EUR J PHYS REHABIL MED 2012;48:413-21

Diaphragmatic breathing exercises and pelvic floor retraining in children with dysfunctional voiding

V. ZIVKOVIC [1], M. LAZOVIC [2], M. VLAJKOVIC [3], A. SLAVKOVIC [4], L. DIMITRIJEVIC [1], I. STANKOVIC [1], N. VACIC [4]

[1]*Clinic of Physical Medicine Rehabilitation and Prosthetics Clinical Centre Nis, Nis, Serbia*
[2]*Rehabilitation Institute Belgrade, Belgrade, Serbia*
[3]*Department of Nuclear Medicine Clinical Centre Nis, Nis, Serbia*
[4]*Clinic of Paediatric Surgery Clinical Centre Nis, Nis, Serbia*

Background. **Dysfunctional voiding (DV) in neurologically normal children is characterized by involuntary intermittent contractions of either the striated muscle in external urethral sphincter, or the pelvic floor during voiding. Urinary incontinence, pelvic holding maneuvers, voiding difficulties, urinary tract infections (UTIs), constipation and vesicoureteral reflux are highly associated with DV.**
Aim. **To investigate the role of abdominal and pelvic floor muscle (PFM) retraining in children with DV.**
Design. **Prospective clinical controlled study**
Setting. **Outpatient clinical facility**
Population. **Forty-three children, 5-13 years of age, with dysfunctional voiding**
Methods. **In addition to standard urotherapy (education, timed voiding, adequate fluid intake, voiding posture and pattern, constipation management and hygiene issues), children were assigned abdominal and PFM retraining. Diaphragmatic breathing exercises were done in lying and sitting positions, for the purpose of achieving abdominal muscle relaxation. PFM retraining consisted of low-level three-second contractions followed by thirty-second relaxation periods. Selected children received pharmacotherapy (anticholinergics or desmopressin). Recurrent symptomatic UTIs were treated with antibiotic prophylaxis. Uroflowmetry with PFM electromyography and ultrasound residual urine volumes were obtained before and at the end of the 12-month treatment period. Clinical manifestations and uroflowmetry parameters were analysed before and after the therapy.**
Results. **After one year of therapy, urinary incontinence was cured in 20 out of 24 patients (83%), nocturnal enuresis in 12 out of 19 children (63%), while 13 out of 19 children (68%) were UTI free. All 15 patients recovered from constipation. Post-treatment uroflowmetry parameters showed significant improvements and a bell-shaped curve was observed in 36 out of 43 children.**
Conclusion. **In combination with standard urotherapy, abdominal and pelvic floor muscle retraining is beneficial for curing urinary incontinence, nocturnal enuresis and UTIs in children with DV, as well as for normalizing urinary function. Further trials are needed to define the most effective treatment program which would result in the best treatment outcome.**
Clinical rehabilitation impact. To improve clinical and objective treatment outcome in dysfunctional voiders. Diaphragmatic breathing and pelvic floor muscle exercises are simple and easy to learn and could be assigned to children aged 5 or older. As they do not require special equipment, they can be performed at all health care levels.

KEY WORDS: Child - Urination - Pelvic floor.

Corresponding author: V. Zivkovic, Clinic of Physical Medicine, Rehabilitation and Prosthetics, Clinical Centre of Nis, Stara zeleznicka kolonija 5/6, 18 000 Nis, Serbia. E-mail: petvesna67@gmail.com

Dysfunctional voiding represents a functional voiding disorder which affects the voiding phase of the micturition cycle.[1] Terms previously used to

