

Aesthetic and Functional Outcomes of Primary Hypospadias Repair: A Single-centre Prospective Interventional Study

TIBAR BANERJEE¹, ANIRBAN BASU², SUDIPTA BERA³, SOUVIK ADHIKARI⁴

ABSTRACT

Introduction: The results of hypospadias repair are often marred by a high rate of complications. The contemporary hypospadias repair aims to reduce the complications with the utilisation of plastic and urogenital surgical principles. However, the aesthetic and functional outcomes are often less emphasised.

Aim: To evaluate the functional and aesthetic outcomes related to the clinical grades of hypospadias and different surgical methods used for hypospadias repair.

Materials and Methods: In this single-centre prospective interventional study, a total of 50 patients were operated on for hypospadias and studied between March 2020 and October 2021 at the Department of Burn and Plastic Surgery, IPGME&R and SSKM Hospital, Kolkata, West Bengal, India. The severity of hypospadias was assessed with the Glans-Meatus-Shaft (GMS) score. The postoperative aesthetic and functional outcomes were evaluated with the Penile Perception Score (PPS) and Hypospadias Objective Scoring Evaluation (HOSE), respectively. The tabulated data were analysed with Statistical Package for the Social Sciences (SPSS) software (Version 29.0.2.0 Armonk, NY: IBM Corp). The subgroups within the population were compared with the Student's t-test and a p-value <0.05 was considered statistically significant.

Results: The mean age of the study population was 9.92 ± 8.61 years, ranging from one year to 34 years. The mean GMS score was 6.8 ± 2.33 . The mean PPS and HOSE scores were 7.62 (SD 1.5) and 11.6 (SD 1.96), respectively. A 72% of patients had a satisfactory outcome of PPS score (6-9), which is mostly obtained in distal hypospadias cases (25/50). There were significant differences in PPS score ($p=0.008^*$) and HOSE score ($p=0.012^*$) between cases with no chordee and those with severe chordee, but not among other groups based on the severity of chordee. There were significant differences in the PPS score ($p=0.002^*$) and HOSE Score ($p=0.035^*$) were observed between granular and perineal hypospadias. There was significant difference in the PPS score between the procedures for proximal and distal hypospadias group, but not between the procedures within each group.

Conclusion: The chance of obtaining a better aesthetic outcome depends on the lesser severity of the chordee and a distal location of the meatus. The location of meatus, rather than the type of surgery, remains the most important factor influencing both the aesthetic and functional outcome. Use of an intermediate layer with the Dartos flap and Tunica Vaginalis (TV) flap may improve the functional outcome of the surgery. However, this finding needs further larger sample analysis and randomised controlled analysis to draw a strong conclusion.

Keywords: Chordee, Glans-meatus-shaft score, Hypospadias surgery, Penile perception score, Preputial flap, Tubularised incised plate, Tunica vaginalis flap

INTRODUCTION

Hypospadias is the abnormal presence of urethral opening on the ventral surface of the penis. It is often associated with abnormal penile curvature (chordee), altered appearance of the shaft, glans and prepuce and difficulties in erection and micturition [1]. Hypospadias surgery involves the relocation the urethral opening to the tip of the penis, thereby improving cosmetic, functional and sexual compromise. Hypospadias surgery is challenging as the results are often marred by the high rate of complications, such as wound dehiscence, meatal stenosis and fistula formation, among others. Significant efforts have been made in recent years to reduce these complications, in the past years, resulting in the utilisation of plastic surgery and urogenital surgical principles for hypospadias repair and reduced rate of such complications [2]. However, the aesthetic and functional outcome associated with various hypospadias surgeries is often less emphasised [3].

The techniques currently in use are either single-stage or double-stage procedures, depending on the location of the meatus and include Meatal Advancement and Glanuloplasty Incorporated (MAGPI), Tubularised Incised Plate (TIP) by Snodgrass, Vascularised island flaps such as preputial island flaps and two-stage procedures such as in Bracka's or Byar's repair, etc. Utilising interpositional flaps, such as the Tunica Vaginalis (TV) flap or Dartos flap, is also quite common [4-7].

