Outcomes of Tubularized Incised Plate Urethroplasty (TIPU) for Hypospadias at Tikur Anbesa Specialized and Menelik II Referral Hospitals: One-year Prospective Cohort Study

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OBJECTIVE To evaluate the results and related factors of tubularized incised plate (TIP) urethroplasty at two institutions.

METHODS This was a prospective cohort analytical study conducted over a period of 12 months. All patients who underwent TIP urethroplasty in the specified period were studied. Quantitative and qualitative data of the intrinsic parameters of the penis were obtained and patients were followed for an average period of 14.72 ± 3.67 months (range 9-21months) after surgery.

RESULTS One hundred twenty-nine patients (N = 129) were included in the study. The mean age at surgery was 50.93 months. The mean glans size and pre-incised urethral plate width were 14.34 mm and 8.38mm respectively. The post-operative results were satisfactory with the meatus in a glanular position in 122(94.6%) patients. Overall, 49 patients (38%) developed complications. Eighteen patients (14%) developed early complications whereas forty-two (32.6%) patients had late complications. UCF and Meatal stenosis occurred in 27 (20.9%) & 14 (10.9%) patients respectively. Seven patients developed recurrent hypospadias and dehiscence of glans occurred in eight patients (6.2%).

CONCLUSION TIP can be used to repair for all types of hypospadias in the absence of severe penile curvature. It has more complication rate in proximal than distal hypospadias. Distal hypospadias were the most common type of hypospadias corrected with TIP. UCF and meatal stenosis were the most common complication followed by glans dehiscence and recurrent hypospadias. Glans size, age at surgery, plate width, location of meatus and stretched penile length were the most determinant factors for the outcome. UROLOGY 00: 1–6, 2022. © 2022 Elsevier Inc.

Hypospadias is one of the most common congenital defects affecting the external male genitalia. The urethral opening is located more proximally anywhere between the tip of the penis and the perineum. The incidence is ~1 in 250 male newborns, although its incidence seems to be increasing.

Over 300 methods of surgical repair have been described for the correction of hypospadias, with no procedure accepted as the gold standard for each degree of hypospadias. In recent times, with a better understanding of factors contributing to successful repair, the numbers of operations done have been considerably reduced in different centers. Most centers use tubularized incised plate urethroplasty (TIPU) which was first described in 1994 by Snodgrass[1] and has become the most popular technique.[1-5] Patients operated with TIPU have been reported to have low complication rates similar to those of older techniques.[6]

Eighty percent of urethroplasty complications are diagnosed within 1 year after surgery. Potential outcomes include urethroplasty complications (fistula, glans dehiscence, meatal stenosis, urethral stricture, diverticulum), urinary function (spraying, deflected stream, uroflow rate), sexual function (straightness of erection, ejaculation), and

Abbreviations: *AAU, Addis Ababa University; TASH, Tikur Anbesa Specialized Hospital; MH, Menelik II Referral Hospital; TIPU, Tubularized Incised Plate Urethroplasty; UP, Urethral Plate; TGD, Transverse Glans Diameter; UCF, Urethrocutaneous Fistula; UCs, Urethroplasty Complications; VC, Ventral Chordee*

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cosmetic appearance. While there is merit in determining all these, with the majority of operations done in pretoilet-trained boys, it is most common to assess various techniques by comparing urethroplasty complications (UCs). However, few studies specifically state when such UCs were diagnosed, and so the duration of follow-up to encounter the majority of them remains ill-defined.[7]

Due to the popularity of the TIP repair technique, a large number of papers giving outcomes and complication rates have been published globally. As there is a paucity of prospective study of the outcomes of the TIP repair in Ethiopia, we did this study with a view to assess the application of TIPU to all degrees of hypospadias and evaluate possible results by analyzing the complication rates to accurately determine representative complication rates for this technique and related factors.[8-12]

RESEARCH OBJECTIVES

The general objective of the study was to assess the outcome and related factors of hypospadias repair with Tubularized incised plate (TIP) urethroplasty at two institutions.

METHODES AND MATERIALS

Institutions based Prospective Cohort both descriptive and Analytical study design was used.

All patients operated with TIP during the study period were included. Data were collected by using predesigned and structured questionnaire and Some instruments, like sterile rulers and protractors, were used for objective measurement.

The data were collected at different time periods (preoperative in the ward, intraoperative, and postoperative at first week, 1st, 3rd, 6th and 9th months, and at 1 and 2 years).

