

Efficacy Of Interferential Electrical Simulation Versus Para-Sacral Transcutaneous Electrical Nerve Stimulation In Management Of Nocturnal Enuresis

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Abstract: Background: Enuresis is a common childhood health problem affecting the quality of life of the child and his or her family. We have evaluated the efficacy of interferential (IF) electrical stimulation and Para-Sacral transcutaneous electrical stimulation (TENS) in children with nocturnal enuresis (NE). Objective: To study the effect of the interferential electrical stimulation versus the effect of Para-sacral transcutaneous electrical stimulation in children with nocturnal enuresis. Methods: This was a randomized clinical trial in which 45 children, aged 6–18 years with NE were recruited and randomly divided into three groups. Children in the control group received standard urotherapy only (hydration, scheduled voiding, toilet training, diet), whereas children in the IF group underwent standard urotherapy + 12 sessions of IF electrical stimulation for 20 min three times per week and the children in the third group were treated with 12 sessions of Para-Sacral TENS. After the completion of the treatment program, the improvement score was calculated to identify relative decrease in wet nights for each child. All children were followed for one week before and after treatment. Results: In interferential electrical stimulation (IF) group, complete response was observed in 66.7%, partial response in 20% and 13.3% had no response. In Para-sacral transcutaneous electrical stimulation (TENS) group, full response was observed in 53.3%, partial response in 26.7% and 20% had no response. In control group, full response was observed in 13.3%, partial response in 6.7% and 80% had no response. Significant reduction in mean of number of wet nights before and after treatment was seen in interferential electrical stimulation (IF) and Para-sacral transcutaneous electrical stimulation (TENS) group (from 5.80 ± 1.47 and 6.20 ± 1.52 to 0.73 ± 1.22 and 1.33 ± 1.75) respectively, $P=0.000$. Conclusion: Interferential electrical stimulation (IF) and Para-sacral transcutaneous electrical stimulation (TENS) were effective in reducing the number of wet nights without causing any side effects.

Keywords: Electrical stimulation, Interferential therapy, Nocturnal enuresis, Transcutaneous electrical nerve stimulation.

1. INTRODUCTION

Bladder control is gained by age of 5 years of life. In children stable bladder control develops at 3 to 6 years, starting with day time control and later also during night.^[1] Nocturnal enuresis is a worldwide childhood problem known as involuntary urination during sleep after the age of 5 or 6 years with a frequency of at least twice a week without congenital or acquired lesions of the central nervous system.^[1] Nocturnal enuresis NE can be divided according to the presence of daytime symptoms into mono symptomatic (NE without daytime urinary symptoms) and non-mono symptomatic nocturnal enuresis (NE accompanied by daytime symptoms).^[2] Enuresis is also classified into primary enuresis if the child has never gained bladder control and secondary if he relapsed after developing bladder control for at least 6 months. Although nocturnal enuresis is usually idiopathic there are many factors that can contribute in developing enuresis which are insufficient functional bladder capacity, excessive overnight urine production and inability of the child to awake when the bladder is full.^[3] Because of the over production of urine during sleep which exceeds the functional nocturnal bladder capacity and the abnormal sleep pattern (abnormalities in the arousal response to the full bladder) enuresis occurs in these children.^[4] NE has a deep impact on the life quality of the child and his family.

Children with NE suffering from serious concerns regarding social interaction, such as being teased by peers, social isolation, avoiding school activities like trips or camps and inability to stay over at friends.^[5] Enuresis can result in low self-esteem and lower social skills and performance especially in children from a lower socio-economic background, those who have uneasy parents in dealing with enuresis and those who have experienced a series of treatment failures.^[6] Nocturnal enuresis can be treated with different therapeutic methods. These methods include behavioral therapy and lifestyle modification, alarm training, pharmacological treatment and conservative treatment such as bladder training, abdominal/pelvic floor relaxation exercises, electrical stimulation, biofeedback and acupuncture.^[7]

Electrical stimulation:

