How do asymptomatic toilet-trained children void following tubularized incised-plate hypospadias repair?

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Abstract

Purpose: To evaluate the functional outcome in the form of urinary flow rates in asymptomatic children following uncomplicated tubularized incised plate urethroplasty (TIPU) hypospadias repair. Methods: We reviewed the records of children who underwent TIPU at our institution between April 1997 and September 2007 and included only asymptomatic toilet-trained children who had an uncomplicated postoperative course and had undergone uroflometry not less than 1 year postoperatively. Unfavourable voiding parameters were either a plateau curve, a peak flow below the 5th percentile range in nomogram or a post-void residual (PVR) more than 20% of the total functional capacity of the bladder. Uroflowmetry findings were analyzed against variables, including the surgeon, the severity of hypospadias, the presence of a hypoplastic urethra, the use of double layer closure, the performance of a spongioplasty and the use of a stent. Serial uroflowmetries, when available, were compared with respect to the initial flow study.

Results: In total, 59 patients were eligible for the study. The mean age at surgery was 2.4 years. Hypospadias was distal penile in 50 (85%) and mid and proximal penile in 9 (15%). Mean follow-up was 3.3 ± 2 (1-9.5) years. The uroflow curve was bell-shaped in 18 (30%), interrupted in 8 (14%), slightly flattened in 27 (46%) and plateau in 6 (10%). Flow rate nomograms revealed that 40 (68%) were above the 20th percentile, 10 (17%) were below the 5th percentile and 9 (15%) were between these ranges. PVR was >20% of the pre-void volume in 9 children (15%). No patient demonstrated all three unfavourable parameters together. The groups of children with unfavourable functional voiding parameters were compared to the children with favourable parameters specifically with respect to the possible predictors of outcome. Follow-up uroflometry in 17 patients showed improvement in the flow curve, flow rate and PVR with significant improvement of maximum urinary flow rate (Qmax) and PVR values.

Conclusions: Asymptomatic, urodynamic abnormalities were observed in our study following uncomplicated TIPU repair. These

abnormalities were not related to the variation of the technique among surgeons. Spontaneous improvement has been noted on serial flow studies.

Introduction

The objectives of reconstructive surgery in hypospadias are to maintain function and to produce an aesthetically satisfactory penis. Snodgrass introduced tubularized incised-plate urethroplasty in 1994 and it has rapidly become one of the most widely applied techniques for hypospadias repair because of its simplicity and excellent cosmetic results.¹ However, there have been reports raising the concern that the functional outcome may be suboptimal based on observed weak postoperative flow curves.² We present the functional outcome of asymptomatic children following uncomplicated tubularized incised plate urethroplasty (TIPU).

Methods

Charts of patients who underwent TIPU at the Montreal Children's Hospital, Montreal, Quebec, between April 1997 and September 2007 were reviewed. Patients were included if they were toilet-trained, asymptomatic and had a valid flow rate data done more than a year after TIPU. The flow rate was considered valid if the voided volume was more than two-thirds of the expected bladder capacity. Children with postoperative complications or those who required dilation were excluded. The surgical technique was similar to that described by Snodgrass.³

Variables predictive of outcome included the surgeon, the degree of hypospadias, the presence of a hypoplastic urethra, double layer closure, performing spongioplasty⁴ and the use of a stent. Uroflow data (flow curve shape, post-void residuals [PVR] and age-related flow rate nomograms) were used to evaluate the functional outcome.

We considered the presence of either a plateau curve, a peak flow below the 5th percentile range in age-related

flow rate nomograms⁵ or a PVR more than 20% of the total functional capacity of the bladder as a sign of unfavourable functional outcome. The results of the children within these groups were compared to the rest who had favourable parameters regarding the clinical variables previously identified as possible predictors.

Children who had a second follow-up uroflow study were identified and the changes in their functional outcome parameters were recorded.

