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Efficacy of Parasacral Transcutaneous Electrical Nerve Stimulation in Children with Refractory Detrusor Overactivity

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What's known on the subject? and What does the study add?

There are limited studies on the application of transcutaneous tens stimulation (TENS) in the treatment of refractory lower urinary tract symptoms. Nine articles have been published in high-impact journals in the last three years related to parasacral TENS in voiding dysfunction in children. The content of these articles includes the recommended sequences and treatment responses. When evaluated from this point of view, there are still no precise results regarding parasacral TENS application, and clinical evaluations are still valuable. Although ICCS states that 10-25 Hz is effective in TENS application, treatment protocols at different frequencies and durations for refractory bladder overactivity and success rates for different durations have been published in the literature. We aimed to present the success rate of the protocol we created based on the lowest recommended Hz and the shortest treatment duration because continuity in the pediatric group and compliance with treatments planned at high Hz is difficult. In this study, p-TENS was applied in children diagnosed with detrusor overactivity. It was shown that the protocol positively affected symptoms and incontinence.

Abstract

Objective: This study aimed to evaluate the effectiveness of parasacral transcutaneous electrical nerve stimulation (p-TENS) in children with detrusor overactivity (DO) who were subjected to standard medical treatment, urotherapy, and/or biofeedback.

Materials and Methods: Thirty-two children (female: 17, male: 15) underwent p-TENS because of refractory lower urinary tract dysfunction symptoms between 2017 and 2019. Children with neurogenic bladder (n=7) and dysfunctional voiding (n=13) were excluded. The data of 12 children diagnosed with DO after the urodynamic study (boys: 8, girls: 4), were evaluated for treatment response 6 months after the last session. p-TENS was performed using S2-3 dermatome 2 days a week for 3 months. Each session lasted 20 min with a frequency of 10 Hz and generated a pulse of 250 μs.

Results: The median age of 12 children was 11 years (interquartile range 25-75, range: 9.5-12.5). Incontinence is the main complaint. Significant improvement in uroflow parameters was detected in all children. Urgency, urge incontinence (p=0.016), and constipation (p=0.031) rates were significantly decreased. Voiding dynamics revealed improved voiding patterns (pre/post tower shaped pattern; n=7 *vs.* n=2), and incontinence was completely resolved in nine children (75%).

Conclusion: P-TENS has emerged as a therapeutic alternative in children with DO refractory to standard treatment protocol and medication.

Keywords: lower urinary tract dysfunction, refractory overactivity, TENS, urinary incontinence

Introduction

Detrusor overactivity (DO) is a condition characterized by involuntary detrusor contractions during the bladder-filling phase that can result in urinary incontinence. DO is a common problem in pediatric urology practice that may lead to renal deterioration and affect children's quality of social life (1-3).

Behavioral changes, medication (anticholinergics), and animated biofeedback effectively treat lower urinary tract dysfunction (LUTD) symptoms in DO (2-6). However, a limited number of children are refractory to standard therapies.

Parasacral transcutaneous electrical nerve stimulation (p-TENS) has been used to treat LUTD refractory to standard treatment

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protocols in children. Nevertheless, previous studies have reported different treatment protocols and outcomes (7-11).

In the present study, we evaluated the efficacy of p-TENS for refractory LUTD symptoms related to DO in children. We hypothesized that p-TENS is a non-invasive and effective alternative treatment option for the restoration of voiding dynamics and for reducing incontinence.

Materials and Methods

Regarding treatment response, medical records of children who underwent p-TENS for refractory LUTD symptoms were retrospectively evaluated (2017-2019). Children with neurological disease (n=7) and dysfunctional voiding (n=15) were excluded, and children diagnosed with refractory DO were included in the study.

