Received: 14 May 2022 | Revised: 10 June 2022 | Accepted: 19 June 2022

DOI: 10.1111/luts.12456

ORIGINAL ARTICLE

WILEY

The effect of duration between sessions on biofeedback treatment in children with dysfunctional voiding

Raziye Ergun MD[1] | Naime Ipek Ozturk MD[2] | Cagri Akin Sekerci MD[3]

[1]Pediatric Urology, Derince Training and Research Hospital, Kocaeli, Turkey

[2]Pediatric Surgery, Derince Training and Research Hospital, Kocaeli, Turkey

[3]Department of Urology, Division of Pediatric Urology, School of Medicine, Marmara University, Istanbul, Turkey

Correspondence
Cagri Akin Sekerci, Associate Professor of Urology, Department of Urology, Division of Pediatric Urology, School of Medicine, Marmara University, Fevzi Çakmak Mah, Muhsin Yazicioglu Cad. No:10, Ust Kaynarca/Pendik/Istanbul, Turkey.
Email: cagri_sekerci@hotmail.com

Abstract

Objective: Biofeedback is an effective treatment in children with standard urotherapy-resistant dysfunctional voiding (DV). However, the duration of the session intervals is not standardized. We aimed to compare the effectiveness of daily and weekly sessions of biofeedback treatments.

Methods: The data of children who received biofeedback due to DV between March 2018 and May 2019 were retrospectively evaluated. The children were divided into two groups, one with daily and the other with weekly sessions. The voiding patterns in uroflowmetry (UF), maximum flow rate (Qmax), electromyography activity, post-void residual volume (PVR), the ratio of voided volume to expected bladder capacity (EBC) (%), and Dysfunctional Voiding and Incontinence Scoring System (DVISS) were compared between the two groups.

Results: A total of 45 children (39 girls [86.6%] and 6 boys [13.3%]) were included in the study. The daily group consisted of 27 (60%) children and the weekly group of 18 (40%). Qmax, PVR, number of abnormal UF patterns, voiding volume/EBC, and DVISS scores were similar between the two groups before treatment. Voiding parameters improved statistically significantly in both groups following biofeedback, but there was no difference between the two groups. A statistical difference was found between the results of DVISS after treatment ($P = .03$).

Conclusion: Both types of biofeedback treatment (daily and weekly) are effective methods that improve voiding parameters and DVISS values in children with DV. Therefore, the duration between sessions can be determined according to the suitability of the patient and the biofeedback unit.

KEYWORDS
biofeedback, children, dysfunctional voiding, lower urinary tract dysfunction

1 | INTRODUCTION

Lower urinary tract (LUT) dysfunction in childhood is a very common condition that can cause serious problems in a wide range from social life to deterioration of the urinary tract. An estimated 20% to 30% of children may suffer dysfunctional voiding (DV) and associated symptoms such as urinary incontinence, enuresis, and constipation (1). It is characterized by an inability to relax the pelvic floor muscles or overactivity during voiding. DV is defined by the International Children Continence Society (ICCS) as a contraction of the urethral sphincter or pelvic floor during voiding with a staccato pattern and accompanying electromyography (EMG) activity during repetitive uroflowmetry (UF) (2). There is no neurological pathology in patients with DV; the main problem is that the children relax the sphincter muscles instead of squeezing when they want to hold the urine, or they tighten the sphincter muscles instead of relaxing during voiding.

Although the etiology is not known exactly, it is known that delay in toilet training, urinary tract infections (UTI), learned misbehaviors, and environmental factors can affect it (3). Biofeedback, which is a specific urotherapy method, can be used together with standard urotherapy in the treatment of DV, and it is aimed to provide re-void training by using the pelvic floor muscles appropriately (4). It develops the child's awareness and voluntary control by using external devices that improve pelvic floor muscle/sphincter activity (5). It was demonstrated to be more effective than urotherapy alone in terms of improvement in voiding patterns, postvoid residuals, and the incidence of UTI and vesicoureteral reflux (VUR) (6).

However, the lack of standardization of biofeedback, which reported clinical improvement of 64% to 100% in various studies (1,7,8), seems to be its biggest limitation. As is known, there is no consensus between both the number of sessions and the session intervals. Therefore, in this study, we aimed to evaluate the effectiveness of daily and weekly biofeedback treatment in children with DV.

