

A novel technique for repair of mid-penile hypospadias using a preputial skin flap: results of 110 patients

Hazem Elmoghazy¹ · Mohamed M. Hussein¹ · Elnisr Mohamed¹ ·
Abdelbasset Badawy¹ · Gamal Alsagheer² · Ahmed Mamdouh Abd Elhamed¹

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Abstract

Background Several techniques have been used to repair mid-penile hypospadias; however, high failure rates and major complications have been reported. In this study, we describe a novel technique using a well-vascularized flap of the inner and outer preputial skin.

Methods A total of 110 male children with hypospadias underwent repair by our technique between 2008 and 2015. The inclusion criteria were children with mid-penile or slightly more proximal hypospadias, with or without ventral chordae, and an intact prepuce of the cobra eyes variety. Recurrent cases, patients with other preputial types, and circumcised children were excluded from this study. The prepared flap was sutured in its natural longitudinal orientation to the created urethral plate strip to form a neo-urethra over a urethral catheter. Outcome measures included surgical success without the formation of a urethra-cutaneous fistula, no ischaemia of the flaps, glans dehiscence or infection and functional outcome and cosmetic appearance.

Results The median follow-up duration was 3.3 years. There were 63 cases of mid-penile hypospadias (57.3 %), and in 47 cases (42.7 %), the meatus was slightly more proximal. The age of the patients ranged from 1.1 to 8.0 years, with a mean age of 4.6 ± 1.2 years. Surgery was successful in 106 (96.4 %) cases. Minor complications occurred in 11 patients (10 %) and included oedema of glans in ten patients and bluish discoloration on the ventral

aspect of the glans close to the suture line in three patients. All patients improved within 2 weeks after surgery. Long-term follow-up revealed a properly functioning urethra with a forward, projectile, single, compact, and rifled urinary stream of adequate calibre and cosmetically acceptable repair. No cases of meatal retraction, meatal stenosis, urethral stricture, or acquired urethral diverticulum occurred.

Discussion Our technique is different from the split prepuce in situ technique. We create a narrow strip of the urethral plate that facilitates glanular closure, and we use the inner and adjacent outer skin in a vertical manner to preserve excess skin for penile coverage. Prepuce is split at midline to preserve more preputial skin with favourable dartos tissue for penile skin coverage. The glans is closed using a stitch-by-stitch method that has not been described previously.

Conclusion This study presents a novel technique for mid-penile hypospadias repair using a preputial skin flap with excellent results in terms of short- and long-term outcomes.

Keywords Paediatric · Hypospadias · Flap

Introduction

Hypospadias is a common congenital anomaly that results from the incomplete development of the urethra causing an abnormal location of the external urethral meatus proximal to its site at the tip of the glans [1]. Many surgical techniques for hypospadias repair have been described since Duplay originally described the details of urethral reconstruction in 1874 [2]. The use of onlay island preputial skin flaps for hypospadias repair has had superior results and has a lower complication rate compared to the use of tubularized flaps [3]. Most techniques for hypospadias

✉ Hazem Elmoghazy
moghazyh@gmail.com

¹ Department of Urology, Sohag University Hospital, Alshark District, Sohag, Sohag Governorate, Egypt

² Department of Urology, South Valley University Hospital, Qena, Egypt

repair use the inner preputial skin only, which may be associated with relatively devascularized dorsal penile skin and Byars flaps, which are often of doubtful viability or even insufficient for covering the ventral side of the penis [4]. We developed a new technique to allow for one-stage repair of mid-penile hypospadias using a well-vascularized flap of the inner and outer preputial skin.

Patients and methods

A total of 110 male children with hypospadias were included in the study. The inclusion criteria were as follows: child with mid-penile or slightly more proximal hypospadias with or without ventral chordae and a prepuce of the cobra eyes variety [1]. Recurrent cases, those with other preputial types, and circumcised children were excluded from this study. Children who had severe chordae intra-operatively that required sacrifice of the urethral plate were also excluded.

All surgeries were performed between October 2008 and January 2015.

Outcome measures

The primary endpoints included surgical success without failure of the repair and without the formation of a urethrocutaneous fistula, ischaemia of the flaps, glans dehiscence, or infection. These endpoints were assessed at 5 days, 15 days, and 2 months after surgery.