describe the condition include detrusor-sphincter discoordination, non-neurogenic neurogenic bladder, occult neurogenic bladder, which all describe the non-neurogenic nature of the disorder.[2] The syndrome was first described in 1973 as a behavioral disorder and it was believed that psychological factors played the major role in its development.[3, 4] Van Gool first emphasized that the syndrome is due to the maturational delay of the CNS and a dysfunction of external urethral sphincter.[5] Now it is regarded as a learned behavior resulting from the failure to relax the urethra and pelvic floor muscles with voiding caused by overactivity of the urethral sphincter or pelvic floor muscles during the voiding phase of the micturition cycle. According to the 2006 International Children's Continence Society (ICCS) standardization of terminology of lower urinary tract function in children, dysfunctional voiding is a "urodynamic entity characterized by an intermittent and/or fluctuating uroflow rate due to involuntary intermittent contractions of the striated muscle of the external urethral sphincter or pelvic floor during voiding in neurologically normal individuals".[1] Symptoms include voiding difficulties such as hesitancy, straining, intermittency, a weak stream, and the feeling that bladder is not completely emptied. Due to inadequate emptying of the bladder and the presence of residual urine after voiding, children often void frequently during the day, and in some cases display urinary incontinence and nocturnal enuresis. Urinary frequency and urinary incontinence can also be caused by the detrusor overactivity, since it is possible for the dysfunction of the filling and emptying phase to coexist in children with dysfunctional voiding. In an attemp to prevent urinary incontinence or postpone voiding, children assume characteristic postures which involve crossing the legs, holding the genitalia, sitting on heels (pelvic holding maneuvers). Urinary tract infections, constipation and vesicoureteral reflux (VUR) are highly associated with dysfunctional voiding.

Although there is no general agreement concerning the approach to this problem, and the treatment varies from one patient to the next, there are several ways of treating DV, including urotherapy, pharmacotherapy, surgery in the most severe cases, and even Botulinum toxin type A application in some children.[6] "Urotherapy" stands for non-surgical, non-pharmacologic treatment of lower urinary tract function and can be defined as a bladder re-education or rehabilitation program aiming at correction of filling and voiding difficulties.[7] It involves the change of habits that a child has aquired during the period of toilet training and the development of motor control of the micturition reflex. Urotherapy starts with both parental and child education about the importance of regular hydratation and voiding, optimal voiding regimens, constipation treatment and genital hygiene.[8] Together with this standard treatment, the pelvic floor retraining is initiated, and it includes pelvic floor exercises and various forms of biofeedback (visual, tactile, auditory, electromyography) with the same aim in mind - to help the child establish pelvic floor awareness and control, and relearn pelvic floor muscles (PFM) relaxation.

During the past decade, it has been shown that the PFM are not an isolated unit, but a part of the abdominal capsule,[9] which they form together with the diaphragm, superficial and deep abdominal muscles. As lower abdominal and PFM act sinergistically, it is important that both be relaxed during voiding.[10] Therefore, the aim of the study was to investigate the role of abdominal and pelvic floor muscle retraining in children with dysfunctional voiding.

Materials and methods

Patients

Since 2005 forty-three patients (65% girls), aged 5-13, mean age 7.5±2.5, who were referred to the Clinic of Physical and Rehabilitation Medicine for urotherapy, had been included into the prospective clinical study.

The diagnosis of dysfunctional voiding was based on clinical symptoms (urinary incontinence, hesitancy, straining, intermittency, weak stream) and three consecutive staccato and/or interrupted uroflowmetry curve shapes with increased pelvic floor EMG activity during micturition. Children with neurological disorders, mental retardation and structural abnormalities of lower urinary tract were excluded from the study. All patients had previously been treated by pediatricians in primary care with timed voiding, hydratation and constipation management for 3 months with no significant success.

On entering the study each patient underwent a history and physical examination. The parents were asked to keep voiding diares for their children du-

ring a 48-hour period. Urinalysis and urine culture, ultrasound of kidneys and bladder and uroflowmetry with pelvic floor electromyography (EMG) were performed in all children. X-ray voiding cystourethrography was performed in all boys to exclude structural abnormalities of lower urinary tract, and in all patients with recurrent UTIs to detect the presence of VUR. During the evaluation period all children were UTI free.

Treatment protocol

Prior to entering the program, the parents and children were informed about the study and about the significance of urotherapy in dysfunctional voiding treatment; the program was presented and their participation in the study was recommended. When the parents provided written informed consents, children underwent diaphragmatic breathing exercises and pelvic floor retraining in addition to standard urotherapy.

Standard urotherapy

Standard urotherapy started with the education of the children and their parents about the normal function of the bladder and external urinary sphincter and the nature of their voiding disorder. Motivation for the treatment was explored. If a child was not motivated for the treatment, the program was delayed. The importance of regular fluid intake (200 mL 5-6 times per day) and regular voiding were explained. Special voiding charts that a child had to fill out at home were provided. In the same session, an optimal voiding posture was demonstrated in front of a mirror: a sitting position, with feet supported, hips abducted and abdominal muscles relaxed (both for boys and for girls). After a qualified physiotherapist provided simple voiding instructions, the children were asked to void when they experienced the normal sensation of the need to void. Special toilet seat adaptations were made for smaller children and foot support was provided. Micturition was supervised and corrections were made if necessary, with the aim of achieving a long, strong and loud void. Less than one minute after voiding, postvoid residual (PVR) urine volume was measured by ultrasound.