Based on the protocols recommended by the International Children's Continence Society (ICCS) for LUTD, standard urotherapy training is provided to all children by the same urotherapy nurse in which behavioral regulations (fluid consumption and diet regulation) and recommendations for voiding and defecation (posture during voiding and defecation, timed voiding) are explained. Anticholinergic treatment (0.3-0.6 mg/kg/day in three doses) was the initial treatment protocol. The animated biofeedback protocol was added to anticholinergic refractory DO, and the combination treatment was continued for three months (6,12). The animated biofeedback sessions are performed once a week in the first month and once every two weeks in the second and third months. Before p-TENS, it was ensured that all children applied these routine protocols completely. Although the children completely applied these standardized treatment protocols, incomplete treatment responses in incontinence were accepted as resistant to treatment (4).

Dysfunctional voiding symptom scoring was used for LUTD symptom assessment, and urinary incontinence, frequency, urgency, urge incontinence, and holding maneuvers were noted (13). The urinary system was examined anatomically and functionally with uroflow electromyogram (UFM-EMG) (at least twice at different times), and post-void residual urine (PVR) was measured by ultrasound immediately after voiding before and after p-TENS. Voiding diaries were also checked before and after treatment to confirm the reliability of anamnesis. However, medical records kept by the physician and uroflow parameters were evaluated.

The protocols of the children who underwent urodynamic study before treatment were re-evaluated for misdiagnosis. Moreover, urodynamics was performed in children who were diagnosed using noninvasive evaluation. In all children, urodynamic evaluations were performed following the ICCS standard, and DO diagnosis was made by detection of detrusor contractions during filling cystometry (6).

In UFM-EMG, Q_{max}, voiding time, voiding volume, and voiding curve were evaluated (14). The bladder capacity was calculated using the formula (age+1) x 30 mL (15). A single PVR was considered significant when it was greater than 15% of the estimated bladder capacity for age or greater than 20 mL (6).

The frequency of urinary tract infections (UTI) was determined from the children's medical records based on urine cultures with bacterial growth. Antibiotics were initiated in children with UTI at a suppression dose appropriate for their weight (16).

Constipation was evaluated by clinical findings and the Bristol stool scale (17). Treatment was based on hold training, time habits, and dietary guidance for all children,and laxative treatment for children with constipation classified as Bristol 1 and 2.

P-TENS was performed using the S2-3 dermatome with the electrodes placed in the parasacral region while the children were in the prone position (Figure 1, BioBravo, dual channel MTRplus Vertriebs GmbH) (18). The sessions were held twice a week in the hospital. During the p-TENS sessions at the hospital, the family was informed about how to apply p-TENS. After ensuring that they applied p-TENS correctly, the device was loaned to the family for home use for the rest of the sessions. The total

