

# Outcomes of Tubularized Incised Plate Urethroplasty in Proximal Hypospadias: A Single-Center Experience

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**Abstract:** **Background:** The aim of this study was to assess the outcomes of the tubularized incised plate (TIP) urethroplasty in the treatment of proximal hypospadias. **Methods:** A prospective study was conducted at Children's Hospital 2 in Ho Chi Minh City from March 2012 through March 2015. Patients presented with proximal hypospadias were submitted for a TIP urethroplasty. Data were collected and analyzed in terms of patient characteristics, operative data, postoperative complications, and outcomes at least 6 months after the operation. **Results:** The 278 patients were enrolled in this study. Mean age of the patients was  $3.6 \pm 2.8$  years. Median follow-up time was 2.0 years [0.5 - 3.7 years]. The success rate of TIP urethroplasty was in 197/278 (70.9%) patients. The 81/278 (29.1%) patients reported with failure of TIP urethroplasty: urethral fistula in 57/278 (20.5%) patients, partial urethral dehiscence in 18/278 (6.5%) patients, and meatal stenosis in 6/278 (2.1%) patients. Patients  $\geq 3$ -year-old and length of neourethroplasty  $\geq 3$  cm were significantly associated with a risk of TIP technique failure with adjusted ORs: 1.9 [1.3 - 2.8],  $P=0.001$  and 3.4 [1.7 - 6.8],  $P<0.001$ ; respectively. **Conclusions:** TIP urethroplasty could be an alternative method for repairing proximal hypospadias with good results.

**Keywords:** Hypospadias, Urethroplasty, Tubularized Incised Plate (TIP), Complications, Outcomes

## Abbreviation

- TIP: Tubularized Incised Plate
- UP: Urethral Plate
- TVF: Tunica Vaginal Flap
- PDF: Preputial Dartos Flap
- PC: Penile Curvature

## 1. Introduction

Hypospadias is a common congenital abnormality of the penile urethra that is mainly characterized by an ectopic position of the urethral meatus and a penile curvature of varying degrees [1]. The goals of surgical treatment are to straighten the penis by correcting the ventral penile curvature (PC) and to create a neourethra with its meatus at the tip of the glans [1]. To date, over 300 methods of surgical repair have been described for the correction of hypospadias [2]. However, no current evidence suggests the superiority of one surgical technique over another, especially in cases with more proximal hypospadias [3].

The treatment of proximal hypospadias is always a challenge for the pediatric urologists [4,5]. The choice of surgical methods is somehow limited, technically difficult or even requiring staged procedures, and a high rate of postoperative complications [3,2,6]. In 1994, Snodgrass introduced the tubularized incised plate (TIP) urethroplasty which is based on an old principle of urethral plate (UP) tubularization, also known as the Thiersch-Duplay procedure [7]. The TIP repair is a once-off technique and involves the preservation of UP

considered as a currently clinical concept in urethroplasty [8-10,2]. The technique is rapidly gaining popularity due to its simplicity, low complication rate, as well as superior cosmetics, and has become the most frequent technique used for repairing distal hypospadias [10,7,11]. The feasibility of this technique to proximal hypospadias has been also demonstrated in some reports in the literature. However, large-scale prospective studies are still lacking [3,12,6]. Therefore, we conducted this study at the Children's Hospital 2 in Ho Chi Minh City, Vietnam to investigate the role of the TIP urethroplasty in repairing proximal hypospadias.

## 2. Methods and Materials

A prospective study was conducted at Children's Hospital 2 in Ho Chi Minh City, Vietnam from March 2012 to March 2015 in accordance with the Research Ethics Committee of the hospital. Patients presented with proximal hypospadias underwent hypospadias repairs in intention to do a TIP urethroplasty. The penile skin was degloved with a U-shaped incision that preserved the UP followed then by removing dysplastic and/ or fibrous tethering tissue. An artificial

erection was induced by injecting normal saline to detect PC. Depending on the degrees of PC, if the PC is  $< 30^\circ$ , a midline dorsal plication was used. On the contrary, if the PC is  $\geq 30^\circ$ , the UP would be then mobilized. If the PC decreases to  $< 30^\circ$ , midline dorsal plication was applied in parallel. If the PC remains  $\geq 30^\circ$ , a UP transection had to be done [13]. The latter patients were, therefore, excluded from the survey of TIP urethroplasty. In the most severe cases, a corporotomy using dermal graft has been done to release the persistent PC. These patients were then shifted to 2-staged procedures.