All uroflow studies were performed using Aquarius TT from (Laborie Medical Technologies, Mississauga, ON). The built-in age-related flow rate nomograms were used.⁵

Statistical analysis was done using Chi-square and Fisher's exact. For paired variables a Wilcoxon rank test was used. A p value <0.05 was considered statistically significant.

Results

The charts of 391 patients undergoing TIPU were evaluated and 68 patients were found to have valid uroflow studies. Nine patients were excluded (2 had meatotomy, 1 postoperative retention and fixation of supra-pubic catheter, 1 detrusor sphincter dyssynergia, 3 re-do, 1 with urethral stricture and proximal diverticulum, 1 fistula). In total, 59 patients were included in the study and their mean age at surgery was 2.4 ± 2.4 (0.6-11) years. The mean period of follow-up was 3.3 ± 2 (1-9.5) years and the mean age at time of the initial uroflow study was 5.4 ± 2.2 (2.9 -13.5) years

Five surgeons designated A, B, C, D, and E did 25%, 29%, 9%, 17% and 20% of the repairs, respectively. The severity of hypospadias was distal penile in 50 (85%) and proximal penile in 9 (15%). Distal urethral hypoplasia was present in 16 cases (27%), double layer closure was used in 25 cases (42%), and spongioplasty was performed in 21 cases (36%). A urethral stent was left following surgery in 48 patients (81%), while the remaining 11 patients (19%) had a stentless repair and were allowed to void spontaneously postoperatively.

Means of maximum urinary flow rate (Qmax), voided volume and PVR were 12 ± 4.9 (4.5-34.8) mL/sec, 156 ± 70 (86-353) mL and 20 ± 19.5 (0-72) mL, respectively. The uroflow curve pattern postoperatively was bell-shaped in 18 patients (30%) (Fig. 1, part a), interrupted in 8 (14%) (Fig. 1, part b), slightly flattened in 27 (46%) (Fig. 1, part c) and plateau in 6 (10%) (Fig. 1, part d). Nomograms for the peak flow rate in mL/sec revealed that 40 patients (68%) were above the 20th percentile, 10 (17%) were below 5th percentile and 9 (15%) were in-between. The PVR was >20% of bladder



Fig. 1. Flow curve shapes. (a) bell shaped, (b) interrupted, (c) slightly flattened and (d) plateau.

capacity at the time of testing in 9 patients (15%) with a mean of $11\pm9.3\%$ (0%-33%). No patient demonstrated all three unfavourable parameters.

The groups of children with unfavourable functional voiding parameters were compared to the children with favourable parameters specifically with respect to the possible predictors of outcome. There was no statistically significant difference noted for any predictor evaluated (Table 1).

A second extended follow-up uroflow study was available for 17 patients. The mean total follow-up period for these patients was 4.5 ± 2.2 (1.6-9.5) years. The initial postoperative uroflow study for these patients was performed at a mean age of 5.3 ± 2.2 (2.9-11) years. The mean interval period between uroflow studies was 1.7 ± 0.8 (0.7-3.7) years. The functional outcome parameters were compared for the initial and follow-up studies. There were improvements in the shape of the flow curve, the flow rate and the degree of evacuation. (Table 2, Fig. 2, parts a, b). Moreover, a statistically significant improvement of Qmax was noted from initial value of 12.3 ± 4.2 to 15.4 ± 4.8 mL/sec during the extended follow-up (p < 0.001). Mean PVR percentage decreased from $11\pm9\%$ to $5\pm8\%$ of the functional bladder capacity (p < 0.008).



Fig. 2. Spontaneous improvement in flow rate following tubularized incised plate urethroplasty repair of hypospadias. (a) A uroflow study in a 4-year-old boy one year following surgery. (b) Follow up study in the same child at the age of 7.