Figure 1.—Diaphragmatic breathing exercises in supine position.

Diaphragmatic breathing exercises

After abdominal muscle assessment revealed that the children generally had strong abdominal holding, diaphragmatic breathing training was the next treatment step. Diaphragmatic breathing exercises were demonstrated by a physiotherapist and the purpose of these exercises – the relaxation of abdominal muscles, was explained to both children and their parents. Patients were divided into small groups (3-4 children per group) and parents were invited to take part in the learning process. Exercises were done in lying and sitting positions respectively. In supine, with the lower extremities supported over a pillow and hands positioned on the abdominal muscles, children were asked to inhale the air through the nose, bulge the abdomen outwards as much as possible, hold their breath for a few seconds, and then exhale slowly through pursed lips (Figure 1). The same exercise was then performed in both side-lying positions and in a sitting position in front of the mirror (Figures 2, 3). Children were instructed to watch the anterior abdominal wall movement during inspiration and to repeat the same action while seated on the toilet to initiate voiding. They were asked to perform the diaphragmatic breathing exercises daily at home.

Pelvic floor muscle exercises

After diaphragmatic breathing exercises, each child in group A was taught individually how to identify PFM. A physiotherapist enhanced the prop-

Figure 2.—Diaphragmatic breathing exercises in side-lying position.

Figure 3.—Diaphragmatic breathing exercises in front of the mirror.

rioception of PFM activity with each child by external palpation over the perineum. A child was asked to contract the PFM without activating the accessory muscles, and then to relax them. Self- palpation of PFM and m. transversus abdominis was used as a feedback of correct technique. Once a child had learned the correct recruitment of PFM, pelvic floor exercises were introduced. They included three-second submaximal contractions, followed by a prolonged, thirty-second relaxation, with the emphasis on relaxation. Children were asked to do 30 repetitions of these exercises daily at home under their parents' supervision during the whole treatment period.

During the treatment period children were asked to keep: a 48-hour voiding diary, voiding chart, nocturnal enuresis chart and a defecation diary for 14 days, recording defecation frequency, stool consistency, episodes of fecal incontinence and abdominal pain. Additionally, parents of children with nocturnal enuresis were asked to weigh the diapers on wet nights and to record the volume of the first morning void for one week (nocturnal urine production). If nocturnal urine production exceeded 130% of expected bladder capacity for the given age, nocturnal polyuria was diagnosed.[1] Bladder capacity was calculated in milliliters using the formula: (age in years x 30) +30 until the age of 12.[1] Reduced bladder capacity was diagnosed when the maximum voided volume on 48-hour voiding diary was less than 65% of expected bladder capacity for the given age.[1] Rome III criteria were used for establishing the diagnosis of functional constipation.[11]

Therapeutic sessions were held monthly. The number of sessions depended on patient's clinical and objective improvement seen on uroflowmetry. Every session began with the analysis of the diaries and charts and the recording of changes from the previous visit regarding urinary incontinence, nocturnal enuresis, defecation frequency and UTIs. Compliance with the treatment was discussed. Every child was asked to perform diaphragmatic breathing exercises and pelvic floor exercises and corrections were made if necessary. The emphasis was put on regular home training and compliance with it was checked.

When children felt the normal urge to void, uroflowmetry with pelvic floor EMG and PVR urine measurement were performed. Children were encouraged to continue with the therapy.

Constipation treatment

The treatment consisted of parental and child's education, regular toilet visits after major meals, adequate posture during defecation, dietary and hydratation changes. Laxatives (lactulosae in a dose of 1ml per kg bodyweight per day in one to three doses) were given during the treatment with the aim of achieving 1 to 2 stools of milkshake consistency each day.