The authors hereby present an institutional experience regarding the aesthetic and functional outcomes of various hypospadias surgeries. The study aimed to evaluate functional and aesthetic outcomes related to various clinical grades of hypospadias and the surgical methods used for hypospadias repair.

MATERIALS AND METHODS

The present single-centre prospective interventional study was conducted at a tertiary care hospital and teaching institute in eastern India, Department of Burn and Plastic Surgery, IPGME&R and SSKM Hospital, Kolkata, West Bengal, India, between March 2020 and October 2021. The study was conducted after receiving clearance from the hospital's Ethical Board (Memo No: IPGME&R/IEC/2020/573) and as per the standard ethical guidelines. Written informed consent was taken from all patients for the surgery, participation in the study and unanonymised data publication of unanonymised data.

Inclusion criteria: All patients of any age group attending the plastic surgery Outpatient Department with difficulties in straight-line micturition, altered meatal location and penile appearance since birth were examined clinically. The patients were diagnosed to have hypospadias on finding the urethral meatus on the ventral aspect of the penis and were included in the study.

Exclusion criteria: Patients with the syndromic association and a history of previous operation for the same were excluded. The

patients who did not consent to participate in the study or lost in follow-up before six months postoperatively were also excluded.

Sample size calculation: To calculate the required sample size for a correlation study, the formula for Pearson's correlation coefficient is:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \cdot (1+p)(1-p)}{\Delta^2}$$

At a confidence level of $\alpha=95\%$, standard normal variate $Z_{\alpha/2}=1.96$. For 80% power, $Z_{\beta}=0.84$. To estimate the minimum sample size and assuming a moderate correlation, Correlation coefficient $\rho=0.50$ and taking a small effect size $\Delta=0.4$.

So,

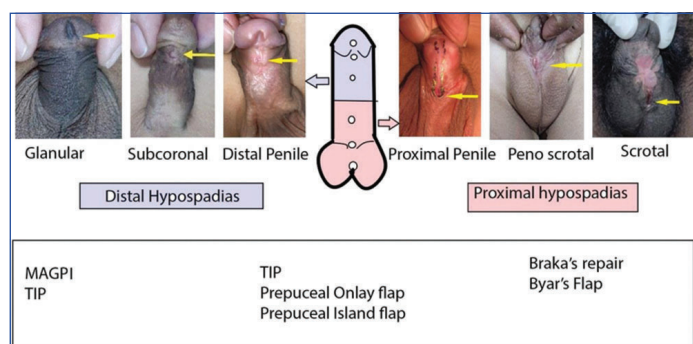
$$n = \frac{(1.96+0.84)^2 \cdot (1+0.5) \cdot (1-0.5)}{(0.4)^2}$$

Calculating this expression: $n \approx 36.75$

Rounding up to the nearest whole number minimum sample size will be 37. Assuming a 20% loss in follow-up, approximate 50 was considered as the final sample size.

Study Procedure

Based on the location of the meatus preoperatively, the cases were divided into distal and proximal hypospadias. As per the severity of the chordee, the cases were graded as no chordee, mild, moderate and severe chordee. As per the location of meatus and considering the degree of chordee, patients were subjected to different surgical plans [Table/Fig-1] [8,9].



[Table/Fig-1]: Meatal location-based categorisation of hypospadias and spectrum of surgical options [8,9].

Surgical plan: The surgical strategy authors adopted was based on the severity of hypospadias, the position of the meatus and the choice of procedure by two different operative surgeons. The severity of the hypospadias was measured preoperatively with the Glans-Meatus-Shaft (GMS) score, which takes into consideration individual components such as glans size/urethral quality, penile shaft curvature and meatus location. Values between 1 to 4 are assigned to various appearances of each component to calculate the final score ranging between 3-12. The GMS score is graded as mild (3-6), moderate (7-9) and severe (10-12) [10]. More unfavourable appearances were assigned higher scores.

