

Learning curve for TIP urethroplasty: A single-surgeon experience

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Abstract

Introduction: We evaluate the influence of surgeon experience and other clinical factors on the success of primary hypospadias repair, using the tubularized incised plate urethroplasty (TIPU) technique.

Methods: We retrospectively reviewed pediatric cases of primary hypospadias repair performed by a single pediatric urologist (soon after his fellowship training) using TIPU between July 2002 and January 2011. The surgical techniques (including the fact that the procedure was an outpatient one) were the same for each patient. The overall complication rate (CR) was analyzed for the following factors: patient age, use of a stent, meatal position, and surgeon experience. All significant covariates on univariate analysis or with a clinical relevance were entered into a multivariable logistic regression model. A non-linear model was created to estimate the change in the CR over the years.

Results: Pediatric patients (median age 1.4 years old) presenting with distal (n = 251), midshaft (n = 22) or proximal (n = 30) hypospadias and with a minimum 6-week follow-up (median 13 months) were included. Most patients (87%) had a urethral stent postoperatively (mean duration 9.8 days). In total, 96 patients had 133 complications: 27 meatal stenosis, 25 meatal coronal migrations, 22 urethrocutaneous fistulas and 59 other complications. Of these, 53 patients underwent a second operation. On multivariate analysis, the only factor increasing the CR was a non-distal meatus. The non-linear model demonstrated a significant learning curve with a decreasing CR over the years. The limitations of this study are its retrospective nature and lack of long-term follow-up.

Conclusions: When using TIPU, the CR significantly increases as the meatal position gets more proximal; the learning curve stabilizes after about 50 to 75 cases.

Introduction

Hypospadias is one of the most common birth defects and its prevalence is rising.^{1,2} Numerous types of surgical techniques have been described over the years and are still used by different surgeons. The main goal of any hypospadias repair is to reach and maintain a normal urinary and reproductive function with good cosmetic result.³ One of the most frequently used procedures, the tubularized incised plate urethroplasty (TIPU), was popularized by Snodgrass in the 90s.⁴ The technique is now the gold standard to correct distal hypospadias; it is also being used more for midshaft and proximal cases.^{5,6} Its popularity and acceptance can be explained by its versatility and its optimal and durable aesthetical and functional results with minimal complications. It is also popular because it can be performed as a single-stage procedure.

Different TIPU risk factors have been identified over the years and various technical modifications have been presented.⁷⁻⁹ More recently, a new important factor is emerging – surgeon experience. Frimberger and colleagues highlighted the complexity of creating a straight phallus with an anatomically positioned meatus and good cosmetic results. This complexity underlines the importance of fellowship training in this procedure.¹⁰

In this study, we report a 9-year experience of a single academic pediatric urologist (soon after his return from fellowship) with TIPU for the correction of primary hypospadias. Our objective was to evaluate the influence of predetermined clinical factors, including surgeon experience on TIPU outcomes for primary hypospadias. We hypothesized that the learning curve of TIPU will remain constant over time for a fellowship-trained pediatric urologist.

Methods

In this retrospective study, approved by the local ethics board, we reviewed the medical records of 344 pediatric patients who underwent primary TIPU by a single pediatric urologist between July 2002 and January 2011. All forms of hypospadias (distal, midshaft and proximal) were included. Position of meatus, presence of ventral curvature, age at surgery, blood loss, use and duration of stenting, follow-up period, and complications were recorded. We excluded patients over 14 years old and patients with a follow-up of less than 6 weeks. Based on previous reports,^{8,11,12} we selected 4 potential risk factors for complications and included them in our analysis: age, stenting, initial meatal position, and surgeon experience.

The operative technique for TIPU remained the same over the years, except for some minor adjustments. Through the years, the surgeon paid greater attention to avoid incising the urethral plate too distally to decrease the risk of meatal stenosis. Also, the surgeon stopped overlapping the dartos flaps in a 2-layer fashion on the reconstructed urethra. Instead, he secured 1 flap distally underneath the glans wings and the other more proximally. This helped decrease the tissue redundancy on the ventral aspect of the penis and improved the aesthetic look of the penis.