The secondary endpoints included functional outcome and cosmetic appearance. Functional outcome was considered satisfactory when a straight penis was obtained with an external meatus at the tip of the glans and the patient could micturate an ideal stream of urine (single, compact, rifled, non-dispersed urinary stream of adequate calibre). These outcomes were assessed up to 5 years after surgery.

Success outcome depends on both primary and secondary outcomes.

Ethics committee approval was obtained for conducting this research study.

Post-operative follow-up

All patients were discharged home on the day of surgery, and on the 5th post-operative day, they returned for removal of the dressing and urinary catheter and for assessment of their operation. Patients were evaluated for the following aspects: presence of bleeding, haematoma, infection, oedema, or torsion; appearance of the glans penis, suture line and genitalia; and ability to have easy painless micturition of a straight non-dispersed urinary stream. A dispersed urinary stream can be expected prior to complete suture dissolving.

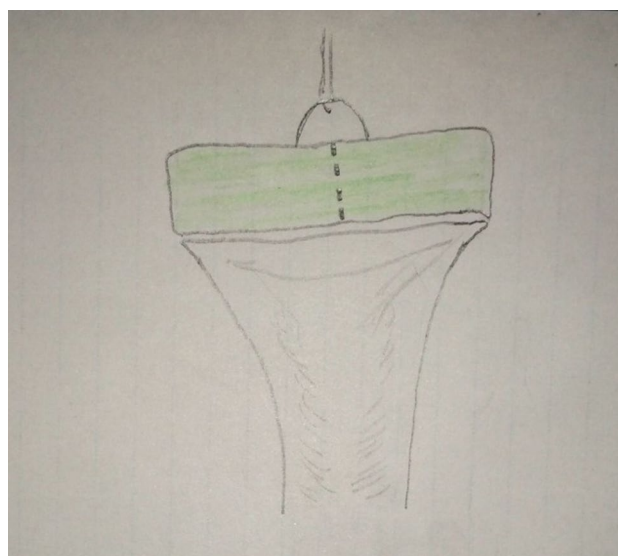


Fig. 1 Midline dorsal incision of the prepuce to create two flaps



Fig. 2 Correction of any residual curvature using dorsal plication

Follow-up was scheduled at 2 weeks, 2 months, 6 months, 1 year, and then yearly after surgery. During these visits, patients were evaluated for the same previous issues in addition to assessing the site of the neo-meatus, presence of any curvatures, quality of the urinary stream, and satisfaction of

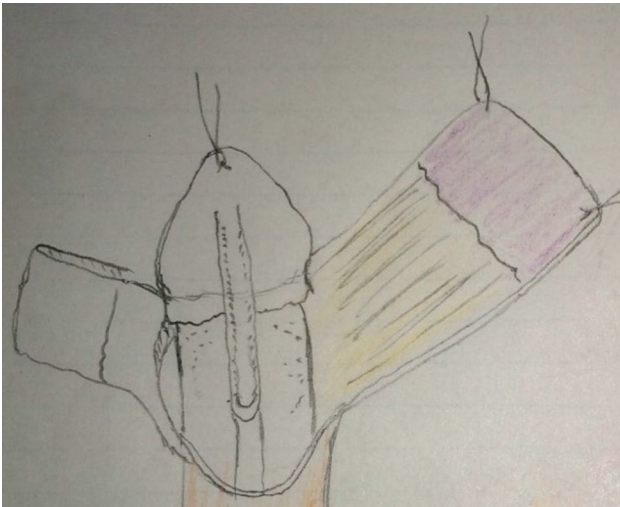


Fig. 3 Determine the length of the preputial tissue required to form a neo-urethra

the parents and physicians who did not participate in the surgery in the cosmetic appearance of the penis. Evaluation of our patients depends on special questionnaire that was evaluated by the operator, high specialized nurse, parents, specialized paediatric surgeon not included in the study.

Operative technique

A traction suture is placed in the glans. Two parallel incisions are made in the urethral plate 2–3 mm from each other to create a small strip of the urethral plate for tube support only. The two incisions are extended to the apex of the plans. Another circumferential incision is made approximately 6 mm proximal to the corona sulcus. Then, the penile skin is de-gloved along the Buck's fascia (Figs. 1, 2).

In patients with mild to moderate chordae, the chordae are excised, and the residual curvature is corrected using the Nesbit technique. Then, artificial erection is induced to confirm adequate penile straightening.

