Original Article

Outcomes of Tubularized Incised Plate Urethroplasty on Uroflowmetry and Hypospadias Objective Scoring Evaluation Scores

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Abstract

Background: Both urinary flow characteristics and aesthetic appearance of the phallus determine the success of a procedure for hypospadias correction. **Objectives:** The objective of this study was to evaluate the outcomes of tubularized incised plate (TIP) urethroplasty on post-operative uroflowmetry (UFM) and Hypospadias Objective Scoring Evaluation (HOSE) scores. **Patients and Methods:** A prospective study was conducted on all hypospadias patients who underwent TIP urethroplasty in the department of paediatric surgery at a tertiary centre from March 2020 to September 2021. Post-operative HOSE and UFM were performed at 3, 6 and 9 months of surgery. Collected data were analysed. **Results:** A total of 30 children with hypospadias underwent TIP repair; 7 (23.33%) developed urethrocutaneous fistula; among the rest 23 patients, 7 (30.43%) had bell-shaped (BS) curve at 3 months, which increased to 60.87% 6 months and 76% at 9 months. 60.87% patients at 3 months, 69.56% at 6 months and 60% at 9 months had normal flow rate. Type of curve, maximum flow rate and number of fistulae showed improvement with time. On objective assessment, the mean HOSE score was found to be 14.8, 14.8 and 14.49 at the end of 3, 6 and 9 months of surgery, respectively. Acceptable cosmetic results were obtained in 96.67% of the boys, with a HOSE score of ≥14. **Conclusion:** HOSE score, being an objective assessment tool, provided reliable and reproducible evaluation of post-operative outcomes of hypospadias surgery. UFM must be done in every hypospadias patient who undergoes urethroplasty irrespective of the result of HOSE scoring, as it quantifies the urinary flow characteristics.

Keywords: Hypospadias Objective Scoring Evaluation Score, hypospadias, tubularized incised plate urethroplasty, uroflowmetry

Introduction

The assessment of outcomes of surgery for a heterogeneous anomaly like hypospadias is difficult. Although voiding urine in a single stream from a meatus located at the tip of the glans might please the post-operative hypospadias patient, the surgeon may not still be satisfied by his urinary flow. Similarly, a good flow with poor aesthetics may be equally bothersome. Therefore, a successful hypospadias surgery may have different meaning to the patient and the surgeon. A formal assessment tool for the outcome of surgery should therefore address the urinary flow characteristics as well as the cosmetic results of the surgical procedure. It should also have less observer variability. Several researchers have independently tried to assess the urinary flow with uroflowmetry (UFM).[1,2] When it comes to cosmetic outcome, not only the absence of fistula but also the position and shape of the meatus, the urinary stream (whether single stream or not) and the angulation of the penis when erect all have a say. 'Hypospadias Objective Scoring Evaluation (HOSE)' is an objective assessment tool which includes all these individual components.[3]

Tubularized incised plate (TIP) urethroplasty as described by Snodgrass is a common procedure for middle and distal hypospadias and selected proximal hypospadias where a midline incision in the urethral plate helps in mobilisation of

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the urethral plate for urethroplasty.[4] Its outcome was evaluated by a prospective study wherein post-operative UFM and HOSE scoring were periodically done by two different observers. We present the results of our study.

Patients and Methods

A prospective study was conducted on all hypospadias patients who underwent TIP urethroplasty in the department of paediatric surgery at a tertiary care hospital from March 2020 to September 2021 after approval from the institutional ethics committee (1562/IEC/IGIMS/2020). Informed consent for the inclusion in the study was also taken from the parents of the patients.