Recurrent UTIs treatment

Children who had symptomatic UTIs and showed positive urine culture on monthly assessment were

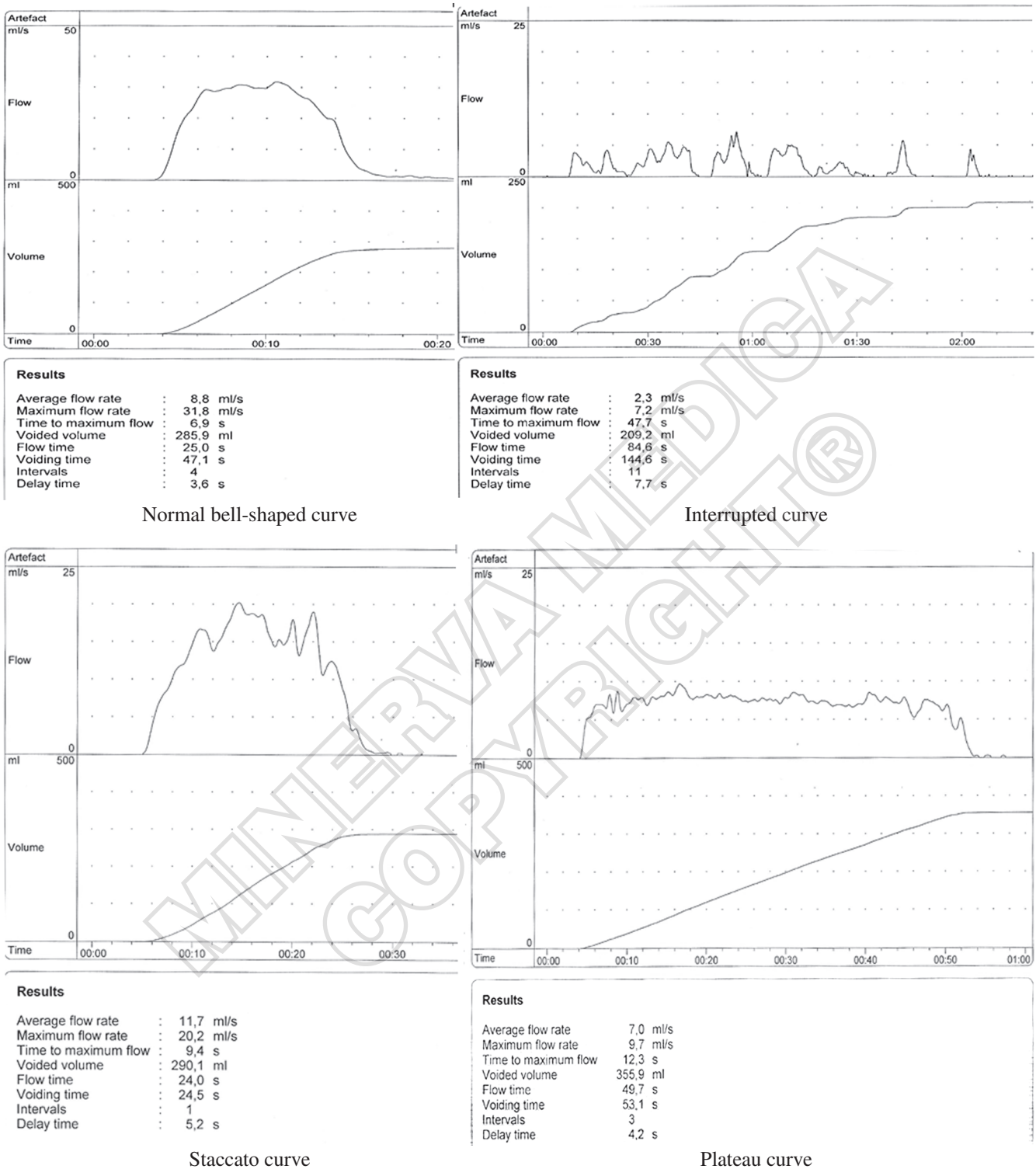

Figure 4.—Uroflowmetry curves.

administrated antibiotic prophylaxis (nitrofurantoin in nightly dose of 1ml per kg bodyweight) for three months.

Pharmacotherapy

Patients who had reduced bladder capacity and did not have PVR urine were prescribed anticholinergics (oxybutynin chloride 0.3 mg/kg body weight per day). Antidiuretic hormone (desmopressin) 0.2 mg oral formulation was prescribed to be taken 1 hour before going to bed in all the patients with nocturnal polyuria.

Treatment result evaluation

One year after the beginning of the program the patients were re-evaluated. Control uroflowmetry with EMG was performed using uroflowmeter (UF Master, MMS, The Netherlands). Skin EMG electrodes were placed perianally 2 and 10 o'clock position. Children voided two times when they felt the need to void. Less than a minute after voiding, PVR urine was recorded by ultrasound (Aloka, SSD-500, Japan).