Discussion

The need to evaluate both the cosmetic and functional outcome is critical if we are to effectively evaluate advances in operative technique for hypospadias repair. In 1978, Page and Akin demonstrated that uroflowmetry to assess functional outcome following hypospadias is more objective than the use of urethral sounds.⁶ Calibration using urethral sounds is invasive and often misleading.⁶ Uroflow data obtained from populations of normal children have been standardized to both age and body surface area leading to the development of different peak flow nomograms.^{5,7}

Although weak flow rates have been reported following different techniques of hypospadias repair, they can be associated with a wide variety of patient complaints and physical findings. Many patients can be asymptomatic.⁸ Uroflowmetry has since been recommended as an important non-invasive tool to evaluate functional results following hypospadias surgery to identify asymptomatic strictures early.⁹

Snodgrass reported the results of uroflow studies in 17 patients followed for a mean period of up to 45 months (6 months to 7 years) after TIPU. All patients had rates within the 95th percentile range on age-related flow rate nomograms.¹⁰ Similarly, Gurdal and colleagues used Toguri nomogram⁷ to report good intermediate-term functional results of TIPU in 19 patients after a follow-up of 3.1 years. Eighteen patients had a normal Qmax with respect to their age, 1 (5%) was below the 20th percentile and no patient was below the 5th percentile. These studies can be criticized for performing the uroflow assessments following urethral calibration. Our study did not include any patient undergoing urethral calibration.

Marte and colleagues reported that the TIPU technique gives satisfactory functional results for midshaft and proximal hypospadias cases as well.¹¹ They analyzed the Qmax for 21 patients (16 mid penile and 5 proximal), according to the Toguri nomograms and found only 3 (14%) were below 5th percentile. All 3 of the patients required intervention. We observed that 10 (17%) of our patients were below the 5th percentile for Qmax and none of them required further intervention. Also, none of them demonstrated all three unfavourable voiding parameters. Moreover, two of these patients had a follow-up flow study and one was normalized while the other remained below 5th percentile. While the previous studies relied mainly on nomograms for functional evaluation, we additionally examined the shape of the flow curve and the amount of PVR as additional indicators of an unfavourable outcome. The utility of Toguri nomogram has been recently studied. Kaya and colleagues showed that the evaluation of obstruction according to the Toguri nomogram may not be necessary in patients with a normal bell-shaped flow pattern in uroflowmetry.¹²

Table 1. Predictive factors tested for initial functional outcome in 64 asymptomatic patients*												
		Age-related flow rate nomograms					PVR					
Variable	Bell shaped	Slightly flattened	Plateau, obstructed	Interrupted	p value	Above 20th percentile	In 20th percentile and >5th percentile	Below 5th percentile	p value	<20%	>20%	p value
Hypospadias												
Degree												
 Distal 	16	20	6	8	0 50	35	6	9	0.4	41	9	0 22
 Proximal 	2	7	0	0	0.56	5	3	1	0.4	9	0	0.33
Surgeons					-							
• A	7	7	0	1	0.18	11	2	2	0.13	14	1	0.1
• B	9	3	2	3		13	2	2		16	1	
• C	0	3	1	1		3	1	1		2	3	
• D	1	7	0	2		8	1	1		8	2	
• E	1	7	3	1		5	3	4		10	2	
Distal urethral hypoplasia • Yes • No	5 13	7 20	3 3	1 7	0.33	12 28	0 9	4 6	0.75	13 37	3	0.69
Double layer closure												
• Yes	9	13	1	3	0.23	18	3	4	04	23	2	0.28
• No	10	14	5	5	0.23	22	6	6	0.4	27	7	0.20
Spongioplasty												
Yes	8	9	2	2	1	13	4	4	0.20	19	2	0 47
• No	10	18	4	6	1	27	5	6	0.30	31 7	7	0.4/
Stenting												
• Yes	13	22	6	7	0.58	30	9	9	0.14	42	6	0.05
• No	5	5	0	1		10	0	1	0.14	8	3	0.35
*Highlighted columns	are unfavorable ou	tcome PVR no	tvoid residual									