Optical magnification was used for all cases. All patients underwent TIPU as per the basic principles described by Snodgrass.^{4,13}

All cases were performed on an outpatient basis. Follow-up visits happened at the time of stent removal (mean 12 days [range: 0-26]), at 2 months and then 1 year postoperatively or after the children became potty-trained.

The flow rate was selectively indicated for patients with voiding difficulty and/or a narrow meatal orifice or weak stream. A meatal stenosis was diagnosed when there was a flow rate of less than 5 mL/sec.

Success was defined as the presence of an anatomically positioned vertical slit-like meatus, a normal urinary stream and a satisfactory cosmetic appearance, resembling a circumcised penis.

Surgical technique

A circumferential incision was done at the base of the glans to deglove the penis, and to correct the ventral curvature if present. The corpus spongiosum was mobilized. An artificial erection was created with saline injection and the intrinsic ventral curvature was corrected with a dorsal plication as needed. Two parallel vertical incisions were made at the junction of the urethral plate and glans wings, isolating the urethral plate. The urethral plate was then widened by a longitudinal midline dorsal incision from the meatus to its distal extent and tubularized using 7-0 polyglyconate

absorbable sutures with a 2-layer closure over an 8 Fr or 10 Fr Zaontz stent (Cook Medical, Bloomington, IN). The first layer is done with a running suture and the second in an interrupted fashion. The stent was secured to the glans with a 5-0 polypropylene suture when left in place. The spongiosum was re-approximated to cover the neourethra. The dartos pedicle dissected from the dorsal foreskin was divided medially; one half was placed to cover the distal reconstruction and the remaining half to cover the proximal urethra. Glanuloplasty was performed in a standard manner with interrupted 6-0 monofilament polyglyconate synthetic absorbable sutures. Skin closure was carried out with interrupted 5-0 coated polyglactin 910 sutures.

Statistical analysis

We calculated descriptive statistics, such as frequency distributions or medians, with standard deviations to summarize the patients' clinical characteristics. The dependent variable was the overall complication rate and it was defined as a success or a complication. The independent variables were patient's age at surgery (less or greater than 1 year), stenting (yes/no), and meatal location (distal vs. midshaft and proximal). Univariate analysis, with Student's t-test and Pearson chi-square test, was carried out to evaluate the significance of a priori identified risk factors for overall complications. Next, all covariates with a *p* value <0.05 on univariate analysis, as well as those with a priori established clinical relevance, were entered into a multivariable logistic regression model. Results were analyzed in terms of odds ratio (OR), with lower and upper 95% confidence intervals (CI).

To evaluate the impact of the variable surgeon's experience on complication rate, we separated surgeon experience into quartiles. Then, we compared meatal stenosis and fistula rates among the different quartiles with a chi-square test. We also compared the overall complication rate (number of complications [meatal stenosis, fistulas, aesthetic imperfections, infections, etc.]/number of cases) among the different quartiles with Kruskal-Wallis test; we also created a non-linear model. The dichotomous variable of interest (success vs. complication) was converted to a continuous variable: the cumulative rate. The cumulative rate was defined as the surgeon's complication rate (the number of complications cumulated at a time [T]/number of cases at that time). A graph representing the actual data point was created and a negative exponential curve was then adjusted to link the cumulative rate and the number of surgeries done by the surgeon over time with the NLIN procedure of SAS. The model was confirmed as accurate by the technique described by Saxton and colleagues.¹⁴ The model was then adjusted for the following variables previously identified: age at surgery, use of a stent and hypospadias severity.

