

PROBLEMS OF PEDIATRICS

New Method of Urethral Valve Surgery in Children

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Abstract

This article presents the results of the surgical treatment of the posterior urethral valves (PUV) in 58 children (between 2 months and 15 years of age), between 1998 and 2009. In all, 26 patients were treated using the endoscopic method (EM) and 32 patients were treated by the proposed method, using a metallic urethrotome (MU). Diagnosis of the urethral valves was done using ultrasonography, voiding cystourethrogram, urethrocystoscopy, uroflowmetry and cystomanometry. Mathematical modeling was applied to assess the treatment methods. The proposed method, using the metallic urethrotome, was preferable to the endoscopic method.

Keywords: urethral valves, metallic urethrotome, endoscopic method, uroflowmetry, mathematical modeling.

Introduction

The urethral valves showed congenital disorders characterized by severe changes not only in the bladder, but dysplastic disorders as well, in the renal parenchyma [1, 2, 3]. Therefore, early diagnosis and prompt treatment of this disease is vital in the life of each child [4], in order to prevent irreversible changes in the urethral walls [5,6]. The advancement and improvement of endoscopic instruments can destroy valves as a result of the coagulation electrodes or miniature knives. However, the transurethral method has some drawbacks: post treatment in pediatric patients, 35% of cases showed the development of recurrent urinary tract infection and urethral stricture [7]. The incidence of recurrence after primary valve ablation can extend up to 20-45% [8] and sometimes even to the point where the complete removal of the valve needs to be resorted to. Re-ablation had to be done eight times, and the valve was preserved in 12-56% of cases [9]. Primary transurethral resection of the valve in newborn boys is traumatic, and it is sometimes very difficult to avoid iatrogenic damage of the urethra due to the penis size and the narrowness of the external urethral orifice. After the

transurethral resection of the urethral valves in children, 9% of cases showed the development of urethral stricture, while 50% of the newborn revealed a similar problem [9,10]. It was these events that inspired our study.

Objective: The development of a new, easy-to-perform method of urethral valve surgery in children, which involves minimal surgical intervention, without expensive equipment and can be implemented in clinics in economically poor countries and regions.

Material and Methods

This article presents the results of the surgical treatment of the posterior urethral valves (PUV) in 58 children (between 2 months and 15 years of age), between 1998 and 2009. Diagnosis of the urethral valves was done using ultrasonography, voiding cystourethrogram, urethrocystoscopy, uroflowmetry and cystomanometry. Mathematical modeling was applied to assess the treatment methods. In all, 26 patients were treated using the endoscopic method (EM) and 32 patients were treated by the proposed method, using the designed valve removal MU (Patent UZ # FAP 2009 0046, 08. 23.2010).

The designed valve removal tool (MU) consists of two parts (Figure 1):

- Handle equipped with a valve holding portion.
- Handle equipped with a valve cutting device.

It should be noted that the working part of the MU is constructed in three versions according to Sharrer: a) #5-7,

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b) 8-10, and c) #12-14 to remove the urethral valves in infants, young children and older children, respectively. In our study, we applied the vesicoendoscopic puncture method proposed by Zh. B. Beknazarov [1], given the fact that the peritoneum is located above the symphysis (on average 2.4 ± 0.3 sm) in children from the newborn period to 15 years, and the front wall of the bladder is not covered by the peritoneum and lies under the rectus abdominis.

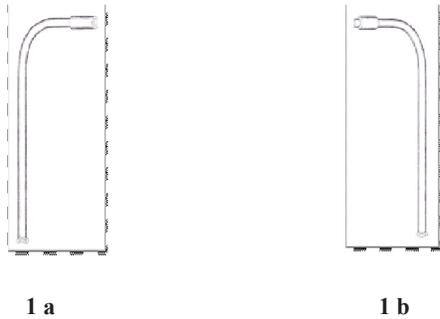
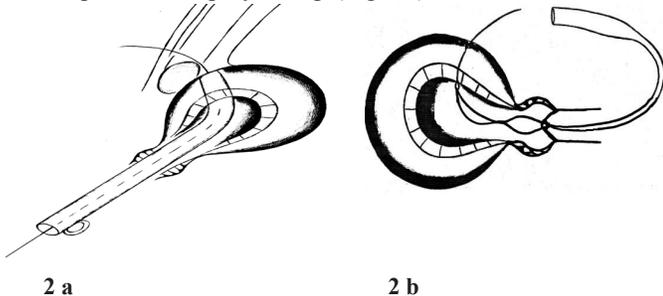


