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Outcome of spongioplasty alone as second layer of tubularised incised plate urethroplasty in patients with hypospadias

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Abstract

Background: Spongioplasty alone or in combination with local tissue flaps can be used as a second layer for the prevention of complications of tubularised incised plate urethroplasty (TIPU) of hypospadias repair. It can be used when wide urethral plate and well-developed robust spongiosum are present. This study aims to review the success rate and complications of TIPU performed utilising spongioplasty alone as a second layer in Type 3 well-developed robust spongiosum.

Methods: This is a retrospective observational study conducted between January 2015 and December 2019 at a tertiary care centre. A total of 21 patients aged 4–15.4 years with primary hypospadias having a Type 3 well-developed robust spongiosum, Glans score ≤ 2 , Meatal score ≤ 4 , and Shaft score ≤ 3 underwent TIPU using spongioplasty alone as a second layer. The hospital stay ranged from 10 to 14 days and follow-up from 12 to 36 months.

Results: Hypospadias was distal in 12 (57.1%), mid in 5 (23.8%), and proximal penile in 4 (19.1%) patients. The mean Glans Meatus Shaft score was 6.1 ($G = 1.25$, $M = 2.95$, $S = 1.9$) with a range of 3–9. An early post-operative complication of preputial oedema and bladder spasm developed in 1 (4.7%) patient each. Meatal stenosis developed in 1 (4.7%) patient. None developed urethrocutaneous fistula. At 3 months all patients had good urinary flow (> 15 ml/s) and good cosmesis. All the patients/parents (in case of minors) were satisfied with the result.

Conclusion: Spongioplasty alone as the second layer after TIPU for primary penile hypospadias in patients with well-developed robust spongiosal tissue is associated with minimal, easily manageable complications.

Keywords: Complications, Hypospadias, Urethroplasty, Retrospective studies, Spongioplasty, Tubularised incised plate urethroplasty, Urethra

1 Background

Hypospadias is the most common congenital defect of the urethra because of incomplete tubularisation of the urethral plate. Its incidence is 0.8–8.2 per 1000 live male births [1]. The Glans Meatus Shaft (GMS) score is used at the time of the surgical procedure to assess the quality of the glans, urethral plate, the location of the

urethral meatus, and degree of penile curvature to objectively assign scores to stratify severity [2, 3]. Tubularised incised plate urethroplasty (TIPU) is a widely used procedure for distal and midshaft hypospadias repair [4, 5]. It steadily provided low complication rates and good cosmesis.

Urethrocutaneous fistula forms the most common complication reported (60% of all complications) with an incidence of under 10% [6]. A second vascularised layer over the urethral tube is utilised to prevent this complication. The ideal vascularised layer has been a matter of

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debate for decades, and it includes transverse island dorsal subcutaneous flap, dorsal single- or double-layered dartos flap, ventral-based dartos flap, scrotal dartos, preputial flap, spongioplasty, and tunica vaginalis flap, among others [7]. Spongioplasty alone is rarely performed as a vascularised layer as it may be deficient in some cases, accompanying the hypospadias. Bhat et al. [7] classified spongiosum into three categories: mild (Type 1), moderate (Type 2), and well-developed robust (Type 3). We evaluated the success rate of spongioplasty alone as a second layer tissue cover post-TIPU in patients with Type 3 well-developed robust spongiosum.

2 Methods

2.1 Study population

All patients with primary hypospadias who had presented to our department during the study period and satisfied the inclusion criteria were included in the study. Written informed consent was obtained for the surgery from the patients or caregivers (in the case of minors). The study was approved by the hospital research and ethics committee with the reference number—Ethics committee no. IEC/Pharm/RP/406/May/2021.

2.2 Study design

A retrospective observational study was carried out at our institution, reviewing records of hypospadias patients operated on between January 2015 and December 2019. Hospital records of history, admission, operative procedure, and follow-up were assessed and analysed.