For distal and less complicated cases, one-stage repair was the norm. Only in cases of complex proximal meatus and or having poor urethral plate was a two-stage procedure used. All glanular cases were done by the MAGPI procedure. For the subcoronal presentation of the meatus, either the MAGPI or the TIP was done as per the operative surgeon's choice. For distal penile cases, the TIP was the mainstay of treatment, with or without supplementation of the onlay flap or preputial island flap, based on intraoperative assessment. For mid-penile cases, a varied range of procedures was used, including the TIP, Bracka's procedure, Byar's flap and preputial island flap [4-7]. Proximal penile cases were operated mainly by the TIP flap, in addition to a few cases where Bracka's procedure and the preputial island flap were done. For penoscrotal and perineal

cases, Bracka's procedure was the mainstay of treatment, while the two-stage Byar's flap was an alternative, though less favourably chosen.

Outcome assessments: Immediate and late complications were noted. All patients were followed-up and evaluated with uroflowmetry, Penile Perception Score (PPS) and Hypospadias Objective Scoring Evaluation (HOSE) score at the end of six months postoperatively. Uroflowmetry was done to assess the urinary stream.

Aesthetic outcomes were evaluated through clinical and photographic assessment and stratified according to the PPS. On a four-point Likert scale, patient or their parents opined on their perception of the meatal position and shape, glans shape, shaft skin shape and overall penile appearance, each on a scale of very dissatisfied "0" to very satisfied "3". A total score ranging from a minimum 0 to a maximum 12 was calculated on all four items. The final score is graded as follows: score 0-6: dissatisfied, 7-9: satisfied and 10-12: very satisfied, which provided insight into the overall aesthetic outcome of the surgery [11].

Functional outcomes were evaluated based on the 'HOSE Score' proposed by Holland AJ et al., which is based on five-point scoring considers the meatal location, the shape of the meatus, urinary stream, erection and any presence of fistula. Each component is assigned values between 1 and 4, corresponding to different grades. The total score can range from 5 to 16 and a lesser value indicates better outcome [12].

STATISTICAL ANALYSIS

All the data were compiled into a Gantt chart and subjected to statistical analysis. The SPSS (Version 29.0.2.0, Armonk, NY: IBM Corp) software was used for statistical analysis. Data were expressed as the mean and Standard Deviation (SD) and compared using the Student's t-test. The p-value of <0.05 is taken as statistically significant.

RESULTS

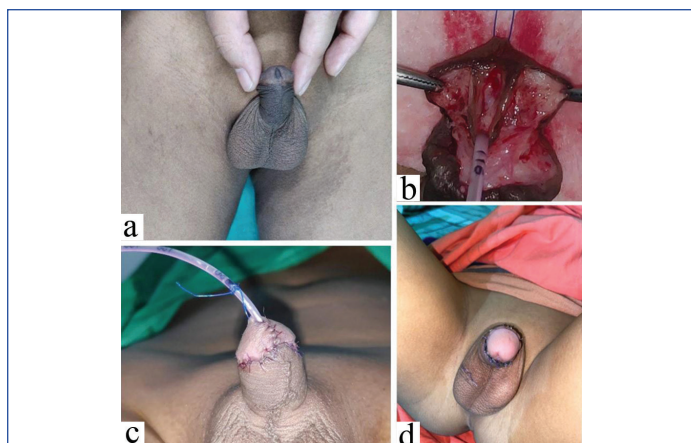
Demographic and clinical profile: The mean age of the study population was 9.92 ± 8.61 years, ranging from 1 year to 34 years. A total of 6 patients (12%) had a family history of similar complaints. As per the location of the meatus, glanular, subcoronal, distal penile, mid-penile, proximal penile and peno-scrotal/perineal hypospadias were noted in 10, 7, 13, 5, 7 and 8 cases, respectively.

As per the severity of the chordee, no chordee, mild, moderate and severe chordee were noted in 10, 18, 17 and 5 cases, respectively. The mean GMS score of the patients was 6.8 (SD 2.33). The severity of hypospadias, as per the GMS score and its relation to the location of meatus, is shown in [Table/Fig-2].