Figure 1

The designed metallic urethrotome

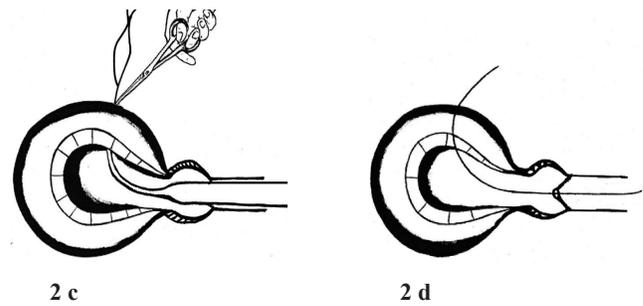
Removal technique of the urethral valve using the MU by the vesico-endoscopic puncture method (Figure 2).

The bladder is catheterized using the vesico needle with the protective catheter (Fig. 2a). The outer end of the catheter is pushed down so that the inner end of the catheter abuts against the front wall of the bladder, and then the needle is pulled in right inside until it enters into the suprapubic region. The protective catheter is removed while holding the needle in the suprapubic area. The fishing line of the final loop of the drainage catheter is pulled through a bore needle and the ends of the fishing line are tied. The needle is pulled up from the suprapubic region. After the needle is slowly pulled up then the first loop of the fishing line is completely taken out. Given the fact that the first fishing line is 0.4 mm in thickness, and the second is 0.8 mm, the second loop is taken out through the skin with ease. After that the second loop is carefully and slowly pulled up, and the thin part of the drainage catheter moves on the skin surface followed by its thick part. To create a tunnel, the thin part of the loop drainage catheter is clamped with a spiky clamp (Fig. 2b).

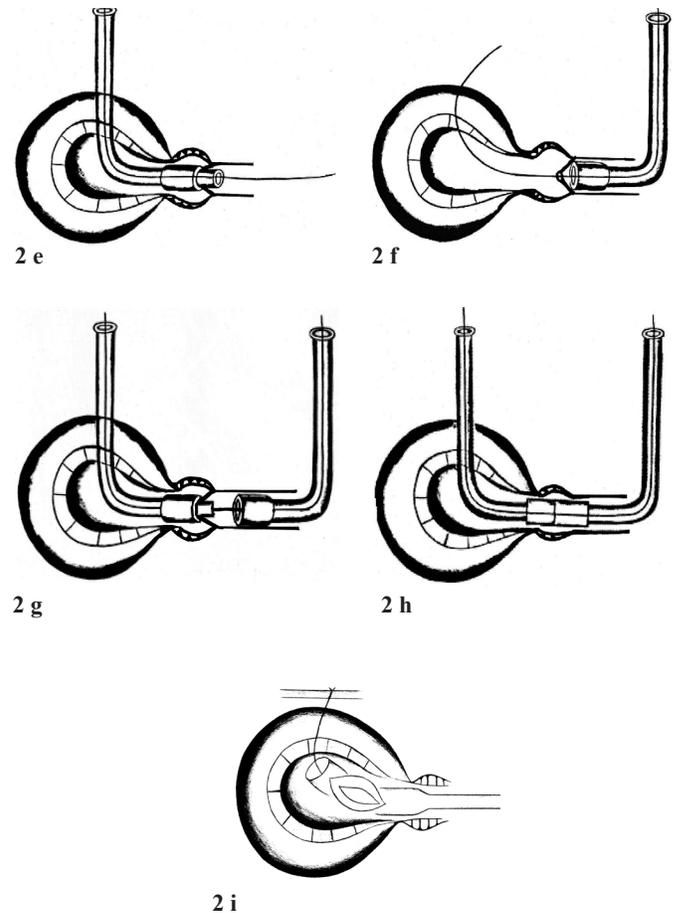


Next, the loop drainage catheter is pulled out from the urethra (urethral part) and, at this time, the tip of the clamp is introduced into the bladder lumen, and then (by opening and clamping) it is gradually is drawn outward (Fig. 2c). Herewith, a suitable sized tunnel is formed in the anterior abdominal wall and bladder wall.