ES has been used for a long time as an alternative method of treatment for urinary syndromes such as incontinence, frequency, urgency^[8] and for overactive bladder with good results in adults and in children.^{[9][10]} The precise mechanism of action of ES is not fully clear yet but clinically there is a good improvement in urinary symptoms and in the urodynamics pattern such as increasing bladder capacity and decreasing unstable bladder contraction.^{[11][12]}

Interferential electrical stimulation IF-ES is a type of electrical stimulation that depends in the physiological effect of using two alternative current signals of different frequency.^[13] IF-ES therapy has been widely use in treatment of variety musculoskeletal and neurological disorders and in management of urinary incontinence.^[14] TENS is simple analgesic technique that use electric current produced by a portable device and delivered across the skin via conducting pads for nerve excitation and pain relief.^[15] The aim of our study was to evaluate the effect of interferential electrical simulation versus the effect of Para-sacral transcutaneous electrical stimulation in children with nocturnal enuresis.

2. METHODS

Between January 2018 and December 2018, 45 children (26 boys and 19 girls) with nocturnal enuresis NE were enrolled in this randomized clinical trial. The Ethics Committee of Scientific Research Secretary of Al-Neelain University approved the study protocol (IRB NO: NU-IRB-18-3-3-10). All participants and their parents provided informed consent.

2.1 Patient's evaluations

The patients were children aged 6–18 years diagnosed by NE recruited from the enuresis clinic at Dr. Salma Dialysis Center-Khartoum-Sudan (March-December 2018). Nocturnal enuresis was defined as primary, secondary, mono symptomatic and non mono symptomatic nocturnal enuresis according to ICCS definitions. The diagnosis of NE was done based on a detailed clinical history, physical examination, urinalysis (to exclude urinary tract infection (UTI), complete bladder diary and a 2 day daytime frequency and volume chart. The inclusion criteria were an age of 6-18 years and NE with a history of at least one episode of bedwetting per week. Children having any type of psychiatric problems, neurological disorders, anatomical abnormalities and/or UTI were excluded from the study. The maximum voided volume (MVV) was calculated by completing a 48-h voiding diary, and then the expected bladder capacity (EBC) was obtained using the formula [(age in years +1) ×30=ml].^[16] Participants in the three groups underwent complete physical, neurological and urological examinations, as well as urinary system evaluation. The evaluations included urine analysis and urine culture to identify UTI, kidney and bladder ultrasound to assess anomalies and post-void residue and a voiding chart. Complete bladder diary consisting of a 7-night record of incontinence episodes, 48-h daytime frequency and volume chart including episodes of wetting, voiding frequency, voided volume, post voiding residual volume and fluid intake (time and volume) were recruited from patients to evaluate enuresis. All patients were asked to complete the 7-day voiding diary requirement before and after completion of the treatment sessions. 45 patients from our clinic who met the inclusion criteria for the study were allocated in a randomized controlled trial using random number generator software into three equally sized treatment groups. The IF group included 15 children (age range 7–17 years) who underwent standard urotherapy combined with IF electrical stimulation; the TENS group 15 child who underwent standard urotherapy and Para sacral TENS. The control group consisted of 15 children who received only standard urotherapy.

2.2 Patient education and treatment program

The 15 children in the control group underwent standard urotherapy only. The first step in this treatment program is to provide both the children and parents with simple explanations of urinary and gastrointestinal tract functions. Children with low voiding frequency or voiding postponement were encouraged to adapt regular fluid intake and timed voiding (every 2-3 h) during the day. Children were trained in optimal toilet posture/frequency and advised to avoid fluids 2-3 h before sleep and parents were asked to record voiding frequency and wet nights in the voiding diary. Patients were also taught an optimal voiding posture in order to obtain optimal toilet training. Rewards were also used for dry nights and bladder training including emptying the bladder before going to bed and after waking up as a part of behavioral therapy.^[1] Children were oriented to avoid coffee, tea, citric fruits, soft drinks, chocolate and irritating foods. For children with constipation, stool regulation is a necessary part of treatment.^[1] Therefore, a high fiber diet was advised. Compliance to this treatment program was also reinforced in each follow- up visit. The 30 children in the IF and TENS therapy group received both standard urotherapy (treatment program as described above) and electrical stimulation.

