

Original Research Article

COMPARISON OF OUTCOME BETWEEN TUBULARIZED INCISED PLATE URETHROPLASTY AND MATHIEU'S FLIP FLAP URETHROPLASTY FOR DISTAL PENILE HYPOSPADIAS USING SMITH'S DE-EPITHELIALIZED FLAP AS INTERPOSITION TISSUE

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ABSTRACT

Background: **Aim:** To compare outcomes of tubularized incised plate (TIP) urethroplasty (Snodgrass) and Mathieu's flip-flap repair in distal penile hypospadias using Smith's de-epithelialized flap as an interposition layer, with respect to complications, technical feasibility, and cosmetic results.

Materials and Methods: This randomized controlled trial was conducted in the Public hospital, Delhi, over 18 months. 28 boys aged 6 months to 12 years with isolated distal penile hypospadias without chordee were enrolled and randomized into two groups: Group A (TIP) and Group B (Mathieu's repair). In both groups, Smith's de-epithelialized flap was used as an interposition layer. Patients with thin or poorly developed perimeatal skin were excluded. Outcomes assessed included postoperative complications and cosmetic appearance using the Pediatric Penile Perception (PPP) score.

Results: The primary complication observed was urethrocutaneous fistula. At catheter removal (postoperative day 10), fistula rates were 35% (5/14) in Group A and 28% (4/14) in Group B. Wound infection occurred in 7% of patients in both groups. All fistulae in the Mathieu group resolved with conservative management within 3 months, whereas one patient (7%) in the TIP group had a persistent fistula. Cosmetic outcomes were comparable, with mean PPP scores of 10.93 ± 0.26 in Group A and 10.86 ± 0.36 in Group B.

Conclusion: With appropriate case selection, particularly considering perimeatal skin quality, Mathieu's repair provides functional and cosmetic outcomes comparable to TIP urethroplasty in distal penile hypospadias. The use of Smith's de-epithelialized flap as an interposition layer may contribute to favorable healing and reduced complication rates.

Keywords: TIPU, Mathieu's flip flap, Smith's De-epithelialized flap.

INTRODUCTION

Hypospadias is among the most common congenital anomalies of the male external genitalia, resulting from a developmental defect in the fusion of the urethral folds. Consequently, the urethral meatus opens anywhere along the ventral side of the penis,

from the perineum to the glans, with an incidence of approximately 1 in 250 live births.^[1,2] Distal hypospadias represents the most frequent subtype. Various surgical techniques have been described for its correction, including meatal advancement and glanuloplasty incorporated (MAGPI), Mustardé repair, and Duckett onlay flap procedures.^[3-7]

Tubularized incised plate urethroplasty (TIPU), popularized by Snodgrass, incorporates primary tubularization of the urethral plate with a relaxing incision in its posterior wall to allow for forward hinging. It has gained widespread acceptance due to its simplicity and favorable cosmetic outcomes, specifically achieving a slit-like meatus. However, complications such as meatal stenosis, urethral stricture, and fistula formation remain significant concerns.^[8-11]

Conversely, Mathieu's flip-flap repair is an excellent technique for subcoronal (distal) to midshaft meatus in a penis without chordee. Although it is a well-established procedure that offers reliable outcomes with minimal complications, it is frequently criticized for creating a "bucket-handle" meatus, which is cosmetically suboptimal.^[11] In our study, we utilized the Mathieu's and 'V' Incision Sutured (MAVIS) meatoplasty modification to achieve a desirable slit-like configuration within the Mathieu's procedure.^[12] Various tissues, such as the tunica vaginalis, dartos flap, and de-epithelialized flaps, have been used to cover the urethroplasty. Interposition tissue prevents the neourethral suture line from directly contacting the skin suture line while supplying a fresh, rich network of blood vessels to the newly constructed tissue. This enhanced blood flow accelerates cellular healing and tissue regeneration. Furthermore, it obliterates empty anatomical dead spaces created during surgery, thereby preventing fluid collections (such as hematomas or seromas) that can harbor bacteria and cause infection. Additionally, it provides mechanical reinforcement to securely contain the urine stream within the new channel during the early phases of healing.

Reviewing the literature, the use of interposition flaps, particularly the Smith de-epithelialized flap, has been suggested to reduce complications. However, limited comparative data exist, especially within the Indian demographic.^[14-16] Furthermore, objective cosmetic assessment using validated tools, such as the Pediatric Penile Perception Score (PPPS), has not been widely incorporated into these evaluations.

This study aims to compare TIPU and Mathieu's repair using the Smith flap, focusing on post-operative complications, procedural ease, and objective cosmetic outcomes.