2.3 Inclusion criteria

Patients with primary hypospadias were selected based on the GMS score. Patients with a Glans score of ≤ 2 , a Meatal score of ≤ 4 , and a Shaft score of ≤ 3 were termed favourable and included in this study. The decision to perform spongioplasty alone as the second layer was taken after assessing the spongiosa intraoperatively. Spongiosa was classified into three types based on its appearance and vascularity:

Type 1: Poorly developed [Fig. 1]

Thin spongiosal tissue with decreased vascularity. The diameter of the neourethra covered by spongiosum was less than the proximal healthy urethra after spongioplasty.

Type 2: Moderately developed



Fig. 1 Intraoperative picture of a 13 years old with mid-penile hypospadias showing poorly developed spongiosum

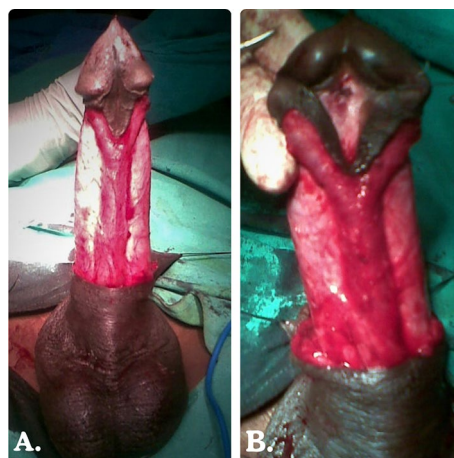


Fig. 2 A Intraoperative picture of a 15.4 years old with distal penile hypospadias showing well-developed robust spongiosum. **B** Intraoperative picture of a 13 years old with distal penile hypospadias showing well-developed robust spongiosum

Average thickness and spongiosal vascularity. The diameter of the urethra covered by the spongiosum after spongioplasty was almost equal to that of the proximal healthy urethra.

Type 3: Well-developed robust [Fig. 2]

Thick spongiosum with good vascularity. The diameter of the neourethra covered with spongiosum was greater than that of the proximal healthy urethra.

Only the patients with Type 3 (well-developed robust) spongiosum with primary hypospadias who were

suitable candidates for Snodgrass repair were included in our study.

2.4 Exclusion criteria

Patients with prior failed hypospadias repair, disorders of sexual differentiation, ventral chordee which was not amenable to penile degloving or dorsal plication and unfavourable GMS score were excluded from this study (Fig. 3).

2.5 Surgical technique

The repair was done using the technique described by Snodgrass [5]. The surgeries were carried out under general anaesthesia using fine instruments, and bipolar cautery without the use of tourniquet or adrenaline. A U-shaped incision was made encircling the meatus to the corona, preserving the urethral plate, and then extended circumferentially around the corona. Penile degloving was done up to the root of the penis by creating a plane at the level of the Buck's fascia. The correction of penile curvature was checked by the Gittes test. Persistent penile curvature following penile degloving was corrected by urethral plate dissection. A vertical incision was made over the urethral plate up to the mid-glans. Using an appropriately sized catheter and 6-0 Vicryl suture, urethroplasty was done by subcuticular technique. Spongionoplasty was performed by dissection of the spongiosum proximal to the meatus between the Buck's fascia and the

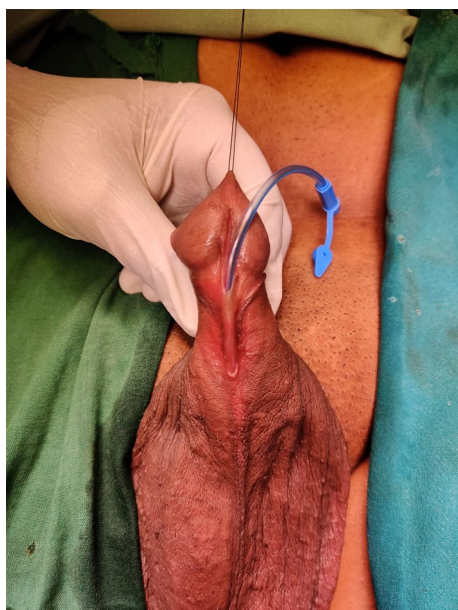


Fig. 3 A 14 years old with primary hypospadias with narrow urethral plate and diverging corpora spongiosum with a Glans score of 3 (excluded from the study)