Descriptive statistics and logistic regression were carried out with the statistics software SPSS 15.0 (SPSS Statistics, Chicago, IL). The negative exponential curve was carried out with SAS 9.2 software (SAS Institute, Cary, NC). All tests were 2-sided and a p value <0.05 was considered statistically significant.

Results

Of the patients who underwent TIPU over 9 years, 303 patients qualified for our study. Meatal location was distal in 251 cases (82.8%), midshaft in 22 (7.3%) and proximal in 30 (9.9%). A total of 123 patients had ventral curvature (104 cutaneous, 19 intrinsic). The age at surgery ranged from 5 months to 13.8 years (median 1.4 years old). Stenting was performed in 263 (86.8%) cases for a median duration of 12 (range: 0-26) days. Stentless cases were not equally distributed over the years; 52% of the first 50 cases did not have a stent versus 5.5% of the cases from the remaining group ($p < 0.01$). There was no change over the years concerning the operative time for distal hypospadias repair with a median of 90 minutes. The follow-up ranged from 1.8 to 104 months (median 13.4 months).

The overall success rate was 76.9%. Complications were found in 96 (31.7%) patients, of whom 10 needed a simple meatoplasty and 43 a more complex revision. The most frequent complication was meatal stenosis, followed by meatal coronal migration, fistula and cosmetic imperfections. Coronal migration was defined as a partial distal dehiscence with a final meatus located at the corona. Three patients experienced recurrent ventral curvature and 7 patients had a breakdown of the repair or complete dehiscence (Table 1).

On univariate analysis, age <1 year at surgery and midshaft or proximal meatal location were significantly associated with higher complication rates ($p < 0.01$) (Table 2). On multivariate analysis, meatal location remained the only factor significantly associated with more complications (Table 3).

The analysis of surgeon experience by quartiles confirmed a statistically significant difference among the groups with regards to the overall complication rate ($p = 0.03$), the occurrence of meatal stenosis ($p = 0.0026$), and fistulas ($p = 0.018$) (Fig. 1). The complication rate reduced over time as the surgeon became more experienced.

Using the aforementioned non-linear model, the learning curve was estimated considering the cumulative rate of complications for the entire cohort, as well as for distal and non-distal hypospadias separately. Although the first 50 cases could not be modeled because of the instability of the results, the analysis showed an exponential decrease in the cumulative complication rate (Fig. 2). Of note, the slope of the decrease was more pronounced for non-distal than for distal hypospadias, but it remained significant for both groups (Fig. 3, Fig. 4).

Discussion

Although hypospadias is a common birth defect, with an incidence of 0.4 to 8.2 per 1000 live births,¹² some cases are still challenging for urologists, even after a 2-year fellowship.^{10,15} Our study supports this statement, as we demonstrated a decreasing complication rate as the surgeon's experience increased. In addition, the only other factor influencing TIPU outcomes was the initial meatal position.

In our study, the outcome of the first 50 cases was less predictable and could reflect a steeper part of the learning curve, as the surgeon needed time to adapt when starting independent practice. This idea is reinforced by the learning curve for proximal hypospadias, which showed a steeper slope, as fewer cases are encountered compared to distal defects.

After the first 50 to 75 cases, the learning curve stabilized and became a predictable negative exponential curve, suggesting that the surgical outcome improved at a constant rate and did not rapidly reach a plateau. Therefore, even after intensive fellowship training with exposure to many different hypospadias procedures under the supervision of experienced surgeons, urologists may still experience a steep learning curve at the beginning of an independent practice, with a significantly higher rate of complications. This reinforces the idea that hypospadias surgery, and more precisely TIPU, is a technique that needs to be performed in experienced hands to minimize the complication rate. An appropriate number

Table 1. Complications for distal and non-distal hypospadias

Complications	Distal, n (%)	Non-distal, n (%)
None	181 (72.0)	19 (37.0)
Meatal stenosis	19 (7.6)	8 (15.4)
Fistula	9 (3.6)	13 (25.0)
Meatal coronal migration	15 (6.0)	10 (19.2)
Complete dehiscence	0 (0.0)	7 (13.5)
Aesthetical imperfection	17 (6.8)	5 (9.6)
Urinary tract infection	0 (0.0)	2 (3.8)
Cutaneous infection	12 (4.8)	3 (5.8)
Residual chordee	1 (0.4)	2 (3.8)
Others	8 (3.2)	2 (3.8)

Note: One patient might have had more than one complication and therefore can appear more than once in the table.