Preparation of the flaps is initiated by determining the length of the preputial tissue required to form a neo-urethra. A midline incision is made in the dorsal and ventral prepuce (Figs. 1, 2).

This creates two equal halves of the dorsal prepuce in a V-shape. One half is used for creation of the neo-urethra, and the other is used for penile coverage (Fig. 3).

For creation of the neo-urethra, an onlay flap is prepared. In a 5–10-mm piece of the mucosal flap, the overlying preputial skin is kept intact, and the penile shaft skin proximal to this area is dissected up to the apex of V-shaped dorsal incision and then excised (Fig. 3). The length of the dorsal preputial skin kept depends on the length of the tube needed (Fig. 4).

The prepared flap is sutured in its natural longitudinal orientation to the created urethral plate strip to form a

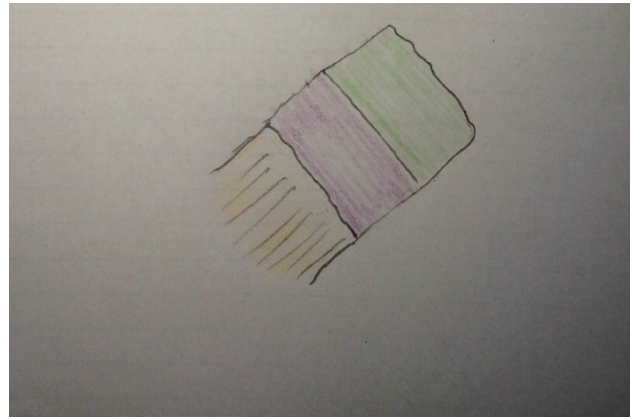


Fig. 4 The onlay flap is prepared from both inner and outer preputial skin

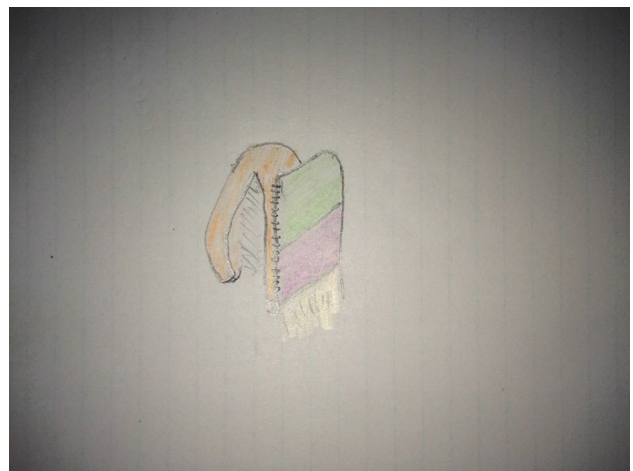


Fig. 5 The new flap is sutured to the urethral plate in its vertical axial direction

neo-urethra using a running 6/0 polyglactin suture over a 12–14-Fr urethral catheter (Fig. 5). The glans is closed in a new fashion using stitch-by-stitch technique. By using this method, we use stitches between the glans and flap till complete closure in a conical manner. Then the glans are closed together in two layers. We did not use a suprapubic tube in any of our cases. The redundant de-epithelialized pedicle was used to form a second layer of coverage of the neourethral suture lines by using an interrupted 6-0 polyglactin suture; this allowed for a bulky well-vascularized piece of tissue to be interposed between the neo-urethra and skin closure. A compressive sterilized dressing was used (Figs. 6, 7, 8).

Results

Between October 2008 and January 2015, 365 patients presented with hypospadias at our paediatric urology clinic. A

