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Uroflowmetric Monitoring and its Role in Evaluating the Results of Surgical Treatment in Children with Urethral Valves

Habibullo A. Akilov PhD, ScD[1], Zhumanazar B. Beknazarov, PhD, ScD[1], Mamathon K. Kholmurodov PhD, ScD[2], Yodgor Mirzo H. Nurmatov[1]*, Erkin B. Hakkulov, PhD[1]

[1]*Tashkent Institute of Postgraduate Medical Education, Tashkent, Uzbekistan*
[2]*Namangan State University, Namangan, Uzbekistan*

Abstract

This paper presents the results of research and treatments in 41 children (from two months to 15 years of age) with urethral valves. In all, 16 patients were treated using the endoscopic method, 7 patients by employing the polyethylene urethrotome and 18 patients treated by the proposed method, using a metallic urethrotome. 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.

Key words: *urethral valves, metallic urethrotome, endoscopic method, uroflowmetry, mathematical modeling.*

Introduction

Uroflowmetry (UFM) is the common noninvasive method used to measure the rate of urine flow during urination, and has been employed for several decades [1,2,3]. This method, despite its undeniable virtue has significant limitations, the principal one which is the difficulty in interpreting the uroflowgrams. It is well known that the nature of the jet and the urine flow rate, without accounting for the presence of organic or functional disorders of the lower urinary tract, depend upon the time of day, the surroundings and the emotional state of the subject [1,4,5]. In light of these, one can correctly assume that the estimation of one or few individual uroflowgrams is subjective and the conclusion based upon their assessment may be incorrect. This clinical problem, the objective of which is the estimation of the urination, is partially solved by applying uroflowmetry monitoring (UM) in clinical practice [1,6-11],. However, even if the instrumental and methodological basis of the UM were resolved, the question of an adequate system for analyzing large amounts of information remains unresolved.

Objective: The development of new principles for the evaluation of programs and the results of UM in children with urethral valves, as well as the determination of the importance of the UM as the choice of treatment method and the assessment of the effectiveness of the surgical treatment.

Material and Methods

A total of 41 children between two months and 15 years of age were examined. In all, 16 patients were treated by the endoscopic method (1st group), 7 patients by using a polyethylene urethrotome (2nd group) and 18 patients treated by employing the proposed method (Patent UZ # FAP 2009 0046, 08. 23.2010),

***Corresponding author**: Yodgor Mirzo Nurmatov, Head of the department of pediatric urology and adolescent gynecology, Namangan regional children's multi-disciplinary medical center. 9,Ulugbek Street, 717104, Namangan region, Namangan district, village Irvadan, Uzbekistan. Tel: 998-93-9419777 .*
E-mail: yodgormirzo@rambler.ru

using the metallic urethrotome (3rd group). Examination of the patients included blood and urine tests, ultrasound of the kidneys and urinary tract, uroflowmetry and uroflowmetry monitoring. The results of the rhythm of spontaneous voiding, urethrocystoscopy, cystometry and urethral profilometry and x-ray examination were recorded for medical reasons.

Method for determining the dynamics of the urine flow rate during urination: (This method is used for the total identification of tonus, contractile activity of the detrusor and urethral patency). The uroflowmetry technique is simple and easy to use in patients of all ages. The urine flow rate was determined by using the Goldberg's formula [1]:

$$P = V / t,$$

where P is the urine flow rate (mL/sec), V - the amount of urine (mL), t – duration of the urination episode (sec).

UM was performed before and after treatment of the posterior urethral valve in all 41 patients. In all, 3 patients were examined after primary surgery; 38 children were examined at 6 to 9 months post treatment.

To obtain this data, we focused on the aggregate indicators of bladder function; also, the uroflowmetry data and the effective bladder volume were taken into account. Results of the UM, including an assessment of the relationship between the volume and maximum flow rate, were taken on the XY plane. To arrive at a conclusion on the regularity of the urination, recording of urination (at least 7-10 times) was done between 2 and 4 days. A regression line was thus constructed. Later, a comparative assessment of the data was performed. Statistical processing of the results of the UM was done using the same "Data Analysis" Excel package.

