

Efficacy of Vibroacoustic Stimulation Treatment of Enuresis in Children

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Abstract

Background and Aim: Functional voiding disorders (FVDs) are common problems in children. The effect of vibroacoustic therapy has not been examined in children with FVDs. The aim of this study was to investigate the efficacy of vibroacoustic therapy for treatment of FVDs in children.

Methods: Seventy-eight children were included in this prospective study. Dysfunctional voiding score (DVS) and nocturnal enuresis (NE) score were measured before and after vibroacoustic treatment. The success of vibroacoustic therapy use was evaluated according to the percentage of decrease in DVS and NE scores relative to the pre-treatment values. Descriptive and analytic statistical methods were applied for data analysis using SPSS software version 22.0.

Results: The mean age of the participants was 8.65 ± 3.11 years, and half of them were boys. Of 78 patients, 60 were school-aged and 18 were preschool-aged children. A significant difference was noticed between DVS score ($p < 0.01$) and NE score ($p < 0.01$) before and after vibroacoustic therapy in school-aged children. No significant correlation was observed between the success of vibroacoustic therapy and factors such as enuresis type (primary/secondary), applied form of pharmacologic therapy, baseline DVS and NE score, and the presence of a positive family history and expressed through percentage of decrease in DVS and NE scores in school-aged children.

Conclusion: The results of the present study showed the positive effect of the vibroacoustic therapy in school-aged children with functional voiding disorders. It is, however, necessary to conduct further prospective studies in order to confirm its effectiveness and determine its long-term results.

Keywords: Child; Enuresis; Urinary bladder.

Conflict of interest: The authors declare no conflict of interest.

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Introduction

Abnormal filling and emptying of the urinary bladder that are not the consequences of neurological, morphological or other medical causes are known as functional voiding disorders (FVDs). FVDs are common problems in childhood (1-7) and are seen in 5% to 15% of the pediatric population, in 21.8% of school-aged children, and in more than 40% of patients managed by pediatric nephrologists or urologists. FVDs are associated with first or second degree vesicoureteral reflux (VUR) in 54% of the cases and with dilating (third and fourth degree) VUR in 70% of the cases.

They are responsible for recurrent urinary tract infections (UTIs) in 65% to 85% of the patients (7), which usually require antibacterial treatment and prolonged antibacterial prevention and contribute to increased antibacterial resistance (8). FVDs have a negative effect on the self-confidence of children and their quality of life. Therefore, early detection and treatment are necessary.

Therapeutic approach to FVDs

There are pharmacological and non-pharmacological approaches to treatment of FVDs (urotherapy). Non-pharmacological urotherapeutic

interventions include training of pelvic floor muscles, behavioral modifications, neuromodulation, and urinary bladder catheterization. According to specific indications, pharmacological measures include the use of desmopressin, oxybutynin, propiverine, tolterodine or solifenacin, while tricyclic antidepressants are no more in use in clinical practice because of their cardiac side effects. An instillation of botulinum toxin is indicated in a very distinct group of patients with urinary bladder hyperactivity who do not respond to these therapeutic measures, although its therapeutic effect is temporary (10).

Many studies reported the successful use of the electric current at a frequency of 10 to 25 Hz as presacral transcutaneous electric nerve stimulation and percutaneous tibial nerve stimulation for treatment of hyperactive urinary bladder (11, 12).

Another non-invasive, non-pharmacologic treatment method for voiding dysfunctions is vibroacoustic therapy, which includes microvibrations at a frequency of 20 to 18000 Hz and a maximum amplitude of 100 micrometers. Vibroacoustic therapy originates from the fact that microvibrations are present in every living organism – plants, animals, and humans.

The source of microvibrations can be internal (pulsatile cardiac activity, pulsatile activity of arterial blood vessels, and muscle activity) or external (for plants – wind, for humans – shower, massage, physical activity, etc.) Therefore, vibroacoustic therapy is compatible with microvibrations and is completely harmless to humans. Vibroacoustic technology was developed during 1970s when its therapeutic effects were recognized for treatment of children with mental disorders. Vibroacoustic therapy is widely practiced and accepted as a method of conventional medicine in some countries.

One study found that its use was associated with positive effects in patients with obstructive/irritative disturbances of the lower urinary tract (13).