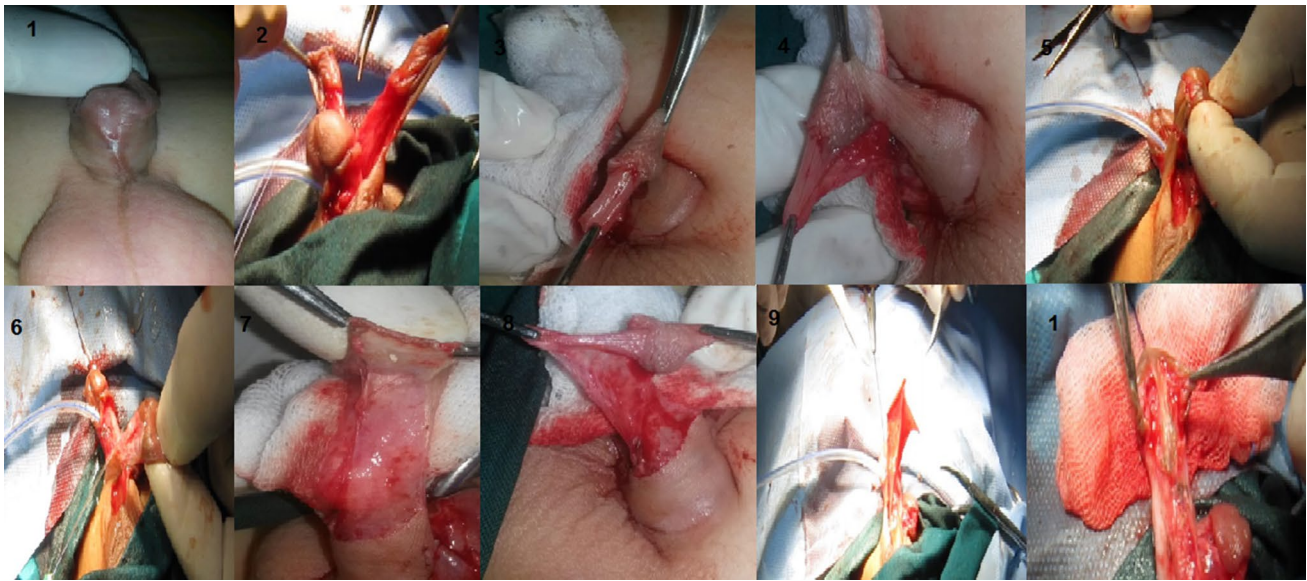


Fig. 6 1 Male child 6 years with mid-penile hypospadias (hypoplastic urethra which was excised to near proximal penile). 2 Midline splitting of the dorsal preputial skin to obtain V-shaped vascularized Byars flaps. 3, 4 Determination of the flap needed. 5 Making a superficial incision in the epidermis proximal that extends to the outer preputial skin, then starting de-epithelization distally towards the apex

of the V incision. 6, 7 Extension of de-epithelization of the dorsal dartos, proximal to the outer preputial skin, down to the apex of the V-shaped incision of the Byars flaps. 8, 9 Obtaining well-vascularized outer and inner preputial skin flaps. 10 Making a narrow strip of the urethral plate with wide glanular wings, with bilateral incisions that extend to the tip of the glans for achieving a tension-free closure

