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Surgical outcomes of modified Mathieu repair in midshaft hypospadias: An 8-year prospective experience

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Abstract

Hypospadias is one of the most common congenital anomalies of the male genitalia, with midshaft variants accounting for approximately 20-30% of cases. Surgical correction is essential to restore functional voiding, correct penile curvature, and achieve a cosmetically acceptable outcome. Although the Mathieu technique has historically been applied to distal hypospadias, several modifications have been proposed to improve cosmetic results and broaden its indications. This study evaluates the outcomes of a modified Mathieu technique for midshaft hypospadias. A prospective interventional study was conducted at Al-Sader Teaching Hospital, Basrah, Iraq, between January 2017 and December 2024. Thirty-seven male patients aged 2-17 years (mean 4.2 years) with midshaft hypospadias, with or without chordee, underwent repair using the modified Mathieu technique. Both primary (59.5%) and secondary (40.5%) cases were included, while patients with proximal hypospadias, disorders of sexual differentiation, or incomplete follow-up were excluded. Postoperative outcomes were assessed using the Hypospadias Objective Scoring Evaluation (HOSE) system, with follow-up at 2 weeks, 1 month, 3 months, and 6 months. Most patients (83.8%) achieved meatal location at the glans tip and 78.4% demonstrated a slit-like vertical meatus. Functional outcomes were favourable, with 81.1% of patients showing a single urinary stream and 91.9% demonstrating straight erections. The mean HOSE score was 15.6 ± 1.4 , with 81.1% achieving a satisfactory outcome ($\text{HOSE} \geq 14$). Complications occurred in 24.3% of patients, the most common being urethra-cutaneous fistula (13.5%), followed by meatal stenosis (5.4%), wound dehiscence (2.7%), and infection (2.7%). No cases of flap necrosis were observed. The modified Mathieu technique provides a reliable and cosmetically favourable option for midshaft hypospadias repair, with acceptable complication rates and outcomes comparable to TIP urethroplasty. It represents a valuable alternative for selected patients, particularly when preservation of vascularity is essential.

Keywords: Hypospadias, Midshaft hypospadias, Mathieu technique, Modified Mathieu repair, Urethroplasty, Pediatric urology

Introduction

Hypospadias is one of the most common congenital anomalies of the male genitalia, characterized by an ectopic location of the urethral meatus on the ventral aspect of the penis, often accompanied by ventral curvature (chordee) and an incomplete prepuce^[1]. Its incidence is reported at approximately 1 in 200-300 live male births, with wide geographical and ethnic variations. Midshaft hypospadias represents an intermediate form, lying between distal and proximal defects, and accounts for nearly 20-30% of all cases. Surgical correction is usually required to achieve functional micturition, penile straightening, and satisfactory cosmetic outcomes, ideally before school age to minimize psychosocial impact^[2].

Over 200 techniques have been described for hypospadias repair, reflecting the complexity and variability of the condition. Historically, the Mathieu technique, first introduced in the 1930s, became popular for distal hypospadias because of its straightforward approach, reliable vascularity, and relatively low complication rates^[3]. However, traditional Mathieu repair often produced a rounded or "fish-mouth" meatus, which was cosmetically less acceptable compared to the slit-like meatus achieved with tabularised incised plate (TIP) urethroplasty^[4].

To address this limitation, several modifications of the Mathieu technique were proposed. These include incorporating a perimeatal-based flap with deepithelialized wings or combining it with an incision of the urethral plate to achieve a more slit-like and natural-appearing meatus. Such refinements improved cosmetic outcomes and broadened the indications of Mathieu-type repairs beyond distal hypospadias^[5, 6].

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Midshaft hypospadias poses particular surgical challenges due to its intermediate location, variability in urethral plate quality, and frequent association with chordee. The modified Mathieu technique has gained attention as a viable option for this group. By using a perimeatal-based flap in combination with urethral plate augmentation or deepithelialized flap modifications, surgeons can create a well-vascularized neourethra with a terminal slit-like meatus while minimizing tension. This method also avoids excessive reliance on urethral plate incision, which may compromise vascularity in certain cases^[7].