2 | MATERIALS AND METHODS

The data of children who underwent biofeedback therapy for DV between March 2018 and May 2019 in the pediatric urology clinic were evaluated retrospectively. Ethical approval was obtained from the local ethics committee (No. 2021/01-06). Informed consent was obtained from the parents of the children included in the study. Children with neurogenic bladder, anatomical malformations related to incontinence, less than 5 years old, uncooperative, or previously undergoing urological surgery were excluded from the study. All children presenting with daytime urinary incontinence, urgency, enuresis, constipation, recurrent UTI, and hesitancy were evaluated by physical examination, urine analysis, voiding diary, UF with EMG, postvoid residual urine volume (PVR) and Dysfunctional Voiding and Incontinence Scoring System (DVISS) in the initial evaluation. DVISS was originally developed and validated by Akbal et al (9). The children with pathological pelvic floor activity during voiding and accompanying abnormal voiding patterns or LUT symptoms underwent standard urotherapy and biofeedback. The voiding patterns were classified as bell shape, intermittent, staccato, plateau, and tower (2). The children were divided into two groups according to the daily and weekly implementation of the biofeedback sessions. While biofeedback was applied consecutively on weekdays in the daily group, it was applied once a week in the weekly group. Urinary system ultrasonography was requested for all patients diagnosed with DV. Appropriate antibiotics were started for children with a positive urine culture, and voiding cystourethrography was performed in appropriate cases. The expected bladder capacity (EBC) according to age was calculated with the formula (age + 1) × 30 (10). At the beginning of biofeedback, patients and their parents were interviewed in the urotherapy unit of our clinic. In the first session, a comprehensive training was given to the children, accompanied by their families, on the anatomy of the urinary system, normal and abnormal voiding, planned voiding, appropriate position during voiding, nutrition and fluid intake recommendations, constipation control, and urogenital area hygiene, within the scope of standard urotherapy. In addition, patients with constipation were started on oral laxatives.

2.1 | Biofeedback method

Children were asked to come to the therapies with a full bladder. By explaining the surface electrodes, a total of three electrodes were placed in the perianal region in the lithotomy position, one each at 3 and 9 o'clock and one for the pelvis or patella. UF was performed with EMG using a urodynamic device in the appropriate voiding position. A stool was placed under the feet of the little children for support, and urination was ensured in the correct position. The children were requested to relax during voiding, and then the PVR was measured by ultrasound and recorded. A total of 10 minutes of animated biofeedback was performed. The children were taught to relax only with sphincter control, without using the gluteal and abdominal muscles. The changes in the visuals on the monitor during pelvic floor contraction and relaxation were explained to the children. Psychological strategies were applied to increase the self-confidence of the children, to make progress, and to motivate them. Sessions were administered on a daily or weekly basis. The clinical response of the patients was defined according to the ICCS recommendation (no response: <50% reduction; partial response: 50% to 99% reduction; complete response: 100% reduction) (2). The maximum flow rate (Qmax) in UF, PVR (mL), presence of EMG, voiding pattern, voiding volume/EBC (%), and DVISS were compared before and after treatment.

2.2 | Statistical analysis

Data were analyzed using the IBM Statistical Package for the Social Sciences version 22 (IBM SPSS Statistics for Windows, Chicago, Illinois). The normality of the distribution of the variables was evaluated using the Shapiro-Wilk test. As the distribution of continuous variables did not show a normal distribution, continuous data were presented with median, minimum, and maximum. Comparisons of independent and dependent groups were done with the Mann-Whitney *U* test and Wilcoxon signed ranks test, respectively. The McNemar test was used for binary categorical dependent data and Fisher's exact test for independent data. A *P* value <.05 was accepted as statistically significant.