Regarding patients with successful preservation of UP after correcting PC, a TIP technique was used for urethroplasty (Fig. 2-D). A deep midline relaxing incision was made in the UP from the meatus to its most distal extent. The plate was tubularized by using 7.0 absorbable stitches [PDS® (polydioxanone) sutures] and a variety of suture techniques, including interrupted or running sutures placed through all layers. A silicone bladder catheter with an appropriate caliber (8 -12 Fr) was used, often 8 FR, and usually removed at 7 to 10 days after operation. An intraoperative compression dressing by sterile gauzes and a soft compression bandage was used and removed 3 days after operation (Fig. 2-H). In all cases, barrier layers were placed over the neourethra by using either a preputial dartos fascia flap (PDF) or a tunica vaginalis flap (TVF). All the cases have been operated on only by the 2 senior surgeons of the Department of Urology at Children's Hospital 2, Ho Chi Minh City, Vietnam.

Postoperative management was performed by evaluating the complications such as bleeding, swelling, hematoma, infection, rupture, accidental removal of the catheter. According to each complication, appropriate management was provided. Patients were discharged when in good postoperative condition and after removal of the catheter.

Demographic and clinical data were collected on the date of birth, age at surgery, operative characteristics, postoperative complications, and follow-up results. Patients underwent urethroplasty operation according to TIP technique and followed up for at least 6 months after operation were enrolled into this study.

### 3. Statistics

Data are reported as mean and standard deviation or as median and range for continuous variables according to the normality of the distribution, and as number and proportion for discrete data. Chi-square or Fisher's exact test were used to compare categorical data. Non-parametric Mann-Whitney U tests were used to compare medians. Univariate and multivariate logistic regressions were used to identify the contribution of independent variables by calculation of odds ratios (ORs) and 95% confidence intervals (CIs). All tests were two sided and a p-value of  $<0.05$  was considered as significant. Cramer's V was used to measure the association between nominal variables. IBM SPSS Statistics version 20 (SPSS, Chicago, Illinois, United States) was used for statistical analysis.

## 4. Results

### 4.1 Patient and operative characteristics

A total of 359 patients presented with proximal hypospadias underwent a urethroplasty operation during the time of this study. Of note, 81/359 (22.6%) of patients have been undergone a urethral plate transection to correct severe penile curvature and shifted to the 2-staged procedures; therefore, excluded from this study.

Patient and operative characteristics according to types of urethroplasty operation were illustrated in Table 1. There were no significant differences in terms of age at surgery, age groups, as well as associated anomalies between the group of patients with single stage repair (TIP technique) and 2-staged repairs. Regarding operative characteristics, 67.2% of the patients with 2-staged repairs had posterior hypospadias (penoscrotal, scrotal, and perineal in 60.5%, 3.7%, and 2.5%, respectively) as compared to 39.2% of the patients with single stage repair (penoscrotal, scrotal, and perineal in 36.3%, 2.2%, and 0.7%),  $p < 0.001$ . In addition, 100% of the patients with 2-staged repairs had penile curvature  $\geq 30^\circ$  after degloving that required a UP transection.

### 4.2 Postoperative outcomes

The postoperative outcomes including follow-up time, postoperative complications, and treatments were shown in Table 2. Mean follow-up time was  $2.1 \pm 0.9$  years. The overall success rate of TIP technique was 70.9% (197 out of 278 patients). Figure 1 showed the complication and the reoperation rates according to the patients with a middle shaft and posterior hypospadias.

In regard to postoperative outcomes, there were 6 patients presented with meatal stenosis requiring a meatoplasty, 57 (20.5%) patients with urethral fistula requiring a fistula correction, and 18 (6.5%) patients with partial urethral dehiscence requiring a redo-urethroplasty have been done. In overall, 81 patients (29.1%) required a surgical intervention which was considered as a failure of TIP technique. Other complications such as urethral stricture, urethral diverticulum, and urethral dehiscence were not observed in our patients at the last follow-up visit.