2.3 Interferential electrical stimulation

Electrical stimulation consisted of 12 sessions of IF electrical stimulation for 20 min three time per week performed by a physiotherapist. The IF electrical stimulation IF-ES was at a beat Sweep frequency of 5-25 Hz, duration of 250 μ s, a carrier frequency of 4 kHz, with a repeated time of 6 s and adjustable amplitude (0–50 mA). The same IF current device (Gymna DUO 200, TWO CHANNEL ELECTROTHERAPY UNIT) was used for all children. Two rectangular (2.5×3.5 cm) electrodes were bilaterally placed on the skin of the symphysis pubic, and the two other electrodes from each channel were placed crossly on the skin under the ischial tuberosity. With this approach the IF current from each Channel would cross within the bladder and pelvic floor muscles.^[16] The intensity was adjusted according to the patient's tolerance and increased until the child reported a strong but comfortable level of sensory awareness with no visible muscle contractions. Maximum current intensity was below the pain threshold and was well tolerated by the child.

2.4 Para-sacral transcutaneous electrical nerve stimulation PTENS

The patients received 12 sessions of Para-sacral TENS, 3session/week, each session last for 20 minutes. 2 superficial electrodes (2.5 x 3.5 cm) were placed on each side of S2 and S3. The wave form used was a biphasic continues wave form with frequency of 10 Hz, and pulse width of 250 μ s. The intensity was gradually increased to the maximum tolerable level.^{[17][18]} The same current device (Gymna DUO 200, TWO CHANNEL ELECTROTHERAPY UNIT) was used for all children.

2.5 Outcome measurement

Children in the three groups were followed and evaluated before, during and after treatment. All families were asked to record a complete voiding diary before and after the intervention. According to the new ICCS definitions primary outcome measures were evaluated, in which no response is defined as <50 % reduction in wet nights, a partial response as a 50–99 % reduction in wet nights and a full response as a

100 % reduction in wet nights after treatment. After the completion of the treatment program an improvement score was calculated for each patient using the following formula and expressed as percentage: [(wet night before the treatment – wet night after the treatment)/wet night before the treatment].^[19]

2.6 Sample size and statistical analysis

The sample size was 45 patients, and the study was designed to have 95% power ($\alpha=0.05$). Statistical analysis was performed with Statistical Package of Social Science software (version; 16 SPSS). Data were represented as mean \pm standard deviation (SD). The chi square test was used to analyze the data and to compare variables between the control, IF and TENS groups. Student's t- test was used to compare variables in each group before and after treatment. A P value of <0.05 was considered to be statistically significant.

3. RESULTS

Forty five children ranging in age between 6 and 18 years (26 boys and 19 girls) with nocturnal enuresis were enrolled in this study. There were 30 (67%) children with primary enuresis and 15 children (33%) with secondary enuresis. All participants completed the voiding diary before and after treatment. The mean number of wet nights per week prior to treatment was 6.20 ± 1.3 (range 3–7 nights/week) in the control group, 5.80 ± 1.47 (range 3-7nights/week) in the IF group ($P=0.593$) and 6.20 ± 1.52 (range 2-7 nights/week) in the TENS group. The mean number of wet nights per week in the control, IF and TENS groups decreased to 5.4 ± 2.8 , 0.73 ± 1.22 and 1.33 ± 1.75 respectively. ($P= .068$, $P= 0.000$ and $P= 0.000$ respectively). The improvement score in the IF and TENS groups was significantly higher than that in the control group (66.7% and 53.3% vs. 13.3%, $P=0.001$) Figure1. According to the new ICCS definitions, among the 15 children who received only standard urotherapy (controls), two (13.3 %) responded to standard urotherapy (100 % reduction in wet nights) after completion of the treatment course. In the IF group, 10 children (66.7%) responded to standard urotherapy + IF therapy (100 % reduction in wet nights) after completion of the treatment courses. In the TENS group, 8 children (53.3%) responded to standard urotherapy + TENS therapy (100 % reduction in wet nights) after completion of the treatment courses. Of the 15 children in each group, one (6.7 %) of those in the control group, three (20 %) in the IF group and four (26.7%) in the TENS group, showed a partial response to treatment ($P=0.001$). Two of the 15 (13.3 %) children in the IF group and three (20%) in the TENS group did not responded to IF therapy. The details of responses to the treatment according to ICCS definitions in both subgroups (MNE and NMNE) in the three groups are presented in Table 1. No side effects were reported during and after IF and TENS therapy by the parents and children.