Recent studies highlight favourable results with the modified Mathieu technique in midshaft hypospadias, with overall success rates exceeding 85-90%. Complications such as urethra-cutaneous fistula, meatal stenosis, and wound dehiscence remain possible but appear reduced compared with older Mathieu approaches^[8]. Furthermore, cosmetic evaluation tools like the Hypospadias Objective Scoring Evaluation (HOSE) suggest that the modified technique provides excellent cosmetic outcomes, approaching those of TIP urethroplasty, but with a potentially lower risk of meatal stenosis^[6,9].

Given the surgical complexity of midshaft hypospadias and the need for durable, functional, and cosmetically acceptable repairs, this study aims to describe the new modification on Mathieu technique and use it on mid-penile hypospadias with or without chordee.

Methods: This prospective interventional study was conducted at Al-Sader Teaching Hospital, Basrah, Iraq, for the duration between January 2017 and December 2024 on patients diagnosed with mid-penile hypospadias with or without associated chordee. The study was carried out in a single tertiary referral centre by the same surgical team to ensure consistency of the operative technique. Written informed consent was obtained from the parents or guardians of all patients prior to inclusion. Ethical approval for conducting the study was secured according to institutional guidelines.

A total of 37 male patients aged between 2 and 17 years (mean = 4.2 years) underwent surgical correction using the modified Mathieu technique. Both primary cases (22 patients) and secondary cases following failed previous hypospadias repair (15 patients) were included. Nine patients had associated penile chordee of varying degrees. Exclusion criteria were patients with proximal penile, penoscrotal, or scrotal hypospadias, Patients with disorders of sexual differentiation, and patients with

incomplete follow-up data.

All patients underwent a complete history and physical examination including the assessment of: Position of the urethral meatus, Presence and degree of chordee (assessed by artificial erection test intraoperatively), Previous history of surgical intervention for hypospadias (to identify secondary cases), general health status and fitness for anaesthesia. Parents were counselled about the surgical procedure, possible complications (fistula, meatal stenosis, dehiscence), and expected outcomes.

All procedures were carried out under general anaesthesia with caudal analgesia for postoperative pain relief. The patient was placed in the supine position, and a 4/0 silk traction suture was inserted into the tip of the glans penis. An artificial erection test was performed to assess the degree of chordee. A transverse incision of approximately 10 mm was made 2 mm distal to the native urethral meatus using a No.15 scalpel blade, through which any fibrous tissue causing chordee was carefully released. A second longitudinal incision was then made 2 mm below the glans tip, and a tunnel was created between the two incisions using tenotomy scissors, with meticulous haemostasis achieved using bipolar cautery. A Foley's catheter (10 Fr or wider, depending on penile size) was introduced through the tunnel to serve both as a stent and as a calibrator for the neourethra.

The parametalar flap was outlined with a fine-tip skin marker, with care taken to avoid hair-bearing skin by curving the flap design laterally. The flap length was determined according to the distance to the glans tip. Elevation of the flap was performed with its underlying Dartos fascia to ensure a well-vascularized pedicle, and infiltration with xyloadrenaline (1:200,000) was used for adequate haemostasis. The parametalar flap was then tubularized over the Foley's catheter using a single dorsal suture line technique with 6/0 polyglactin (Vicryl) sutures, performed under 2.5× loupe magnification for precision. Two fine traction sutures were placed at the distal end of the flap to facilitate its passage through the glans tunnel.

The tabularised flap was gently pulled through the tunnel using the traction sutures and secured at the glans tip with interrupted 5/0 Vicryl sutures. Skin closure was completed with interrupted 5/0 Vicryl sutures. Finally, a standard dressing was applied, consisting of topical fusidic acid ointment, sterile gauze, and adhesive tape. The wound was inspected on the first postoperative day to exclude hematoma formation, and the Foley's catheter was left in situ for 14 days before removal in the outpatient clinic.