3 | RESULTS

A total of 45 children (39 girls [86.6%] and 6 boys [13.3%]) aged 11 (5-17) years were included in the study. There were 27 (60%) children in the daily group and 18 (40%) children in the weekly group. The median age of the children in the daily group was 10 (5-16) years

TABLE 1 Age, parameters of UF, DVISS, and number of sessions in daily and weekly biofeedback groups

	Daily (n = 27)		Weekly (n = 18)					
	Before	After	Before	After	*P* value[a]	*P* value[b]	*P* value[c]	*P* value[d]
Age (years)	10 (5-16)		11 (5-17)		.898	NA	NA	
Qmax (mL/s)	18 (8-62)	24 (14-51)	16.5 (4-50)	26.5 (12-42)	.451	**.014**	**.003**	.450
PVR (mL)	79 (16-270)	22 (5-239)	103.5 (11-274)	22 (5-313)	.728	**<.001**	**.007**	.861
EMG activity (+) (%)	27 (100)	5 (18.8)	18 (100)	5 (27.8)	NA	**<.001**	**<.001**	.489
Abnormal UF pattern (%)	14 (51.9)	2 (7.4)	13 (72.2)	4 (22.2)	.172	**.002**	**.004**	.199
Voiding volume/EBC (%)	72.7 (36.3-214.4)	94.6 (27.1-162.7)	74.6 (16.1-217.7)	85 (39.4-309.5)	.660	.929	**.043**	.917
DVISS	15 (6-27)	2 (0-15)	17.50 (7-33)	6 (0-29)	.329	**<.001**	**<.001**	**.03**
Sessions	5 (4-10)		10 (4-15)		.073	NA	NA	NA

Abbreviations: DVISS, Dysfunctional Voiding and Incontinence Scoring System; EBC, expected bladder capacity according to age; EMG, electromyograph; NA, not applicable; PVR, postvoid residual urine volume; Qmax, maximum urine flow rate; UF, uroflowmetry.
[a]Daily vs weekly before treatment.
[b]Before and after daily treatment.
[c]Before and after weekly treatment.
[d]Daily vs weekly after treatment.

TABLE 2 Improvement rates in Qmax, PVR, voiding volume/EBC, and DVISS after biofeedback treatment

	All children (n = 45) (mean [SD])	Daily (n = 27) (mean [SD])	Weekly (n = 18) (mean [SD])
Qmax (%)	54.56 (50.27)	39.84 (66.95)	76.65 (66.95)
PVR (%)	53.85 (50.37)	53.83 (49.28)	53.89 (53.15)
Voiding volume/EBC (%)	33.55 (76.91)	21.05 (73.47)	52.30 (80.23)
DVISS (%)	68.82 (30.30)	74.70 (30.08)	59.99 (29.23)

Abbreviations: DVISS, Dysfunctional Voiding and Incontinence Scoring System; EBC, expected bladder capacity according to age; PVR, postvoid residual urine volume; Qmax, maximum urine flow rate; SD, standard deviation.

TABLE 3 Voiding patterns of daily and weekly groups before and after biofeedback treatment

	Pretreatment		Posttreatment	
	n	%	n	%
Daily (n = 27)				
Bell shape	13	48.1	25	92.6
Intermittent	3	11.1	1	3.7
Tower	1	3.7	-	-
Plateau	5	18.5	1	3.7
Staccato	5	18.5	-	-
Weekly (n = 18)				
Bell shape	5	27.8	14	77.8
Intermittent	7	38.9	1	5.6
Tower	-	-	-	-
Plateau	2	11.1	-	-
Staccato	4	22.2	3	16.7

and of the children in the weekly group 11 (5-17) years ($P = .898$). Constipation treatment was also applied to 12 children during standard urotherapy. However, due to the persistence of LUT symptoms consistent with DV after treatment, they underwent biofeedback therapy. The number of sessions applied was 5 (4-10) in the daily group and 10 (4-15) in the weekly group ($P = .073$). Posttreatment follow-up was 6 (3-10) months. The number of patients with complete response was 17 (37.8%), partial response was 23 (51.1%), and nonresponse was 5 (11.1%). Table 1 shows the comparison between the groups in terms of age, voiding parameters, DVISS scores, and the number of sessions. Qmax, PVR, number of abnormal UF patterns, voiding volume/EBC, and DVISS scores were similar between the two groups before treatment. There was a significant improvement in all voiding parameters in the weekly group compared to pretreatment. In the daily group, significant improvement was found in all voiding parameters except voiding volume/EBC. After treatment, all voiding parameters were similar between the two groups. It was observed that the DVISS score was lower in the daily group 2 (0-15) than in the weekly group 6 (0-29) ($P = .03$) (Table 1). The rates of improvement in Qmax, PVR, voiding volume/EBC, and DVISS after biofeedback treatment are shown in Table 2. The voiding patterns of the daily and weekly groups before and after the biofeedback treatment are shown in Table 3. While UTI was detected in 29 (64.4%) patients before the treatment, it was detected in only 3 (6.7%) patients after the treatment.