During follow-up time, 95 out 278 patients (34.2%) clinically presented with the narrow urinary stream have, therefore, undergone a meatal dilation. As a result, 89 out of these 95 patients have been successfully managed solely by meatal dilatations. Interestingly, 7 patients had a mild urethral fistula that was spontaneously resolved after a series of meatal dilations for treating meatal stenosis as well.

Table 3 shows the association between patient and operative characteristics with the risk of a TIP failure. The risk of a TIP technique failure was significantly increased in patients  $\geq 3$  years of age, with a length of neourethra  $\geq 3$ cm. However, in multivariate regression analysis after adjustment of age groups, position of meatus, penile curvature, materials covering neourethra, length of neourethra, risk of failure of TIP technique was significantly

increased in patients  $\geq 3$  years old (adjusted OR = 2.0, 95% CI [1.3 – 2.8],  $p = 0.001$ ), and length of neo-urethra  $\geq 3$ cm (adjusted OR = 3.4, 95% CI [1.8 – 6.8],  $p < 0.001$ ). The position of meatus was not introduced into the multivariate regression because of its high correlation with length of neo-urethra (Cramer’s  $V=0.62$ ).

**Table 1:** Patient and operative characteristics of 359 patients operated on for hypospadias according to types of urethroplasty

Characteristics	Single-stage repair (TIP), (n=278)	Two-staged repairs, (n=81)	P-value
<b>Age at surgery (months)</b>			
- Mean $\pm$ SD	3.6 $\pm$ 2.8	3.6 $\pm$ 2.6	0.91 <sup>a</sup>
- Median (range)	2.6 (0.8 – 15.0)	2.7 (0.9 – 12.7)	0.87 <sup>b</sup>
<b>Age groups, n (%)</b>			0.66 <sup>c</sup>
- 0 – < 3 years	160 (57.6)	45 (55.6)	
- $\geq 3$ – $\leq 6$ years	84 (32.2)	23 (28.4)	
- > 6 years	34 (12.2)	13 (16.0)	
<b>Positions of meatus after degloving, n (%)</b>			
- Mid-shaft	83 (30.0)	2 (2.5)	-
- Proximal penile shaft	86 (30.9)	25 (30.9)	
- Penoscrotal	101 (36.3)	49 (60.4)	
- Scrotal	6 (2.1)	3 (3.7)	
- Perineal	2 (0.7)	2 (2.5)	
<b>Degrees of penile curvature, n (%)</b>			
- No	166 (59.6)	0	-
- < 30°	85 (30.5)	0	
- $\geq 30^\circ$	27 (9.7)	81 (100%)	
<b>Methods of correcting curvature, n (%)</b>			
- Degloving	165 (59.4)	0	-
- Midline dorsal plication	86 (30.9)	4	
- Midline dorsal plication + UP mobilization	27 (9.7)	0	
- Plate transection	0	81 (100%)	
- Corporotomy and dermal grafting	0	3	
<b>Materials covering the neourethra, n (%)</b>			
- Preputial dartos fascia flap	248 (89.2)	-	
- Tunica vaginalis	30 (10.8)	-	
<b>Length of neourethra (cm)</b>			
- Mean $\pm$ SD	3.2 $\pm$ 1.0	-	
- Median (range)	3.0 (1.5 – 8.0)	-	
<b>Operation time (minutes)</b>			
- Mean $\pm$ SD	116.5 $\pm$ 23.5	-	
- Median (range)	115 (65 – 185)	-	

Abbreviation: TIP, tubularized incised plate; UP, urethral plate

<sup>a</sup> T-test; <sup>b</sup> Mann-Whitney U test; <sup>c</sup> Fisher-exact test

**Table 2:** Postoperative outcomes, complications, and follow-up of patients underwent TIP (Snodgrass) techniques in urethroplasty operation (n=278)