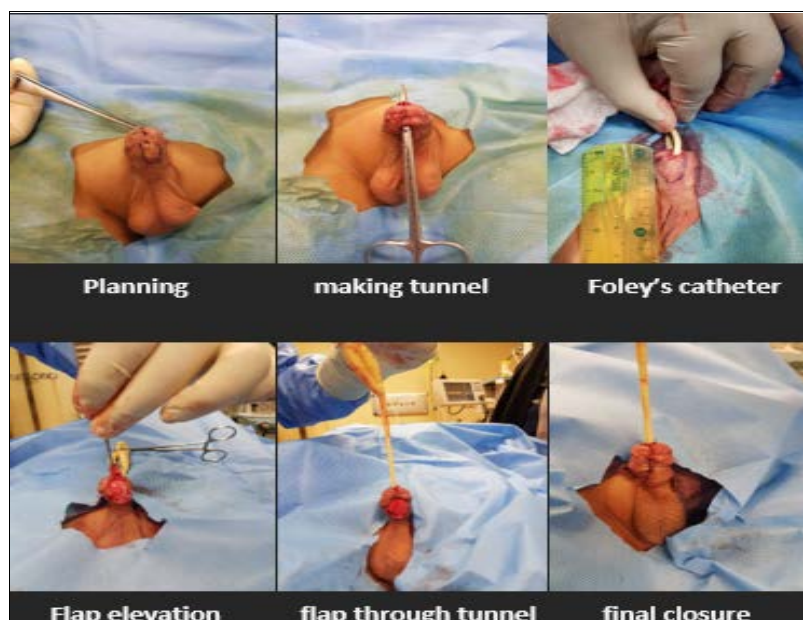


Fig 1: Key Steps of the Modified Mathieu Technique for Mid-penile Hypospadias Repair

Postoperative outcomes were assessed using a standardized approach combining cosmetic, functional, and complication-related parameters. Evaluation was performed at follow-up visits (2 weeks, 1 month, 3 months, and 6 months) by the operating surgeon and an independent surgeon not involved in the procedure. Cosmetic outcome was objectively assessed using the Hypospadias Objective Scoring Evaluation (HOSE) system, which evaluates five parameters: meatal location, meatal shape, urinary stream, straightness of erection, and presence of complications. Each parameter is scored, with a maximum score of 16 representing a satisfactory result. Complications were recorded systematically and included urethra-cutaneous fistula, meatal stenosis, wound dehiscence, infection, and flap necrosis. Patients with complications were scheduled for secondary corrective surgery as appropriate.

Patient demographics, operative details, and postoperative outcomes were recorded. Data were analysed descriptively and presented in frequency tables and percentages using SPSS version 26.

Results

A total of 37 male patients with mid-penile hypospadias were included in this study. The mean age was 4.2 ± 2.8 years (range: 2-17 years). Among the study population, 22 patients (59.5%) underwent primary repair, while 15 patients (40.5%) had secondary repair following previous failed procedures. Chordee was present in 9 patients (24.3%) (Table 1).

Table 1: Baseline Characteristics of the Study Population (n = 37)

Variable	No.	%
Age / (Range)	4.2 ± 2.8 / (2-17)	
Type of case		
Primary repair	22	59.5
Secondary repair	15	40.5
Chordee	9	24.3

Postoperative outcomes were assessed using the Hypospadias Objective Scoring Evaluation (HOSE) system. Most patients (83.8%) achieved satisfactory cosmetic results, with 83.8% demonstrating meatal location at the glans tip and 78.4% having a vertical slit meatus. Functional outcomes were similarly favourable, with 81.1% of patients exhibiting a normal urinary stream and 91.9% showing straight erections. Complications occurred in 9 patients (24.3%), whereas 30 patients (81.1%) achieved a total HOSE score ≥ 14 , indicating overall satisfactory outcomes. The mean total HOSE score was 14.6 ± 1.4 (Table 2).