Post-operative HOSE scoring and UFM were performed and data were collected. During follow-ups, all patients except those having fistula underwent UFM study at the 3rd, 6th and 9th months of surgery. Patients having urethrocutaneous fistula (UCF) were operated after 1 year, if found persistent. Rest of the patients were further followed up, three monthly for any symptoms till 18 months of surgery. UFM and HOSE scoring were also done at 18-month follow-up. UFM was measured using a rotating drum flowmeter, and the urinary flow curve (UFC) of every patient was determined. Voided volume maximum (Q_{max}) and average flow rate (Q_{avg}) were measured, and the results of Q_{max} were expressed as percentiles. Q_{max} was considered (1) normal flow rate (NFR) if percentile values were >25th centile, (2) equivocally obstructed flow rate (EOFR) when values were in between the 5th and 25th centile range and (3) obstructed flow rate (OFR) if values were <5th centile. The urinary flow patterns were classified as bell-shaped (BS), slightly flattened (SF), interrupted (I) or plateau (P).

A five-point scoring system called 'HOSE' as described by Holland *et al.* was used for objective assessment.[3] Meatal location was described based on its location on glans and shaft of the penis, i.e. distal glans, proximal glans and coronal or more proximally on the penile shaft, and scored from 4 to 1. Meatal shape was classified as either a vertical slit or circular and scored 2 or 1. Urinary stream assessed with the child voiding, either in a single stream or spray, and was scored accordingly 2 or 1. Penile angulation was determined after an erection witnessed by the assessor or based on a parental evaluation using the following guidelines: straight, mild angulation (<10°), moderate angulation (>10° but < 45°) and severe angulation (>45°), with corresponding scores varying from 4 to 1.[3,5] Finally, any UCF (documented post-operative fistula) was classified as sub-coronal or more distal, proximal and multiple/complex, with scores from 4 if found absent to 1 for multiple or complex UCF. The scoring system was designed so that the minimum total score would be 5 (corresponding to the lowest score for each variable) and the maximum total score would be 16 (corresponding to the highest score for each variable). A score of ≥14 was considered acceptable. Table 1 summarises the HOSE assessment tool.[3]

The first UFM and HOSE scoring were done at 3 months; the second and third UFM and HOSE scoring were done at 6 months and 9 months, respectively. To evaluate the adequacy of HOSE score as a scoring system for objective assessment, two independent scores by two different medical observers at 3 and 9 months were compared to see the agreement between them while using the HOSE scoring.

For the calculation of sample size, search was done to look for the mean and standard deviation (SD) values for Q_{max} on UFM for boys having hypospadias in the pre-operative period. They were taken from a similar study by Pandey *et al.*[6] The corresponding mean and SD values were taken to be 6.57 mL/s and 1.63 mL/s, respectively. Taking these values as values for SD (1.63), effect size (13% increase) and baseline values for Q_{max} (6.57) in hypospadias patients, sample size was calculated using online software called ClinCalc.com. It was found to be 29. Hence, the sample size of 30 was chosen for this study.

All these 30 patients were then categorised into three groups based on the position of the meatus (distal penile hypospadias [DPH], midpenile hypospadias [MPH] and proximal penile hypospadias [PPH]). All operated patients were considered for objective assessment (HOSE) while only those patients without fistula were evaluated urodynamically. All patients who had any other surgery other than TIP urethroplasty, mentally retarded patients, those not willing to participate or those lost to follow-up were excluded from the study.

For statistical analysis, variables were categorised as nominal, ordinal or continuous. For ordinal variables, non-parametric Mann–Whitney test and Wilcoxon signed-rank tests were used. *t*-tests for independent means were used for continuous variable with normal distribution, while non-parametric tests were used for continuous variables without normal distribution. For statistically comparing the UFM curves, numbering was done for the types of curves (BS curve was given a score of 4, SF a score of 3, I a score of 2, P a score of 1 and F a score of 0); the resulting ordinal scale data were analysed using non-parametric statistical tests. Online social science statistics tool was used for these tests. Percentiles for flow rates were calculated using the Microsoft Excel statistical tool. Kappa statistics were used to find the agreement between two observers (medical observer 1 and medical observer 2) while using the HOSE scores. Statistical significance was based on $P < 0.05$.