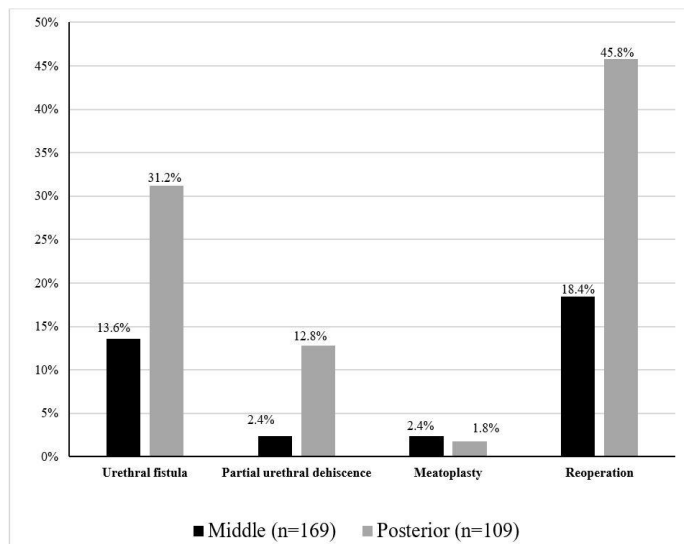
Variables	Results
<b>Follow-up time (years)</b>	
- Mean $\pm$ SD	2.1 $\pm$ 0.9
- Median (range)	2.0 (0.5 – 3.7)
<b>Overall success rate, n (%)</b>	197 (70.9)
<b>Complications during follow-ups, n (%)</b>	
- Urethral fistula	57 (20.5)
- Partial urethral dehiscence	18 (6.5)
- Complete dehiscence	0
- Meatal stenosis	6 (2.1)
- Urethral stenosis	0
- Urethral diverticulum	0
<b>Treatment, n (%)</b>	
- Dilation	89 (32.0)
- Meatoplasty	6 (2.1)
- Fistula correction	57 (20.5)
- Redo-urethroplasty	18 (6.5)

Abbreviation: TIP, tubularized incised plate

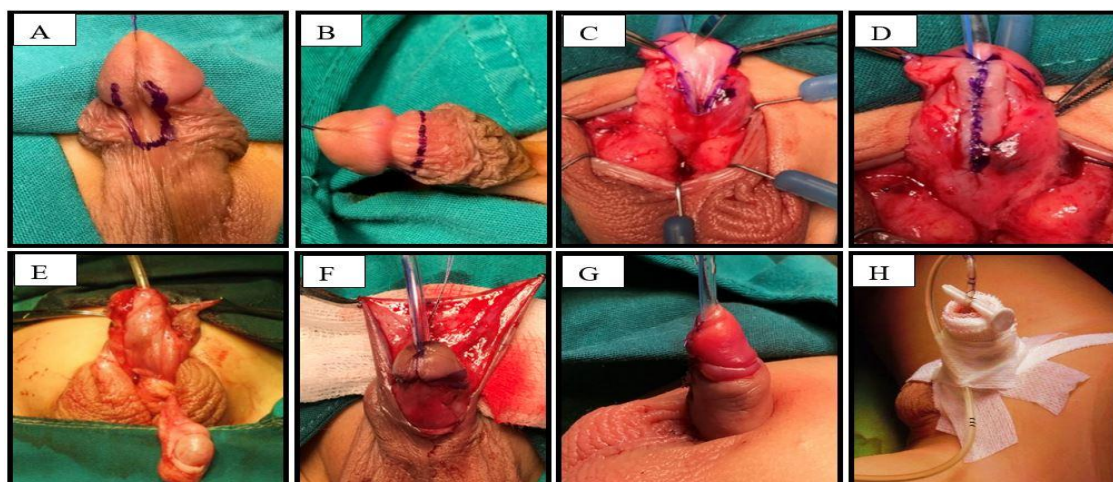
**Table 3:** Factors associated with the risk of failure of Snodgrass technique in the 278 patients undergoing an urethroplasty operation using multivariate logistic regression