Fig. 4 Intraoperative picture of a 6 years old with mid-penile hypospadias showing adequate mobilisation of spongiosum

tunica albuginea from lateral to medial until its approximation was possible without tension (Fig. 4). The urethral plate along with the spongiosum was mobilised without damaging the spongiosum or cavernosum in order to preserve the blood supply to the spongiosum, and the urethral plate was maintained. Glans wings were raised with an oblique incision at about 45 degrees, preserving the spongiosum, adequate enough to cover the neourethra without hampering its blood supply. Spongionoplasty alone was done over the neourethra in a Type 3 well-developed robust Spongiosum (Bhat's classification) as the second layer. Skin closure was done by using Byar's flap. Intravenous antibiotics were administered for 5 days, followed by oral antibiotics until the dressing was removed. The dressing and the catheter were removed on the 10th post-operative day. The outcome of the procedure was assessed at the time of discharge and thereafter 3 monthly for one year. Cosmesis was assessed by the operating surgeon at 3 months based on factors like Glans size > 14 mm, shape of the meatus (conical or not), absence of chordee, and good foreskin appearance (absence of extra skin tags, ears, and irregularity). Cosmesis was termed "good" if all four factors were present. In the absence of any one of the four factors, cosmesis was termed as poor. The functional outcome was assessed objectively using uroflowmetry and subjectively by visual assessment of the urinary stream at 3 months. Uroflowmetry success criteria included a normal Bell-shaped curve, $Q_{max} > 15$ ml/sec with a urine output of

Table 1 Patient demographics and characteristics

| Age (in years) | 4–8 | 8–12 | > 12 |
|------------------------------------|-----|------|------|
| No. of patients (n = 21) | 9 | 7 | 5 |
| Circumcised (14.2%) | 2 | 1 | 0 |
| Clinically notable chordee (61.9%) | 6 | 4 | 3 |

Table 2 Sitewise distribution and GMS score of the primary hypospadias

| | | | |
|------------------------------|----|--|------|
| <i>Sitewise distribution</i> | | | |
| Distal penile | 12 | | |
| Mid-penile | 5 | | |
| Proximal penile | 4 | | |
| <i>GMS score</i> | | | |
| Glans score (G) | 1 | | 14 |
| | 2 | | 7 |
| | 3 | | None |
| | 4 | | None |
| Meatus score (M) | 1 | | None |
| | 2 | | 5 |
| | 3 | | 12 |
| | 4 | | 4 |
| Shaft score (S) | 1 | | 8 |
| | 2 | | 7 |
| | 3 | | 6 |
| | 4 | | None |

more than 150 ml, and post-void residue < 50 ml. Patients' and parents' satisfaction was also assessed regarding the cosmesis, urinary stream, and the curvature of the penis. No objective tool was used for this assessment. Statistical analysis was performed using Microsoft Excel 2010 and IBM SPSS Statistics for Windows, Version 22.0.

3 Results

Out of 94 patients who presented in the study period, a total of 21 patients were included in the study. The age range of patients was 4 to 15.4 years, with a mean of 7.5 years (Table 1). The hospital stay ranged from 10 to 14 days, and the period of follow-up was 1–3 years. Hypospadias was distal penile in 12 (57.1%), mid-penile in 5 (23.8%), and proximal penile in 4 (19.1%) cases, respectively. Mean GMS score was 6.1 ($G = 1.25$, $M = 2.95$, $S = 1.9$) with a range of 3–9 (Tables 2, 3).

Chordee correction was required in 13 (61.9%) patients, which was carried out successfully by penile degloving in 11 (52.4%) patients. Two (9.5%) patients required both penile degloving and urethral plate dissection. None of the patients' required dorsal plication for chordee correction.