The Data is entered with Epi-data and is presented as standard deviation (±mean) and average (%). Data analysis was performed in SPSS version 24.0. Chi- square test or Fisher test was applied to compare qualitative data. Furthermore, A regression logistic model was deployed for multivariable data analysis and determining independent parameters. P values less than 0.05 were considered statistically significant.

RESULTS AND DISCUSSION

RESULTS

Sociodemographic result. A total of 129 patients (aged 6-168months, mean 50.93 months) underwent TIP by 22 surgeons at two institutions: 66% (n = 85) at MH and 34%(n = 44) at TASH. Those surgeons were Seven consultant pediatrics surgeons, 14 pediatric surgery residents and one fellow. 80 patients (62%) (n = 69 assisted, n = 11 independently) were done by residents and fellow, and others(n = 49) were done by consultants with experience of 3 to 24 years.

Clinical Data. The mean age at presentation was 27.59 ± 36.809 with the range of 1-168months. The commonest presentations were abnormal meatal opening (96.9%) and abnormal urinary stream (92.2%). In some patients (8, 6.2%) abnormality was not detected by the family.

Almost all patients were having hooded dorsal preputial skin and deficient ventral skin except those who were circumcised (5patients) and one with enact preputial skin. Majority (86 patients − 66.7%) had shallow glanular groove and others (43 patients 33.3%) had deep groove. Hormonal treatment was given for 4 patients (3.1%).

Operative findings and techniques. The minimum and maximum ages at surgery were 6 and 168 months respectively with mean age of 50.93 ± 39.064 months. 129 patients undergone TIP procedures at two Institutions. 22 surgeons were involved (seven consultant pediatrics surgeons, 14 pediatric surgery residents and one fellow). 62% of patients (n = 80) were done by residents and fellow assisted by consultant (n = 69) and independently (n = 11). Others were done by consultants with experience of 3 to 24 years.

Data of the intrinsic parameters of the penis were obtained for all patients. Meatal location was distal in 59.7% (n = 77), midshaft in 13.2%(n = 17) and proximal in 27.1%(n = 35) patients. (Table 1)

Stretched penile length was measured for each patient. It was ranging from 2 -7 cm with average length of 4.23cm. It was standardized with penile growth curve for age and 30.2% of patients (n = 39) had penile length below 3rd percentile.

Glans size was normally distributed with a mean of 14.34 mm (range 10−20mm), whereas pre- incised urethral plate width was normally distributed with a mean of 8.38mm (range 6−20mm). 17.8% of patients (n = 23) had transverse glans diameter measured less than 14mm whereas only 3.1% patients (n = 4) had pre-incised urethral plate width of less than 8mm. Urethral plate to glans diameter ratio was calculated and the mean ratio was 0.59 with minimum and maximum ratio of 0.4 and 1.25 respectively. Only 8 patients had less than 0.5 ratio.

Artificial erection was done for each patient and chordee was measured objectively. 35 patients had persistent chordee from which 32 patients had mild and 3 patients had severe chordee. Chordee were corrected for 27 patients with dorsal tunica albuginea plication with Baskin type at the 12-o'clock position. The

Table 1. Operative findings and techniques

Type of Hypospadias	Number (N = 129)	Percent (%)
Distal hypospadias	77	59.7
Midshaft hypospadias	17	13.2
Proximal hypospadias	35	27.1
Penile length		
<3rd percentile	39	30.2
≥3rd Percentile	80	69.8
Glans Diameter		
< 14mm	23	17.8
≥14mm	107	82.2
Urethral plate width		
< 8mm	4	3.1
≥8mm	125	96.9
Type of Tissue used for 2nd layer		
Dartos Flap	116	89.9%
Tunica Vaginalis Flap	11	8.5%
Spongioplasty	1	0.8%
No coverage	1	0.8%

rest 8 patients were untouched because their chordee were not significant. Incidence of chordee in relation to meatal location were 7(9%) in distal, 5(29.4%) in mid and 23(67.6%) in proximal hypospadias.

24 patients (18.6%) had thinned out anterior wall of native urethra with the mean length of 3.46mm ± 2.01(2-10mm) for whom the thinned-out wall opened and re- tubularization done for 14 patients, left untouched for 9 patients and tubularized without opening for 1 patient.