Table (1): Comparison of level of response between MNE and NMNE ($\chi^2=4.673$ NonSig $P=.097$): Level of response according to ICCS: Non response 0- 49 % reduction in wet nights, Partial response 50–89 % reduction in wet nights, Full Response 90-100 % reduction

Type of NE	Level of response		
	No response	Partial response	Full response
MNE	24.0%	20.0%	56.0%
NMNE	55.0%	15.0%	30.0%

Table (2): Comparison of level of response to treatment between IF, TENS and control group ($\chi^2=17.656$, Sig $P=.001$) Level of response according to ICCS: Non response 0- 49 % reduction in wet nights, Partial response 50–89 % reduction in wet nights, Full Response 90-100 % reduction

Treatment group	Level of response		
	No response	Partial response	Full response
Control group	80.0%	6.7%	13.3%
IF group	13.3%	20.0%	66.7%
TENS group	20.0%	26.7%	53.3%

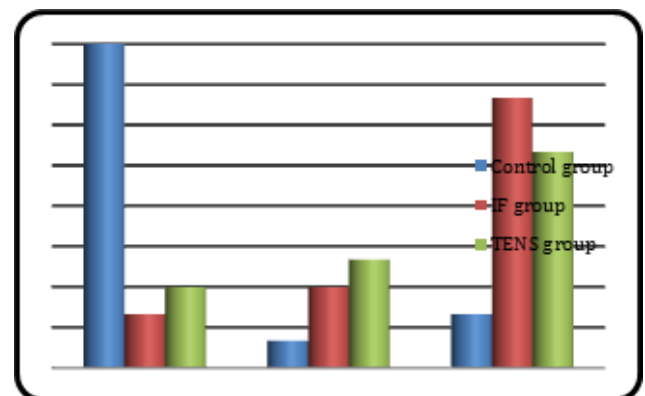


Figure (1): Comparison of level of response to treatment between IF, TENS and control group: Level of response according to ICCS: Non response 0- 49 % reduction in wet nights, Partial response 50–89 % reduction in wet nights, Full Response 90-100 % reduction

4. DISCUSSION

Nocturnal enuresis (NE) is a common problem in children. In many instances, it causes a lot of anxiety and discomfort to the families and children themselves. Nocturnal polyuria, bladder dysfunction and sleep arousal difficulties are the three suggested etiologies for NE. Because the pathophysiology of NE is multifactorial, treatment should be based on the specific underlying etiologies of each patient. Non pharmacological approach like alarm training and pharmacological approach including anti cholinergic and desmopressin medications have been developed based on the postulated underlying etiologies of NE. Unsatisfactory cure rates, side effects of the medications and lack of adherence to conventional therapies have led to the use of alternative