The early post-operative complications of prepuce oedema and bladder spasm were seen in one (4.7%) patient each and were managed conservatively. Meatal stenosis developed in a patient with distal hypospadias and a GMS score of 7 (Table 4). None of the patients developed a urethrocutaneous fistula. Meatal stenosis was corrected by meatoplasty after a trial of repeated meatal calibration failed. All patients had good urinary flow (> 15 ml/s) and post-void residue of < 50 ml on uroflowmetry at 3 months of evaluation. None of the patients had any other complications. At 3-months' follow-up, cosmesis was assessed by the operating surgeon and it was found to be good in all 21 patients. All the patients/parents (in the case of minors) were satisfied with the final cosmesis, urinary stream, and appearance of the penis at 3 months.

4 Discussion

Hypospadias is a common congenital anomaly in boys. The worldwide reported incidence range of hypospadias is 4–44/10,000 [1]. Surgical management is challenging due to multiple factors. Various classification systems have been proposed to classify the type and severity of

Table 3 Patients excluded from the study

| Patients excluded (n = 73) | n |
|--|----|
| Poorly/moderately developed spongiosa | 19 |
| Glans score > 2 | 14 |
| Ventral chordee not amenable to degloving or dorsal plication or Shaft score > 3 | 11 |
| Failed hypospadias surgery | 8 |
| Poorly/Moderately developed spongiosa + Ventral chordee not amenable to degloving or dorsal plication or Shaft score > 3 | 8 |
| Glans score > 2 + Ventral chordee not amenable to degloving or dorsal plication or Shaft score > 3 | 5 |
| Poorly/Moderately developed spongiosa + Glans score > 2 | 4 |
| Disorder of sexual differentiation | 4 |

Table 4 Early and late post-operative complications following tubularised incised plate urethroplasty

| | n (%) | Clavien–Dindo grade |
|---|----------|---------------------|
| <i>Early post-operative complications</i> | | |
| Skin necrosis | 0 | – |
| Scrotal oedema | 0 | – |
| Wound dehiscence | 0 | – |
| Preputial oedema | 1 (4.7%) | I |
| Bladder spasm | 1 (4.7%) | I |
| <i>Late post-operative complications</i> | | |
| Residual chordee | 0 | – |
| Fistula | 0 | – |
| Meatal stenosis | 1 (4.7%) | IIIa |
| Stricture | 0 | – |

hypospadias to prognosticate and predict the surgical outcome [2].

The earliest classification of hypospadias was based on meatal location [8]. Duckett et al. [8] in their study of 1286 cases of hypospadias over 5 years, reported that 49% of cases were anterior, 21% were middle, and 30% were posterior in location. However, for complete assessment of hypospadias, other aspects like chordee, glans, prepuce, and penile shaft are also important. Later, GMS score assessment was developed, which incorporated physical findings in the operating room, with a higher GMS score associated with an increased risk of developing a complication [1, 2].

Two theories of urethral development have been proposed:

1. CLASSICAL: Ectodermal Ingrowth Theory
2. NEWER TWO ZIPPER HYPOTHESIS: Endodermal Theory

In both, the spongiosa develops from the surrounding mesodermal tissue of the urethral plate, and the degree of hypoplasia of the spongiosa depends on the severity of hypospadias and the proliferation of mesodermal tissue [9, 10].

TIPU was first described by Snodgrass in 1994 for hypospadias [5]. For its lower complication rates and vertically oriented meatus, it quickly gained widespread adoption. It is the most common procedure used for distal and mid-hypospadias [4]. In proximal hypospadias, aggressive dissection of the urethral plate may lead to devascularisation and is associated with higher risks of complications like stricture formation and meatal stenosis [11]. Hence, TIPU has fallen out of favour for

STAGED repair in proximal hypospadias. Concerns about a higher risk of urethroplasty failure when combined with a corporal grafting procedure in a single-stage repair have led to this paradigm shift [11–13]. In our study, TIPU was performed in carefully selected cases of proximal penile hypospadias with a Glans score of 1 or 2 and a Shaft score of 2 or 3 (mild to moderate chordee). None of the patients required additional procedures for chordee correction apart from penile degloving with or without urethral plate dissection. No complications were seen on follow-up in patients with proximal penile hypospadias. Arshadi et al. [14] performed TIPU in 63 cases of proximal hypospadias with a fistula rate of 14.2%. They suggested TIPU as a reliable and effective procedure for proximal hypospadias in patients with glans size > 14 mm and minimal to moderate chordee.