4 | DISCUSSION

DV, one of the voiding disorders, occurs as a result of incorrectly acquired voiding habits during the toilet training period of children. During this period, children wrongly contract their external urethral sphincter as the easiest method to hold their urine, and this wrongly acquired behavior can be manifested by contraction of the pelvic floor muscles during voiding (11). Biofeedback is a noninvasive and nonpharmacological treatment recommended in the ICCS and European Association of Urology (EAU) guidelines for the treatment of children with DV (4,12). It has been shown in many studies to be an effective and reliable treatment method (1,7,13,14). Biofeedback has been shown to be effective not only in the treatment of pelvic floor muscle overactivity in the voiding phase but also in resistant overactive bladder (15). Numerous studies have been conducted since Kegel first reported that he had effective results with pelvic floor therapy in women with urinary incontinence (16). In 1979, Maizels et al first reported biofeedback therapy, and then in 1999, McKenna et al described animated biofeedback (17,18).

In the management of voiding dysfunction in pediatric urology, the focus of biofeedback is to retrain the pelvic floor muscles, which is a unique treatment option because it does not require invasive intervention and is a cost-effective method. The goal of treatment is to improve the child's ability to store urine and empty the bladder more effectively, thereby reducing the amount of PVR. During biofeedback, the children learn about the physiological activity of voiding and filling phases by audio and visual aids. In the treatment of DV, biofeedback has been shown to have a sustained effect of up to 80% and to be more effective than standard urotherapy alone (19,20). Also, it has been found to have a positive effect on concomitant recurrent UTI, obstructive or nonobstructive hydronephrosis, and VUR (7,21,22).

However, it is known that biofeedback, which is a very effective treatment, has some limitations, especially the method of application. The lack of clarity on issues such as session duration, number of sessions, and time between sessions seems to be the most important limitation. Besides, there are no recommendations in the ICCS and EAU guidelines on these issues. In this context, for the first time in the literature, this study aimed to investigate the effect of the time between biofeedback sessions on the treatment outcomes. In our clinic, biofeedback is normally performed on an outpatient basis and in weekly sessions. Nevertheless, the hospital where the study was carried out, is the reference center of its region. Consequently, many patients apply to this center from outside the city. Patients who were referred from outside the city for this treatment, which was performed in many sessions, were treated as inpatients and on daily sessions. Particularly, this patient group constitutes the daily group in this retrospective study. Age, UF parameters, and DVISS score were found to be similar in both groups at the beginning of treatment. Also, the number of sessions applied to both groups was statistically similar (daily 5 [4-10], weekly 10 [4-15]; $P = .073$). After the treatment, it was observed that all parameters improved in both groups, except for the voiding volume/EBC only in the weekly group. In addition, after treatment all parameters were similar in both groups except for DVISS. We consider that the similarity of the daily and weekly results ensures that the session planning can be made according to the conditions of the patient and the biofeedback unit.

Another important issue regarding biofeedback treatment is that the number of sessions varies between studies. Herndon et al reported an 87% improvement in incontinence with a mean of 4.9 sessions, Kibar et al reported a clinical objective improvement of 64% to 82% with a mean of 4.4 sessions, and Porena et al reported an 80% improvement in incontinence with a mean of 11 sessions (7,19,23). It has been reported that the animated biofeedback achieved success in up to 50% fewer sessions than the nonanimated ones (mean 3.6 and 7.6 sessions) (14). This effect is thought to be due to the fact that animated biofeedback increases the children's attention with its visual and auditory stimuli. However, there is no study evaluating the cooperation and motivation of children on this subject. In this study, we applied between 5 and 15 biofeedback sessions to children. Drzewiecki BA et al recommended at least three sessions of biofeedback to improve voiding patterns in children with staccato patterns (13). However, there are no data in the literature about how often voiding patterns should be checked with UF with EMG. In this study, children were checked with UF and EMG at the end of each session after the first five sessions, and treatment was terminated when a normal pattern was achieved.