Hammouda and colleagues reported that a third of patients after an intermediate follow-up period of 2 years had flat curves with a low Qmax (below 5th percentile) on age-related flow rate nomograms. Only 2 (4.2%) had PVR above 10%.² In contrast, our results compare favourably to those of Hammouda and colleagues, with only 6 patients (10%) having a plateau-shaped curve with low peak flow rates. We did however find that 9 of our patients (15%) had an initial PVR >20% of their bladder capacity at the time of the study. Two of these 9 patients had a follow-up assessment: one showed a zero PVR and the other had the same high PVR but with normalization of the shape of his curve (bell-shaped instead of flattened).

The hypospadias literature offers many hypotheses attempting to explain weak flow rates following hypospadias repair. The possibility of low intravesical pressure during micturition has been suggested, but this is obviously difficult to demonstrate without the use of formal cystometric studies, an invasive investigation which could hardly be justified in an asymptomatic child.¹³ Rigidity of the neourethra has also been proposed as a cause of weak flow.¹⁴ Others claim that is related to the absence of the corpus spongiousum.8

All the assumptions noted above lack objective supporting evidence. No study has addressed the impact of possible clinical factors that may contribute to unfavourable voiding outcomes. We have examined the surgeon, the severity the hypospadias, as well technical details, such as performing a spongioplasty, double layer closure and postoperative stenting as possible predictive factors. No significant associations were identified. However, the lack of statistical significance might be attributed to the relatively small sample size in our series.

Observations have been published in support of the normalization of weak urinary flow rates following TIPU. Holmdahl and colleagues noticed the improvement of Qmax from a median of 8.8 to 11 mL/sec and from 5.7 to 7.6 mL/sec for distal and proximal hypospadias repairs, respectively within an 8-month period.¹⁵ Similarly, El-Hout and colleagues reported that flow rate parameters changed over time. They showed that even after adjustment for voided volume and age, 37% of initially flat curves became bell-shaped.¹⁶ The gradual normalization of flow rates was suggested to result from the postoperative softening of tissues.¹⁵ We observed that although some of our asymptomatic children after TIP repair initially showed suboptimal functional results, the short-term extended follow-up in 17 (29%) of patients showed spontaneous improvement in most of these parameters thus supporting the observations of pre-

rable 2. Extended follow-up of functional outcome in 17 asymptomatic patients												
		Shape of	the curve		Age-rela	PVR						
Variable	Bell shaped	Bell shaped Slightly flattened		Interrupted	Above 20th percentile	In 20th percentile and >5th percentile	h Below 5th entile		>20%			
After follow-up in												
11 patients												
 Initially 	5	10	0	2	12	3	2	15	2			
 Follow-up 	12	2	0	3	15	1	1	16	1			
*Highlighted columns are unfavorable outcome. PVR: nostvoid residual												

Table 2. Extended follow-up of functional outcome in 17 asymptomatic patients

vious authors. This report confirms prior findings that the initial flow rate curves are not predictive of the calibre of the reconstructed urethra. In fact, these findings are relevant as they inject a dose of patience in the surgeon rather than promote unnecessary interventions for fear of missing an evolving stricture.

Naturally there are limitations surrounding our observations. This was a retrospective study. The patients are a fraction of the denominator operated on in the same time interval (59/391). However we have explored multiple other factors, such as the role of urethral hypoplasia, spongioplasty and secondary layers. We had only 9 patients with proximal hypospadias which makes their analysis underpowered. We are however able to survey the initial outcomes in a group of 59 patients and support the observation of spontaneous improvement of flow rates over time in a subgroup of children. A larger and prolonged prospective study would be needed to verify our observations.

Conclusion

Asymptomatic, urodynamic abnormalities were observed in our study following uncomplicated TIPU repair. These abnormalities were not related to the variation of the technique among surgeons. Spontaneous improvement has been noted on serial flow studies.

Competing interests: None declared.

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