Table 2: Postoperative Outcomes by HOSE Score

Variable	No.	%
Meatal location	Glans tip	31 83.8
	Coronal / sub-coronal	6 16.2
Meatal shape	Vertical	29 78.4
	Circular	8 21.6
Urinary stream	Single	30 81.1
	Spray	7 18.9
Erectile function	Straight erection	34 91.9
	Residual chordee	3 8.1
Complications	Absent	28 75.7
	Present	9 24.3
Total HOSE (mean $\pm$ SD)		15.6 ± 1.4
Total HOSE score ≥ 14 (satisfactory outcome)		30 81.1

The most common postoperative complication was urethra-cutaneous fistula, observed in 5 patients (13.5%), followed by

meatal stenosis (5.4%), wound dehiscence (2.7%), and infection (2.7%). No cases of flap necrosis were reported. Overall, 24.3% of patients experienced at least one complication (Table 3).

Table 3: Postoperative Complications

Variable	No.	%
Urethro-cutaneous fistula	5	13.5
Meatal stenosis	2	5.4
Wound dehiscence	1	2.7
Infection	1	2.7
Flap necrosis	0	0.0
Total complication	9	24.3

Discussion

Hypospadias remains one of the most challenging entities in paediatric urogenital reconstruction because success demands a stable, well-vascularized neourethra, a straight phallus, and a terminal, slit-like meatus with durable function through puberty and adulthood. Midshaft variants add complexity: the urethral plate is often of variable quality, chordee is not uncommon, and tissue availability for well-covered tubularization can be limited [10]. In this context, refining meatal-based flap techniques to preserve vascularity and optimize cosmesis is clinically important especially in health systems where case-mix includes reoperations and delayed presentations. Our study contributes prospective data on a modified Mathieu approach designed to extend indications into mid-penile hypospadias while maintaining favourable functional and cosmetic outcomes.

In our cohort (n=37), objective outcomes by HOSE were encouraging mean total HOSE 15.6 ± 1.4 with 81.1% achieving HOSE ≥ 14 . Cosmetically, 83.8% had a glanular meatus and 78.4% a vertical slit; functionally, 81.1% voided with a single stream and 91.9% had a straight erection. Overall complications occurred in 24.3%, driven chiefly by urethra-cutaneous fistula (13.5%), followed by meatal stenosis (5.4%), with no flap necrosis observed. These figures suggest the modification can achieve high rates of acceptable outcomes in a real-world mix of primary (59.5%) and secondary (40.5%) cases with 24.3% chordee. Our mean HOSE (15.6) and satisfactory rate (81.1% ≥ 14) compare favourably with published series using HOSE across mixed severities (mean ≈ 14.5 - 14.6 ; satisfactory proportions ≈ 70 - 76%). This alignment supports both the validity of our results and the usefulness of HOSE as a reproducible, outcome-oriented metric [11, 12].

A historical criticism of the classic Mathieu repair was the “fish-mouth” meatus. Modifications that include urethral plate incision or perimeatal flap refinements markedly improve meatal shape. Contemporary series of Mathieu-IP report slit-like meatus in $\sim 90\%$ (e.g., 89.5% vs 13.8% with onlay in a head-to-head comparison), which brackets our 78.4% and likely reflects our inclusion of midshaft location, chordee, and reoperations. Technique-related factors (glans size, glans wing coaptation, and traction through a glans tunnel) also influence this endpoint and may improve further along the learning curve [13, 14].