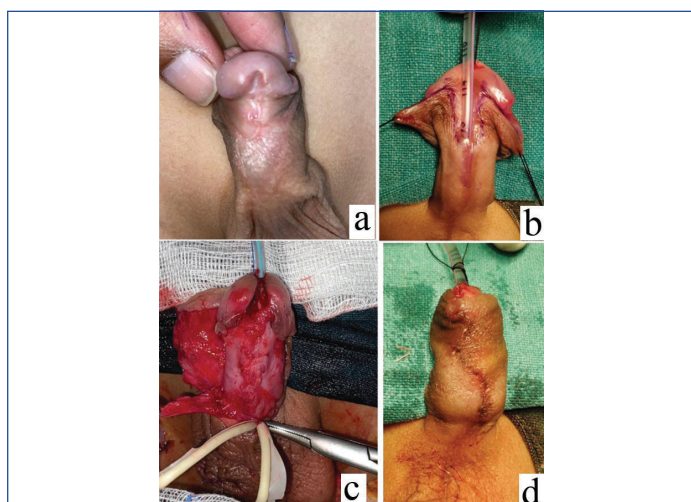
Position of meatus	Severity (GMS score)			Total N=50
	Mild (3-6)	Moderate (7-9)	Severe (10-12)	
Glanular	10 (20%)	0	0	10 (20%)
Subcoronal	7 (14%)	0	0	7 (14%)
Distal penile	4 (8%)	9 (18%)	0	13 (26%)
Mid penile	1 (2%)	4 (8%)	0	5 (10%)
Proximal penile	1 (2%)	2 (4%)	4 (8%)	7 (14%)
Penoscrotal/Perineal	0	1 (2%)	7 (14%)	8 (16%)
Total	23 (46%)	16 (32%)	11 (22%)	50

[Table/Fig-2]: Severity of hypospadias, as per GMS scores related to the location of the meatus. Values presented as n (%).

Operative profile: In the present study, the most commonly used procedure was TIP, which was done for subcoronal, distal penile, mid-shaft and proximal penile defects [Table/Fig-3]. In most of the TIP cases, a second waterproofing layer was used with the Dartos fascia or TV flap [Table/Fig-4].



[Table/Fig-3]: TIP repair for distal hypospadias. a) Preoperative location of meatus; b) Tubularisation of urethral plate; c) Immediate postoperative location of meatus and appearance of glans and penile shaft; d) Delayed postoperative appearance.



[Table/Fig-4]: TIP and intermediate layer of Tunica Vaginalis (TV) flap repair of mid-penile Hypospadias: a) Preoperative photograph; b) Marking of urethral plate and prepuce for Degloving; c) Incorporation of Tunica Vaginalis (TV) Flap; d) Postoperative photograph.

In the present study, 39 (60%) patients were operated on as a single-stage procedure. Among them, the MAGPI procedure, TIP procedure, TIP with preputial onlay flap and preputial island flap were done in 13 (26%), 17 (34%), 5 (10%) and 4 (8%) cases, respectively. Among the 11 (22%) multi-stage procedures, nine were Bracka's procedure and two were Byar's flap. The number of various reconstructive procedures as per the location of the meatus has been shown in [Table/Fig-5].

Location of meatus	Procedures						Total
	MAGPI	TIPS	TIPS+ onlay flap	Preputial island flap	Bracka's	Byar's flap	
Glanular	10	0	0	0	0	0	10
Subcoronal	2	5	0	0	0	0	7
Distal penile	1	9	2	1			13
Mid penile	0	1	1	1	1	1	5
Proximal penile	0	2	2	2	1		7
Perineal	0	0	0	0	7	1	8
Total	13	17	5	4	9	2	50

[Table/Fig-5]: Number of various surgical procedure in relation to the location of the meatus.

Outcome analysis:

Aesthetic outcome: The mean PPS score of the study was 7.62 (SD 1.5). The outcome shows that 36 patients (72%) had a PPS score of 7 and 9, with 25 of them having distal hypospadias. The PPS score in relation to the degree of chordee is shown in [Table/Fig-6].