The following parameters were evaluated: voided volume (VV, ml), average flow rate (AFR, mL/s), maximum flow rate (MFR, mL/s), flow time (FT, s), shape of the curve, PVR urine volume and total bladder capacity. The shape of the uroflow curve was defined as normal (bell-shaped), staccato, interrupted and plateau according to the 2006 ICCS criteria (Figure 4).[1] Uroflowmetry curve with fluctuations larger than the square root of the maximum flow rate was defined as staccato. Interrupted curve was defined as the curve reaching the baseline during voiding. Plateau-shaped curve had a low amplitude and a rather even flow. The 1998 ICCS definition of plateau type as a curve with a value of MFR/FT<0.5 was also used.[12] Total bladder capacity (PVR urine volume and voided volume) was expressed as a percentage of age expected bladder capacity.

Treatment result was classified as "cured" in children in whom urinary incontinence and nocturnal enuresis disappeared completely; "improvement" included reduction of wetting episodes for more than 50% per week, and "unchanged" included cases in which urinary incontinence, and nocturnal enuresis persisted (the reduction of wetting episodes per week was less than 50%). In children with UTIs, no UTI during the 12-month period classified the patients as "cured", whereas UTIs that persisted classified them as "unchanged". In children with constipation ≥3 bowel movements per week, ≤2 episodes of fecal incontinence per month and no abdominal pain with no laxative treatment for >1 month were classified as "recovering".[13]

Statistical analysis

Statistical analysis was done using program SPSS 12.0 for Windows. Values were presented as mean ± standard deviation. Descriptive statistics, nonparametric McNemar and parametric paired samples T-test were used. Differences were considered significant if $P<0.05$.

Results

During the treatment period almost 50% of children were receiving pharmacotherapy: anticholinergics were prescribed in 11 children while desmopressin was recommended in 11 children. VUR was detected in 4 girls. Antibiotic prophylaxis was prescribed in 15 children due to recurrent symptomatic UTIs and VUR. Mean number of therapeutic sessions was 6.5.

Urinary incontinence was present in 24 out of 43 patients (56%) before the treatment. It was cured in 20 patients ($P<0.0001$). An improvement in urinary incontinence was noticed in 3 patients. Nocturnal enuresis was present in 21 patients (48%) before the treatment. It was cured in 14 patients ($P<0.0001$) and improvement was noticed in 4 boys (21%) (Table I). The mean number of wetting episodes per day (2.5±2.9 *vs.* 0.3 ±1.1, $P < 0.0001$) and night (2.6±3.0 *vs.* 0.5±1.6, $P<0.0001$) per week was significantly reduced at the end of the treatment (Table II).

Nineteen children had UTIs on entering the study. UTIs were cured in 13 patients ($P<0.001$). Constipation was recovered in all 15 patients ($P<0.001$) (Table I). Table III represents the uroflowmetry parameters in children before and after the therapy. At the end of the study post-void residual urine, AFR, MFR, FT and total bladder capacity were markedly improved.

All children had abnormal uroflowmetry curve shape with increased PFM activity during voiding on entering the study. The majority of children had

TABLE I.—*Clinical manifestations prior to and after the treatment.*

Clinical manifestations	Before therapy	After therapy	P
Urinary incontinence	24	4	<0.0001
Nocturnal enuresis	21	7	<0.0001
Urinary tract infections	19	6	<0.001
Constipation	15	0	<0.001

TABLE II.—*The mean number of wetting episodes per day and night per week prior to and after the treatment.*

Symptoms	Before therapy	After therapy	P
Urinary incontinence	2.5±2.9	0.3±1.1	<0.0001
Nocturnal enuresis	2.6±3.0	0.5±1.6	<0.0001

TABLE III.—*Uroflowmetry parameters in children before and after therapy.*

	Before	After	P
Voided volume (mL)	283.5±173.7	254.1±115.7	NS
Residual urine (mL)	28.8±48.3	7.9±11.6	<0.01
Total bladder capacity (%)	127.3±67.6	93.5±34.6	<0.01
Average flow rate (mL/s)	8.9±4.4	13.7±5.0	<0.001
Maximum flow rate (mL/s)	19.3±9.3	25.7±8.5	<0.001
Flow time (s)	35.4±19.5	19.2±6.9	<0.001

staccato curve shape, while 6 children had interrupted curve shape before treatment. At the end of the study bell-shaped uroflowmetry curve was observed in 36 patients (P<0.001). Out of 37 patients with initial staccato voiding pattern, bell-shaped uroflowmetry curve was observed in 31. Four children continued to have staccato while interrupted and plateau curves were recorded in 2 patients after treatment. Bell-shaped uroflowmetry curve was also observed in 5 out of 6 children who initially had interrupted curve.