Factors	N	Failure (n=81)		Univariate OR [95%CI]	Multivariate Adjusted OR [95%CI]
		%	p-value		
<b>Age groups</b>					
- < 3 years	160	23.1	0.001	1	1
- ≥ 3 years	118	37.2		1.9 [1.1 – 3.1]	2.0 [1.3 – 2.8]
<b>Positions of meatus #</b>					
- Middle	83	15.7	0.002	1	-
- Posterior	195	34.9		2.9 [1.5 – 5.6]	-
<b>Penile curvature</b>					
- < 30° after degloving	251	27.9	0.317	1	1
- ≥ 30° after degloving	27	40.7		1.8 [0.8 – 4.0]	1.6 [0.7 – 3.7]
<b>Materials covering neourethra</b>					
- Preputial fascia flap	248	30.2	0.11	1	1
- Tunica vaginalis	30	20		1.7 [0.7 – 4.4]	0.5 [0.2 – 1.2]
<b>Length of neourethra</b>					
- < 3 cm	88	15.9	<0.001	1	1
- ≥ 3 cm	190	35.3		2.9 [1.5 – 5.5]	3.4 [1.8 – 6.8]

#: The position of meatus was not introduced into the multivariate regression because of its high correlation with length of neo-urethra (Cramer’s V=0.62). Middle forms include mid-shaft and proximal penile shaft hypospadias; posterior forms include penoscrotal, scrotal, and perineal hypospadias.



**Figure 1:** Percentages of complications according to preoperative position of meatus (n=278). Middle forms include mid-shaft and proximal penile shaft hypospadias; posterior forms include penoscrotal, scrotal, and perineal hypospadias



**Figure 2:** Illustration of tubularized incised-plate urethroplasty; A, B: U-shape and coronal incision; C: deep midline urethral plate incision; D: urethroplasty sutures with catheter bladder placed in situ; E: tunica vaginalis flap; F: glanuloplasty; G: straight penis after urethroplasty; H: intraoperative dressing with elastic bandage.

## 5. Discussion

The current concept of hypospadias repair is to preserve the UP to create a neourethra according to TIP urethroplasty [2,14]. However, persistent PC defects, as well as histopathological abnormalities of UP, could be the factors more common in cases with severe proximal hypospadias that prevent the implementation of TIP urethroplasty [10,8]. Notwithstanding, the TIP urethroplasty has not only become the most popular technique for correction of distal hypospadias, it has also been applied to proximal forms [15]. Nevertheless, the repair of proximal hypospadias remains a challenge for pediatric urologists [3].

In terms of the outcomes, our study showed that the success rate of TIP urethroplasty was reported with 70.9% (197 out of 278 patients), whereas failure of TIP was reported in 81 other patients (29.1%) in whom a reoperation was required; including urethral fistula 20.5%, partial urethral dehiscence 6.5 %, and meatal stenosis 2.1%. Our results were comparable or even better in comparison with the results of previously published series in the literature. Snodgrass *et al.* reported a total complication of TIP repair for proximal was 37% [16]. According to Braga *et al.*, a total complication rate of TIP was 60% in 30 children with proximal hypospadias [17]. Recently, Pfistermuller *et al.* reported a total complication rate of TIP was 10.3% (mean 10.3%, range 6.3 - 16.3%) with reoperation rate of 12.2% (mean 12.2%, range 7.7 - 18.6%) according to a meta-analysis of complication rates of TIP repair including 4675 patients for primary proximal hypospadias [2]. Of note, our results were comparable with other studies using techniques commonly used for proximal hypospadias as well; such as with onlay flap, onlay tube, the overall complication rates were 31- 42% with fistula rates of 14-23% [10,18-21]. Braga *et al.* reported the success rates of the TIP and the transverse island onlay methods were 60% and 43%, respectively [17]. Looking more precisely at the postoperative complications, our report found that patients  $\geq 3$  years old and the length of neourethra  $\geq 3$  cm significantly correlated with a higher risk of failure of the TIP technique. In fact, the patients with posterior hypospadias experienced higher incidences of urethral fistula, partial urethral dehiscence, and reoperation as compared with proximal penile shaft hypospadias as shown in Fig. 1 [2].

Noticeably, there was a wide range of complication rates related to TIP repair published in the literature [2]. At our knowledge, the present series was the prospective study with a remarkable number of patients as compared with other series published in the literature. The median follow-up time of our report was 24 months after the operation. In addition, all the cases were operated on only by the 2 senior pediatric urologists. It is noticed that significant improvements in the results of proximal hypospadias repair could be achieved with accumulating experiences [3].