Table 2. Univariate analysis (unadjusted odds ratio displayed)

Variables	Unadjusted OR	95% CI	p value
Age <1 year old at surgery	2.0	1.5-2.7	<0.01
Midshaft/proximal defect	5.2	2.8-9.8	<0.01
No stenting	1.5	1.0-2.2	0.05

OR: odds ratio; CI: confidence interval.

Table 3. Multivariate analysis (model including experience)

Variables	Adjusted OR	95% CI	p value
Age <1 year old at surgery	0.9	0.8–1.0	0.31
Midshaft/proximal defect	5.5	2.8–10.7	<0.01
No stenting	1.4	0.6–3.4	0.40

OR: odds ratio; CI: confidence interval.

of hypospadias cases should be performed annually to reach and maintain surgical proficiency; we have confirmed that learning curve and surgical experience have a significant impact on patient outcomes. A similar concept has been previously described regarding other urological surgeries, such as radical prostatectomy^{16,17} and cystectomy.¹⁸

To the best of our knowledge, our study is a first to demonstrate the impact of the learning curve on TIPU outcomes of an individual surgeon, since returning from fellowship.

Complications occurring with TIP urethroplasty for distal and proximal hypospadias are well-described.^{8,15} One of the strengths of our study is that we can assume that all major complications were recorded in our charts due to the unavailability of another pediatric urologist within a reasonable distance. The complication rates observed in our study are similar to other reports.^{8,9} Complication rates get even smaller when considering only the last 50 cases (2% meatal stenosis and 2% fistulas). These results again emphasize the importance of having hypospadias surgery performed by specialized pediatric urologist with a high volume of cases to optimize the success rate.

Urethrocutaneous fistula was not the most common complication encountered after the repair of distal hypospadias as it was in the non-distal group. This could be explained by the fact that all meatal stenosis, even the ones only requiring in-office calibration or dilatation, were recorded in the present study. Also, patients presenting concomitantly with a meatal stenosis and a fistula were recorded as having 2 complications, even though the fistula was probably a result of the meatal stenosis.

There was an obvious change in the use of stents throughout the years in our cohort. A stent was left in place in about half of the first 50 cases compared to 95% of the subsequent cases. This difference can easily be explained by the fact that a stent was rarely used during the fellowship training, since a urology resident, fellow or attending was always available to catheterize a patient after a fresh repair, if needed. In a solo pediatric urology practice, patients with stentless TIPU surgery were sometimes required to be catheterized by less experienced personnel. Therefore, the risk of devastating complications was increased. Since the stent was well-tolerated by most patients, it was decided to leave one in place in almost every patient thereafter.

One of the major limitations of our study is its retrospective design. During data collection, we realized that many patients unfortunately had no follow-up after the first