All patients were undergone urethroplasty with 6.0 vicryl with subepithelial continuous suturing techniques with the orientation of suturing of vertical in 33 patients (25.6%) and horizontal of transverse in 96 patients (74.4%). Glansplasty done with 5.0 vicryl with horizontal mattress. Different tissues were used as interposition layer. Dartos flap was the most used tissue in 116 patients (89.9%) followed by tunica vaginalis flap in 11 patients. Only spongioplasty was done for 1 patient and no coverage for 1 patient. To secure Hemostasis, tourniquet was used for 117 patients, hemostat or artery forceps were used in 20 patients and simple compression in 7 patients. We did not use any electrical cautery for hemostasis. The minimum and maximum duration of surgery taken was 40 minutes and 180 minutes respectively with the mean duration of 90.89 ± 28.39 and the mean duration of anesthesia was 108.88 ± 28.74(range 50-200 minutes) (Table 1).

All patients were stented (6,8 or 10 F NG tube) for a mean duration of 6.9 days (range 3-12 days). Antibiotics ointment-soaked pressure dressing was used for all patients with mean duration of 3.26 ± 0.813days (range 1-6 days). From this we found that Average length of hospital stay was 6.64 ± 1.825 days (range 2-12days). Day care surgery done for 4 patients. The most commonly give analgesics was paracetamol syrup or suppository. Ceftriaxone was given for all patients postoperatively with mean duration 34.4 hrs. (range 12 -120 hours). Post-operative PO antibiotics were given for majority of patients (96.1%) with mean duration 6.99 ± 0.89days (range 5-14 days). Mean follow-up was 14.72 ± 3.67 months (range 9-21months) (Table1).

Outcomes. The post-operative results are satisfactory with the meatus in a glanular position in 121 patients (117 patients at tip of the glans and 4 patients at mid glans) and hypospadic position in n = 8 patients (6.2%). Fifty-two patients have a vertical slit like orientation of the meatus and majority (n = 77) patients have round meatal configuration. Majority of patients (n = 100, 77.5%) have normal urinary stream and the others have abnormal streaming like spraying at micturition (14 patients), deviation of stream (5 patients) and thin stream (10 patients). In almost 96 percent (124 patients) their families are satisfied for penile appearance.

Complications. 38% of patients(n = 49) developed complications including both early (n = 18, 14%) and late complications (n = 42,32.6%). From early complications, bleeding in two patients, hematoma in 1 patient, penile edema in five patients, UTI in 6 patients, skin necrosis in 1 patient, skin dehiscence in 1 patient and catheter dislodgement in seven patients (Table 2).

Late complications including meatal stenosis in 10.9% patients(n = 14), urethrocutaneous fistula (UCF) in 20.9% patients(n = 27), granular dehiscence in 6.2% patients(n = 8), meatal regression in 1.6% patients(n = 2), recurrent hypospadias in 5.4% patients(n = 7), recurrent chordee in 1 patient, penile torsion in 1 patient, urethral stricture in 1 patient and buried penis in 1 patient.

Table 2. Complications

Early Complications (n = 18,14%)	Late Complications (n = 42, 32.6%)
Bleeding (n = 2	*Meatal stenosis (n = 14,10.9%)*
Hematoma (n = 1)	*UCF (n = 27,20.9%)*
Penile edema (n = 5)	*Granular dehiscence (n = 8,6.2%)*
Skin dehiscence (n = 1)	*Meatal regression (n = 2,1.6%)*
skin necrosis (n = 1)	*Recurrent hypospadias (n = 7,5.4%)*
UTI (n = 6)	*Recurrent chordee (n = 1)*
Catheter dislodgement (n = 7)	*Penile torsion (n = 1)*
	Urethral stricture (n = 1)
	Buried penis (n = 1)

Meatal stenosis. Majority of meatal stenosis patients 8 patients (57.1%) diagnosed in the first postoperative month and 2 patients at 3rd month and 4 patients at 6th month. 6 patients with meatal stenosis were managed with serial dilatation, 2 patients were followed conservatively, for 2 patients meatoplasty done and 3 patients are not yet managed.

UCF. Majority of patients with UCF were diagnosed in the first postop month [6 patients (22.2%) at first week and 16 patients (59.3%) at 1st month follow up]. The remaining 3 patients (11.1%) at 3rd month and 2 patients (7.4%) at 6th month. The commonest site of UCF is subcoronal (19 patients- 70.4%) which is followed by coronal (2 patients- 7.4%) and multiple UCF (two patients- 7.4%). The others are 1 patient at granular, one patient at distal penile, one patient at mid penile and 1 patient at proximal penile areas. Five of the fistulas (18.5%) healed spontaneously, four (14.8%) of them repaired at 6th month and the remaining 18 patients (66.7%) with UCF are waiting for repair.