Results

A total of 30 hypospadias patients were operated and evaluated during the study period of 18 months. The age varied from 2 years to 12 years, with a mean age of 6.03 years. Out of 30, 17 (56.67%) had DPH, 8 (26.67%) had MPH and 5 (16.67%) had PPH.

Out of 30 patients, 7 (23.33%) developed UCF and hence UFM could not be performed in them. In the remaining 23 patients, 7 (30.43%) had BS curve, 10 (43.47%) had SF, while 6 (26.08%) had *P* at the end of 3 months. At 6-month follow-up, 14 (60.86%) patients had BS and 9 (39.13%) had SF. The gradual improvement in the UFC over a period was noted

in patients having SF and P curves. Table 2 summarises the nature of UFC over time in this study. At the end of 9 months, 19 (76.00%) had BS, 5 (20.00%) had SF, while 1 (4.00%) had P type curves. Statistical comparison showed a statistically significant difference in the scores of the curves attained on UFM at 3 and 9 months after surgery ($P < 0.05$). The rest five patients still had UCF at the end of 9 months, and hence, UFM could not be done in those patients.

The UCF patients were taught occlusive micturition and advised meatal calibration to be done at the institute on regular post-operative visits. Two patients out of seven having UCF had spontaneous UCF closure at the end of 6 months. One such patient whose fistula had healed had a *P* type curve, while the other had SF type curve at the end of 9 months. With these data, it can be observed that with gradual progression of time, the UFC tend to improve from P/SF towards BS curve as majority of our patients (76%) had BS at the end of the study while it was only 30% at the start of the study.

The average Q_{max} at the end of 3 months was 8.0 mL/s which improved to 9.4 mL/s at the end of 6 months and had a maximum of 10.5 mL/s at the end of 9 months. The importance of Q_{max} lies in predicting and defining obstructive flow rate. Following standard definition of obstructive flow rate, 3/23 (13.04%) patients in our study had OFR at the end of 3 months while 2/23 (8.69%) had OFR at the end of 6 months and 3/25 (12.00%) at the end of 9 months. Six out of 23 (26.08%) patients in our study had EOFR at the end of 3 months while 5/23 (21.73%) had EOFR at the end of 6 months and 7/25 (28.00%) at the end of 9 months. Fourteen out of 23 (60.87%) patients in our study had NFR at the end of 3 months while 16/23 (69.56%) had NFR at the end of 6 months and 15/25 (60.00%) at the end of 9 months. The obstructive flow rate gradually improved with time and urethral calibration at the end of 9-month follow-up period. Table 3 depicts these changes in Q_{max} over time. Statistically significant differences were found when comparing Q_{max} values at 3 and 9 months ($P < 0.05$).

All the operated patients were evaluated objectively with HOSE scoring. The range of HOSE scores in our series of patients varied from 13 to 16. The mean HOSE score was 14.8, 14.8 and 14.96 at the end of 3, 6 and 9 months of surgery, respectively. On comparing, HOSE score (ordinal variable) at 3 and 9 months of study showed no significant difference ($P = 0.41794$). Acceptable cosmetic results were obtained in 29 (96.67%) of the boys, with a HOSE score of ≥14. As regards the changes in the components of HOSE score, of the five patients who had an improvement in HOSE score, it could be attributed to improvement in urinary stream in three patients with calibration and gradual healing of fistula on dilatation of neourethra in two patients. Table 4 shows the overall results of the study.

The most common complication observed in our study was poor urinary stream which was observed in 20/30 (66.67%) at the end of 3 months which gradually improved over time and with calibration in three patients.

