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Research Article

Effectiveness of Transcutaneous Posterior Tibial Nerve Stimulation for Refractory Idiopathic Overactive Bladder in Children

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Abstract

Background: Transcutaneous posterior tibial nerve stimulation (TPTNS) is a promising treatment modality for idiopathic overactive bladder (OAB) in the pediatric population. *Objective:* To evaluate the efficacy of TPTNS in children suffering from idiopathic OAB refractory to conventional therapies. *Method:* It is a retrospective study including children with clinical OAB syndrome refractory to treatment. The TPTNS protocol consisted of a daily 20-minute session (5 times per week, frequency 10 Hz, pulse width 200 µsec). All patients and family were instructed on how to use the device at home. Treatment efficacy was assessed based on perceived clinical improvement or success using a 3-day voiding diary and visual analog scale (VAS). The evaluation of treatment effectiveness was done after 1 and 6 months. *Result:* A total of 55 children were included in the study (31 girls and 24 boys), with a mean age of 10.6 ±3.1 years. All patients experienced urinary urgency, 78.2% had frequency and 51% urge incontinence. 32.7% exhibited both daytime and nighttime symptoms. After one month of TPTNS, clinical outcomes showed improvement in 52 patients. The perceived improvement was more pronounced for daytime symptoms. After 6 months, 65.5% were considered cured while the remaining patients showed continued improvement. On the VAS, 72.7% assessed the improvement in symptoms as between 9/10 and 10/10. *Conclusion:* TPTNS represents a potentially effective and noninvasive treatment strategy for idiopathic OAB in children, showing significant symptom improvement without adverse effects. However, further research is needed to determine optimal treatment parameters.

Keywords

Transcutaneous Posterior Tibial Nerve Stimulation, Neuromodulation, Overactive Bladder, Children

1. Introduction

Overactive bladder (OAB) is the most common voiding dysfunction in children. It is defined by the International Children's Continence Society (ICCS) as urinary urgency, usually accompanied by frequency and nocturia, with or without urinary incontinence, in the absence of urinary tract infection or other obvious pathology [1]. OAB tends to reach its highest incidence between the ages of 5 and 7 years [2]. The prevalence of OAB in children ranges from 15 to 20% with a higher prevalence in boys. It decreases with age, dropping from 23% at 5 years old to 12.2% at 13 years old [3,

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4]. OAB is not always associated with detrusor overactivity, a term that can be used only after a urodynamic evaluation.

The therapeutic arsenal for idiopathic (non neurologic) OAB in children includes voiding hygiene measures, constipation management, behavioral therapy, pharmacological treatments (antimuscarinic) and more recently, neuromodulation [3, 5]. The idea behind using neuromodulation is to activate one nerve conduction pathway in order to inhibit or stimulate another. In urology, this approach aims to modulate the neurological control of the bladder and sphincter function [6]. But the precise mechanism underlying the therapeutic efficacy remains unclear. It is believed that neuromodulation promotes bladder relaxation by increasing beta-adrenergic activity and decreasing cholinergic activity [5].

Neuromodulation is approved for use in adults with refractory OAB [7]. However, despite its effectiveness with a growing body of evidence, its use for children remains off-label [3, 8]. Various nerve stimulation techniques have been explored and evaluated in children with OAB. Posterior tibial nerve stimulation (PTNS) modulates the micturition reflex by stimulating the sensory afferent fibers of the posterior tibial nerve, which are located in the same region as the sacral anterior roots [5, 6, 8].

We conducted this study to evaluate the efficacy of transcutaneous PTNS (TPTNS) in children suffering from idiopathic OAB refractory to conventional therapies.

2. Materials and Methods

A retrospective single-center study was conducted in the department of Physical and Rehabilitation Medicine. It involved 55 children with clinical OAB syndrome that was refractory to conventional therapies and who were prescribed TPTNS. Were included patients over the age of 7 with idiopathic OAB validated clinically. Exclusion criteria included patients with anatomical abnormality in the lower urinary tract in renal and bladder ultrasound, patients with OAB secondary to neurogenic bladder whether congenital or acquired, and an interruption of the treatment protocol for more than 2 consecutive sessions.