Degree of chordee	PPS score			Total n=50
	Dissatisfied (0 to 6)	Satisfied (7 to 9)	Very satisfied (10 to 12)	
None	1 (2%)	7 (14%)	2 (4%)	10 (20%)
Mild	1 (2%)	16 (32%)	1 (2%)	18 (36%)
Moderate	7 (14%)	10 (20%)	0	17 (34%)
Severe	2 (4%)	3 (6%)	0	5 (10%)
Total	11 (22%)	36 (72%)	3 (6%)	50

[Table/Fig-6]: Number of patients in relation to the severity of chordee and Grade of PPS Score.

Functional outcome: The mean HOSE score was 11.6 (SD 1.96). The HOSE score was significantly different between severe chordee and no chordee ($p=0.012^*$) and between severe chordee and mild chordee ($p=0.071$) [Table/Fig-7].

Chordee	Number	PPS (Mean±SD)	HOSE (Mean±SD)
No chordee	10	8.7±1.16	12.3±1.83
Mild	18	7.94±1.16	11.83±2.09
Moderate	17	6.88±1.32	11.35±1.69
Severe	5	6.2±1.92	10.2±2.30
Pair-wise comparison		p-value	t-test
No chordee vs Mild		0.11	0.17
No chordee vs Moderate		0.032*	0.08
No chordee vs Severe		0.008*	0.012*
Mild vs Moderate		0.07	0.49
Mild vs Severe		0.039*	0.041*
Moderate vs Severe		0.27	0.06

[Table/Fig-7]: PPS score and HOSE score in relation to severity of chordee.

*statistically significant

When comparing the PPS score with the severity of chordee, significant differences were observed in the PPS score between no chordee and moderate chordee ($p=0.032^*$) as well as between no chordee and severe chordee ($p=0.008^*$) cases [Table/Fig-7].

There were significant differences in the PPS score between glanular and proximal penile cases ($p=0.043^*$) and between glanular and perineal cases ($p=0.002^*$) [Table/Fig-8].

Meatal position	No. of patients	PPS score (Mean±SD)	HOSE score (Mean±SD)
Glanular	10	8.5±1.08	12.3±1.83
Subcoronal	7	8±1.53	12.71±1.79
Distal penile	13	7.92±0.95	11.31±2.14
Mid penile	5	7.8±1.3	12.2±1.3
Proximal penile	7	7.14±1.35	11.43±1.27
Perineal	8	5.63±1.41	10±2.14
Pairwise comparison		p-value	t test
Glanular vs Subcoronal		0.61	0.68
Glanular vs Distal penile		0.44	0.21
Glanular vs Mid penile		0.36	0.87
Glanular vs Proximal penile		0.043*	0.51
Glanular vs Perineal		0.002*	0.035*

[Table/Fig-8]: PPS and HOSE score in relation to meatal location.

*statistically significant

When comparing the location of meatus, the HOSE score was significantly different between glanular and perineal hypospadias ($p=0.035^*$), but not in between other groups [Table/Fig-8].

The PPS score and HOSE score in relation to different surgical procedures have been shown in [Table/Fig-9]. There were significant differences in PPS score between MAGPI and Bracka procedures and between the MAGPI and Byar's flap; however, the location of

meatus remains the confounding factors. However, the MAGPI and TIPS procedure were used for distal hypospadias and when comparing them, it was noted that the PPS and HOSE scores were not statistically different between these procedures.