Discussion

Pelvic floor muscles are not an isolated unit, but part of the abdominal capsule surrounding the abdominal and pelvic organs.[9] The structures this capsule comprises are the diaphragm, superficial and deep abdominal muscles, and pelvic floor muscles. These muscles act in co-ordination [10] and they contribute to continence, pelvic organ function, intra-abdominal pressure generation, antigravity support and lumbo-pelvic stability.[14] Dysfunction of PFM can present itself with overactivity leading to dysfunctional voiding, obstructed defecation and perineal and perianal pain. Many of these patients have an overactive abdominal wall that is not released to allow PFM relaxation.[9]

In children with dysfunctional voiding "*an overcompensating external urinary sphincter responds to inhibit the detrusor reflex resulting in the development of a staccato flow rate pattern as the urine flow velocity generated by a detrusor contraction decreases during urethral sphincter/ pelvic floor contraction*".[8] In these children, in addition to standard urotherapy, rehabilitation programs are directed mainly at the pelvic floor muscles, recognition of their function and relaxation. As lower abdominal (*transversus* and *obliquus internus abdominis*) and pelvic floor muscles act synergistically, it is important that both are relaxed during voiding.[9, 10] To our knowledge, this is the first study so far that included abdominal muscle relaxation in the treatment of children with dysfunctional voiding. Diaphragmatic breathing exercises were easy to learn and served to teach the children abdominal relaxation. In diaphragmatic breathing inspiration the diaphragm moves caudally, enlarging the thoracic cavity, and the anterior abdominal wall bulges outwards. It has been shown that the bulging decreases urethral pressure in healthy women [15] and this should facilitate voiding and defecation.

Pelvic floor exercises were introduced to pediatric urology by Wennergren and Oberg, with the aim of increasing children's awareness of their pelvic floor musculature and teaching them how to contract and relax these muscles at will.[16] The emphasis on pelvic floor relaxation served to improve the child's voiding pattern. Since then pelvic floor exercises with/without EMG biofeedback have been used in a number of studies in children with dysfunctional voiding, but only a few studies reported on the pelvic floor exercise parameters such as the degree of contraction, the duration of the contraction and relaxation phase, the number of repetitions and the duration of the treatment. De Paepe *et al.* reported on the EMG biofeedback program that consisted of a 3-second submaximal contraction and a 30-second relaxation phase.[17] One session per week comprised 30 rep-

etitions (maximum 20-24 sessions). In the study of Vasconcelos et al it was recommended that 24 sessions of pelvic floor exercises be done at home for 20 minutes, 3 times a week during a 3-month period (5-second contractions followed by 10-second rest periods).[18] Shei Dei Yang and Wang proposed that their patients increase the strength and duration of contraction to 10 seconds, and to prolong the relaxation period to 30 seconds.[19] Yagci *et al.* instructed children to perform submaximal 3-second contractions followed by 30-second relaxation periods.[20] Children were instructed to perform 30 repetitions 3 times a day at home for 6 months. In a retrospective study Drzewiecki *et al.* analyzed a biofeedback program in which PFM contractions were maintained for 10 seconds, followed by 10 seconds of relaxation in sets of 15.[21] After that the child was advanced to quick flicks with 5 seconds of contraction and 5 seconds of relaxation in sets of 15. A median of 3 sessions (range 1-8) was administered. It is obvious that the protocol of pelvic floor exercises reported in children with dysfunctional voiding has not been standardized. The number of repetitions in one session, the duration of contraction and relaxation phase as well as the period of training varied between the studies. Since our aim with dysfunctional voiders is not to strengthen the overactive pelvic floor but to teach children to relax it, the parameters of pelvic floor exercises must be carefully defined. We used low level 3-second contractions followed by 30-second relaxation to be practiced daily at home for at least 6 months.