The mechanism of action of vibroacoustic therapy is based on sound signals that are transferred through the skin (free nerve endings, Water-Pacinni, and Meisner corpuscles) and vascular mechanoreceptors in different tissues in the action zone in the form of vibrations, resulting in positive biological and chemical reactions including increased intercellular transmission and improved blood and lymph flow (14, 15). However, few

studies have investigated the effect of vibroacoustic therapy in children with voiding dysfunctions. In order to conduct the vibroacoustic wave therapy, the Vitafon-T device (Vitafon Ltd, Saint Petersburg, Russia) was used, which is according to GOST P 50444-92 requirements.

Working hypothesis

Vibroacoustic therapy improves the lower urinary tract function and has positive effects on MNE and NMNE treatment.

The aim of this study was to evaluate the effectiveness of vibroacoustic treatment in children with FVDs.

Methods

This prospective study was conducted in 78 pediatric patients. The follow-up period was 18 months and the patients were divided to two groups according to age, sex, type of enuresis, applied pharmacological therapy and a positive family history of FVDs. Dysfunctional voiding score (DVS) was calculated in all patients before and after vibroacoustic treatment. Based on this score, daily urinary incontinence and nocturnal enuresis (NE) scores were also quantified (16).

Uroflowmetric testing was performed in all patients before and after vibroacoustic treatment to assess the parameters determining the activity of pelvic floor (electromyography), daily diuresis, urinary bladder capacity and residual urine volume. The research was conducted in accordance with the tenets of the Declaration of Helsinki and was approved by the local institutional review board.

Inclusion criteria:

1. Age 5-18 years.
2. Nocturnal enuresis occurring at least three times a week.
3. Informed consent signed both by parents and children included in study.

Exclusion criteria:

1. Neurological disorders.
2. Impaired kidney function.
3. Psychological disorders.
4. UTI.
5. Non-compliance (parents/children).
6. Participation in another therapeutic clinical trial.
7. Use of medications affecting kidney function and urinary tract.
8. Complex anomalies of the urinary tract.
9. Age below 5 years.

Study design

After performing a detailed medical examination and routine laboratory and functional analyses, vibroacoustic treatment was started. Vibroacoustic energy was applied bilaterally to the back projection of the kidneys, sacral region, and anterior aspect of urinary bladder projection and perineum every day for four weeks. Based on a pilot study and preliminary results, it was decided to apply vibroacoustic stimulation gradually as follows. The treatment started with regime 1 (frequency between 30 and 60 Hz, duration five minutes).

The kidney and sacral areas were treated in the first part and urinary bladder and perineal areas were treated in the second part. On the following day, the duration of treatment increased by one minute in previously treated areas until a treatment length of 10 minutes was achieved. Then, kidney projection sites and sacral sites were continuously treated using regime 1 for ten minutes, while urinary bladder projections and perineal areas were treated according to regime 2 (the duration of vibroacoustic stimulation was increased by one minute every day until a treatment time of 20 minutes was achieved). After treating kidney and sacral areas for 10 minutes and urinary bladder and perineal areas for 20 minutes, the same duration was maintained until the end of the fourth week.

The type and severity of dysfunction were evaluated using:

- a) Voiding diary which provided information on DVS and NE score calculation
- b) Uroflowmetric results.

Within- and between-group comparisons were performed before and after treatment with vibroacoustic stimulation. The effects of vibroacoustic stimulation were explained to all parents and children and informed consent was obtained from both parents and children before treatment.

Statistical analysis

Data are presented as frequency and percentage. Analytical statistics were also applied for data analysis. Descriptive statistics included absolute and relative values, measures of central tendency (mean, median) and measures of variability (standard deviation). Analysis also included parametric tests (t-test for two dependent samples) and non-parametric tests (chi-square test, Wilcoxon's test), as well as correlation analysis (Pearson's and Spearman's) and logistic regression

analysis. The data were analyzed using SPSS 22.0 software.

The expected contribution of the study

The results might indicate a positive effect of vibroacoustic therapy in voiding dysfunction treatment in children, which will potentiate the use of this non-invasive, non-pharmacological, and harmless treatment modality in children with enuresis.

Results

Of 78 children included in this research, 39 (50%) were boys and 39 (50%) were girls. The mean age of the subjects was 8.65 ± 3.11 years. The median age was 6.5 years in children with DVS and 12 years median children with NE. NE was present in all children.

The patients were grouped by age, type of enuresis (primary/secondary), family history, and applied pharmacological therapy.

According to age, the subjects were categorized to two groups of preschool-aged (5-7 years of age, $n=18$) and school-aged children (7-18 years of age, $n=60$). Fourteen children (53.8%) had secondary enuresis and the same percentage had a positive family history.

