**Transcutaneous Electrical Nerve Stimulation in Children with Monosymptomatic Nocturnal Enuresis: A Randomized, Double-Blind, Placebo Controlled Study**

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**Purpose:** In a third of all children with monosymptomatic nocturnal enuresis their condition is refractory to first line treatments. Transcutaneous electrical nerve stimulation has been documented to be efficacious in children with daytime incontinence. We investigated the effect of transcutaneous electrical nerve stimulation in children with monosymptomatic nocturnal enuresis without nocturnal polyuria.

**Materials and Methods:** Children with monosymptomatic nocturnal enuresis (3 or more wet nights per week) and no nocturnal polyuria were randomized to treatment with active or sham transcutaneous electrical nerve stimulation involving 1-hour sessions twice daily for 10 weeks in a double-blind design.

**Results:** Of the 52 children with monosymptomatic nocturnal enuresis included in the study 47 completed treatment (mean age 9.5 ± 2.1 years, 38 males). None of the children experienced a full response with complete remission of enuresis. Treatment with transcutaneous electrical nerve stimulation did not lead to significant changes in number of wet nights, nocturnal urine production on wet or dry nights, maximum voided volume with and without first morning voided volume, or voiding frequency when comparing parameters before and after treatment.

**Conclusions:** The present study demonstrates no anti-enuretic effect of transcutaneous electrical nerve stimulation in children with monosymptomatic nocturnal enuresis without nocturnal polyuria. Nocturnal urine production and bladder capacity remained unchanged during and after treatment with transcutaneous electrical nerve stimulation.

**Key Words:** transcutaneous electric nerve stimulation, nocturnal enuresis, pediatrics

Nocturnal enuresis affects 10% to 15% of all 7-year-old children and 0.5% to 2% of young adults.°° NE is a socially and psychologically debilitating condition that can lead to problems with bullying and reluctance to engage in social activities such as overnight stays. Next to asthma, NE is the most common chronic disorder in children and is ranked as the third most distressing life event a child may experience.°°°°

Monosymptomatic nocturnal enuresis, characterized by the absence of daytime symptoms, is a multifactorial disease with the 3 main

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**Abbreviations and Acronyms**

- AVV = average voided volume
- ICCS = International Children’s Continence Society
- MNE = monosymptomatic nocturnal enuresis
- MVV = maximum voided volume
- NE = nocturnal enuresis
- OAB = overactive bladder
- TENS = transcutaneous electrical nerve stimulation

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pathogenic mechanisms of abnormal bladder reservoir function, increased urine production at night known as nocturnal polyuria and the inability to awaken to the signals of a full bladder. Current first line treatment options target the underlying pathogenic mechanisms, and include desmopressin, a synthetic analogue of antidiuretic hormone, and the enuresis alarm. In approximately a third of all children with NE their condition is refractory to first line therapy and new treatment options are needed.

Transcutaneous electrical nerve stimulation has been accepted for the treatment of children with daytime urinary incontinence. Few studies with promising results have evaluated the efficacy of TENS in children with monosymptomatic nocturnal enuresis. A recent study found no immediate effect of TENS on urodynamic parameters in children with daytime incontinence and overactive bladder (Borch et al, unpublished data). This suggests that the effect of TENS is primarily by neuromodulation. In this study we evaluated the use of TENS for children with MNE without nocturnal polyuria.

**MATERIALS AND METHODS**

**Study Participants**

Children 6 to 14 years old with primary MNE were recruited from the clinics at the Center for Child Incontinence, Aarhus University Hospital, a tertiary referral center, and by advertisement in a local newspaper. The diagnosis of MNE was based on a detailed clinical history, physical examination, and home recordings consisting of a week of nocturnal urine production measurements facilitated by diaper weighing and first morning voided volume, as well as 2-day frequency-volume charts.

**Inclusion and Exclusion Criteria**

Inclusion criteria were enuresis frequency of at least 3 nights per week and no treatment for enuresis 1 week up to treatment start with TENS (2 weeks for enuresis alarms). Exclusion criteria were nocturnal polyuria defined as nocturnal urine volume greater than 130% of expected bladder capacity for age (30 × [age in years + 1] ml), ongoing constipation and/or fecal incontinence; daytime symptoms such as urgency, pollakisuria or incontinence; and prior or ongoing treatment with TENS. Children with neurological or anatomical abnormalities of the urinary tract or children who had undergone operations in the urinary tract were excluded from analysis. We performed dipstick urinalysis (Bayer Multistix) before inclusion to exclude urinary tract infection and pregnancy among fertile, sexually active girls. Furthermore, we performed bladder ultrasound (BladderScan) to assess post-void residual, for which more than 20 ml or more than 15% of micturition volume was considered clinically significant.

**Study Design**

Figure 1 presents the study procedures. All children received a patient ID and were randomized (randomization.com) to active or sham TENS. Two physicians not involved in the study ensured that the correct stimulator matched the correct patient ID according to the randomization. The child, parents and investigators were blinded to whether active or sham stimulation was delivered. Participants were instructed in the use of the TENS apparatus. All TENS units (FemiScan Stim) appeared identical but half of them were modified by the manufacturer not to deliver any current or any kind of

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**Figure 1.** Study procedure. Asterisk indicates 7-night recordings of increase in diaper weight, first morning voided volume and 2-day frequency-volume chart.
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