Grans Dehiscence (Breakdown). Eight patients (6.2%) have granular dehiscence and all are complete. 6 of them were happened in the first month (2 patients before discharge and 4 patients diagnosed at 1st month follow up). The other two were diagnosed at 6th postop month. Repaired has been done at 6th month for 2 patients (2 with glansplasty and 2 with redo TIP) and the rest 6 patients are booked for repair.

Recurrent hypospadias. Seven patients (5.4%) have recurrent hypospadias. Three patients (42.9%) at coronal, three patients (42.9%) at subcoronal and one patient (14.3%) at distal penile. Redo TIP done only for one patient at 7th month and the others are booked for repair.

Urethral stricture. One patient developed urethral stricture at 9th postop month and presented with acute urinary retention. Bougienage was tried and was not successful. Temporal urinary diversion done with suprapubic cystostomy. Currently he is waiting for definitive repair.

DISCUSSION

The primary goal of hypospadias surgery is to create a functional penis with a normal appearance. TIP urethroplasty, as described

by Snodgrass, in 1994, has become increasingly popularized, and more reports about this technique are being published. Some studies have reported a preference for TIP owing to the lower complication rates and better cosmesis compared with the other type of procedures.[3]

Approximately 1 out of every 10 distal hypospadias surgeries develops a complication. Surgeons attempt to identify risk factors for complications to make modifications in techniques to improve their results.[13] In this study, we evaluated the results of hypospadias surgery with TIP in terms of potential factors predictive of complication. During 15 months of average follow-up time (9-21months) early and late complications were noticed in 14% and 32.6% of the patients respectively) (Table 2). Studies conducted by Snodgrass,[14] Aslam,[15] Xu,[16] and Springer,[17] have estimated the complications after TIP operation to be between 7 to 31%. Thus, overall late complications in our study (32.6%,) with corrective complication rate (29.5%) were consistent with other contemporary series. The most common complication in this study was UCF which is equivalent to other studies Table 3.

Different risk factors for complications of TIP were identified in different studies. Meatal location is one of the common factors that has long been thought that the hypospadias with a distal meatal orifice, is less prone to complications than those with proximal defects.[18]

Spinoit[19] studied the results of hypospadias surgery in 474 patients and among the statistically significant predictors related to re-operation were proximal hypospadias. Tihitina[20] viewed the high rate of complications was associated with higher burden of severe hypospadias and older age at surgery. Conversely, Arlen[21] showed the meatal location to have no significance on multivariable analysis. They concluded it'd be more important considering the entire hypospadias complex anatomy in defining severity, rather than the meatal location merely.

In our study, both the single-variable and multivariant analysis showed the location of the meatal orifice was significantly related to the complications. In the multivariable study, it was found to be statistically significant (P = .007). Accordingly, we concluded that the closer meatal orifice was to the coronal margin, the fewer complications existed (OR = 9.88, P = .007) Table 4.

The other factor related with outcome of TIP is urethral plate width. Several studies have shown different results regarding the impact of the urethral plate width. In Holland and Smith's study of 48 cases ages 3−7 years old, the width of the urethral plate was found to be directly associated with the development of a fistula. Their cut off point of urethral plate width for complications was found to be 8 millimeters.[22] Further studies by Sarhan,[23] K.E and Chukwubuike[24] confirmed this finding. In a study by Seleim[25] significant connection between urethral plate width and complications was found with a cutoff value of less than 4 mm.

In summary, while previous studies have reported varying results about UP width, in our study the width less than 8mm was associated with the poor surgical outcomes both in the single-variate and multivariate analysis specially with glans dehiscence and recurrent hypospadias (OR = 7.774, P < .001) (Table 4). However, it wasn't significantly associated with UCF in the multivariable study (P = .839). (Supplement Table 1)

The other important factor that affects the outcome of TIP is glans size. Smaller glans widths are associated with greater difficulty during surgery and perhaps complications. Although some other studies have not shown glans diameter to be a risk factor for complications after TIP. In our study we found that it has strong association with majorities of complications. Glans size with less than 14mm was significantly related with UCF (OR = 5.156, P < .001), Glans breakdown (OR = 45.937, P = .001) and recurrent hypospadias(P = <.001). (Supplement Table 2) Also, we found that no significant differences in the outcome of TIP in different glanular groove shapes (complete cleft, incomplete cleft, flat). Other studies focusing on distal hypospadias have found a significant difference related to glans size. It's not clear if these different results are because of variations and modifications in glansplasty technique by surgeons.[18]