In a recently published paper we compared the results of this program, which included diaphragmatic breathing exercises and pelvic floor retraining in addition to standard urotherapy and pharmacotherapy, to the results of the program that included only standard urotherapy and medications.[22] In the first group of children urinary incontinence was cured in 83%, nocturnal enuresis in 66%, constipation in 100% and UTIs in 68% of the children. Moreover, almost all uroflowmetry parameters and curve shapes were significantly improved at the end of the study. The cure rates in the group of children who had standard urotherapy and medicaments were lower: urinary incontinence was cured in 11%, nocturnal enuresis in 33%, constipation in 60% and UTIs in 40% of dysfunctional voiders.[22] McKenna and McKenna reported that conservative treatment including education, hydratation, regular voiding, and pieces of advice given in order to improve voiding phase, treatment of constipation and genital hygiene could cure 20% of patients with dysfunctional voiding without further evaluation or medication.[23] Van Gool *et al.* emphasized the pivotal role of the urotherapist and "remedial teaching" and indicated that nearly 50% of children with non-neurogenic bladder-sphincter dysfunction can be cured by merely explaining the nature of bladder problems to both children and their parents.[24]

Electromyography biofeedback has emerged as an effective tool in children with DV as it provides noninvasive, yet interactive therapy which helps a child gain the control of PFM more quickly, which reduces the need for regular visits to the hospital.[21, 23, 25] Our program could provide a treatment option for the centers that do not have the equipment to provide EMG feedback. Our success rates are comparable to prior reports in which EMG biofeedback has been used during urotherapy.[19, 20, 21] Children required on average 6.5 sessions in order to achieve subjective and objective improvement, which is also comparable with the mean number of sessions in programs with nonanimated EMG biofeedback.[25]

In this study we proposed a treatment option for dysfunctional voiders. Clinical improvement in urinary incontinence, nocturnal enuresis, constipation and UTIs, as well as objective improvements verified through the normalization of uroflowmetry parameters and curve patterns in children treated with diaphragmatic breathing exercises and pelvic floor retraining testify to the importance of abdominal and PFM relaxation programs in children with DV. New prospective studies are needed to define the most effective program, as well as pelvic floor exercise parameters which would ensure the best treatment outcome.

Conclusions

Abdominal muscle and pelvic floor retraining is beneficial in the majority of children with DV for curing urinary incontinence, nocturnal enuresis, constipation and UTIs. Carefully planned and regularly controlled programs including diaphragmatic breathing exercises and pelvic floor retraining lead to the normalization of uroflowmetry parameters and curve type. Learner-friendly exercises can be assigned to children aged 5 or older. As these exer-

cises do not require special equipment, they can be conducted at all health care levels.

Further trials are needed to define the most effective treatment program, as well as pelvic floor exercise parameters which would lead to the best treatment outcome.