Demographic and clinical data, including medical history, were obtained from medical records covering the period from January 2024 to January 2025. All patients had received treatment for their clinical OAB syndrome prior to the initiation of TPTNS. These therapies were often combined: anticholinergic (oxybutynin), desmopressin, nighttime alarm, diet advice, bladder-voiding hygiene, constipation treatment and pelvic floor rehabilitation (biofeedback), with poor clinical results. All these therapies had to be stopped before starting TPTNS.

The treatment protocol consisted of a daily 20-minute TPTNS session (five times per week, frequency 10 Hz, pulse width 200 µsec). Neuromodulation was performed using two self-adhesive surface electrodes placed posterior to the medial malleolus and on the inner aspect of the calf, on the same side. The stimulation intensity was set according to the child's sensory threshold. All patients and family were instructed on how to use the device at home in training sessions. Treatment efficacy was assessed based on perceived clinical improvement or success using a 3-day voiding diary data and visual analogue scale (VAS). Parents used VAS ranging from 0 to 10, where 0 indicated no improvement and 10 represented complete symptom resolution. The primary objective was to evaluate treatment effectiveness in the short and medium term (at 1 and 6 months respectively).

3. Results

A total of 55 children were included in the study (31 girls and 24 boys), with a mean age of 10.6 ±3.1 years at the time of the first consultation in our department. Based on the voiding diary, the distribution of lower urinary tract symptoms is summarized in Figure 1.

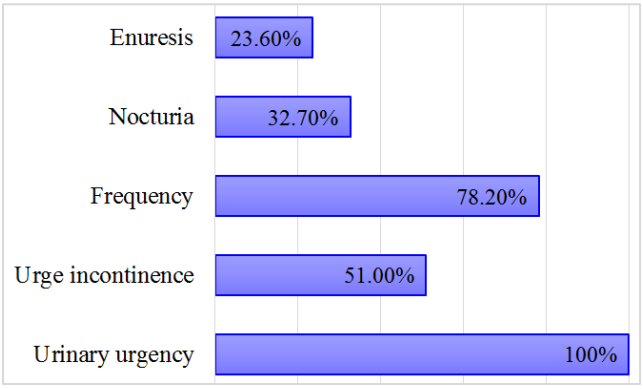

Figure 1. *Distribution of lower urinary tract symptoms.*

All patients experienced urinary urgency. However, only around half presented with urge incontinence. A total of 18 patients exhibited both daytime and nighttime symptoms.

The treatment lasted for six months in the majority of cases (52 patients), while 3 children who showed no improvement discontinued neuromodulation after one month.

After one month of electrostimulation, clinical outcomes showed improvement in 52 patients, who subsequently continued the treatment. Among those presenting both daytime and nighttime symptoms, the perceived improvement was more pronounced for daytime symptoms. After six months, 65.5% (34 out of 52 patients) were considered cured according to the voiding diary, while the remaining patients showed continued improvement. On the visual analog scale, forty parents of patients assessed the improvement in symptoms as between 9/10 and 10/10.

Figure 2 illustrates the clinical outcomes after 1 and 6 months of TPTNS according to the voiding diary.