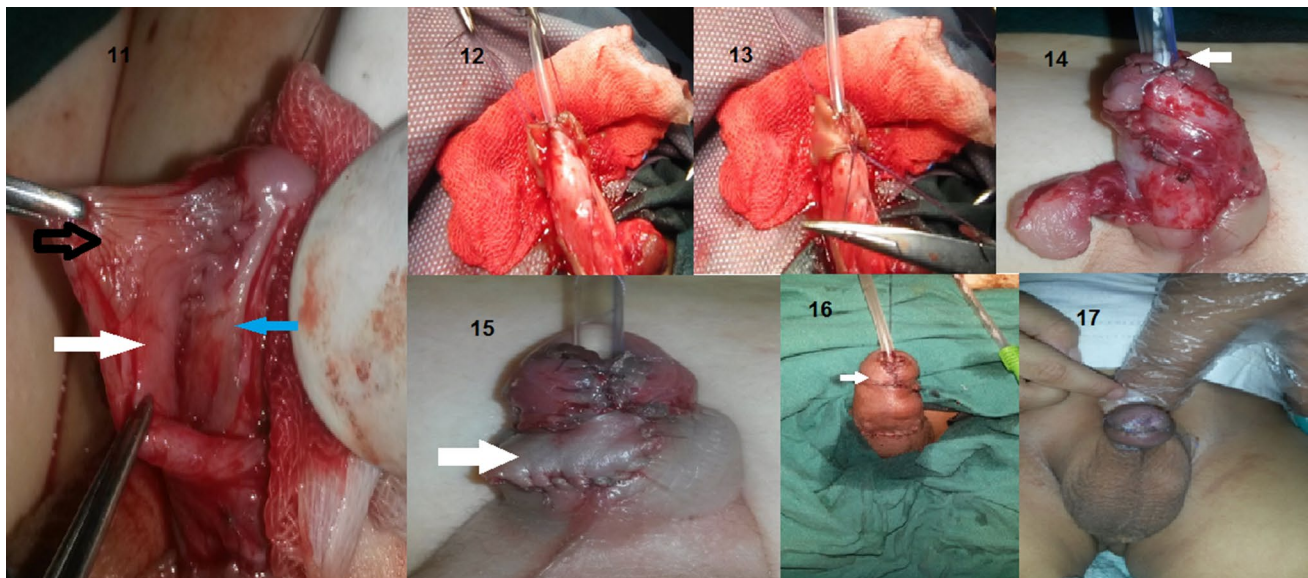


Fig. 7 11 Flap is sutured to the urethral plate in a vertical manner (*white arrow* for inner prepuce, *black arrow* for outer prepuce, and *blue arrow* for urethral plate). 12 We obtain thick dartos for multi-layer covering of the suture line. 13 Well-created glanular wings that cross each other in the midline are shown. This allows tension-free closure of the glans. 14 Glanular closure technique; using stitch-by-stitch method to create vertical meatus then glans closure in the mid-

line using mattress sutures (*white arrow*). 15 Rotation of the other Byars flap (*white arrow*) to cover the ventral aspect of the penis after complete glans closure. 16 Immediate post-operative; cosmetically acceptable repair with completely closed glans at the midline (*white arrow*) with multiple stitches. The meatus at the tip of the glans over 14-Fr urethral catheter. 17 Five days post-operative after removal of the catheter

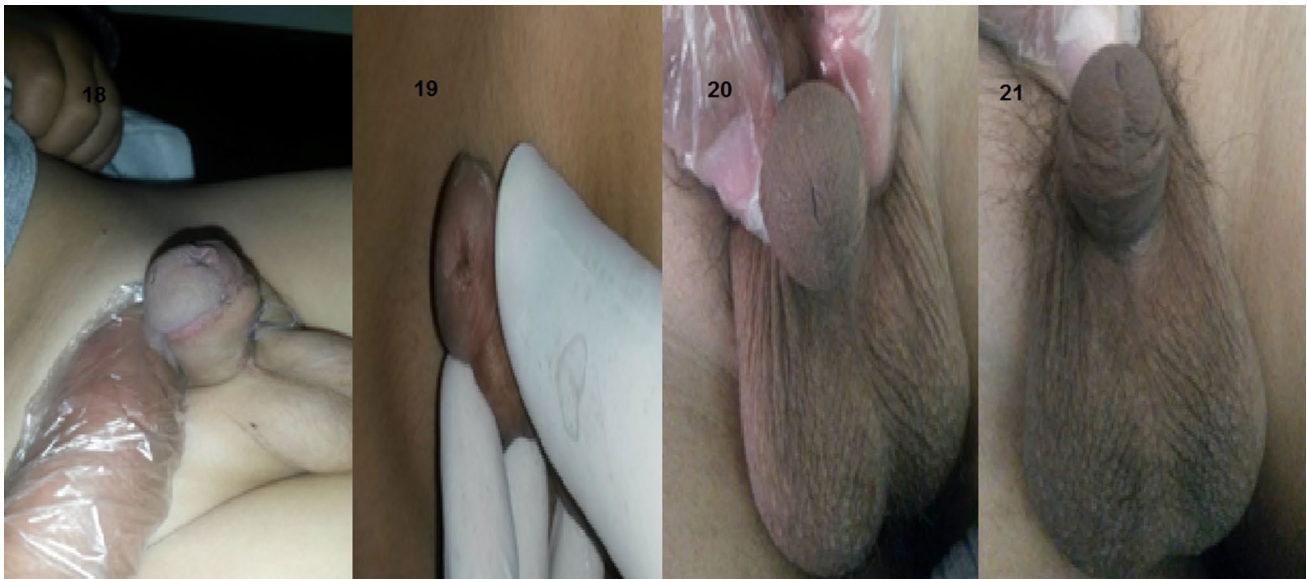


Fig. 8 18 Two months post-operatively. 19 Late follow-up after 3 years. 20 Late follow-up after 5 years ant. view. 21 Late follow-up after 5 years ventral view

Table 1 Characteristics of patients in the study

Variable	Summary
Age of patients (years)	4.6 ± 1.2
Median follow-up (years)	3.3
Site of meatus	
Mid-penile	63 (57.3 %)
Proximal meatus	47 (42.7 %)
Chordae	
Mild	30 (27.3 %)
Moderated	80 (72.7 %)

Continuous variables are shown as mean ± standard deviation, categorical variables are summarized as number (%)

total of 110 patients fulfilled criteria and were included in our study to undergo surgical repair by our novel technique. The median follow-up duration was 3.3 years.