modalities, such as electrical nerve stimulation technique. The precise mechanism of action of electrical stimulation has not fully clarified. Neurophysiological and neuroimaging evidence suggest that the therapeutic effects of electrical stimulation work both peripherally—by affecting muscle fibers and micturition reflexes—and centrally by the restoration of brainstem and cortical activities. To the best of our knowledge, there is no similar study that evaluates and compares the effects of interferential electrical stimulation (IF-ES) with Para-sacral transcutaneous electrical stimulation (TENS) in management of children with NE in Sudan. In this study, we compared the effect of IF electrical stimulation and urotherapy with TENS and urotherapy versus urotherapy alone in the treatment of children with NE. Urotherapy were included in the three groups to minimize the effect of fluid restriction and dietary habit management in symptoms resolution. In this study, prevalence of enuresis in age group of 13 – 18 years was lower than age group of 6 - 12 years, which is in agreement with result of other studies.^[20] Because enuresis is a disease that may be due to delay in development of urine control, therefore prevalence of disease decreases by increase in age.^[20] Predomination of males when compared to females (58% versus 42 %) was observed in this study, that was correlated with result of previous studies of De grazio et al. , Snajderova et al., and Caine et al. Probably, because of the higher rate of stress in males and unknown genetic factors, the prevalence of enuresis is higher in males.^{[21][22][23]} NE had fully resolved in 66.7% of patients in the IF group after IF therapy similar to the result reported by the Fallahzadeh study, he reported that the effect of interferential currents in treatment of enuresis in 40 children 5 to 15 years old (12 set, 3 times per week, 15 minutes, each session) was 62.5 percent.^[24] In the TENS group 53.3% respond (complete response) to the treatment compared to only 13.3% of patients in the control group. This resolution rate is higher than that reported by de Oliveira et al. who investigated the effect of Para-sacral electrical stimulation in 45 children with primary MNE. These authors observed that 15 % of their patients in the case group responded to treatment compared to only 6 % of those in the control group.^[19] Statically, there was significant difference observed between the IF and TENS group in compare with the control group but there was no significant difference between them (IF & TENS) considering the level of response. IF and TENS results in significant reduction of wet nights ($P= 0.000$) in compare with the control group ($P=0.068$). This finding was consistent with the study done by Hagstroem et al. who investigated the effect of TENS Vs sham in children with daytime urge incontinence and enuresis. TENS group showed a significant decrease in incontinence scores, wet nights per week, number of daily urge incontinence episodes and improved response to urgency. All of these were not seen in the sham treated group.^[25] When we compare the level of response to treatment between MNE and NMNE in the three groups, the response rate was higher in children with MNE than NMNE, (full response 56% and 30%) respectively, Since NMNE is more resistant to conventional treatment. This was also observed in Lordêlo et al.'s study who reported low response rate to TENS which may partly be due to their inclusion of NMNE cases and those who did not respond to urotherapy and likely were essentially more refractory.^[26] In comparison of level of response between patients with nocturnal enuresis and voiding abnormality, decreased urine

frequency or increased post voiding residual volume, and patients with nocturnal enuresis only, there was no significant difference between them in the three groups. No side effects were reported during the study period. Despite such positive results, these findings should be considered in the context of a number of limitations, first, it was a short-term study, and second, the sample size was relatively small. Large numbers of patients have dropped out of the study which may be due to the long period of treatment (12 session, 3session/week). A more detailed analysis of correlation among parameters was not possible due to the limited number of patients. Because enuresis has the possibility of spontaneous resolution this was another limitation, which is not unique to our study, and it requires a randomized prospective studies to eliminate such possible confounding variables. Although several studies have reported the safety and efficacy of electrical stimulation for LUTS ES is not yet practiced in Sudan. The reasons may be due to the limited knowledge of the modality, insufficient trained manpower for this outpatient procedure, and cost problems. In conclusion: In conclusion, among our cases of NE, IF and Para-sacral TENS were both effective in reducing the number of wet nights without causing any side effects. There was significant statistical difference in level of response between the IF and TENS in compare with the control group but there was no significant difference between the two modalities. Based on the results of this study, we suggest implementing electrical stimulation as a safe, efficient and well-tolerable treatment modality to the other available treatment options for children with NE. Future studies with a larger sample size, longer follow-up and increased monitoring of voiding parameters are required. It would be helpful to develop guidelines on patient selection criteria for such studies and generally accepted electrical neurostimulation protocol including (optimum number of sessions, number of sessions per week and the ideal current settings).

Conflict of interest: none

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Author Profile

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