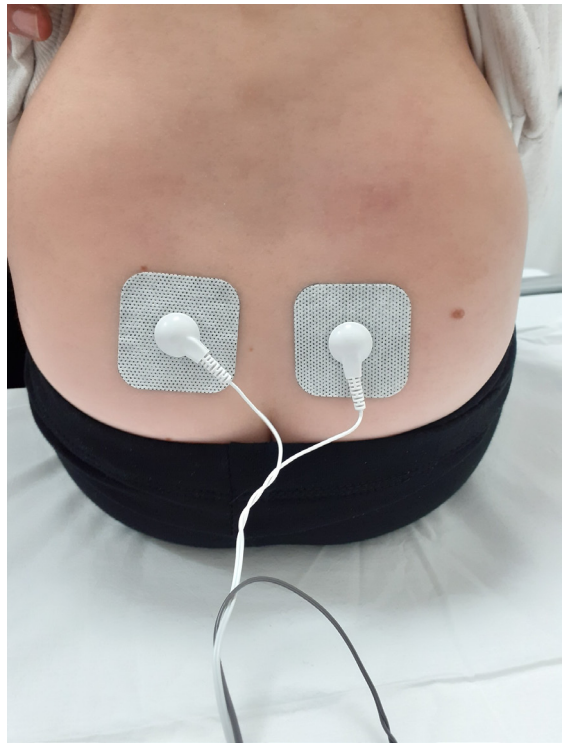

Figure 1. Electrode location in p-TENS therapy

p-TENS: Parasacral transcutaneous electrical nerve stimulation

duration of treatment was limited to 3 months. Each session lasted 20 min, with a frequency of 10 Hz and a generated pulse of 250 µs twice a week. The intensity was determined by the child's sensitivity threshold. Standard urotherapy was continued during p-TENS. Before p-TENS, anticholinergic treatment and biofeedback sessions of the children were terminated. Standard urotherapy was continued. Children were evaluated for treatment response six months after the last p-TENS session.

Statistical Analysis

The statistical examination was performed using IBM SPSS v21.0 software. Descriptive statistics are presented as frequency (n) and percentage (%) for categorical variables and mean, standard deviation, and median (25.p-75.p) for numerical variables. The conformity of continuous variables to normal distribution was evaluated by the Shapiro-Wilk test. The chi-square test and Fisher's exact test were used to compare categorical variables; the categorical McNemar test was used for the dependent group comparison of variables. The independent groups' t-test and Mann-Whitney U test were used to compare the numeric variables of the two independent groups. Dependent groups t-test and Wilcoxon test were used to compare the two dependent groups. In addition, a generalized linear model was used to evaluate the pre-and post-treatment changes in continuous variables that met normal distribution conditions according to the diagnostic group. A p-value of <0.05 was considered significant.

Results

Twelve children were evaluated for the study. There were 8 boys (67%) and 4 girls (33%). At the time of diagnosis, 7 (58%) children had non-monosymptomatic enuresis, 3 (25%) had daytime urinary incontinence, and 2 (17%) had monosymptomatic enuresis.

Improvement was detected in the holding maneuver (58 *vs.* 25%), frequency (58 *vs.* 25%), and urinary tract infection (33 *vs.* 17%). However, these treatment responses did not reach statistical significance. Urgency (p<0.001), urge incontinence (p=0.016), and constipation (p=0.031) complaints decreased significantly after treatment. Among the uroflow parameters, Q_{max} decreased (p=0.012), voiding time prolonged (p=0.001), voided volume increased (p=0.001), and PVR decreased (p=0.012). The tower-shaped voiding pattern (n=7) was dominant at the beginning of treatment. After treatment, the tower-shaped pattern continued in 2 children, and the others were in a bell-shaped configuration. Urinary system symptoms and uroflow parameters in children with DO before and after p-TENS are summarized in Table 1.

After p-TENS, it was found that the incontinence completely resolved in nine children (75%). Complete response was detected in 50% of monosymptomatic enuresis (n=1), 86% of non-monosymptomatic enuresis (n=6), and 67% of daytime incontinence (n=2).

Discussion

Recently, p-TENS has been used as an alternative treatment option in children with non-neurogenic LUTD symptoms who do not benefit from standard urotherapy, biofeedback, and/or medical treatment (7-11,19-21). However, there are few studies on transcutaneous administration in children with refractory symptoms. Because of the lack of a standard treatment protocol,

Table 1. Urinary system symptoms and uroflow parameters in patients with detrusor overactivity (DO) before and after p-TENS treatment

	DO (n=12)		
	Before	After	p
Symptoms			
Holding maneuver	7 (58)	3 (25)	0.125[1]
Frequency	7 (58)	3 (25)	0.125[1]
Urgency	12 (100)	3 (25)	<0.001[1*]
Urge incontinence	10 (83)	3 (25)	0.016[1]
Urinary tract infection	4 (33)	2 (17)	0.5[1]
Constipation	7 (58)	1 (8)	0.031[1]
Uroflow parameters			
Q_{max} mL/s[*]	21.9 (20.2-24.75)	19.9 (18.70-21.30)	0.012[2]
Voiding time s[*]	20 (16.5-22.5)	26.50 (23.50-30)	0.001[2]
Voiding volume (mL)[*]	270 (170-312)	370 (345-441)	0.001[2]
Postvoid residue urine (mL)[*]	5 (3.5-6)	1 (0-4)	0.012[3]