Many studies have reported the appropriate age for hypospadias surgery in terms of anesthesia and psychosocial factors; however, the effect of age on surgical complications remains controversial.[26] The American Pediatric Academy stated that the most appropriate age for the surgery is 6-12 months.[27] Ziada[27] reported a higher rate of complications in patients 4 years and older. Nuininga[28] found a complication rate of 54% in patients 1-14 years of age (average 7 years). Weber[26] reported that age at surgery had no effect on the surgical complication rate, and that surgeries performed in those aged 6-18 months are beneficial only in psychosocial aspects. In this study, we examined the relationship between age and hypospadias TIP surgery complications that was found in 22.7% of patients aged (6-18 months) and 34.6% of patients aged greater than 18months with no statistically significant difference. Complication rates increased proportionately in patients older than 18months, with a statistically significant difference in fistula rate in the age group greater than 4years (P = .034) (Table 4). Tihitina[20] in the same institution showed that higher rate of complication was attributed to ages at surgery in which most of the patients were beyond 18 months of age.

Table 3. Complication rate after TIP in different studies

Studies	Complication rate	Number of pts	Age range (mean)	Type of hypospadias	Follow-up length (mean)
Snodgrass et al[14]	30%	118	3-156mo	Proximal	8wks -82mo
Aslam et al[15]	7%	93	3-7yrs (3.5yr)	Midshaft and distal	3-103mo (56m)
Shivaji et al[32]	11%	100	1-5yrs (2.7yr)	Distal	3mo-4yrs (23m)
Xu et al[16]	20	176	1-14yrs (4.3yr)	Proximal	12-51mo
Mane et al[32]	11%	100	1-5yrs (2.7yrs)	Distal	(23m)
Dokter et al[31]	31%	205	4.5mo-11.1yrs (10.3mo)	All	1mo-13.5yrs (4.7yr
Arlen et al[21]	14.1%	262	12.3 ± 3.7mo	All	7.7 ± 9.3mo
Our study	29%	129	6-168mo (50.93m)	All	9-21mo (14.93m)

Table 4. Multivariate analysis Potential risk factors for Urethroplasty complication (UC) after TIP repair

	Total (N = 129) Number (%)	UC (n = 49) Number (%)	*P*-value	OR	95% CI
Hospital					
TASH	44 (34%)	19 (38.8%)	.382	1.393	0.66-2.93
MH	85 (66%)	30 (61.2%)			
Hormonal Treatment					
Yes	4 (3.1%)	3 (6.1%))	.121	5.152	0.52-5.99
No	125 (96.9%)	46 (93.9%)			
Circumcision					
Yes	5 (3.9%)	3 (6.1%)	.316	2.543	0.41-15.79
No	124 (96.4%)	46 (93.9%)			
Granular Groove					
Deep	43 (33.3%)	11 (22.5%)	.043*	0.434	0.19-0.97
Shallow	86 (66.7%)	38 (77.5%)			
Age at Surgery					
<48months	76 (58.9%)	25 (51%)	.155	0.592	0.29-1.22
>=48months	53 (61.1%)	24 (49%)			
Surgeons					
Resident	70 (54.3%)	26 (53.1%)	.996	1.001	0.69-1.46
Fellow	10 (7.8%)	5 (10.2%)			
Consultant	49 (37.9%)	18 (36.7%)			
Penile length					
<3rd percentile	39 (30.2%)	19 (38.8%)	.1	1.9	0.88-4.09
>=3rd percentile	90 (69.8%)	30 (61.2%)			
Glans width					
<14mm	23 (17.8%)	19 (38.8%)	<.001*	12.033	3.78-38.31
>=14mm	106 (82.2%)	30 (61.2%)			
Meatal location					
Proximal	35 (27.1%)	21 (42.9%)	.011*	2.787	1.26-6.15
Midshaft	17 (13.2%)	10 (20.4%)	.064	2.674	0.94-7.57
Distal	77 (59.7%)	18 (36.7%)	<.001*	0.207	0.1-0.44
Chordee after degloving					
No chordee	94 (72.9%)	30 (61.2%)	.05	0.493	0.24-1
=<30 degree	32 (24.8%)	18 (36.7%)			
>30 degree	3 (2.3%)	1 (2.1%)			
Pre-incised UP width					
<8mm	4 (3.1%)	4 (8.2%)	.009*	0.00	0.00
>=8mm	125 (96.9%)	45 (91.8%)			
UP to Glans Diameter ratio					
<0.5	8 (6.2%)	4 (8.2%)	.474	1.689	0.4-7.09
>=0.5	121 (93.8%)	45 (91.8%)			
2nd Layer					
Dartos Flap	116 (91.3%)	46 (93.8%)	.488	1.63	0.41-6.47
Tunica Vaginalis Flap	11 (8.7%)	3 (6.2%)			