MATERIALS AND METHODS

Study Design and Setting

This randomized controlled trial was conducted in the Department of Pediatric Surgery at a tertiary care public hospital in Delhi over an 18-month period.

Eligibility Criteria

Inclusion Criteria

- Boys aged between 6 months and 12 years.
- Distal penile hypospadias, defined as a meatus within 5 mm of the corona.
- Mild or minimal chordee (< 15 degree)

Exclusion Criteria

- Fibrotic perimeatal skin.
- Hypoplastic urethra.
- Micropenis.
- Reoperative or recurrent cases.

Randomization and Allocation Concealment

A total of 28 patients met the eligibility criteria and were randomly assigned in a 1:1 ratio to two parallel groups (14 patients each): Group A (Tubularized Incised Plate Urethroplasty, TIPU) and Group B (Mathieu's Flip-Flap Urethroplasty). Randomization was achieved using a computer-generated random number sequence. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes, which were opened intraoperatively by an independent coordinator after confirming suitability for the assigned technique.

Surgical Standardization

To minimize inter-observer and procedural variability, all surgical procedures were performed by three senior consultant pediatric surgeons **adhering to a strictly standardized institutional protocol for both techniques.**

Sample Size and Statistical Power

Previous literature reports a urethrocuteaneous fistula incidence of 5.76% for the TIPU procedure compared to 14.5% for Mathieu's procedure. Assuming these reference values, a standard two-sample proportion sample size formula was utilized:

Formula used:

$$n = \frac{p_1(1-p_1) + p_2(1-p_2)}{(p_1 - p_2)^2} C_{p, power}$$

Substituting the following in the above formula

$$p_1 = 0.145$$

$$p_2 = 0.057$$

$$C_{5\%, 80\%} = 7.9$$

$$n = 54.$$

Assuming these as reference values, the minimum required sample size at 5% level of significance and 80% power is obtained as at least 27 patients in each group.

However, due to strict time constraints and case volume over the 18-month study period, a convenience sample of 14 patients per group (total (N = 28)) was enrolled. **Consequently, this study was executed and powered as a pilot trial to evaluate local institutional trends.**

Outcome Measures

Primary Outcomes:

- Incidence of urethrocuteaneous fistula.
- Meatal stenosis.
- Wound infection.
- Wound dehiscence.
- Urethral stricture.

Secondary Outcomes

- Operative duration (in minutes).
- Subjective surgical ease.

- Functional outcome, defined by urinary stream quality.
- Objective cosmetic outcome using the Pediatric Penile Perception Score (PPPS).

Cosmetic Assessment

The PPPS was evaluated at 3 months postoperatively. To avoid observer bias, evaluations were performed independently by a resident doctor (not involved in the surgery) and the parents. A 4-point Likert scale was used to assess four parameters:

- Meatal position and shape.
- Glans appearance.
- Penile shaft skin appearance.
- Overall cosmetic satisfaction.

Surgical Technique

Tubularized Incised Plate Urethroplasty (TIPU / Snodgrass Repair)

In the TIPU repair group, an 8–10 mm wide segment of the urethral plate was demarcated distal to the urethral meatus. Incisions were made along the lateral borders of the urethral plate, extended subcoronally, and completed ventrally as a U-shaped incision proximal to the urethral meatus. Following meticulous degloving of the penis, the glanular wings were adequately developed lateral to the urethral plate. A midline vertical incision was then made along the urethral plate using a scalpel. The neourethra was reconstructed over an appropriately sized (6–8 Fr) feeding tube or catheter using continuous subcuticular sutures with 6-0 polyglactin. A Smith flap was raised from one side and translocated to cover the neourethra. Glanuloplasty was subsequently performed in two layers using 6-0 polyglactin, followed by the completion of the meatoplasty and skin closure.

Mathieu's Flip-Flap Repair with MAVIS Modification

In the Mathieu's repair group, a traction stay suture was placed in the dorsal glans to stabilize the phallus. The required length of the ventral skin flap was determined by measuring the distance from the proximal edge of the meatus to the tip of the glans. A ventral-based skin flap was then outlined maintaining an appropriate length-to-width ratio. The flap was carefully dissected off the underlying urethra by tunneling scissors between the flap and the urethra, preserving the perimeatal subdermal vascular plexus. Penile degloving was then completed.

Two paramedian incisions were extended to the tip of the glans, and the lateral glans wings were widely mobilized to allow tension-free midline approximation. The raised ventral flap was sutured to the edges of the urethral plate in a continuous subcuticular fashion up to the glanular tip. A Smith de-epithelialized flap was then placed as an interposition layer.