Table 1: Components of Hypospadias Objective Scoring Evaluation scoring system

HOSE - Hypospadias Objective Scoring Evaluation

Assessor: **Patient:**

Date:

Variable	Score	Diagram
1. Meatal location		
Distal glanular	4	
Proximal glanular	3	
Coronal	2	
Penile shaft	1	
2. Meatal Shape		
Vertical slit	2	
Circular	1	
3. Urinary Stream		
Single stream	2	
Spray	1	
4. Erection		
Straight	4	
Mild angulation (< 10°)	3	
Moderate angulation (> 10° but < 45°)	2	
Severe angulation (> 45°)	1	
5. Fistula		
None	4	
Single - subcoronal or more distal	3	
Single - proximal	2	
Multiple or complex	1	
Total		

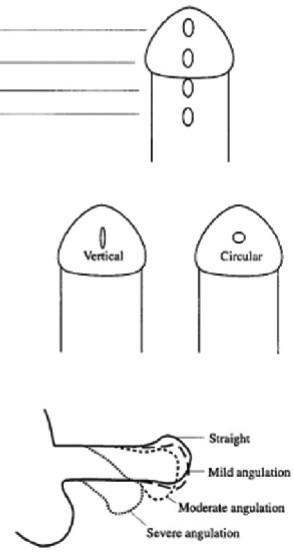


Table 2: Results of the type of Uroflowmetry curves at 3, 6 and 9 months after surgery

UFC	At 3rd month of surgery	At 6th month of surgery	At 9th month of surgery
BS	7	14	19
SF	10	9	5
P	6	0	1
I	0	0	0

UFC- urinary flow curve; BS – Bell shaped; SF – slightly flattened; P- Plateau; I – Interrupted

Table 3: Maximum velocity at 3, 6 and 9 months after surgery

Percentile	At 3rd month of surgery	At 6th month of surgery	At 9th month of surgery
<5th percentile*	03	02	03
5-25th percentile*	06	05	07
>25th percentile*	14	16	15

*Microsoft Excel statistical tool

The second most common complication observed was UCF which was present in seven patients (23.33%) at the end of 3 months but in five patients (16.67%) at the end of 9 months. Residual mild chordee (acceptable <10°) was observed in four patients (13.33%) at the end of the study. It was possible to

Table 4: Overall results of the Study

Parameter/Variables compared	Nature of the variable	Summary of results	*P*
HOSE Score at 3 & 9 months	Ordinal	Non-parametric; Mann-Whitney *U* test[#] (*U*-value -395; *Z*-score=0.80575)*	0.41794 (>0.05)
Uroflowmetry curve (numbered as per type)	Ordinal	Non-parametric; Wilcoxon Signed Rank test (*Z*-score = -3.7236)* *W*-value=0	0.0002 (<0.05)
Qmax values at 3 & 9 months	Continuous, normal distribution**	Parametric; *t*-test for independent means (*t*-value =-4.56185)*	0.000038 (<0.05)
(Voided volume/Expected bladder capacity) at 3 & 9 months	Continuous, normal distribution**	Parametric; T-test for independent means (*t*-value =-4.47259)*	0.00005 (<0.05)
Voiding time at 3 & 9 months	Continuous, normal distribution**	Parametric; *t*-test for independent means (*t*-value =-0.81197)*	0.42099 (>0.05)
Average velocity at 3 & 9 months	Continuous, non-normal distribution (*P*<0.05)**	Non-Parametric; Mann-Whitney *U* test (*U*-value -170.5; *Z*-score=2.40428)*	0.0164 (<0.05)

*EZ SPSS (Social science statistics); **Kolmogorov –Smirnov test of normality; [#]Two ordinal samples with independent measures

Table 5: Complications of Tubularized Incised Plate Urethroplasty at 3 and 9 months

Complications (Components of HOSE score)	No. of pt at 3 months	No. of Pt. at 9 months
Poor Urinary Stream	20	17
UCF	07	05
Residual Chordee	04	04
Round meatus	03	03
Meatus at proximal glans	02	02

achieve vertical slit like meatus in 27/30 (90%) patients while the rest three patients (10%) had round meatus. The meatus after surgery was seen in distal glans in 28 patients (93.33%) while the rest two patients had meatus located in proximal glans. Table 5 summarises the complications found in this study.