The common complications associated with TIPU include urethrocutaneous fistula, glans dehiscence, meatal stenosis, urethral stricture, urethral diverticulum, lichen sclerosis, and recurrent penile curvature. The most common is the formation of urethrocutaneous fistulas (>60%) [15]. Various procedures and techniques have been described to reduce the incidence of fistula formation. However, no single technique can claim to achieve complete success [7]. One of the most important factors is the protective intermediate vascularised layer between the neourethra and skin. The commonly harnessed intermediate layer includes the tunica vaginalis flap (TVF), dorsal preputial dartos flap (DPF), and spongioplasty, among others [16, 17].

The corpus spongiosum (CS) is a vascularised protective covering that surrounds the normal urethra and may aid in the natural propulsion of semen. A spongiosal layer also decreases the tension on the suture line of urethroplasty in the midline, especially during erection [7]. However, the use of CS alone to cover the neourethra is infrequent. Spongioplasty was first described by Beaudoin [18] and Yerkes [19] in 2000 in separate studies. Beaudoin et al. [18] described the anatomy of CS in different forms of hypospadias. They suggested a correlation between penile curvature and the level where CS diverges. Yerkes et al. [19] classified distal CS as present on either side of the urethral plate. It may be present as distinct pillars of healthy erectile tissue or may appear fibrous in others. In their study of 25 patients, Y to I spongiosum wrap was performed as a second layer in various forms of one-stage urethroplasty and they reported no fistula formation. However, in their study, there were no selection criteria for using spongiosa. DPF is most commonly used as a second layer. However, it is found to be complicated by oedema, necrosis of skin, hematoma, and torque of the penile shaft [16, 20]. Tunica vaginalis flap, although associated with a lower fistula rate in various

studies as compared to DPF, it will require a separate incision in cases of distal hypospadias and cannot be utilised in cases of undescended testis [21–23]. Several investigators have shown spongioplasty to be as protective as DPF [19]. In contrast, Dodat et al. [24] showed no fistula formation in any of 51 patients who underwent TIPU with spongioplasty alone, as in our study. Bhat et al. [17] compared the results of TIPU with spongioplasty alone and TIPU with spongioplasty and DPF. The fistula rate of spongioplasty alone was 2.5%, whereas it was 5% when combined with DPF. Hafez and Helmy [25] compared the effects of DPF and spongioplasty on the complication rate of TIPU repair for penoscrotal hypospadias and reported a significantly lower success rate of 68% when spongioplasty alone was utilised and 92% with DPF. The reported rate of fistula with spongioplasty alone in various other studies is 0–31% [6]. The variable rate of success may be explained by the variations in spongiosal anatomy. A poorly developed spongiosal tissue may not be sturdy enough to prevent fistula formation, and other complicating factors like a narrow urethral plate or severe chordee may affect overall results. In our study, we have incorporated the GMS score to rule out these factors, excluding patients with a Glans score of 3 or more and a Shaft score of 4 (severe chordee). Bhat et al. [7] intraoperatively divided spongiosa into 3 types based on thickness, vascularity, and robustness and recommended it to be utilised in all patients as an intermediate layer.

In their prospective study of 113 patients with primary hypospadias, they compared the success rate of spongioplasty alone as an additional layer in 3 types of spongiosum. They found a 0% fistula rate when Type 3 well-developed robust spongiosum was used as compared to 11.3% in Type 2 and 23% in Type 1 spongiosum. Our study included Type 3 well-developed robust spongiosum in 21 patients having mid, distal, and proximal penile hypospadias without any fistula or major complications, except one patient who had meatal stenosis (incidence of 4.7%). In their study of 80 patients, Bhat et al. [17] reported meatal stenosis as 7.5% in their study.