Next, the loop drainage catheter is pulled out from



the urethra (urethral part) and the second loop is taken out, outward. Accordingly, the initial part of the second loop is located over the bladder, and the associated part of the loop with the loop drainage is located on the outer part of the urethra. This second loop serves as a guide to the MU (Fig. 2d). This fishing line is carried out through the channel of the handle of the valve-holding part of the MU; the latter is freely inserted through the tunnel into the bladder, and then in the back of the urethra, sensing the identified obstacles (Fig. 2e).



The valve-holding part of the MU is supported in this position; the valve-cutting part of the MU is introduced through the external urethral orifice and is slowly brought to the valve-holding part of the MU so that the fishing line becomes taut, and which provides an exact match of the valve-cutting part of the MU with the valve-holding part of the MU (Fig. 2f). When the valve-cutting part of the MU enters inside of the valve-holding part of the MU, the valve is completely circularly dissected (Fig. 2g-h).

After these manipulations, the MU is removed and the catheter is left in the urethra lumen for urethral drainage for 3-5 days (Fig. 2i).

To assess the urodynamic bladder, we performed mathematical calculations using intravesical pressure, the rate of urination and the urethral resistance coefficient on urination (Table 1). Mathematical modeling was applied to assess the treatment methods.

Table 1

The urodynamic parameters before and after removal of the urethral valve

Parameters	Endoscopic method			Metallic urethrotome		
	Prior to surgery	P	Post surgery	Prior to surgery	P	Post surgery
Thickness of the wall of the bladder (sm)	0.62±0.08	<0.05	0.54±0.02	0.59±0.07**	<0.01	0.50±0.05**
Maximum bladder capacity (mL)	162.7±37.2	<0.05	147.5±31.91	190.2±34.99*	<0.05	180.61±23.39*
Residual urine (mL)	45.11±19.4	<0.05	11.19±7.19	40.48±12.4**	<0.01	8.93±2.28**
Lumen of the passage of urethra	0.30±0.04	<0.05	0.47±0.04	0.31±0.03**	0.01	0.50±0.03**
Urethral resistance coefficient	0.28±0.07	<0.05	0.11±0.06	0.22±0.06**	<0.01	0.05±0.02**
Rate of urination (mL/s)	6.98±0.88	<0.05	13.42±0.81	7.52±0.74**	<0.01	16.36±0.60**
Intravesical pressure (mmWC)	34.91±2.13	<0.05	43.73±0.47	36.31±1.91**	<0.01	49.51±0.38**

Note: * $p < 0.05$, ** $p < 0.01$ between "Endoscopic method" and "Metallic urethrotome".

Results and discussion

The mathematical model of the intravesical pressure, the rate of urination, and the urethral resistance at urination:

$$y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + a_7x_7$$

where:

y – the urodynamic parameters;

x_1 - the thickness of the wall of the bladder;

x_2 - the maximum bladder capacity;

x_3 - the rate of urination;

x_4 - the residual urine;

x_5 - the lumen of the passage of the urethra;

x_6 - the resistance of the urethra;

x_7 - the intravesical pressure;

a_0, a_1, \dots, a_7 – constants.

The method of least squares was used to construct a mathematical model. To calculate the coefficients the MathCAD package was applied. The veracity of the coefficients was tested using Fisher's statistics; they were found to be significant with a probability of $p = 0.95$. By comparing the models obtained for the two surgical methods of treatment of the urethral valve, the following conclusions can be drawn.

Conclusion

- The lumen of the passage of the urethra is increased on removal of the PUV using MU when compared with the results obtained using the EM method.

- The urethral resistance at urination is significantly less after the removal of the PUV using MU as compared with using EM.

- The rate of urination greatly increased after the removal of the PUV using MU when compared with the results obtained using the EM method.

- The voiding intravesical pressure is normalized to a greater extent after the removal of the PUV using MU when compared with using EM.

- The benefits of the new method lead to a rapid restoration of normal urodynamics in the upper and lower portions of the urinary tract.

Thus, it has been shown that the removal of the urethral valve using MU is the optimal method of surgical treatment of PUV in children.

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