Regarding urethral fistula, it was well established as one of the most common complications in hypospadias repair [22]. The TIP repair has evolved to incorporate modifications that have significantly lowered complications [2]. We used the covering layers with materials collected from either PDF or TVF in the present study [16,23]. According to Babuet *al.*,

TVF reduces the fistula rate and is superior to PDF as a waterproofing layer for primary TIP repair [23]. In our series, the failure rates with TIP repair for TVF and for PDF were 20% and 30.2%, respectively. However, the difference was not significant ( $p=0.110$ ) (Table 3). Of note, the TVF was usually used in cases of posterior form as compared with PDF for middle form; whereas the rates of fistula in cases of posterior form more frequent than in cases of the middle form [6]. It is still controversial and needs more, big prospective controlled series to compare between these 2 modifications [6,19].

On the other hand, the association of urethral fistula with urethral dilation has been found in 7 cases in our series that previously described by Elbakry *et al.* [24]. In 1999, Snodgrass *et al.* recommend performing urethral dilation in routine after TIP urethroplasty [25]. However, later on, the authors stated that it just need in some real meatal stenosis [19,26]. It raised a dilemma to dilate meatus postoperatively in routine or not in an attempt to reduce the incidence of fistula. In our series, we postoperatively followed up the patients carefully to detect early the abnormality of a urinary stream during urination. In cases with a narrow urinary stream and difficulty to dilate with catheter 8Fr, we performed meatal dilation in parallel with educating the parents to perform it daily at home. And we validated the results in each visit during follow-up time. As the results, we reported 7 patients in our series had a mild urethral fistula that was spontaneously resolved after a series of meatal dilations for treating meatal stenosis as well.

In regard to the correction of PC considered as a very important issue in hypospadias repair, several methods and modifications have been introduced to release this defect [27]. One striking shortcoming of TIP repair is the failure of UP preservation due to severe penile curvature in more proximal cases requiring a UP transection to straighten the penis. In our report, UP transection has to be done in 29.1% (81/359 cases). Snodgrass *et al.* reported with 36% of UP transection in patients with proximal hypospadias [9]. Of note, not many authors mentioned the rate of successful UP preservation in cases of high-degree penile curvature in a prospective manner [16].

As well demonstrated by Erol *et al.*, the contribution of UP in urethroplasty resulted from the anatomical findings (good vascularization, rich nerve supply and an extensive muscular and connective tissue backing) [8]. This study was designed in the intention to maximize the opportunity of using UP for TIP repair. Snodgrass *et al.* have shown a potential extension of TIP indication by UP dissection from the corpora to enable straightening of severe penile curvature that previously resulted in UP transection due to high-degree of curvature [10,28]. However, some reports have raised concerns about the impact of the latter technique on the postoperative outcomes. In fact, aggressive urethral mobilization for proximal TIP repair increases the risk for ischemia-induced urethral stricture resulting in focal devascularization of the neourethra with possible symptomatic stricture development [8,29]. In our report, the 27 patients with severe  $PC \geq 30^\circ$  degree had undergone a UP mobilization divided from corpus spongiosum [30]. The rate of TIP failure in the group with UP mobilization was 40.7%

compared with 27.9% in the group without UP mobilization; however, the difference was not significant ( $P=0.317$ , as shown in Table 3). Otherwise, our prospective series with the median follow-up of 24 months reported no severe postoperative complications such as urethral stricture.

From the first description of Snodgrass in 1994, several modified techniques have been introduced and helped to improve the outcomes of TIP urethroplasty, which makes this technique feasible and simple to use especially in the treatment of proximal hypospadias [2,10,28,9,19]. The benefits of TIP technique as described in the literature for primary repair of distal hypospadias could be also applied in our series for patients with more proximal hypospadias in whom the UP was well preserved [2,15]. The advantages of this procedure include its simplicity, less time consuming, and a very good appearance of the penis looks like one which has been only circumcised [31]. The current goal of hypospadias repair is both to restore good function and normal appearance to the penis [32,33]. Importantly, its complication rates were comparable with the most commonly used techniques for these somehow challenging cases [17]. Therefore, we recommend that UP preservation in urethroplasty should be achieved whenever possible [8].