Spongioplasty also reduced the degree of penile curvature in 2 patients with a Shaft score of 3 (moderate chordee 30–60 degree), and they did not require dorsal plication. As observed by Hayashi et al. [20] spongioplasty reduced the degree of penile curvature and allowed dorsal plication to be avoided in more than half of hypospadias patients who displayed moderately severe chordee. So, we feel additional cover along with spongioplasty is not necessary in a properly selected case. Combining spongioplasty with DPF increases tissue bulk and may be complicated by oedema, necrosis of skin, hematoma, and torque of the penile shaft [15, 19]. In our study, 2 patients were complicated with preputial oedema and 1 patient

with bladder spasm. None of them developed skin necrosis or hematoma post-operatively. To assess the outcome of each surgery, we used clinical examination and unaided visual inspection for the chordee assessment. We did not use any validated objective scoring system for cosmesis evaluation. The assessment of the cosmesis by the operating surgeon was based on certain visual parameters like glans size, shape of the meatus, residual chordee, and foreskin appearance. Similarly, the cosmesis satisfaction was assessed subjectively by the patients or their parents based on direct questions regarding the outcome. However, the functional outcome was assessed objectively by performing uroflowmetry.

We recommend that in carefully selected patients with primary hypospadias (Glans score of 1 or 2 with a Shaft score of 1, 2, or 3, i.e. no, mild, or moderate chordee, respectively), post-TIPU, wherever Type 3 well-developed robust spongiosum is available, spongioplasty alone is sufficient as the second layer to avoid complications.

The limitations of our study are that it is a retrospective observational study. As it is a non-comparative study without any control group, it only assessed the outcomes of the second layer used as per the selection criteria. Further studies employing the GMS score to objectively assign the severity of hypospadias are required to confirm its utility. There is a need for a randomised control comparative study with a large sample size for confirmation of our results.

5 Conclusion

Spongioplasty alone as the second layer after TIPU for primary penile hypospadias in patients with Type-3 well-developed robust spongiosal tissue is associated with minimal, easily manageable complications.

6 Main points

1. Which flap to use as a second cover in primary repair of hypospadias, is a matter of debate.
2. Our study assesses the utility of GMS score perioperatively to objectively assign scores to stratify the severity of hypospadias and help decide the type of surgery.
3. Spongioplasty alone as a second layer can suffice, wherever it is thick and robust.

Abbreviations

CS: Corpus spongiosum; DPF: Dorsal preputial dartos flap; GMS: Glans, Meatus, Shaft; TIPU: Tubularised incised plate urethroplasty; TVF: Tunica vaginalis flap.

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None.

Author contributions

Concept: MM, VAG. Design: MM, VAG. Definition of intellectual content: MM, VAG, MA, PS, VS, SS, SD. Literature search: MM, VAG, MA, PS, VS, SS, SD. Data acquisition: MM, MA, PS, VS, SS, SD. Data analysis: MM, VAG, MA, PS, VS, SS, SD. Manuscript preparation: MM, VAG, MA. Manuscript editing: MM, VAG, MA, PS, VS, SS, SD. Manuscript review: MM, VAG, MA, PS, VS, SS, SD. Guarantor: VAG. MM wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval and consent to participate

Approval taken from Institutional Ethics Committee at Grant Medical College and Sir JJ Hospital, Mumbai. Ethics committee no. IEC/Pharm/RP/406/May/2021. Consent to Participate: informed written consent to participate in the study was provided by all participants (or their parent or legal guardian in the case of children under 16).

Consent for publication

Informed written consent for anonymized information to be published was provided by all participants (or their parent or legal guardian in the case of children under 16).

Competing interests

The authors declare that they have no competing interests.

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