Our fistula rate (13.5%) mirrors the pooled 13% reported in a meta-analysis comparing Mathieu and TIP for distal repairs, indicating that in a more demanding midshaft cohort our modified approach achieves complication rates comparable to distal benchmarks. At the same time, randomized and comparative data show that Mathieu with urethral-plate incision can yield fistula rates as low as 2.9% and lower than TIP (e.g., 2.9% vs 18.7%), highlighting what is technically achievable in strictly selected distal or mid-distal cases and underlining the role of meticulous coverage and tissue quality. The spread

across studies ($\approx 3\text{--}15\%$) likely reflects heterogeneity in case severity, age, surgeon experience, and protective layers^[15-17].

Our meatal stenosis rate (5.4%) sits within ranges reported for contemporary TIP and flap techniques; several syntheses suggest meatal stenosis and strictures are at least comparable and in some analyses lower after Mathieu-type repairs than after standard TIP (e.g., urethral stricture $\sim 2\%$ Mathieu vs $\sim 5\%$ TIP). The preservation of vascularized tissue and avoidance of an extensive midline plate incision in selected patients may contribute biologically to these differences^[18].

Our complication profile differs from some other case reports. Three case-mix features plausibly elevated risk in our series. Firstly, secondary repairs (40.5%) prior surgery, scarring, and compromised vascular beds increase fistula risk and reoperation likelihood. Secondly, midshaft location and chordee (24.3%) more proximal meatal positions and curvature correlate with higher complication rates compared with purely distal disease. Thirdly, age range up to 17 years (mean 4.2 y) older age at repair has been identified as a risk factor for fistula in multiple cohorts, potentially via plate stiffness, wound dynamics, or postoperative behaviours^[19-21].

Our technique emphasizes a perimeatal-based flap elevated with Dartos and deepithelialized coverage, then tubularization over a stent and atraumatic glans tunnelling. This approach is consistent with longstanding evidence that robust second-layer coverage reduces fistula formation and supports healing, while maintaining axial vascularity key when extending indications from distal to midshaft sites or when operating in reoperative fields. Recent analyses continue to support the protective effect of well-vascularized coverage, though absolute benefits depend on tissue quality and surgical execution^[22-23].

Taken together, our outcomes show that a modified Mathieu repair can deliver high rates of acceptable HOSE scores (81.1% ≥ 14), terminal meatal location (83.8%), slit-like meatus (78.4%), and normal stream (81.1%) in midshaft hypospadias including in a substantial minority of reoperations without flap loss. While our fistula rate (13.5%) aligns with pooled averages across techniques, it exceeds the best published figures from carefully selected distal cohorts, suggesting that results are sensitive to selection and operative context. Notably, prospective series and meta-analyses indicate that hybrid Mathieu strategies (e.g., Mathieu-IP) can broaden candidates and improve cosmesis with “reasonable” complication rates, reinforcing the viability of meatal-based flaps beyond purely distal disease when the urethral plate is suboptimal or plate incision is undesirable^[24, 25]. The limitations are the sample size, single-centre nature, and follow-up limited to 6 months, which can miss late functional or cosmetic issues that surface during growth and sexual maturation. Long-term studies document that new or recurrent problems can emerge years after childhood repair, underscoring the need for extended surveillance into adolescence and adulthood.

Conclusion

For midshaft hypospadias with or without chordee and including reoperations the modified Mathieu technique achieved favourable cosmetic and functional outcomes with acceptable complications. Our results are comparable to pooled international data and, in some aspects (HOSE performance and meatal cosmesis), approach outcomes reported for more distal cohorts employing modified Mathieu strategies. Future work should include longer follow-up, stratified analyses by primary vs. secondary repair and degree of curvature, and comparative effectiveness against TIP and other contemporary techniques

using standardized, patient-reported and objective metrics.

Authors' contributions

1. Conceptualization; Data Curation; Investigation; Methodology; Project administration; Resources; Software; Writing - original draft and Writing - review & editing
2. Conceptualization; Data Curation; Investigation; Methodology; Project administration; Writing - original draft and Writing - review & editing

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Conflicts of interest

The authors declare no conflict of interest regarding this article.

Ethical approval

The Medical Ethical Committee of The Department of surgery approved this study.

Availability of data

On request.

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