Five patients who had UCF were further followed up for 3 months and underwent successful fistula closure after 1 year of first surgery. Remaining 25 patients were followed up at 3 months interval till 18 months after surgery. Eighteen months after surgery, 64% had NFR, 24% had EOFR and 12% had OFR on UFM. Furthermore, 72% had BS, 24% had SF and 4% had *P* type of curves on UFM. The mean HOSE score of these patients at 18-month follow-up was 14.5. There was no significant difference between outcomes at 9 and 18 months of surgery.

Kappa statistics was used for agreement between two observers (medical observer 1 and medical observer 2) for HOSE scoring at 3 and 9 months of age. At 3 months of age, there was 96.67% agreement between the observers with a value of Cohen's kappa of 0.90. At 9 months of age, the value of Cohen's kappa was still high with 96.67% agreement. These findings suggest that there is not much difference in HOSE scoring between two observers with comparable knowledge and examination skills.

Discussion

Although the native anatomy dictates the surgical procedure in hypospadias, there is no established single way to address a particular anatomy and to judge the post-operative results. Post-operative assessment involves not only the aesthetic appearance of the penis but also the final urinary stream.[7] A good-looking phallus without a satisfactory stream or with a urinary stream which involves a lot of straining is equally a failure. While HOSE scoring gives an objective assessment, a formal UFM quantifies the flow and volume characteristics of a void.[4,8] This study was conducted to evaluate the post-operative results (both urinary flow characteristics and appearance) in patients with adequate urethral plate operated through TIP urethroplasty as popularised by Snodgrass.[4]

Similar studies have been conducted at other centres, and researchers have had varying inferences.[9,10]

The mean age of our study population was 6.03 years (range = 2–11.5 years). Compared to some other centres, this age group is older than what is the appropriate age of hypospadias repair (6–18 months). Reasons of delayed presentation might be due to lack of awareness of this defect among parents in this part of the country and apprehension of surgery in small children. Most surgeons favor early correction of hypospadias to avoid any future psychosocial or psychosexual problems of surgery in grown up children.[11] Ziada *et al*. found that fistula incidence was higher (15.8%) in older age group (4 years old or older).[12] Although outcome of hypospadias surgery is better in younger age group, anesthesia-related risk factors must be considered when operating in very early infancy.

The most common type of hypospadias in our study was DPH (56.67% of all cases). Our patients were followed up with UFM at 3, 6 and 9 months after surgery. Thereafter, 3 monthly follow-ups were done till 18 months with a final UFM at 18 months. It was characteristically identified as BS, interrupted and SF and plateau-shaped curves. Out of the 23 patients who were initially without fistula, periodic UFM assessment revealed a statistically significant improvement in the nature of the curves, the urinary flow rates (Q_{max} and average velocity) and voided volumes. These could be attributed to the natural healing process and urethral

calibration in patients tending to form meatal stenosis. Elbakry recommended urethral calibration in patients with thin urinary stream or a tendency for meatal stenosis.[13] We believe that during the active healing process, any obstruction at the level of the meatus in the form of meatal stenosis would not only lead to fistula formation but also to suboptimal flow rates on examination. A simple maneuver in the form of urethral or meatal calibration would ensure distal patency thereby lessening pressure at the proximal repair site and better flow rates. In a similar study, Piplani *et al.* concluded that both pre-operative and post-operative periodic UFM assessment of urinary stream is indispensable to judge the urinary flow outcome of hypospadias surgery.[14] Hadidi emphasised on the functional obstruction in cases of TIP urethroplasty due to the creation of a long narrow groove in this procedure.[15] Elbakry *et al*. reported better post-operative results with tubularized intact and laterally augmented urethral plate urethroplasty techniques in comparison to TIP urethroplasty.[16]

In a study involving 60 patients with DPH and MPH who underwent TIP urethroplasty, Naumeri *et al*. did a comparison of the rates of UCF after single dartos and double dartos cover.[17] Out of 60 children, 8 (13.3%) developed UCF, of which 7 (23.3%) fistulae developed in single-dartos TIP urethroplasty and 1 (3.3%) developed in double-dartos TIP urethroplasty.[17] The fistula rate in our series at the end of 9 and 18 months was 16.7% which is comparable to the single-dartos TIP urethroplasty.

