept for 3 days.

The SLAM technique was associated with a complication rate of 3%. Most complications occurred within the first 6 months after surgery, but 3 patients developed minute fistulae after 2 to 3 years. The SLAM technique

was performed on 47 patients older than 18 years. None of the 47 patients reported problems associated with hair growth inside the urethra. Longer follow-up period continuing after puberty is being carried out.

Incision of the urethral plate was first described by Reddy [13] in 1975, Orkiszewski [14], and Rich et al [8] and popularized by Snodgrass [9]. The technique has become increasingly popular in recent years partly because of the good cosmetic outcome, which can be achieved [3].

In the 1990s, a complication rate of less than 5% was to be expected in distal hypospadias [15]. Some studies suggested that a complication rate of the TIP technique less than 10% is to be expected [16]. However, some long-term follow-up studies of the TIP technique reported a complication rate

Table 2 Details of complications after the SLAM technique

Complications	No. of complications
Fistula detected within 2 mo	4
Fistula detected between 2 and 6 mo	7
Fistula detected after 6 mo	3
Wound disruption	7
Meatal stenosis	4
Total complications	25 (3%)

reaching 35% in distal hypospadias and 66% in proximal hypospadias [17].

Holland and Smith [18] showed that natural urethral plate configuration plays an important role in the higher complication rate reported with the TIP technique. Narrow and flat urethral plates are more susceptible to stenosis, despite incision and tubularization. Sarhan et al [19], in a prospective randomized study on 80 boys, concluded that a urethral plate of 8 mm or more was essential for a successful TIP repair. Others suggested that the size of the glans, rather than the different glans configuration (cleft glans, incomplete cleft, or flat glans), plays an important role in the incidence of complications [20]. On the other hand, these mechanisms are not involved in the Mathieu procedure. In fact, neourethra reconstruction with the Mathieu procedure is independent of urethral plate characteristics or glans configuration [21].

In a prospective randomized study, Aminsharifi et al [10] compared the standard TIP technique and Mathieu technique combined with incision of the urethral plate (a technique similar to that described by Rich et al [8]). There was a statistical difference between the 25% complication rate noted with the TIP technique and no complications with the Mathieu combined with urethral plate incision.

The SLAM technique was used in 41 patients with megameatus intact prepuce, and a second layer from the ventral preputial fascia was used. This resulted in a better cosmetic outcome, and neither meatal stenosis nor wound disruption was observed in this series as compared with the pyramid repair [22].

There is a misconception that the Mathieu flap has a poor blood supply coming from a narrow bridge at the base of the flap and that the Mathieu flap is a graft rather than a flap. This is not the case if the parametatal flap is elevated carefully with the underlying fascia and the highly vascular corpus spongiosum. In patients with hypoplastic corpus spongiosum, the flap should be augmented with intermediate vascular layer from the preputial or penile dartos fascia. Retik et al [2] reported a 100% success rate in 204 consecutive patients with the routine use of a protective intermediate layer.

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