* Stastically significance.

Snodgrass described the use of vascularized dartos tissue, dissected from dorsal preputial and shaft skin, for providing additional coverage to the neourethra.[29] Dartos based flaps require skillful dissection, and there are high chances that the vascularity of the overlying skin may get compromised leading to dermal necrosis. The advantage of dartos-based flaps is that they are locally available, are conventional and is universally practiced method and do not require another incision or extension of the incision like for TV flaps. But various studies have documented that tunica vaginalis is a better cover, decreasing the incidence of fistula rates when compared to dorsal dartos flaps.[30] In our study, the fistula rate remained high for dartos flaps (22.4%, 26/116) compared to TV group (0%, 0/11) but it has no statistically significant difference between the two groups(P = .422).

In our study, there was no significant difference in the outcomes with regard to the experience of operating surgeons but there were some complications which are statistically associated with specific surgeons (Table 4).

CONCLUSION

TIP can be used to repair for all types of hypospadias in the absence of severe penile curvature and TIP for proximal hypospadias has more complications rate than the distal hypospadias. Distal hypospadias was the most common type of hypospadias corrected with TIP. UCF and meatal stenosis were the most common complication followed by glans dehiscence and recurrent hypospadias. Glans size, age at surgery, plate width, location of meatus and stretched penile length were the most determinant factors for the outcome.

Strength of the Study

It was a prospective cohort study with accurate data collection with regard to exposures, confounders, and endpoints.

Limitation

It was both expensive and time-consuming because of long follow-up period.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.urology.2022.06.022.

