

## Hypospadias repair and glans augmentation using a modified Mathieu technique

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### Abstract

**Purpose** To describe a modification in Mathieu (perimeatal-based flap urethroplasty) technique that incorporates glans augmentation into the procedure and is applicable for hypospadias patients with small glans and shallow urethral grooves.

**Patients and methods** Fifty-four children with primary hypospadias and small glans underwent either the new double-faced Mathieu (DF-Mathieu) technique (33 patients) or tubularized incised plate (TIP) procedure (21 patients). DF-Mathieu perimeatal-based skin flap was meant to cover the distance from urethral orifice to the tip of the glans and flip back to fill the gap between glans wings. Patients were followed up for 20 months (12–30). TIP group underwent the conventional procedure.

**Results** The mean age in DF-Mathieu and TIP group was 43.1 and 39.8 months, respectively. Post-operative results in DF-Mathieu group revealed one urethral fistula and no urethral break down or necrosis. In TIP group, there were one glans fistula (4.7%) and one meatal stenosis (4.7%). Overall success rate was 97% in DF-Mathieu and 90.5% in TIP operation. After 6 months, all DF-Mathieu patients had slit-like meatus and their cosmetic results were satisfactory.

**Conclusion** Double-faced Mathieu technique seems applicable in patients with shallow urethral grooves when TIP procedure may increase the risk of complications. Unlike its predecessor, this technique eliminates the tension on glans wing sutures and the risk of subsequent neo-urethral break down.

**Keywords** Treatment outcome · Hypospadias · Mathieu · Urethroplasty · Glanuloplasty

### Introduction

Despite the great surgical interest and over 300 surgical procedures for hypospadias repair, controversy continues over the ideal technique. Distal hypospadias is currently treated with acceptable success rates using one-stage repair methods, e.g., MAGPI (meatal advancement and glanuloplasty), TIP (tubularized incised plate), Thiersch-Duplay, Mustardé and Mathieu urethroplasty. The overall reported success rate for hypospadias repair ranges from 85 to 90% in proximal hypospadias to over 98% in glanular hypospadias [1–4].

Among current popular techniques for hypospadias repair, Mathieu technique (perimeatal-based flap urethroplasty procedure) is one of the oldest methods [5]. This technique with complication rate of less than 4% is used as an acceptable procedure for coronal hypospadias repair, and its complications mainly consist of urethrocutaneous fistula and meatal stenosis [5, 6].

In present study, we introduce a modification in Mathieu technique, namely, double-faced Mathieu (DF-Mathieu) procedure which is applicable in distal or mid-shaft hypospadias with shallow urethral groove, by incorporating glans augmentation technique into this procedure. While

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application of TIP procedure as the main preference in distal hypospadias repair is controversial in shallow glanular grooves, we hypothesized that our modification would eliminate the risk of fistula formation in such cases by harvesting a longer flap and flipping back its distal portion between the glans wings. This can eventually lead to a bigger glans and less tension over the neo-urethra.