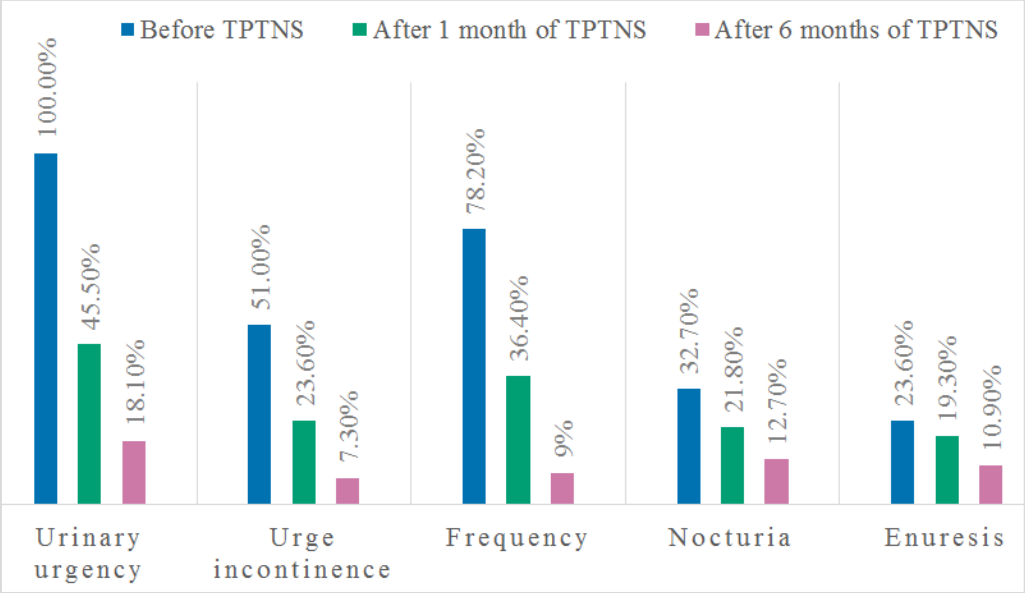

Figure 2. *Clinical outcomes after 1 and 6 months of TPTNS.*

The progressive improvement in lower urinary tract symptoms following TPTNS therapy is noticeable. After one month, substantial reductions were observed in daytime symptoms comparing to nighttime symptoms. After six months, symptoms further improved.

No patient reported any side effects from the use of the device.

4. Discussion

The underlying mechanisms of OAB are intricate, primarily because of the dynamic interaction between the central and peripheral nervous systems [6]. Uncoordinated or disrupted neural transmission in these pathways can result in OAB [9]. The mechanism of action of neuromodulation is still not well understood. It is believed that neuromodulation may help restore the balance between inhibitory and excitatory functions of the central nervous system, thereby regulating the detrusor muscle's activity during bladder filling and emptying. Furthermore, it may involve alterations in central nervous system neurotransmitters, including serotonin, gamma-aminobutyric acid (GABA), and nitric oxide [5].

Physiotherapeutic treatment using electrostimulation of tibial and parasacral nerves has shown to be an effective alternative for managing OAB symptoms in both adults and children [9-13]. In the early 2000s, based on encouraging results in adults, Bower and Hoebeke were the first to report positive outcomes of transcutaneous sacral stimulation in children with OAB by placing the electrodes on the skin over the S3 level [14, 15]. Since then, several pediatric case series have been published on transcutaneous parasacral stimulation (using surface electrodes) and posterior tibial nerve stimulation (using a needle) [10, 16-25]. In the literature, the indications for parasacral or tibial electrostimulation varied, and the patient populations were not homogeneous. To our knowledge, few studies have been published on TPTNS in children with refractory OAB symptoms [26-28].

In the literature, therapeutic evaluation in pediatric studies was very often clinical [10, 14-21, 28]. In our study, we evaluated the effectiveness of TPTNS based on the patient's clinical perception using VAS and the voiding diary. Studies found that neuromodulation (parasacral or tibial nerve stimulation) resulted in an improvement regarding frequency, nocturnal voiding, urgency, urge incontinence, and in mean voiding volume [10, 14-28]. In our study, after 6 months, the most notable improvements were seen in urinary urgency, urge incontinence, and frequency. 65.6% were considered cured, while the remaining patients showed improvement. Although well standardized, urodynamic testing remains an invasive examination. Few studies complemented the clinical analysis with a urodynamic evaluation [22-27, 29]. They found overall an improvement in flowrate and in the flow curve, an increase in maximal cystomanometric capacity and in the volume at the onset of the first overactive detrusor contraction (ODC) and a decrease in maximal bladder pressure during ODC.