Results and discussion

In the group analysis of urination in the children, the regression curve was seen as an ascending line. The lowermost point lay on the mark at around 8 mL/sec, and the topmost point was found at around 52 mL /sec (ordinate). Based on these figures, and given the tendency of the distribution of the paired values of "volume - speed", the ranges of the effective bladder capacity and maximum urine flow rate were determined. As explained, currently the template for the regression analysis of the uroflowgram in adults has already been done. Based on the Abrams-Griffiths classification, the zones of "obstructive" (<10 mL/sec), "dubious" (10-15 mL/sea) and "non-obstructive" (> 15 mL/sec) urination were marked (Figure 1).

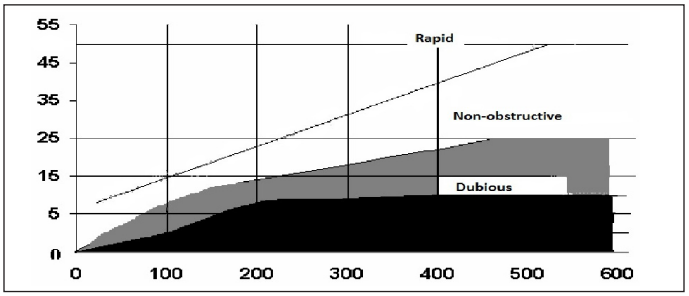

Figure1
The template for the regression analysis based on the Abrams - Griffiths classification.

However, the maximum urine flow rate in children changes corresponding to the significantly smaller urethral cross-section. Besides, urination is not a linear process. To compare the results of the regression analysis on two or more samples, the simplest and most convenient method was utilized, namely a "comparison of the lines in general". For this purpose, a template, as an XY graph, with the zones of "obstructive", "dubious", "non-obstructive" and "rapid" urination marked was developed.

If posterior urethral valve ablation was performed using the metallic urethrotome, the regression line would match more to the lines of "obstructive" and "rapid" types of urination. To clarify this fact, we analyzed the data of 41 patients to determine the type of the urination before and after surgery (Figure 2). As shown in the diagram, the "obstructive" type of the urination was marked in 31 of 41 patients (75.6%), the "doubtful or dubious" type of the urination was marked in 10 patients (24.4%). After eliminating the bladder outlet obstruction, urination improved and the "obstructive" type of the urination remained only in 4 children (9.7%); these patients were operated upon by using endoscopic electroresection. The individual analysis revealed that 4 patients with "rapid" urination type belonged to the 3rd group (metallic urethrotome), while 2 patients were from the 1st group (endoscopic resection).

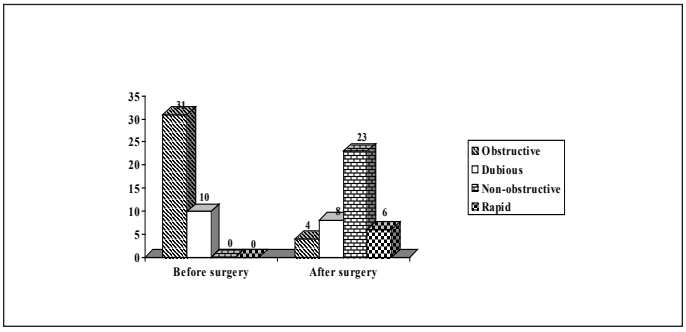

Figure 2
Distribution of the urination types, before and after treatment

Among patients with the "non-obstructive" type of urination, 12 children were identified from the 3rd group, 6 patients from the 2nd group (polyethylene urethrotome), and 5 patients were from the 1st group. The patients, in whom the posterior urethral valve ablation was performed using the metallic urethrotome, did not show either the "obstructive" or "doubtful" type of urination. However, it should be noted that those patients where the posterior urethral valve ablation by endoscopic resection was done using the polyethylene urethrotome were characterized by the development of different pathological symptoms during the late postoperative period, some of which required appropriate treatment. When applying the endoscopic electroresection method, the regression curve corresponded to the "obstructive" and "doubtful" types of urination (Figure 3). However, after application of the metallic urethrotome, the regression curve was observed as a rising line, very different from the line registered in the children subjected to endoscopic electroresection (Figure 4).