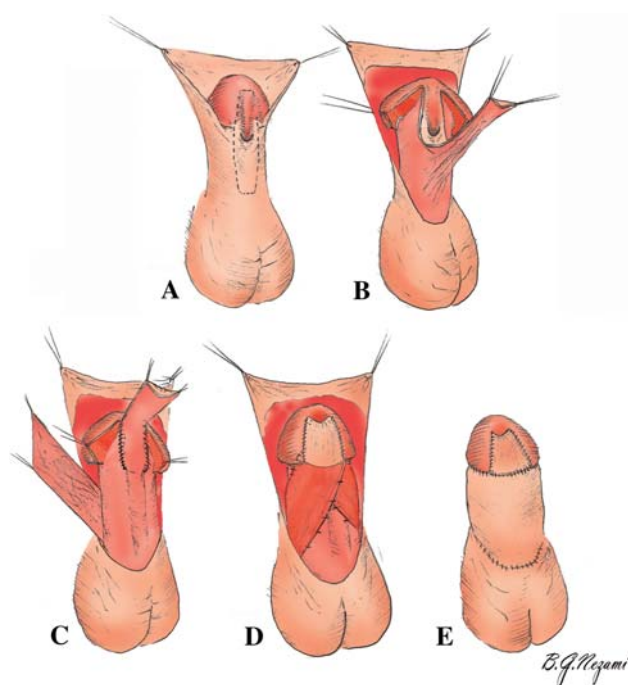
### Patients and methods

Fifty-four patients with distal or mid-shaft hypospadias and shallow urethral groove were enrolled in this study. Patients were randomly divided into two groups for DF-Mathieu and TIP procedures. These cases were selected from patients with distal and mid-shaft hypospadias who presented to our institution between May 2006 and January 2008. Patients with severe chordee, diminutive ventral skin, and those with a history of circumcision or failed hypospadias surgery were excluded. The patients' mean age was 43.1 months (6–144 months) in DF-Mathieu and 39.8 (14–128 months) in TIP group. We routinely use low-dose human chorionic gonadotropin (HCG, 50 IU/kg three times per week for 2 weeks, starting 6–8 weeks before scheduled hypospadias repair) for glans augmentation in such patients. The patients recruited in this study were among those patients unresponsive to HCG treatment. The study was approved by the university ethics committee and was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

### DF-Mathieu technique

After insertion of a traction suture on glans, the urethral plate was outlined. Two parallel longitudinal incisions were made from the tip of the glans to the hypospadiac meatus, extending proximally equal to the distance from orifice to the tip of the glans plus the length of glans (Fig. 1a). The mean width of the harvested flap was 8 mm. Flap was then dissected free from the underlying urethra, preserving its sub-epithelial vascular connections to the bed of the flap in order to reduce the risk of flap ischemic necrosis (Fig. 1b). The penile skin was then degloved after making a circumferential incision 5 mm proximal to the coronal margin. The urethral plate was dissected free from corpus cavernosum in selected cases with chordee (2 cases). There is a possibility that hair bearing skin be included in distal part of the flap. Therefore, especial care was taken to harvest the flap only from the shiny skin of the penile shaft, not extending beyond the penoscrotal junction.

In the next stage, chordee was corrected by dorsal tunica albuginea plication or free tunica vaginalis patch grafts. For urethroplasty, after extending the parallel incisions distally



**Fig. 1** DF-Mathieu technique for repairing hypospadias and shallow urethral groove. **a** The borders of flap are outlined. The length of flap is equal to the distance between the orifice and the tip of the glans plus the length of the glans. **b** Degloving of the penis, dissecting and releasing the flap. Chordee is corrected at this stage. **c** Flap is turned and sutured over the urethral plate with onlay technique. Two dartos flaps are harvested and placed on the neo-urethra. **d** Distal part of the flap is flipped over the dartos flaps and sutured between two wings of glans. **e** The penile skin is re-approximated around the shaft

to the tip of the glans, the glans wings were dissected and onlay urethroplasty was performed over an 8 or 10 Fr silicone tube using 6-zero polyglactin sutures (Fig. 1c). Spongiosorrhaphy was then performed and neo-urethra was covered with two well-vascularized subcutaneous dartos flaps (Fig. 1d). Glanular enlargement was performed with the excessive distal part of the flap. As shown in Fig. 1d, after finishing the urethroplasty, the remaining of flap was averted over the neo-urethra, between the glans wings, and was sutured on each side using 6-0 polydioxanone (PDS) sutures. Skin closure was performed by Byar's skin flap or buttonhole flap technique (Fig. 1e).

Applying penile compressive dressing completed the procedure which was similar in both DF-Mathieu and TIP patients. No suprapubic urinary diversion was used in patients in both groups. In all patients, intravenous antibiotic treatment was given post-operatively for maximum of 48 h, and was then switched to oral antibiotics until removal of urethral catheter. An anticholinergic drug (0.2 mg(kg day)<sup>-1</sup> oxybutynin) was started 1 day after operation and continued until removal of the catheter to prevent bladder spasms and urinary leakage. Patients were discharged after discontinuation of intravenous antibiotics.

Post-operatively, patients in both groups were followed up monthly for 3 months and then bi-monthly to assess the functional and cosmetic results and the possible complications (such as fistula, necrosis, meatal stenosis or meatal malposition). Parental satisfaction was recorded during routine visits. Success was defined as good caliber and single straight urinary stream, satisfactory cosmetic results, no hairy glans and no complications. For statistical evaluation of the differences among groups, we used Fisher's exact and two-tailed *t* tests, with  $P < 0.05$  considered significant.