Biofeedback treatment has been shown to be effective not only in the staccato voiding pattern but also in other pathological patterns. In a study evaluating 61 children with a mean age of 10 years, it was reported that obstructive voiding patterns decreased from 50.8% to 13.1% after biofeedback treatment (24). In another study evaluating the posttreatment results of 77 children with a mean age of 9 years, it was reported that a normal voiding pattern was achieved in 54% of 37 children with interrupted voiding patterns (13). Yagci S et al, on the other hand, found a response to treatment of obstructive patterns in 87.8% at 6-month follow-up and 81.1% at two-year follow-up (25). In our study, the bell shape pattern, which was 18 (40%) at the beginning, increased to 39 (86.6%) after the treatment. Eight of 10 patients with intermittent patterns, 6 of 7 patients with plateau patterns, and 6 of 9 patients with staccato patterns converted to normal patterns with biofeedback.

The study has some limitations. We did not evaluate voiding diaries in this study. However, it has been reported that bladder capacity did not improve significantly after biofeedback treatment (26). Also, most of the studies examining the effect of biofeedback in children with DV did not evaluate the bladder capacity in the voiding diary and compared the voided volume in UF, as in the present study (14,15,24). Invasive urodynamic study was performed in some of the children who did not respond to treatment. However, results were not included in this study. Voiding times at UF were not compared between groups. Another limitation is the short follow-up period. DVISS was used to evaluate symptoms in the study. Symptoms such as voiding frequency, urinary incontinence, urgency, and constipation were not evaluated separately.

5 | CONCLUSION

In this study, it was observed that the daily and weekly intervals between sessions of biofeedback, which is an effective and noninvasive treatment in children with DV, did not affect the success of the treatment. We think that determining the session intervals according to the conditions of the patient and the biofeedback unit will facilitate the implementation of the treatment. Randomized controlled studies to be planned for different session intervals will contribute to the subject in more detail.

FUNDING SOURCES

None.

FINANCIAL DISCLOSURE

None.

DISCLOSURES

None.

AUTHOR CONTRIBUTIONS

Raziye Ergun: Concept design, data collection, data interpretation, manuscript drafting and writing, literature screening. Naime Ipek Ozturk: Data collection, manuscript drafting and writing. Cagri Akin Sekerci: Data interpretation, manuscript drafting and writing, statistical analysis, supervision.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