The **MAVIS (Mathieu and 'v' Incision Sutured) modification** for glanuloplasty was executed as follows: The apex of the Mathieu's flip-flap was stabilized using stay sutures at both ends. A V-shaped incision was marked and excised using iris scissors.

Each side of the "V" was then sutured to the glanular wings using 6-0 polydioxanone (PDS) monofilament. The first structural suture of the glans reconstruction (deep layer) was passed directly through the apex of the V-shaped incision of the Mathieu's flip-flap. After completing the deep layer approximation of the glans, epithelial layer suturing of the glanuloplasty was completed, yielding a vertical, slit-like meatal configuration. Finally, anatomical skin closure was performed.

Smith's Interposition Flap (Vest-Over-Pant Technique)

A 5 mm wide longitudinal strip of skin adjacent to the incision line was marked for de-epithelialization to expose a raw surface of deep dermis. Three traction stay sutures were placed over the marked flap, and de-epithelialization was precisely performed using a scalpel blade or iris scissors to preserve the vital subdermal plexus.

The medial edge of this de-epithelialized flap was brought across the newly constructed, buried urethral tube and secured to the fascial tissue beneath the contralateral skin edge using 6-0 polyglactin or polydioxanone. The contralateral skin edge was then advanced and sutured to the lateral edge of the de-epithelialized strip. This created a dual-layered "vest-over-pant" mechanical barrier, effectively avoiding overlapping suture lines over the neourethra.

Statistical Analysis

Data were analyzed using SPSS v25. Quantitative data was expressed as mean with standard deviation or median with interquartile range based on the normal distribution of the data. Qualitative data was expressed as proportions. P value of <0.05 was considered as significant.

RESULTS

Demographic Data

The study population comprised 28 male pediatric patients with a mean overall age of 5.3 ± 3.0 years, evenly distributed between the two treatment groups.

Postoperative Complications

- **Urethrocutaneous Fistula (UCF):** At the 3-month postoperative evaluation, the definitive UCF rate was 7.1% (n = 1) in the TIPU group and 0% (n = 0) in the Mathieu group. The single persistent UCF in the TIPU group underwent successful surgical closure after a 6-month observation period. Notably, early, minor fistulas were initially observed in 35.7% (n = 5) of the TIPU group and 28.6% (n = 4) of the Mathieu group; however, these resolved spontaneously following daily urethral calibration over a 2-month period.
- **Wound Infection:** Superficial wound infection occurred at an identical rate of 7.1% (n = 1) in both the TIPU and Mathieu groups, which resolved with targeted antibiotic therapy and local wound care.

- **Other Complications:** There were no documented cases of meatal stenosis, urethral stricture, structural dehiscence, or flap necrosis in either cohort during the follow-up period.

Secondary and Functional Outcomes

- **Operative Duration:** The mean operative time was significantly shorter in the TIPU group (96.5 ± 4.39 minutes) compared to the Mathieu group (101.5 ± 8.07 minutes).
- **Cosmetic Outcomes:** Objective cosmetic assessment at 3 months using the Pediatric

Penile Perception Score (PPPS) demonstrated highly comparable results between the two techniques, with a mean score of 10.93 ± 0.26 in the TIPU group and 10.86 ± 0.36 in the Mathieu group.

- **Functional Outcomes:** At the 6-month follow-up, all 28 patients (100%) across both cohorts demonstrated a functionally satisfactory, strong urinary stream without spraying or straining.

Table 1: Sociodemographic and Clinical Characteristics of the Study Participants

Procedure / Category	TIP Urethroplasty (Group A)	Mathieu's flip flap (Group B)	P value
Age	5.36yrs	5.29yrs	-
Operative time	96.57min	101.57min	-
Surgical Infection	1(7.1%)	1(7.1%)	1.00
No. Fistula on post op day 10	5(35.7%)	4(28.6%)	0.68
No. Fistula at 3months	1(7.1%)	0	0.001
PPP score	10.93	10.86	1.00

DISCUSSION

Distal penile hypospadias can be effectively managed by several surgical techniques, among which tubularized incised plate (TIP) urethroplasty and Mathieu's flip-flap repair are the most commonly performed. However, the use of a de-epithelialized Smith flap as an interposition layer has not been widely reported despite its potential advantages. In this randomized controlled trial, we compared the outcomes of TIP urethroplasty and Mathieu's repair with the use of a Smith flap. This flap, first described by Smith in 1973, is a de-epithelialized vascularized flap that preserves local blood supply and provides robust tissue coverage. It promotes rapid tissue adhesion, avoids superimposition of suture lines, and strengthens the neourethral repair. However, the technique requires surgical expertise, as improper handling may result in penile torsion due to uneven tension. Furthermore, its applicability in redo surgeries is limited due to tissue constraints. Reported success rates range between 80% and 90%, with low complication rates of 2-5% by Durham Smith in two stage hypospadias repair.^[14,15,16]

The mean age of patients in the present study was 5.3 ± 3.0 years, which is comparable to previous studies.^[17,18,21] Delayed presentation observed in our cohort may be attributed to lack of parental awareness, poor health education, and delayed referral from primary care centers, which remains a common concern in developing countries. Similar presentation was observed by Imamogul et al and Hamid R et al.