References

1. Springer A, Krois W, Horcher E. Trends in hypospadias surgery: results of a worldwide survey. *Eur Urol*. 2011;60:1184–1189.
2. Steven L, Cherian Abraham, Yankovic Francisca, et al. Current practice in paediatric hypospadias surgery; A specialist survey. *J Pediatr Urol*. 2013;9(6, Part B):1126–1130.
3. Snodgrass W. Tubularized, incised plate urethroplasty for distal hypospadias. *J Urol*. 1994;151:464–465.
4. Cook A. A multicenter evaluation of technical preferences for primary hypospadias repair. *J Urol*. 2005;174:2354–2357.
5. Snodgrass W, Yucel S. Tubularized incised plate for mid shaft and proximal hypospadias repair. *J Urol*. 2007;177:698–702.
6. Snodgrass WT. Tubularized incised plate hypospadias repair: indications, technique, and complications. *Urology*. 1999;54:6–11.
7. Spinoit AF, Poelaert F, Hoebeke P. Re: "Snodgrass. W, et al. Duration of follow-up to diagnose hypospadias urethroplasty complications." J Pediatr Urol 2014;10:208-211. *J Pediatr Urol*. 2014;10:783–784.
8. Emir H, Jayanthi VR, Nitahara K, et al. Modification of the Koyanagi technique for the single stage repair of proximal hypospadias. *J Urol*. 2000;164(3 Pt 2):973–975.
9. Glassberg KI, Hansbrough F, Horowitz M. *THE* koyanagi-nonomura 1-stage bucket repair of severe hypospadias with and without penoscrotal transposition. *The Journal of Urology*. 1998;160(3, Part 2):1104–1107.
10. Powell CR, McAleer I, Alagiri M, et al. Comparison of flaps versus grafts in proximal hypospadias surgery. *J Urol*. 2000;163:1288–1289.
11. Demirbilek S, Kanmaz T, Aydin G, et al. Outcomes of one-stage techniques for proximal hypospadias repair. *Urology*. 2001;58:267–270.
12. Samuel M, Wilcox DT. Tubularized incised-plate urethroplasty for distal and proximal hypospadias. *BJU Int*. 2003;92:783–785.
13. Bush NC. Commentary to 'Is glans penis width a risk factor for complications after hypospadias repair? *J Pediatr Urol*. 2016;;12:317–318.
14. Snodgrass WT, Granberg C, Bush NC. Urethral strictures following urethral plate and proximal urethral elevation during proximal TIP hypospadias repair. *J Pediatr Urol*. 2013;9(6 Pt B):990–994.
15. Aslam R, Campbell K, Wharton S, et al. Medium to long term results following single stage Snodgrass hypospadias repair. *J Plast Reconstr Aesthet Surg*. 2013;66:1591–1595.
16. Xu N, Xue X, Li Y, et al. Comparative outcomes of the tubularized incised plate and transverse island flap onlay techniques for the repair of proximal hypospadias. *Int Urol Nephrol*. 2014;46:487–491.
17. Springer A. Assessment of outcome in hypospadias surgery - a review. *Front Pediatr*. 2014;2:2.
18. Sarhan OM, El-Hefnawy Ahmad SHafez, Elsherbiny Ashraf T, et al. Factors affecting outcome of tubularized incised plate (TIP) urethroplasty: single-center experience with 500 cases. *J Pediatr Urol*. 2009;5:378–382.
19. Spinoit AF, Poelaert F, Van Praet C, et al. Grade of hypospadias is the only factor predicting for re-intervention after primary hypospadias repair: a multivariate analysis from a cohort of 474 patients. *J Pediatr Urol*. 2015;11. 70 e1-6.
20. Tihitena Negussie Mammo, Samuel A, Negash Teamir, et al. Hypospadias repair in ethiopia: a five year review. *Ethiop J Sci*. 2018;28:735–740.
21. Arlen AM, Kirsch AJ, Leong T, et al. Further analysis of the Glans-Urethral Meatus-Shaft (GMS) hypospadias score: correlation with postoperative complications. *J Pediatr Urol*. 2015;11:71 e1-5.
22. Holland AJ. Effect of the depth and width of the urethral plate on tubularized incised plate urethroplasty. *J Urol*. 2000 Aug;164:489–491.
23. Sarhan O, El-Hefnawy Ahmad SHafez, Elsherbiny Ashraf T, et al. Effect of suturing technique and urethral plate characteristics on complication rate following hypospadias repair: a prospective randomized study. *J Urol*. 2009;182:682–685.
24. Chukwubuike KE, Obianyo NEN, Ekenze SO, et al. Assessment of the effect of urethral plate width on outcome of hypospadias repair. *J Pediatr Urol*. 2019;15. 627 e1-627 e6.
25. Seleim HM, ElSheemy MS, Abdalazeem Y, et al. Comprehensive evaluation of grafting the preservable narrow plates with consideration of native plate width at primary hypospadias surgery. *J Pediatr Urol*. 2019;15. 345 e1-345 e7.
26. Weber DM, Schonbucher VB, Gobet R, et al. Is there an ideal age for hypospadias repair? A pilot study. *J Pediatr Urol*. 2009;5:345–350.
27. Ziada A, Hamza A, Abdel-Rassoul M, et al. Outcomes of hypospadias repair in older children: a prospective study. *J Urol*. 2011;185 (suppl 6):2483–2485.
28. Nuininga JE, Gier DE, Verschuren RP, et al. Long-term outcome of different types of 1-stage hypospadias repair. *J Urol*. 2005;174(4 Pt 2):1544–1548.
29. Basavaraju M, Balaji DK. Choosing an ideal vascular cover for Snodgrass repair. *Urol Annal*. 2017;9:348–352.
30. Chatterjee US, Mandal MK, Basu S, et al. Comparative study of dartos fascia and tunica vaginalis pedicle wrap for the tubularized incised plate in primary hypospadias repair. *BJU Int*. 2004;94:1102–1104.
31. Docter, E.M.J. Mouës,, Chantal M, van Rooij, et al., et al. Complications after Hypospadias Correction: Prognostic Factors and Impact on Final Clinical Outcome. *European Journal of Pediatric Surgery*. 2018;28(02):200–206.
32. Shivaji, Arlikar,, J. Dhende,, et al., et al. Modified tubularized incised plate urethroplasty. *J Indian Assoc Pediatr Surg*. 2013;18 (2):62–65. https://doi.org/10.4103/0971-9261.109354.