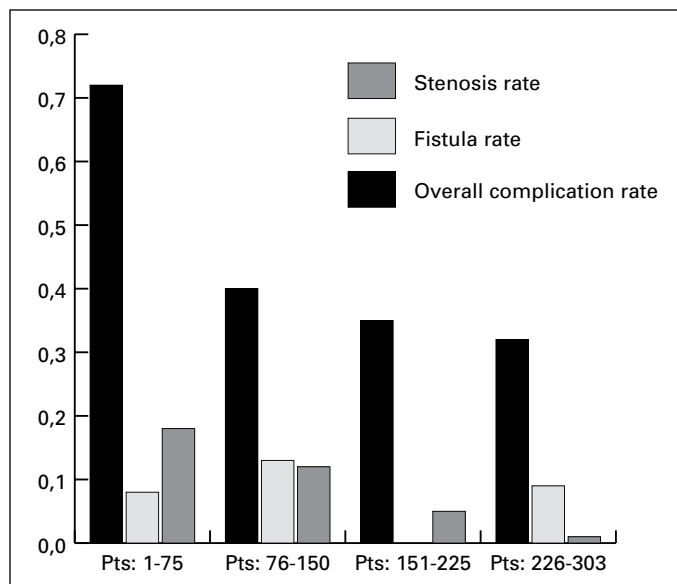


Fig. 1. Complication rates and surgeon's experience (quartiles).

3-month visit. However, most of these patients (64%) were interested in returning for a follow-up visit when contacted by telephone. Long-term complications have been described in hypospadias surgery; several complications can only be diagnosed with longer-term follow-up.^{19,20} The lack of long-term follow-up at our centre is probably multifactorial: (1) since we serve a large territory, patients may be less likely

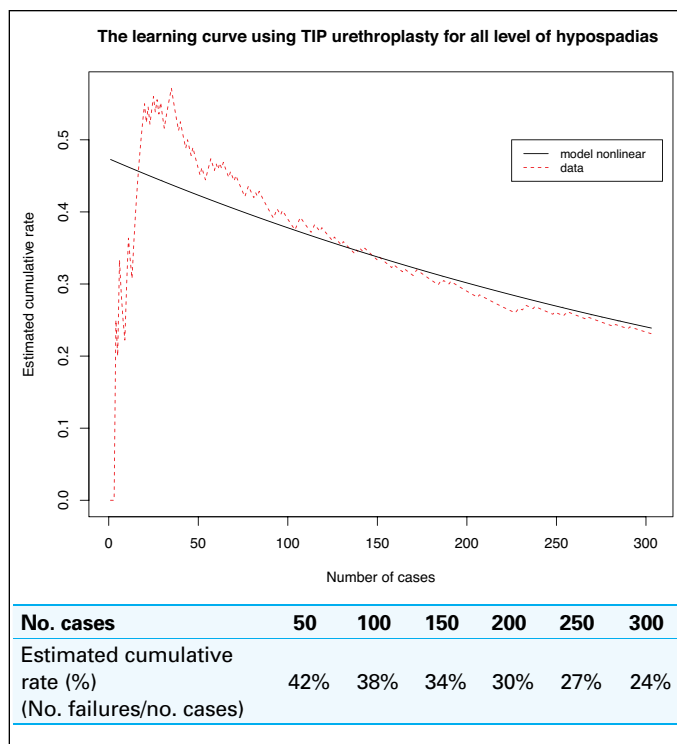


Fig. 2. The learning curve using tubularized incised plate urethroplasty for all degrees of hypospadias.