## 6. Conclusions

TIP urethroplasty could be an alternative and good option for severe proximal hypospadias with its high feasibility and simplicity as opposed to other techniques. It is noteworthy to be considered as a helpful surgical once-off technique for patients suffered from severe hypospadias, especially within the context of resource management for very busy pediatric surgical services in the developing world such as in Vietnam.

## Author Contribution

PHAM Ngoc Thach drafted this manuscript and received the feedback and revisions from the other co-authors; PHAM Ngoc Thach and LE Tan Son were the main surgeons for repairing hypospadias in this study and performed the data collection. All the authors contributed to the design of the study, to the analyses of the data and to the critical revisions of the manuscript.

**Conflict of Interest: none**

## References

- [1] Catti M, Demède D, Valmalle A-F, Mure P-Y, Hameury F, Mouriquand P (2008) Management of severe hypospadias. *Indian Journal of Urology : IJU : Journal of the Urological Society of India* 24 (2):233-240
- [2] Pfistermuller KL, McArdle AJ, Cuckow PM (2015) Meta-analysis of complication rates of the tubularized incised plate (TIP) repair. *J Pediatr Urol* 11 (2):54-59. doi:10.1016/j.jpuro.2014.12.006
- [3] Badawy H, Fahmy A (2013) Single- vs. multi-stage repair of proximal hypospadias: The dilemma continues. *Arab J Urol* 11 (2):174-181. doi:10.1016/j.aju.2013.03.009
- [4] Long CJ, Canning DA (2016) Hypospadias: Are we as good as we think when we correct proximal hypospadias? *J Pediatr Urol* 12 (4):196 e191-195. doi:10.1016/j.jpuro.2016.05.002
- [5] Pippi Salle JL, Sayed S, Salle A, Bagli D, Farhat W, Koyle M, Lorenzo AJ (2016) Proximal hypospadias: A persistent challenge. Single institution outcome analysis of three surgical techniques over a 10-year period. *J Pediatr Urol* 12 (1):28 e21-27. doi:10.1016/j.jpuro.2015.06.011
- [6] Badawy H, Orabi S, Hanno A, Abdelhamid H (2018) Posterior hypospadias: Evaluation of a paradigm shift from single to staged repair. *J Pediatr Urol* 14 (1):28 e21-28 e28. doi:10.1016/j.jpuro.2017.07.007
- [7] Braga LHP, Lorenzo AJ, Salle JLP (2008) Tubularized incised plate urethroplasty for distal hypospadias: A literature review. *Indian Journal of Urology : IJU : Journal of the Urological Society of India* 24 (2):219-225
- [8] Erol A, Baskin LS, Li YW, Liu WH (2000) Anatomical studies of the urethral plate: why preservation of the urethral plate is important in hypospadias repair. *BJU Int* 85 (6):728-734
- [9] Snodgrass WT (2008) Utilization of urethral plate in hypospadias surgery. *Indian Journal of Urology : IJU : Journal of the Urological Society of India* 24 (2):195-199
- [10] Snodgrass W, Bush N (2011) Tubularized incised plate proximal hypospadias repair: Continued evolution and extended applications. *Journal of Pediatric Urology* 7 (1):2-9. doi:https://doi.org/10.1016/j.jpuro.2010.05.011
- [11] Steven L, Cherian A, Yankovic F, Mathur A, Kulkarni M, Cuckow P (2013) Current practice in paediatric hypospadias surgery; A specialist survey, vol 9. doi:10.1016/j.jpuro.2013.04.008
- [12] Springer A, Tekgul S, Subramaniam R (2017) An Update of Current Practice in Hypospadias Surgery. *European Urology Supplements* 16 (1):8-15. doi:10.1016/j.eursup.2016.09.006
- [13] Mingin G, Baskin LS (2002) Management of chordee in children and young adults. *Urol Clin North Am* 29 (2):277-284, v
- [14] W.T. S, A. L (2002) Tubularized incised-plate urethroplasty for proximal hypospadias. *BJU International* 89 (1):90-93. doi:doi:10.1046/j.1464-410X.2002.02524.x
- [15] Cook A, Khoury AE, Neville C, Bagli DJ, Farhat WA, Pippi Salle JL (2005) A multicenter evaluation of technical preferences for primary hypospadias repair. *J Urol* 174 (6):2354-2357, discussion 2357
- [16] Snodgrass W, Yucel S (2007) Tubularized Incised Plate for Mid Shaft and Proximal Hypospadias Repair. *The Journal of Urology* 177 (2):698-702. doi:https://doi.org/10.1016/j.juro.2006.09.104
- [17] Braga LH, Pippi Salle JL, Lorenzo AJ, Skeldon S, Dave S, Farhat WA, Khoury AE, Bagli DJ (2007) Comparative analysis of tubularized incised plate versus onlay island flap urethroplasty for penoscrotal hypospadias. *J Urol* 178 (4 Pt 1):1451-1456; discussion 1456-1457. doi:10.1016/j.juro.2007.05.170
- [18] Ghanem MA, Nijman RJ (2010) Outcome analysis of tubularized incised urethral plate using dorsal dartos flap for proximal penile hypospadias repair. *J Pediatr Urol* 6 (5):477-480. doi:10.1016/j.jpuro.2009.11.008