Procedure	No. of patients	PPS (Mean±SD)	HOSE (Mean±SD)
MAGPI	13	8.23±1.24	11.92±1.94
TIPS	17	8.18±1.07	12.29±1.96
TIPS+Onlay flap	5	8.2±0.45	11.80±1.3
Preputial island flap	4	6.75±1.5	11.00±1.83
Bracka	9	6±1.73	10.11±2.03
Byar's flap	2	6.5±0.71	11±1.41
Pair-wise analysis		p-value	t test
MAGPI vs TIPS		0.76	0.58
MAGPI vs TIPS+Onlay flap		0.81	0.77
MAGPI vs Preputial island flap		0.044*	0.19
MAGPI vs Bracka		0.037*	0.045*
MAGPI vs Byar's flap		0.032*	0.36
TIPS vs TIPS+Onlay flap		0.75	0.41
TIPS vs Preputial island flap		0.041*	0.12
TIPS vs Bracka		0.03*	0.036*
TIPS vs Byar's flap		0.038*	0.14
TIPS+Onlay flap vs Preputial island flap		0.04*	0.23
TIPS+Onlay flap vs Bracka		0.035*	0.049*
TIPS+Onlay flap vs Byar's flap		0.037*	0.45
Preputial island flap vs Bracka		0.48	0.42
Preputial island flap vs Byar's flap		0.71	0.94
Bracka vs Byar's flap		0.63	0.45

[Table/Fig-9]: PPS Score and HOSE score in various procedure.

*statistically significant

Uroflowmetry: Taking into consideration Qmax, all of them had normal results (>25th percentile) postoperatively. There were two cases operated with MAGPI and TIP which had a spraying and bifid stream of urine. Two patients who were operated on with MAGPI and Bracka had hesitancy and poor urinary stream.

Complications: Various early and late complications have been tabulated in [Table/Fig-10].

Early complications		Late complications	
Complication	n (%)	Complication	n (%)
Fistula	5 (10%)	Fistula	5 (10%)
Graft loss	2 (4%)	Urethral stricture	1 (2%)
Wound infection	3 (6%)	Meatal stenosis	3 (6%)
Total	10 (20%)	Total	9 (18%)

[Table/Fig-10]: Complication profile of the study.

DISCUSSION

Successful hypospadias repair includes achieving a straight penis during erection, positioning the meatus at the tip of the glans and allowing for voiding in a single stream while standing position. This is achieved through correction of ventral curvature (chordee) of the penis, i.e., orthoplasty, advancement of the meatus to the tip of the glans (urethroplasty) and repair of the glans and meatus i.e., Glanuloplasty/meatoplasty [11].

For the surgical purpose, the preoperative location of the meatus, degree of chordee, as well as intraoperative meatus location, condition of the urethral plate, penile curvature after chordee correction and tissue availability are taken into decision-making. The final choice of procedure depends on the surgeon's preferences and expertise [4-8].

The contemporary hypospadias repair aims to provide acceptable aesthetic and functional results, lesser complications with less number of interventions. However, due to the varied presentations and challenges caused by the disease itself, these techniques need further evaluation for a better choice of technique according to specific demands. One needs to document the aesthetic prowess and functional capability of the procedures while looking to affect the patient selection and choice of technique in hypospadias cases [13-15].

A GMS score is used in the present study to determine the severity of hypospadias. The GMS is found to be a good tool for determining the severity of hypospadias and has a correlation with surgical outcome [10,16]. In the present study, GMS has a significant correlation with the functional outcome but not with the aesthetic outcome. The chordee is commonly associated with proximal hypospadias, with the severity depending on the location of the meatus [16]. The present study reveals the severity of chordee is significantly related to the aesthetic and functional outcomes also.

A PPS score has been established as a valid tool and has been described in many earlier literature [12,17,18]. In the present study, the PPS score is related significantly to the location of the meatus and the degree of chordee. So the present study indicates that more distal cases had better aesthetic outcomes as compared to proximal ones and the patients with a more severe chordee are seen to have worse PPS. These findings are in line with the findings of Rynja SP et al., who found 70% of the patients were primarily satisfied with the outcomes [17]. Stehr M et al., found that 70.2% of patients had better aesthetic outcomes in patients with distal hypospadias [18]. PPS score was significantly associated with the type of surgery also.

There was a significant difference of PPS score between the procedures for proximal hypospadias group (Bracka, Byar's flap) and procedures for distal hypospadias group (MAGPI, TIPS and TIPS+Onlay flap), as well as between the procedures for mid-penile hypospadias (Preputial island flap) and the distal hypospadias group. But, the differences were not significant between the procedures themselves within each group. Similarly, the HOSE score was significantly different between Bracka's procedure and MAGPI, TIPS and TIPS+Onlay flap, but not between any other groups. This may reflected in that the majority of the cases are distal hypospadias in the study population and location of meatus remains a major confounding factor. The PPS score is not significantly different with MAGPI and TIPS, which were done for distal hypospadias cases.