REFERENCES

1. Koenig JF, McKenna PH. Biofeedback therapy for dysfunctional voiding in children. *Curr Urol Rep*. 2011;12(2):144-152.
2. Austin PF, Bauer SB, Bower W, et al. The standardization of terminology of lower urinary tract function in children and adolescents: update report from the standardization committee of the international Children′s continence society. *NeurourolUrodyn*. 2016;35(4):471-481.
3. Bauer SB. Special considerations of the overactive bladder in children. *Urology*. 2002;60(5 Suppl 1):43-48. discussion 9.
4. Chang SJ, Van Laecke E, Bauer SB, et al. Treatment of daytime urinary incontinence: a standardization document from the international Children′s continence society. *NeurourolUrodyn*. 2017;36(1):43-50.
5. Nieuwhof-Leppink AJ, Hussong J, Chase J, et al. Definitions, indications and practice of urotherapy in children and adolescents—a standardization document of the international Children′s continence society (ICCS). *J Pediatr Urol*. 2021;17(2):172-181.
6. Clothier JC, Wright AJ. Dysfunctional voiding: the importance of noninvasive urodynamics in diagnosis and treatment. *Pediatr Nephrol*. 2018;33(3):381-394.
7. Kibar Y, Ors O, Demir E, Kalman S, Sakallioglu O, Dayanc M. Results of biofeedback treatment on reflux resolution rates in children with dysfunctional voiding and vesicoureteral reflux. *Urology*. 2007;70(3):563-566. discussion 6–7.
8. Schulman SL, Von Zuben FC, Plachter N, Kodman-Jones C. Biofeedback methodology: does it matter how we teach children how to relax the pelvic floor during voiding? *J Urol*. 2001;166(6):2423-2426.
9. Akbal C, Genc Y, Burgu B, Ozden E, Tekgul S. Dysfunctional voiding and incontinence scoring system: quantitative evaluation of incontinence symptoms in pediatric population. *J Urol*. 2005;173(3):969-973.
10. Bauer SB, Nijman RJ, Drzewiecki BA, Sillen U, Hoebeke P. International Children′s continence society standardization report on urodynamic studies of the lower urinary tract in children. *NeurourolUrodyn*. 2015;34(7):640-647.
11. Nevéus T, von Gontard A, Hoebeke P, et al. The standardization of terminology of lower urinary tract function in children and adolescents: report from the standardisation Committee of the International Children′s continence society. *J Urol*. 2006;176(1):314-324.
12. Radmayr C, Bogaert G, Dogan H, et al. *EAU Guidelines, Edition Presented at the Annual EAU Congress Barcelona*. European Association of Urology; 2019.
13. Drzewiecki BA, Kelly PR, Marinaccio B, et al. Biofeedback training for lower urinary tract symptoms: factors affecting efficacy. *J Urol*. 2009;182(4 Suppl):2050-2055.
14. Kaye JD, Palmer LS. Animated biofeedback yields more rapid results than nonanimated biofeedback in the treatment of dysfunctional voiding in girls. *J Urol*. 2008;180(1):300-305.
15. Tugtepe H, Thomas DT, Ergun R, et al. Comparison of biofeedback therapy in children with treatment-refractory dysfunctional voiding and overactive bladder. *Urology*. 2015;85(4):900-904.
16. Kegel AH. The physiologic treatment of poor tone and function of the genital muscles and of urinary stress incontinence. *Western J Surgery Ob-Gyn*. 1949;57:527-535.
17. Mckenna PH, Herndon CA, Connery S, Ferrer FA. Pelvic floor muscle retraining for pediatric voiding dysfunction using interactive computer games. *The Journal of urology*. 1999;162(3 Part 2):1056-1062.
18. Maizels M, King LR, Firlit CF. Urodynamic biofeedback: a new approach to treat vesical sphincter dyssynergia. *J Urol*. 1979;122(2):205-209.
19. Porena M, Costantini E, Rociola W, Mearini E. Biofeedback successfully cures detrusor-sphincter dyssynergia in pediatric patients. *J Urol*. 2000;163(6):1927-1931.
20. Altunkol A, Abat D, Sener NC, et al. Is urotherapy alone as effective as a combination of urotherapy and biofeedback in children with dysfunctional voiding? *Int Braz J Urol*. 2018;44(5):987-995.
21. Ladi-Seyedian SS, Sharifi-Rad L, Amini E, Kajbafzadeh AM. Resolution of hydronephrosis in children with dysfunctional voiding after biofeedback therapy: a randomized clinical trial. *Appl Psychophysiol Biofeedback*. 2020;45(4):259-266.
22. Khen-Dunlop N, Van Egroo A, Bouteiller C, Biserte J, Besson R. Biofeedback therapy in the treatment of bladder overactivity, vesicoureteral reflux and urinary tract infection. *J Pediatr Urol*. 2006;2(5):424-429.
23. Herndon CD, Decambre M, McKenna PH. Interactive computer games for treatment of pelvic floor dysfunction. *J Urol*. 2001;166(5):1893-1898.
24. Alyami F, Ewida T, Alhazmi H, et al. Biofeedback as single first-line treatment for non-neuropathic dysfunctional voiding children with diurnal enuresis. *Can Urol Assoc J*. 2018;13(1):E7-E9.

25. Yagci S, Kibar Y, Akay O, et al. The effect of biofeedback treatment on voiding and urodynamic parameters in children with voiding dysfunction. *J Urol*. 2005;174(5):1994-1997. discussion 7–8.
26. Kajbafzadeh AM, Sharifi-Rad L, Ghahestani SM, Ahmadi H, Kajbafzadeh M, Mahboubi AH. Animated biofeedback: an ideal treatment for children with dysfunctional elimination syndrome. *J Urol*. 2011;186(6):2379-2384.

How to cite this article: Ergun R, Ozturk NI, Sekerci CA. The effect of duration between sessions on biofeedback treatment in children with dysfunctional voiding. *Lower Urinary Tract Symptoms*. 2022;14(5):387-392. doi:10.1111/luts.12456