There were 63 cases of mid-penile hypospadias (57.3 %), and in 47 cases (42.7 %), the meatus was slightly more proximal. Thirty (27.3 %) patients had a ventral curvature, which was corrected by dorsal midline plication. The age of the patients ranged from 1.1 to 8.0 years, with a mean age of 4.6 ± 1.2 years (Table 1).

Surgery was successful in 106 (96.4 %) cases. The repair failed in two patients during the first month after surgery: one patient had a disrupted suture line and the other had a sloughed flap. Both were treated surgically after 6 months. Another two patients presented with urethra-cutaneous fistulae at the site of the original meatus more than 2 months after surgery: one patient was treated conservatively, and

the other patient had a large fistula that required surgical closure. All of these complications occurred in the first 20 cases, and no major complications occurred in the following 90 cases.

Minor complications occurred in 11 patients (10 %) and included oedema of the glans in ten patients and bluish discoloration on the ventral aspect of the glans close to the suture line in three patients. These minor complications improve in all patients within 2 weeks after surgery.

All patients attended the first follow-up visits (days 5 and 15 after surgery and 2 months after surgery). Fifty per cent of patients dropped out of the study 1 year after surgery till the end of follow-up period.

Long-term follow-up (up to 5 years after surgery) revealed a properly functioning urethra with a forward, projectile, single, compact, and rifled urinary stream of adequate calibre and cosmetically acceptable repair. No cases of meatal retraction, meatal stenosis, urethral stricture, or acquired urethral diverticulum occurred.

Discussion

This study included a cohort of 110 patients who underwent repair of midshaft hypospadias using our novel technique and showed that this technique has excellent results, with a 96.4 % rate of successful repair and a low rate of minor complications (10 %), all of which resolved spontaneously without treatment. With a median follow-up duration of 3.3 years, the long-term results in terms of functional and cosmetic outcome were satisfactory.

We think that these results are due to several principals that were considered when developing our technique. First, the prepuce is split at the midline to produce two flaps for neo-urethra formation and for covering the degloved penis. The flaps are used in their axial direction to ensure good vascularity of the flaps, to allow for repair without tension, and to generate a low risk of post-operative flap retraction.

Second, we create a wide neo-urethra using a narrow strip of the urethral plate and a flap with a large width. This provides a distensible and elastic neo-urethra with no risk of outflow resistance in addition to making closure of the glans wings over the wide-bore catheter feasible despite the presence of a bulky pedicle. This explains our good results: no reported cases of meatal stenosis and satisfactory cosmetic outcomes.

Third, the redundant de-epithelized pedicle, which is a bulky well-vascularized piece of tissue, was interposed between the neo-urethra and skin, acting as a second layer of reinforcement of the suture line of the neo-urethra.

Fourth, the use of dorsal preputial skin in the flap, which is a non-hairy with the same characters as inner preputial skin allows increasing flap length according to meatal site.

Several techniques have been described for the repair of mid-penile hypospadias, including tubularized incised plate urethroplasty (TIP) [11], the use of a transverse island flap (TIF) [12], and two-stage repair using a preputial skin graft [13, 14], buccal mucosal graft [15] or bladder mucosal graft [16, 17].

Rushton and Belman [18] described the split prepuce *in situ* technique, but it has many differences from our technique. In our technique, we create a narrow strip of the urethral plate that facilitates glanular closure, while they use the whole width of the plate. Furthermore, we use the inner and adjacent outer skin in a vertical manner to preserve excess skin for penile coverage, especially in more proximal hypospadias cases, while they use the inner preputial skin and a transverse island preputial flap.

We split the prepuce at the midline, which preserves more preputial skin with favourable dartos tissue for penile skin coverage.

Additionally, preservation of adequate skin from the other half of the V flaps with adequate dartos tissue allows for multilayer coverage of the flap. The extended incisions in the plate and glans closure technique used in this study, a stitch-by-stitch method, have not been described previously.