On assessing the results objectively, using HOSE scoring system, 29/30 (96.67%) patients had a HOSE score of ≥14, thereby achieving the goals of hypospadias surgery. The most common complication of surgery was poor urinary stream which usually gradually improved over time with or without urethral calibration. Other investigators have also reported a high incidence of suboptimal urinary stream on follow-ups after Snodgrass procedure.[2,15,16,18] In our study, this complication usually needed parental counseling at the time of follow-up visits. Urethral calibration was done during the time of follow-up visits. There was a statistically significant improvement in the urinary flow as confirmed by comparison of the nature of the UFM curves at 3 and 9 months of surgery, although objective HOSE score comparison at these ages did not reveal any significant difference. Chronological changes in UFM have also been reported by Al Adl *et al*. who observed late improvement in patients operated by TIP urethroplasty but also noted better flow rates with staged grafted procedure for proximal hypospadias.[19] The second most common complication was UCF which usually requires surgical correction. In two patients, these fistulae underwent spontaneous closure and so around 28.57% of fistula resolved over a period of 6 months which is a significant fraction. This incidence of occurrence and spontaneous closure of the UCF in our study is comparable to the incidence as reported in literature.[20,21] In a similar study, Chung *et al.* found that out of 294 patients, 63 patients (21.4%, 63/294) developed UCF after hypospadias repair.[22]

Chordee correction was an integral part of surgery and could be achieved successfully in 26/30 patients. The rest four patients (13.33%) had mild residual post-operative chordee which did not require any further corrective surgery; all these patients had pre-operative chordee, and during surgery, it appeared that with penile degloving, it got corrected fully. Had there been significant chordee pre-operatively and degloving would not have been sufficient for correction, other methods for chordee correction would be needed complicating the procedure and its outcomes. The goal of vertically slit-like meatus well nested in the substance of the glans could be achieved in 27/30 patients. The presence of meatus was on distal glans in 28 cases; two patients who had meatus in proximal glans which did not affect the urinary flow and as such required no further corrective surgery. HOSE scores were acceptable (≥14) irrespective of the location of the final meatus. Although there was a high level of agreement between the two medical observers when doing HOSE scoring at 3 and 9 months after surgery and HOSE scores revealed almost all the components of a proper objective assessment, there were patients who had HOSE score in the acceptable range irrespective of the presence of a fistula or impeded flow on performing UFM. These are some fallacies of a scoring system which in a way masks the individual deficiencies at the component level. Therefore, a formal urinary flow assessment and detailed clinical examination is a must even if HOSE scores are high. Similar observations have been made about the practicality of the HOSE scores by a few other investigators.[23,24] Ceccarelli *et al.* found significant differences in the HOSE scores done by children, parents and surgeons in their study; HOSE score assessment by children themselves was lower than those by the surgeons.[25] Furthermore, HOSE scores were consistently lower for proximal hypospadias.[25] In a study by Al-Adl *et al*., 43 consecutive patients with primary distal hypospadias, who underwent modified TIP urethroplasty, were evaluated cosmetically, and it was found that the mean (SD, range) HOSE score was 15.8 (0.6, 13–16) comparable to our results.[9]

Conclusion

Systematic, prospective data collection facilitated identification of complications of TIP urethroplasty, their risk factors and provided a means to assess the results of modifications made to address them. Although cosmetic results of the procedure were good, urinary flow rates were often suboptimal. We also concluded that HOSE score, being an objective assessment tool, provided reliable and reproducible evaluation of post-operative outcomes of hypospadias surgery. UFM, being a simple and non-invasive procedure, must be done in each hypospadias patient who undergoes urethroplasty irrespective of the result of HOSE scoring, as it quantifies the urinary flow characteristics.

Limitations of the study

The small sample size of this study and limited follow-up of patients are the limitations of this study. A larger study

with longer follow-up period would bring about stronger evidence.

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Conflicts of interest

There are no conflicts of interest.

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