The overall outcomes in our study were favorable. The urethrocuteaneous fistula (UCF) rate was 7% in the TIP group and 0% in the Mathieu's group at 3 months follow-up. These findings are comparable with previously published literature. While some studies have demonstrated similar fistula rates between the two techniques, others have reported higher rates following TIP urethroplasty.^[17-25]

Although our sample size was relatively small, the results are in agreement with existing evidence.

The superior outcomes observed with Mathieu's repair (MAVIS modification for glansplasty) in our study may be attributed to careful patient selection. As a meatal-based procedure, it requires well-vascularized and supple perimeatal skin; hence, patients with fibrosed or unfavorable tissue were excluded. In addition, the surgical design of Mathieu's repair avoids overlapping suture lines, as the neourethral suture lines lie lateral to the dependent portion of the neourethra, thereby reducing the risk of fistula formation.^[12,13] In contrast, TIP urethroplasty involves tubularization of the urethral plate, which may predispose to overlapping suture lines unless an adequate interposition layer is used.

Meatal stenosis was not observed in any patient in our study. This contrasts with previous reports where variable rates have been documented in both techniques.^[17-25] The absence of this complication in our series may be attributed to meticulous surgical technique and appropriate case selection, particularly the exclusion of patients with fibrosed perimeatal tissue.

No cases of urethral stricture were observed in either group. Previous studies have reported variable stricture rates following both TIP and Mathieu's repair. The absence of stricture in our study may be related to meticulous surgical technique use.

Dehiscence and flap necrosis, though reported in the literature, were not encountered in our series. These favorable outcomes may be due to preservation of vascularity, careful tissue handling, and the adjunctive use of a well-vascularized interposition flap.^[17-25]

An important observation in our study was the spontaneous closure of early postoperative fistulae. Fistulae detected at the time of catheter removal resolved spontaneously in all patients in the Mathieu's group and in the majority of patients in the

TIP group with conservative management, including serial dilatation.^[26] Fistula closure rate appears higher than that of reported in the literature and may be attributed to the use of the Smith flap, which provides a thick, well-vascularized tissue layer that promotes healing and prevents epithelialization of the fistulous tract.

The incidence of wound infection was low and comparable between the two groups. This may be attributed to strict perioperative protocols, including preoperative antiseptic preparation, intraoperative antibiotic irrigation, and appropriate postoperative antibiotic coverage. The infection rate observed in our study is similar to that reported in Western literature i.e 2-10%.

The mean operative time was slightly longer in the Mathieu's group compared to the TIP group, likely due to the technical complexity involved in flap creation and suturing. Although statistically significant, this difference may not be clinically relevant. TIP urethroplasty was perceived to be technically easier by trainees, reflecting its shorter learning curve.^[17-25]

Functional outcomes were assessed subjectively by evaluating the urinary stream. All patients demonstrated a satisfactory, thick, and forceful stream at follow-up. Although uroflowmetry provides objective assessment, it was not performed in this study, which may be considered a limitation.^[27]

Cosmetic outcomes, as assessed by the Pediatric Penile Perception (PPP) score, were comparable between the two groups.^[28] With meticulous glansplasty and attention to meatal configuration, a slit-like meatus can be achieved even with Mathieu's repair(MAVIS modification), resulting in satisfactory cosmetic outcomes.

Limitations of the present study include the relatively small sample size, short duration of follow-up, and lack of objective functional assessment such as uroflowmetry.

CONCLUSION

We conclude that with an appropriate selection of cases with distal hypospadias, particularly considering perimeatal skin quality, Mathieu's repair can give functional and cosmetic results comparable to TIP Urethroplasty. Overall results of our study were gratifying and comparable to those available in western literature. However, numbers were limited due to short time frame of the study and a longer period with a higher number of subjects can throw more light on this matter. Also, further studies using different types of interposition flaps simultaneously for both types of procedures can conclusively prove the value addition of Smith flap on the outcome of single stage distal hypospadias repair.

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