Considering these findings, the authors assume that the location of meatus and severity have a major influence on aesthetic and functional outcome, rather than the surgical procedures itself. The present study shows a highest HOSE score in glanular hypospadias, with reducing scores in more proximal cases. The HOSE score has a significant relationship with the location of meatus. These findings are in line with the findings of Güner E and Arkan Y, who found that the lowest HOSE score was in patients with proximal hypospadias and the highest HOSE score was in those with glanular hypospadias [19].

Out of 50 patients in the present study, 17/50 (34%) has any form of complications and this is in the higher normal range of most related studies, with Beuke M and Fisch M reporting 6%-30% complications depending on the type and degree of chordee [20]. The most common complication is urethrocutaneous fistula (10/17), which makes up 58% of all complications requiring intervention and repeat surgery. Meatal stenosis (3/12), seen in MAGPI cases decreased spontaneously with dilation. Graft loss occurred in some cases of Bracka's repair, while wound infection was noted in a few instances. These findings are similar to those of Marrocco G et al., and Snyder CL et al., who found complication rates of 5-40% [21,22].

As these complication profiles are closely related to the severity of the disease [23-25], the choice of individual surgical methods may have a limited impact on overall aesthetic and functional outcomes. However, efforts to limit the complications would, in turn, improve the outcomes.

In most of the TIP cases, a second waterproofing layer was used with the Dartos fascia or TV flap. The intermediate layer was utilised in 14 out of 17 TIP surgery. Among these cases, the TV layer and the Dartos fascia are used in 10 and 4 cases, respectively. Sengol J et al., found that the use of a second layer in conjunction with TIP gave better results [26]. The rate of complications in patients with a second waterproofing layer was found to be better than those with no second layer. Churchill BM et al., found overall complications to be much less on the addition of the Dartos fascia as an intermediate layer, while Kadian YS et al., found the TV layer to be the better option among the two [27,28]. The authors believe that the use of an intermediate layer has improved outcomes in TIP cases, particularly in proximal hypospadias. These findings encouraged authors to believe that use of the intermediate layer in the long run may have a significant impact on the reduction of complications and final aesthetic and functional outcomes. However, the limitations of the present study restrict to draw a definitive inference from the present study.

Limitation(s)

The study is limited by the lack of long-term follow-up and its non randomised control study design. Due to the limited study period a long-term follow-up was not possible, which may impact on delayed outcomes, particularly in children. Moreover, a details comparative analysis could not be done between each procedure or procedure group due to the smaller sample size of proximal hypospadias cases. A future randomised controlled study and multicentre analysis may help to draw a strong conclusion.

CONCLUSION(S)

The chance of obtaining a better aesthetic outcome depends on the lesser severity of the chordee and a distal location of the meatus. The location of meatus, rather than the type of surgery, remains the most important factor influencing both the aesthetic and functional outcome. Use of an intermediate layer with the Dartos flap and TV flap may improve the functional outcome of the surgery. However, this finding needs further larger sample analysis and randomised controlled analysis to draw a strong conclusion.

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PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Burn and Plastic Surgery, IPGME&R and SSKM Hospital, Kolkata, West Bengal, India.
2. Senior Resident, Department of Burn and Plastic Surgery, IPGME&R and SSKM Hospital, Kolkata, West Bengal, India.
3. Assistant Professor, Department of Burn and Plastic Surgery, Institute of Medical Science, Banaras Hindu University, Varanasi, Uttar Pradesh, India.
4. Associate Professor, Department of Burn and Plastic Surgery, IPGME&R and SSKM Hospital, Kolkata, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Sudipta Bera,
Assistant Professor, Department of Burn and Plastic Surgery, Institute of Medical Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India.
E-mail: sudiptacnmc@gmail.com

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