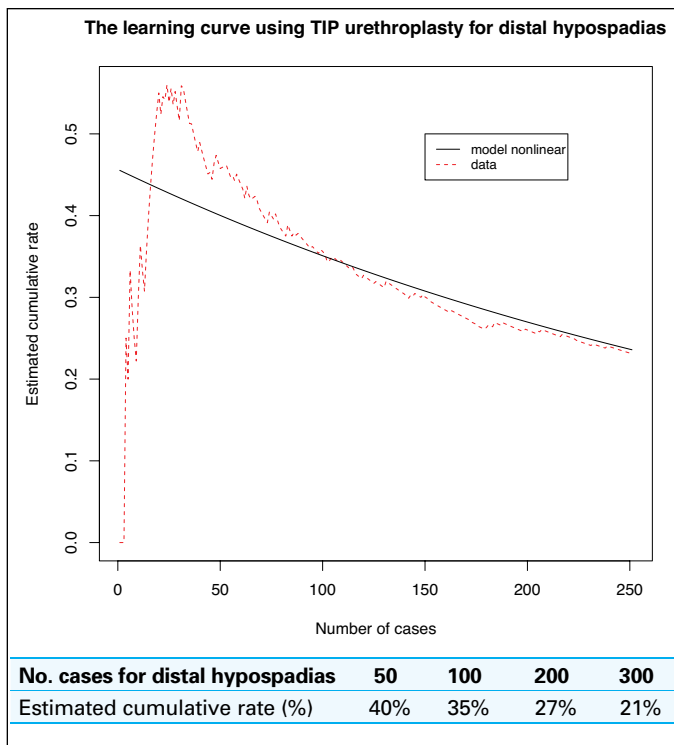


Fig. 3. The learning curve using tubularized incised plate urethroplasty for distal hypospadias.

to travel the distance for their appointment, especially when everything seems normal; (2) patients with no major functional problem can overlook the necessity of a follow-up; (3) very small fistulas or a mild to moderate meatal stenosis might remain asymptomatic in a young toilet-trained boy; and (4) the pediatric urologist in this study has been practicing at our centre for only 12 years. We have seen patients with a urethrocutaneous fistula at longer follow-ups that was noted by the child many years before the clinical appointment without mention to his family members. Considering that most patients responded favourably to the follow-up reminder, it would be beneficial to establish a system to increase compliance to long-term follow-up.

Conclusion

Our study demonstrated the positive impact of surgeon experience on the outcome of TIPU for primary hypospadias repair. TIPU's complication rate stabilized after 50 to 75 cases and continued to further decrease in a negative exponential fashion; this confirms a gradual, but steady, learning curve. This finding underscores that even after fellowship training, the pediatric urologist still needs a high annual caseload to optimize TIPU's outcomes.

Notes: Best Poster in the Pediatrics Session at the 2012 Northeastern Section AUA Annual Meeting in Niagara Falls, September 12–16, 2012.

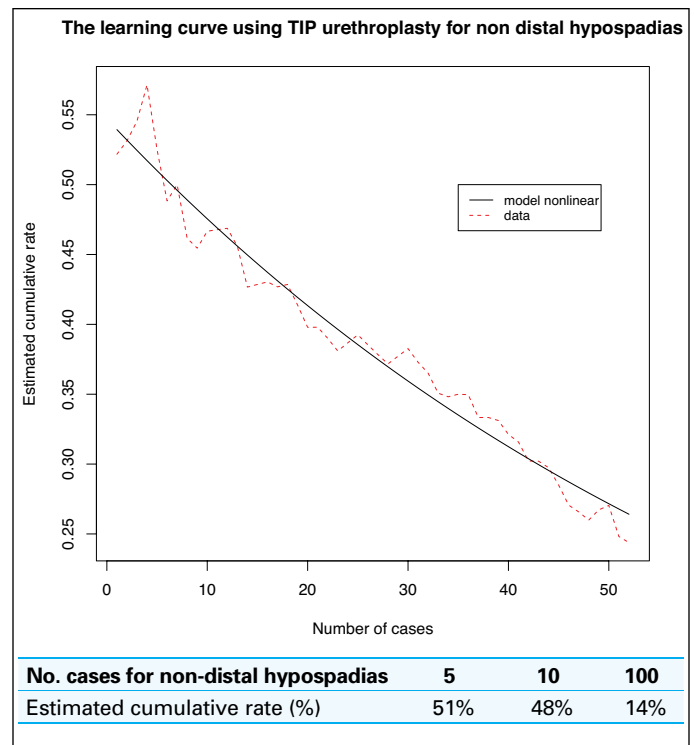


Fig. 4. The learning curve using tubularized incised plate urethroplasty for non-distal hypospadias.

Competing interests: Dr. Deschênes Rompré, Dr. Nadeau, Dr. Moore, Dr. Ajjouj, Dr. Braga and Dr. Bolduc all declare no competing financial or personal interests.

This paper has been peer-reviewed.

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