- [19] Snodgrass WT, Lorenzo A (2002) Tubularized incised-plate urethroplasty for proximal hypospadias. *BJU Int* 89 (1):90-93
- [20] Duckett JW, Jr. (1980) Transverse preputial island flap technique for repair of severe hypospadias. *Urol Clin North Am* 7 (2):423-430
- [21] Wiener JS, Sutherland RW, Roth DR, Gonzales ET, Jr. (1997) Comparison of onlay and tubularized island flaps of inner preputial skin for the repair of proximal hypospadias. *J Urol* 158 (3 Pt 2):1172-1174
- [22] Craig JR, Wallis C, Brant WO, Hotaling JM, Myers JB (2014) Management of adults with prior failed hypospadias surgery. *Translational Andrology and Urology* 3 (2):196-204. doi:10.3978/j.issn.2223-4683.2014.04.03
- [23] Babu R, Hariharasudhan S (2013) Tunica vaginalis flap is superior to inner preputial dartos flap as a waterproofing layer for primary TIP repair in midshaft hypospadias. *J Pediatr Urol* 9 (6 Pt A):804-807. doi:10.1016/j.jpuro.2012.10.022
- [24] Elbakry A (1999) Tubularized-incised urethral plate urethroplasty: is regular dilatation necessary for success? *BJU Int* 84 (6):683-688
- [25] Snodgrass W (1999) Does tubularized incised plate hypospadias repair create neourethral strictures? *J Urol* 162 (3 Pt 2):1159-1161
- [26] Elbakry A (2002) Regular dilatation is unnecessary after tubularized incised-plate hypospadias repair. *BJU international* 90 (4):473-474; author reply 474-475
- [27] Moscardi PRM, Gosalbez R, Castellan MA (2017) Management of High-Grade Penile Curvature Associated With Hypospadias in Children. *Frontiers in pediatrics* 5:189. doi:10.3389/fped.2017.00189
- [28] Snodgrass W, Prieto J (2009) Straightening ventral curvature while preserving the urethral plate in proximal hypospadias repair. *J Urol* 182 (4 Suppl):1720-1725. doi:10.1016/j.juro.2009.02.084
- [29] Snodgrass WT, Granberg C, Bush NC (2013) Urethral strictures following urethral plate and proximal urethral elevation during proximal TIP hypospadias repair. *J Pediatr Urol* 9 (6 Pt B):990-994. doi:10.1016/j.jpuro.2013.04.005
- [30] Mollard P, Castagnola C (1994) Hypospadias: the release of chordee without dividing the urethral plate and onlay island flap (92 cases). *J Urol* 152 (4):1238-1240
- [31] Mustafa M (2005) The concept of tubularized incised plate hypospadias repair for different types of hypospadias. *Int Urol Nephrol* 37 (1):89-91. doi:10.1007/s11255-004-6074-5
- [32] Snodgrass WT (2005) Assessing outcomes of hypospadias surgery. *J Urol* 174 (3):816-817. doi:10.1097/01.ju.0000175046.69696.5b
- [33] Joshi RS, Bachani MK, Uttarwar AM, Ramji JI (2015) The Bracka two-stage repair for severe proximal hypospadias: A single center experience. *J Indian Assoc Pediatr Surg* 20 (2):72-76. doi:10.4103/0971-9261.151549