Published results are variable between different centres and with different techniques. For surgeries that use pedicle flaps, reported complication rates vary in the published literature from 10 to 50 % and repair failure is as high as 34 % [19].

Tubularized incised plate urethroplasty (TIP) has been used successfully for the repair of distal and mid-penile hypospadias of any age with good results; however, extending indications of this procedure to more proximal hypospadias were associated with a high complication rate of 21 % incidence of urethra-cutaneous fistula, as reported by Snodgrass et al. [20]. Other studies [5–7] have reported a fistula rate of 16 % and a rate of failure of surgery and re-operation of 17.5–33 %. A stiff, less elastic, and non-distensible long TIP neo-urethra may account for these high complication rates in the absence of anatomical stricture of the urethra or meatal stenosis. Therefore, the TIP neo-urethra length to calibre ratio may be an indicator of resistance just beyond the native urethra [8]. Additionally, Holland et al. reported that urethral plate width has a great effect on the outcome of cases managed by TIP operation. Therefore, patients with a shallow urethral plate are more likely to have a narrow urethral calibre with a higher risk of developing a fistula [9].

The transverse island flap (TIF) technique is one of the widely used techniques for proximal hypospadias repair, and it has been popularized by Duckett et al. [12], who reported a complication rate of 10 % using that technique.

Many surgeons have reported repair of hypospadias using pedicled onlay or tubed grafts, with a 40 % rate of fistulas, 10 % rate of strictures, and complete breakdown in 7 % of cases. These procedures are associated with poor cosmetic appearance in the form of excessive ventral bulkiness, penile torsion, and meatal abnormalities in up to 60 % of cases [19, 21–24].

Singh et al. [25] presented their experience with the Asopa procedure; they reported complication and fistula rates of 40 and 30 % with tubed repairs compared to 18 and 13 % with onlay flaps, respectively. Proximal hypospadias was a risk factor for poor outcome.

The conventional onlay flap technique involves rotation and asymmetry of the penis to one side, as the vascular pedicle is brought around this side of the penis, and the remaining skin is insufficient for ventral penile covering [4]. This technique was modified by using a double onlay preputial flap, by ventral transpositioning of the total preputial flap, and by passing the penis through a buttonhole incision in the dorsal pedicle while avoiding the blood vessels [10]. However, it is associated with a persistent bulge on the ventral aspect of the penis that probably results from impaired venous or lymphatic drainage [4].

In this study, we present an easy-to-learn technique that was developed by the first author of this report and was reproduced by the other authors of this report without major complications.

Our technique differs from the double-faced flap. In the double-faced: the urethral plate is preserved and a double-faced preputial flap is developed. The inner face of the flap

is sutured to the urethral plate to create the neo-urethra and the outer face together with the rest of the dorsal prepuce is used for ventral skin coverage but without complete glanular closure [28]. However, in our technique both the inner and outer faces of the flap are anastomosed to the urethra with complete glanular closure. So we can say that it is “a single faced inner and outer flap with thick dorsal dartos that provides two layers of covering”.

However, reproducing these results by surgeons at other centres is necessary to validate this technique. Additionally, comparing results of different techniques used for mid-penile hypospadias repair to this technique is necessary. Currently, data for such cases at our institute are being collected, and another study will be reported in the near future. One of the limitations of our technique is the removal of the foreskin, as this can affect the appearance of the penis, which is one of the aspects that was examined during long-term follow-up [26, 27]. However, in our region, circumcision is performed routinely for all male children due to religious beliefs. Another limitation is the small cohort with relatively short FU periods. Another work with larger cohort for longer FU till the end of childhood is under preparation.

In conclusion, this study presents an easy-to-learn novel technique for mid-penile hypospadias repair using a preputial skin flap with excellent results in terms of short- and long-term outcomes.

Authors' contribution H. Elmoghazy contributed to project development, project preparation, data preparation and collection, manuscript writing and editing. M. M. Hussein contributed to data preparation. Elnisr Mohamed contributed to manuscript editing. A. Badawy contributed to data analysis. Gamal Alsagheer contributed to project preparation. A. M. Abd Elhamed contributed to data preparation, manuscript editing.

Compliance with ethical standards

Conflict of interest The author guarantees that there is no financial or personal relations with other people or organizations that could influence our work (no conflict of interest).

Ethical standards Ethics committee approval was obtained.

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