Forty-two children were not treated with pharmacological therapy, while 36 received desmopressin or anticholinergic/antimuscarinic drugs during vibroacoustic treatment. Desmopressin was used as pharmacological therapy in seven children, oxybutynin/tolterodine (as anticholinergic/antimuscarinic drugs) in four, and a combination of desmopressin and oxybutynin in one patient.

DVS and NE scores were determined before and immediately after vibroacoustic treatment. The success of vibroacoustic treatment was evaluated based on comparing the values of DVS and NE score before and after the intervention. If enuresis stopped completely (a DVS/NE score of zero after vibroacoustic treatment), the time of complete enuresis stopping was recorded.

Vibroacoustic therapy resulted in normalization of DVS and NE scores in school-aged children, while no improvement was detected in pre-school-aged patients. In 42 children (56.0%) complete response (enuresis cessation) was detected due to vibroacoustic therapy, which is evaluated based on 100% of reducing DVS and NE score comparing to

the values before vibroacoustic treatment initiation (Figure 1).

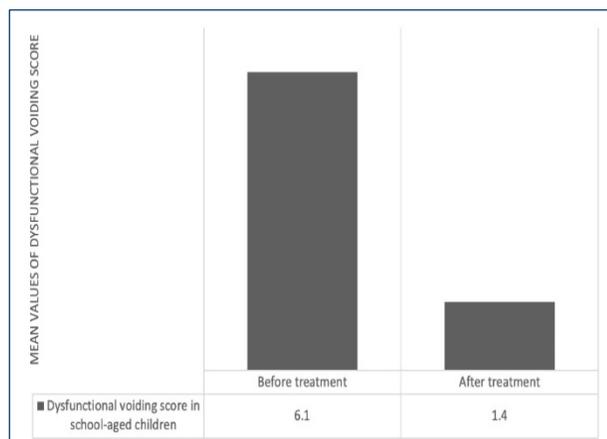


Figure 1. Comparative review of mean values of DVS in school-aged children before and after vibroacoustic treatment.

The dependent sample t-test was used to compare DVS and NE scores before and after applying vibroacoustic therapy. The results showed a statistically significant difference in DVS ($t=7.094$; $p < 0.01$) and NE scores ($t=4.743$; $p < 0.01$). The results of this test showed a highly significant difference in the DVS score before and after the intervention in school-aged children ($t=8.092$; $p < 0.01$), while no significant difference was detected in the pre-school group ($t=2.236$; $p=0.89$). Therefore, preschool-aged children were excluded from further statistical analysis.

Pearson's correlation test did not show any significant correlation between age and success of vibroacoustic therapy, expressed as percent reduction of DVS score, in school-aged children ($r = -0.76$; $p=0.75$). Moreover, there was no correlation between age and NE score ($r = -3.13$; $p=0.22$). There was no significant correlation between age and duration of vibroacoustic therapy until complete cessation of urinary incontinence in children with successful vibroacoustic treatment ($r = 0.03$; $p=0.92$).

A linear regression model showed the significant effect of age, enuresis type (primary/secondary), DVS before vibroacoustic treatment, positive family history, and applied pharmacological therapy on the success of vibroacoustic treatment

expressed as percent reduction of the DVS score ($p > 0.05$).

Discussion

All children included in this study had nocturnal enuresis as a basic type of FVD. Therefore, it can be concluded that nocturnal enuresis is the most common type of FVD in children, which is consistent with several studies (17-19).

In our study, 50% of the children with FVD had primary and 50% had secondary enuresis. In addition, 50% of the children with FVD had a positive family history of similar problems, indicating the importance of correct family history taking since it would lead to early detection of risk factors causing this disorder in children.

This study found that vibroacoustic therapy improved FVDs in children. However, considering a large difference in the DVS score before and after vibroacoustic treatment in children above 7 years and lack of difference in pre-school-aged children, it can be concluded that this treatment has positive effects only in school-aged children with FVDs. Some studies that applied this treatment modality in children below 7 years of age reported a slight improvement, which was insufficient to recommend it in these children. Pharmacological therapy before and during vibroacoustic therapy, a positive family history, and the frequency of urinary incontinence expressed as the baseline DVS score had no effect on the results of vibroacoustic therapy in children with FVDs.

Conclusion

The results of the present study confirmed the positive effect of vibroacoustic therapy in school-aged children with functional voiding disorders. It is, however, necessary to conduct further prospective studies in order to confirm its effectiveness and to evaluate the long-term results.

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Conflict of Interest

The "Vitaфон-T" device, used in this study, was provided by the "Vitaфон Ltd", Saint Petersburg, Russia. The authors declare that there are no other

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Authors Contributions

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