It was found that the frequency of the inflammation of the urethra, bladder and upper urinary tract post the endoscopic resection and posterior urethral valve ablation done by using

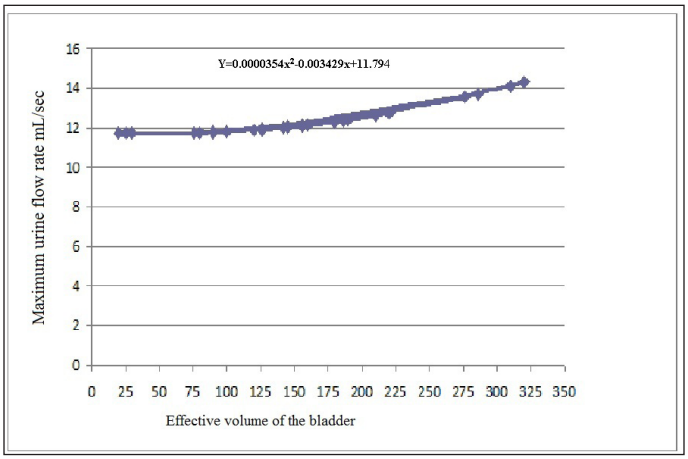

Figure 3
Distribution of the paired values of "volume and speed" of urination in children, after ablation of the posterior urethral valve, using endoscopic electroresection (n=16)

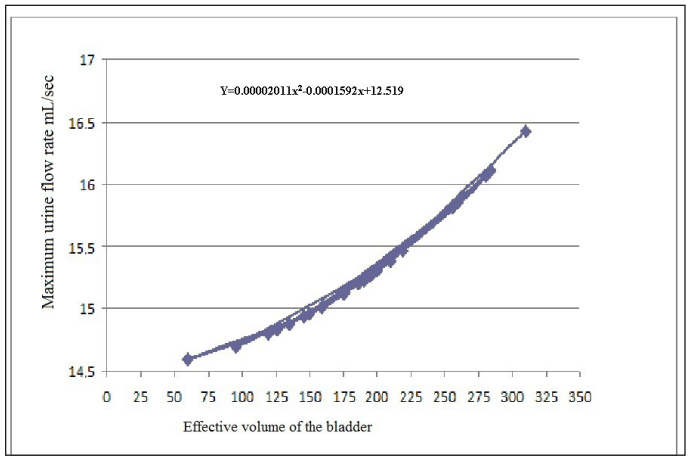

Figure 4
Distribution of the paired values, "volume and speed" of urination in children, after ablation of the posterior urethral valve, employing a metallic urethrotome (n=18)

the plastic urethrotome was significantly higher than following the use of the metallic urethrotome. Endoscopic resection and the use of the plastic urethrotome were accompanied by increased blood urea and creatinine levels. The best results in the late postoperative period in patients of the 3rd group can be explained more as a physiological intervention with circular excision of the valve.

When endoscopic electroresection of the posterior urethral valve was done, burning of the mucous membrane and the remainder of the valve were the main disadvantages observed for this method. However, when the valve was removed using the polyethylene urethrotome, mechanical damage of the mucous membranes of the urethra and an incomplete removal of the valve were not excluded. Circular excision of the posterior urethral valve, with less traumatic manipulation observed when using the metallic urethrotome was found to be very helpful in normalizing the physiological parameters of the bladder and the recovery of the "non-obstructive" type of urination. The template for regression analysis is indispensable when comparing the test results before and after surgery.

Conclusions

Using the template for regression analysis of the uroflowgrams is a sufficiently objective tool for assessing the nature of the urine flow, the degree of obstruction and violation of the reservoir function of the bladder.

The location and nature of the regression lines in combination with the data "volume" and "high-speed" profiles of the urination can be considered the urodynamic parameters for determination of the treatment strategy in children with posterior urethral valves.

The UM, including the regression analysis of the uroflowgrams and the urination profile, being a "sensitive instrument" assessment of the urination, is the objective method of evaluating the results of the surgical treatment.

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