## Results

In DF-Mathieu group, 22 patients (67%) had distal and 11 patients (33%) had mid-shaft hypospadias. TIP group consisted of 12 distal (57%) and 9 mid-shaft (43%) hypospadias. In neither group there was early complications such as bleeding and hematoma. No flap necrosis or skin bruising occurred in the averted flap of DF-Mathieu technique. The follow-up period ranged from 12 to 30 months (mean 20 months). Except for one case with urethral fistula, there was no major complication such as meatal stenosis, split glans and skin dehiscence in DF-Mathieu group. In TIP group, urethrocutaneous fistula (1 patient) and meatal stenosis (1 patient) occurred, with overall 9.5% complication rate.

The mean length of the paramental vascularized flap was 18 mm (range 14–25 mm) and mean width of flap was 8 mm, becoming narrower in its distal part. Chordee was present in 15 cases of DF-Mathieu technique (45%), which was corrected by dorsal tunica vaginalis plication (12 cases) and free tunica vaginalis patch graft (3 cases). There were 12 cases with chordee in TIP group (57%) before hypospadias repair.

Dressing was removed 48 h after surgery and the mean length of catheter stay was 7 days (5–8 days). There was no significant difference in catheter stay between TIP and DF-Mathieu groups. All patients had good caliber and single straight urinary stream in a forward direction. In DF-Mathieu group, although immediate results were less satisfactory, but slit-like meatus was achieved in all patients about 6 months after operation and satisfactory cosmetic results were achieved with normally situated glanular meatus. Post-operatively, there was an increase in glanular circumference in DF-Mathieu group, and the color of flap became consistent with the glans after 6 months. During the follow-up period, no case of intra-urethral hair growth and hairy glans occurred. The overall surgical success rate was 90.5% in TIP procedure compared with 97% in DF-Mathieu group, and statistical analysis showed no significant difference between groups.

## Discussion

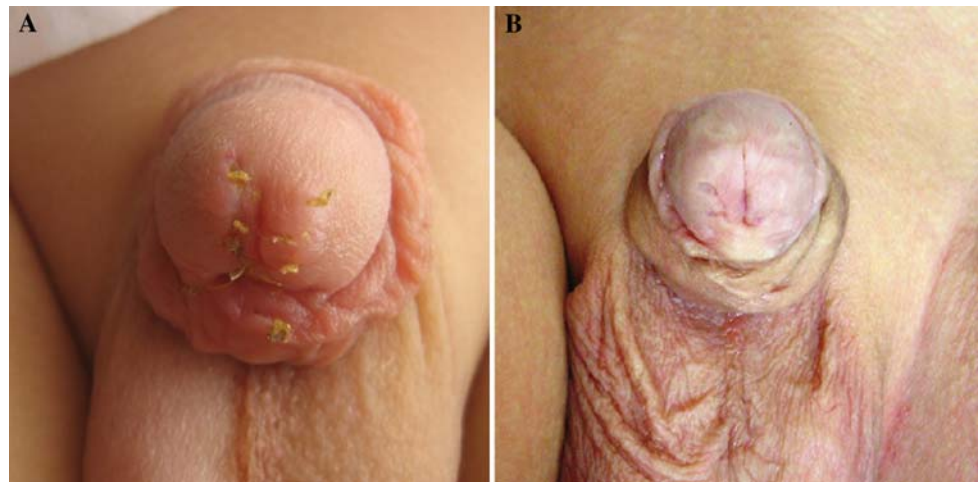
In this study, we applied a modified Mathieu urethroplasty for distal or mid-shaft hypospadias cases with small glans and shallow urethral groove. By positioning the distal part of an extended perimeatal-based flap between glans wings, we can augment the glans and decrease the tension over sutures and the neo-urethra.