References

1. Neveus T, Von Gontard A, Hoebeke P, Hjalmas K, Bauer S, Bower W *et al*. The standardization of terminology of lower urinary tract function in children and adolescents: Report from the standardization committee of the International Children's Continence Society. J Urol 2006;176:314-24.
2. Gontard A, Neveus T. Functional urinary incontinence. In:Hart M (ed). Management of disorders of bladder and bowel control in childhood. London:Mac Keith Press;2006. p. 131-84.
3. Hinman F, Baumann FW. Vesical and ureteral damage from voiding dysfunction in boys without neurologic or obstructive disease. J Urol 1973;109:727-32.
4. Allen TD. The non-neurogenic neurogenic bladder. J Urol 1977;117:232-8.
5. Van Gool JD, Kuitjen RH, Donckerwolcke RA, Messer AP, Vijverberg MAW. Bladder-sphincter dysfunction, urinary infection and vesico-uretheral reflux with special reference to cognitive bladder training. Contrib Nephrol 1984;39:190-210.
6. Petronijevic V, Lazovic M, Vlajkovic M, Slavković A, Golubović E, Miljković P. Botulinum toxin type A in combination with standard urotherapy for children with dysfunctional voiding. J Urol 2007;178:2599-603.
7. Hoebeke P. Twenty years of urotherapy in children: what have we learned? Eur Urol 2006;49:426-8.
8. Chase J, Austin P, Hoebeke P, McKenna P. The management of dysfunctional voiding in children:A report from the standardisation committee of the International Children's Continence Society. J Urol 2010;183:1296-302.
9. Sapsford R. Rehabilitation of pelvic floor muscles utilizing trunk stabilization. Manual Therapy 2004;9:3-12.
10. Sapsford RR, Hodges PV, Richardson CA, Cooper DH, Markwell SJ, Jull GA. Co-activation of abdominal and pelvic floor muscles during voluntary exercises. Neurourol Urodyn 2001;20:31-42.
11. Rasquin A, Di Lorenzo C, Forbes D, Guiraldes E, Hyams JS, Staiano A *et al*. Childhood functional gastrointestinal disorder:child/adolescent. Gastroenterology 2006;130:1527-37.
12. Norgaard JP, van Gool JD, Hjalmas K, Djurhuus JC, Hellstrom AL. Standardization and definitions in lower urinary tract dysfunction in children. Br J Urol 1998;81:1-16.
13. Loening-Baucke V, Pashankar D. A randomized, prospective, comparison study of polyethylene glycol 3350 without electrolytes and milk of magnesia for children with constipation and fecal incontinence. Pediatrics 2006;118:528-35.
14. Sapsford RR, Richardson CA, Stanton WR. Sitting posture affects pelvic floor muscle activity in parous women:An observational study. Aust J Physiother 2006;52:219-22.
15. Sapsford RR, Markwell SJ, Clarke B. The relationship between urethral pressure and abdominal muscle activity (Abstract). Proceedings of the International Continence Society (ICS), 28th Annual Meeting;1998 Sept 14-17; Jerusalem, Israel. 1998:234-5.
16. Wennergren H, Oberg B. Pelvic floor exercise for children:a method of treating dysfunctional voiding. Br J Urol 1995;76:9-15.
17. De Paepe H, Renson C, van Laecke AR, Vande Walle J, Hoebeke P. Pelvic-floor therapy and toilet training in young children with dysfunctional voiding and obstipation. BJU Int 2000;85:889-93.
18. Vasconcelos M, Lima E, Caiafa L, Noronha A, Cangussu R, Gomes S *et al*. Voiding dysfunction in children. Pelvic floor exercises or biofeedback therapy:a randomized study. Pediatric Nephrol 2006;21:1858-64.
19. Shei DeiYang S, Wang CC. Outpatient biofeedback relaxation of the pelvic floor in treating pediatric dysfunctional voiding:a short-course program is effective. Urol Int 2005;74:118-22.
20. Yagci S, Kibar Y, Akay O, Kilic S, Erdemir F, Gok F, Dayanc M. The effect of biofeedback treatment on voiding and urodynamic parameters in children with voiding dysfunction. J Urol 2005;174:1994-7.
21. Drzewiecki BA, Kelly PR, Marinaccio B, Borer JG, Estrada CR, Lee RS *et al*. Biofeedback training for lower urinary tract symptoms:factors affecting efficacy. J Urol 2009;182:2050-5.
22. Zivkovic V, Lazovic M, Stankovic I, Vlajkovic M, Slavkovic A. The evaluation of combined standard urotherapy, abdominal and pelvic floor retraining in children with dysfunctional voiding. J Pediatr Urol 2011;7:336-41.
23. McKenna LS, McKenna PH. Modern management of nonneurologic pediatric incontinence. J Wound Ostomy Continence Nurs 2004;31:351-6.
24. Van Gool JD, De Jong T, Winkler Seinstra P, Tamminen-Mobius T, Lax H, Hirche H *et al*. Randomised, controlled trial of standard treatment, placebo, oxybutynin, bladder training and pelvic floor training, in children with non-neuropatic bladder-sphyncter dysfunction. In:Bael A, editor. Functional urinary incontinence in children:clinical and urodynamic diagnosis, comorbidity and interventions, in multicenter controlled trial. Utrecht:Hellas& Rome; 2008. p. 85-103.
25. Kaye J, Palmer L. Animated biofeedback yields more rapid results than nonanimated biofeedback in the treatment of dysfunctional voiding in girls. J Urol 2008;180:300-5.

The paper was partly presented at the 22nd Annual Congress of the European Society for Pediatric Urology (ESPU) in Copenhagen, Denmark, April 27-30, 2011.

Conflicts of interest.—None.

Acknowledgments.—This work has been supported by the Ministry of Science and Technological Development of the Republic of Serbia, under the project 43011. The authors thank Ruth Sapsford for reviewing this article.

Received on September 8, 2011.
Accepted for publication on December 21, 2011.
Epub ahead of print on June 5, 2012.