[1]: McNemar test, 1* the p-value is less than one per thousand, [2]: Paired t-test, [3]: Wilcoxon test, [*]: median, IQR: Interquartile range (25-75), p-TENS: Parasacral transcutaneous electrical nerve stimulation

clinical results obtained with different treatment protocols have been reported in the literature (7-11,21). In this study, we determined that administering 20 min of TENS twice a week to the parasacral region at 10 Hz frequency and 250 µs generated pulse operation mode effectively treated refractory LUTD symptoms and urinary incontinence secondary to DO, after 6 months of follow-up.

In the literature, different treatment responses related to p-TENS applied at different times and frequencies have been reported (7-11). Finazzi Agrò et al. (22) evaluated the effect of this protocol difference on the treatment response and concluded that the important factor in the success of the treatment was not the duration of the treatment but the number of stimulations in a day. In this study, we observed treatment results similar to those of daily practices with applications of 2 days a week. In addition, the complaints of urge and urge incontinence symptom resolution rates have similar incidence compared with the third-month control rates obtained by Tugtepe et al. (7) with a protocol of 20 min at 10 Hz frequency and 350 generated pulse.

The regression of LUTD symptoms indicates that p-TENS affects voiding dynamics. The reflection of this effect on the uroflowmetry parameters of the children in this study was the positive change in Q_{max} values after treatment. In addition, significant normalization was observed in the voiding patterns. The mechanism of action of p-TENS has not yet been fully elucidated; the stimulation may act on reflexogenic pathways involved in the control of the lower urinary tract and inhibit the parasympathetic excitatory neurons that come and go to the bladder or interneurons in the spinal cord (23,24). In addition, this result may be associated with the proximity of neural networks between the bladder and rectum and changes in innervation affecting both systems (25). TENS is effective for treating chronic constipation (26). Discontinuation of oxybutynin treatment during sessions and stimulation may also have affected the improvement of refractory constipation. The reduced effect of chronic constipation on the bladder may have decreased LUTD symptoms.

The complete response rates in daytime incontinence differ between studies. Tugtepe et al. (7) reported a complete response in daytime incontinence of 70% in 3rd month of treatment. Hoebeke et al. (11) used TENS for 2 h/day to treat 41 children and reported a success rate of 68% at one month and 51% at one year. Our complete response rate in daytime incontinence was 67% 6 months after treatment. These response rate differences can be associated with differences in the protocols applied or are related to the time at which the outcome is evaluated. The complete response rates were also high in non-monosymptomatic patients (86%). An advantage of p-TENS is that no side effects were detected in our study and other studies in the literature (18). However, its effectiveness on LUTD and incontinence is unclear in the long-term follow-up.

Study Limitations

The most important limitation of this study is that it was retrospectively designed with a small sample size. Despite these limitations, it helps to evaluate the functional effects of p-TENS. Better treatment responses can be obtained using the protocols to be defined for specific voiding problems in the future.

Conclusion

The response to p-TENS was significant in the symptoms of children with refractory DO. It is also effective in preventing constipation. P-TENS can be considered an alternative treatment method for refractory DO symptoms in children because it is independent of children and family-dependent factors that will decrease the effectiveness of standard treatments.

Ethics

Ethics Committee Approval: Approved by Istanbul University-Cerrahpaşa Ethic Committee (number: 431.10-2777, date: 18.08.2023).

Informed Consent: Retrospective study.

Authorship Contributions

Concept: E.A.K., B.Ö., Design: E.A.K., B.Ö., Data Collection or Processing: B.S., U.A., Literature Search: B.S., U.A., Writing: E.A.K., B.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

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