The reported success rate for Mathieu technique ranges from 85% to more than 99% in primary repairs [7, 8]. The complications of Mathieu technique such as split glans, skin dehiscence; meatal stenosis and urethrocutaneous fistula (as the most common complication) originate from the method's design of incisions and the subsequent tension over suture lines and neo-urethra. By far, a few modifications have been made to minimize the complications of Mathieu technique such as adding dorsal dartos flap coverage to the neo-urethra [8] or combining Mathieu technique with urethral plate midline incision [9]. Mustardé techniques such as another modification of Mathieu represent a perimeatal-based ventral skin flap which is tubularized and passed through a glans channel to reach the meatus at the penile tip [10].

In 1976, Brannen GE introduced a penile flap reconstruction technique for strictures involving both the fossa navicularis and meatus, and incorporated an inverted U-shaped ventral penile flap to reconstruct the glanular urethra. This procedure required significant flap mobilization to achieve adequate meatal advancement and could result in a retrusive meatus [11]. In present technique, we combined glans augmentation technique and Mathieu urethroplasty by harvesting a longer perimeatal flap and positioning its folded distal portion between the glans wings. In selected patients with small glans and shallow urethral grooves, this technique had satisfactory functional outcomes with slightly lower complication rate (although not significant) compared with TIP procedure. The relatively high complication rate in the TIP series may also be explained by the advanced age of patients compared to other surveys in the literature. This highlights another potential advantage of DF-Mathieu over TIP urethroplasty to provide better results in children with advanced age. After 6–12 months, the color of the flap between glans wings was consistent with the glans (Fig. 2).

Although Mathieu technique was largely superseded by TIP urethroplasty after mid-1990s, it is still preferred in some situations [12, 13]. The decision to select a Mathieu over TIP or onlay procedure today depends primarily on the position of the defect, quality of available skin, size and appearance of the meatus and urethral plate, patient's age, and finally the surgeon's preference. Although TIP urethroplasty with deep urethral plate incision is an option for patients with shallow urethral grooves, there are

**Fig. 2** Representative follow-up photos of repaired hypospadias using DF-Mathieu technique



controversies over its indications and outcomes. Holland and Smith [14] noted fistula in 55% of boys with a flat glans and a plate less than 8 mm wide. Snodgrass provides technical details to avoid strictures in patients with flat urethral plate and suggests that meatal stenosis can result from tubularizing the plate too far distally [15, 16]. In our institution, we prefer DF-Mathieu over TIP urethroplasty with deep urethral plate incision in such patients, especially considering that DF-Mathieu is intended to augment the glans besides creating the neo-urethra.

Glans augmentation for small glans penis is particularly challenging in the presence of hypospadias, and flat glans and its resultant shallow urethral groove make the repair of distal hypospadias with small glans even more difficult. To overcome this problem, several surgical augmentation techniques are introduced [1, 17, 18]. It is noteworthy that surgical methods for glans augmentations are usually considered after treating patients with androgens to enlarge glans. In our institution, patients with small glans routinely receive HCG and the patients recruited in this study were among those unresponsive to hormonal intervention.

Although tension-free closure of the glans wings is usually possible in Mathieu technique, it might raise concern in two situations, first, when the glans is small and flat with abundant spongy glans tissue, and second, in older children with thicker dartos flaps [19]. In this study, we had same problems in our patients who had small flat glans, and their mean age was 43.1 months. Our proposed modification increases the glans circumference and makes glans wings approximation possible without tension. This eliminates the need to remove any spongy tissue from glans and decreases the risk of anastomosis disruption, stenosis and fistula formation secondary to ischemia and compression [20]. Our 3% complication rate in DF-Mathieu technique is especially prominent considering the mean age of our patients (43.1 months) which is quite higher than the optimum age for hypospadias repair in a healthy newborn

(6 months) [21]. However, given the limited number of patients in this study, more controlled surveys are warranted to determine the exact outcome and the advantages of this technique over other methods.

## Conclusions

Combining a glans augmentation technique with the Mathieu procedure (DF Mathieu) might be helpful for especial cases with small glans and shallow urethral groove, by reducing the risk of meatal stenosis, urethrocutaneous fistula, and the overall complications. We had no case of intra-urethral hair growth; however, further studies with long-term follow-ups after puberty are still warranted.

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**Conflict of interest statement** The authors declare that they have no conflict of interest.

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