In our study, we noticed that among patients presenting both daytime and nighttime symptoms, the perceived improvement was more pronounced for daytime symptoms. Hoffman et al. evaluated potential predictors of outcome in children and adolescents with OAB treated with parasacral transcutaneous electrical nerve stimulation (TENS). They found that the response of patients to treatment with parasacral TENS was poorer when they also had nocturnal enuresis [20]. Although our study used TPTNS, our findings indicated that nocturnal enuresis was the symptom that showed the least improvement.

There was considerable heterogeneity in treatment proto-

cols concerning electrical parameters, session duration, number of sessions, and frequency, with no standardized approach. For example, treatment duration ranged from a minimum of one month for Bower et al. [14], Hagstroem et al. [17] and Lordelo et al. [18] to 6 months or even longer for Hoebeke et al. [15], Lordelo et al. [16], Malm-buatsi et al. [22] and Bouali et al. [27]. The frequency of sessions varied greatly, ranging from 20/30 minutes once or twice per week in most of the above-mentioned studies to 2 hours per day, either in one or two sessions [14, 15, 17]. In our study, the treatment protocol consisted of a daily 20 min TPTNS session during 6 months. Treatment by neuromodulation should be carried out for several weeks in order to achieve the desired effects on the perineal and bladder innervation loop. Most of the above-mentioned studies extended the use of neuromodulation to 12 weeks. Given the absence of any harmful impact, long-term therapy is a viable option, naturally depending on the patient's motivation and engagement in managing their condition. In our study, a daily 20-min session during 6 months was not perceived as a burden. Patient adherence to TPTNS was further facilitated by the perceived clinical improvement.

Based on the results of our study, TPTNS may be considered suitable for home treatment due to its noninvasive nature and simplicity. Reported side effects are limited, with skin reactions under adhesive electrodes being the most common, and there are very few contraindications [30]. Moreover, this technique results in better patient cooperation and adherence to treatment. It has been our practice to use TPTNS to treat children with persistent symptoms of OAB despite treatment with anticholinergic and behavioral therapy. Some studies have suggested that the benefits of neuromodulation tend to decline once the treatment period ends, highlighting the need of continuous application in order to achieve better clinical outcomes [13]. Consequently, home-based neuromodulation may be a more practical alternative to frequent medical visits.

The study has some limitations including the retrospective nature (the range of parameters available for analysis was limited) and the lack of a control group. Also, the size of the sample could be considered as small. It would be interesting to assess in a larger patient cohort the effectiveness of TPTNS with a longer follow up.

5. Conclusion

Transcutaneous posterior tibial nerve stimulation appears to be a particularly promising treatment modality for idiopathic OAB in the pediatric population. It significantly improves urodynamic parameters and objective symptoms of OAB, without causing any harmful impact. While the noninvasive nature and simplicity of this treatment supports also its use in managing OAB in children, further studies are needed to establish the optimal stimulation duration, session frequency, intensity, and overall treatment length for its effective clinical application.

Abbreviations

GABA	Gamma-aminobutyric Acid
ICCS	International Children's Continence Society
OAB	Overactive Bladder
ODC	Overactive Detrusor Contraction
PTNS	Posterior Tibial Nerve Stimulation
TENS	Transcutaneous Electrical Nerve Stimulation
TPTNS	Transcutaneous Posterior Tibial Nerve Stimulation
VAS	Visual Analog Scale

Author Contributions

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Hasnaa Boutalja: Methodology, Investigation

Khawla Rsaissi: Investigation

Fatima Lmidmani: Visualization, Supervision

Abdellatif El Fatimi: Visualization, Supervision

Conflicts of Interest

The authors declare no conflicts of interest.

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